Skeletal findings in chest plain film: An overview

Poster No.: C-0992
Congress: ECR 2010
Type: Educational Exhibit
Topic: Chest - Miscellaneous
Authors: J. Acosta Batlle, S. Hernandez Muñiz, M. Ibañez Moya, M. Caravallo Sarrion, I. Cogollos Agruña, J. C. Albillos Merino; Madrid/ES
Keywords: chest radiograph, thoracic cage, osseous diseases
Keywords: Lung, Respiratory system, Thorax
DOI: 10.1594/ecr2010/C-0992

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file. 

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

To describe a variety of skeletal findings that are incidentally discovered or clinically unsuspected on chest radiography performed for another reason.

To differentiate two main categories of findings: a) normal variants and non-relevant pathologic conditions, and b) concerning bone diseases that need further evaluation.

To propose a diagnostic imaging approach, especially in the second group.

To show illustrative examples.
Background

Skeletal structures are too often overlooked at chest radiography, although they are relatively easy to evaluate with this modality.

A careful observation of the thoracic cage allow to discover pathologic conditions of bones themselves, evidence of a systemic disease and clues to significant nearby disease.

Pathologic processes of thoracic bones include congenital dysplasias, inflammatory and infectious diseases, trauma and tumors.

In addition, radiologist should be familiar with a number of normal variants and developmental anomalies, in order to distinguish them from true abnormalities.

Not uncommonly it may be difficult to establish the skeletal origin of a thoracic lesion using chest radiographs. As bone masses and sclerosis are often superimposed on the lungs, may simulate pulmonary disease.

Findings that suggest the possibility of an osseous lesion include: smooth interface with the lung, expansion or destruction of an overlying bone, orientation of an area of increased opacity along the course of a rib, and presence of characteristic calcification.

Identification of subtle lesions on conventional radiography may be problematic in areas where thoracic bones overlie other structures. Therefore, it is useful to search carefully the areas located at the margins of the chest.

Since the introduction of cross-sectional imaging methods, such as CT and MRI, a precise localization of chest wall lesions can be achieved and, in some cases, a definitive diagnosis can be made (Fig. 1A) on page , (Fig. 1B) on page .
A. ANATOMIC VARIANTS, DEVELOPMENTAL ANOMALIES AND PSEUDOLESIONS

1. ANOMALIES OF THE RIBS are not common, but will be seen periodically at radiographic examination (in around 1-2% of all chest films). Most of them are isolated findings that occur sporadically and only rarely are clinically significant.

1a. DEVELOPMENTAL DEFORMITIES OF THE RIBS:

* Forked or bifid rib is the most frequent of these anomalies (0.6%). It consists in that the anterior portion of a rib is duplicated (Fig. 2) on page .

* Fusion or bone bridging occurs in 0.3% of the population. Fused rib is more common in first and second ribs and may affect the posterior arch, the anterior arch or both.

Rib bridge involves a focal joining of adjacent ribs by bone overgrowths (Fig. 3). The bridge may be complete or pseudarthrosis may be present (Fig. 4) on page .

These morphologic anomalies have a female predilection and are more common on the right side. They are usually of little or no clinical significance. However, one should be familiar with them to avoid unnecessary concern.

1b. CERVICAL RIB

It is a supernumerary or accessory rib arising from the seventh cervical vertebrae, that occurs in 0.5% of the population. It articulates with a cervical type transverse process (horizontal type of transverse process, as opposed to upward sloping transverse thoracic process). This anomaly can be perceived as supernumerary by identifying the true second rib, which always articulates anteriorly at the manubriosternal junction.

At radiography cervical rib may be unilateral or bilateral, and range in size from a small ossicle to long bone that often fuses or articulates to the first rib anteriorly (Fig. 5). on page

Although it is usually asymptomatic (in 90% of cases), cervical rib represents the most important anatomic rib variant from a clinical standpoint because it can cause thoracic outlet syndrome by compression of the brachial plexus or subclavian vessels. The syndrome is associated with pain in the hand when the arm is elevated, difference in pulse intensity between the two arms when the affected extremity is in a certain position
and Reynaud phenomenon. It also can cause a "spurious mass" to be palpated in the supraclavicular fossae.

Care should be taken not to confuse a rudimentary or hypoplastic first rib with a cervical rib (Fig. 6).

1c. SHORT RIB

Frontal chest ray film sometimes reveals a shortened mid thoracic rib arch in patients who have no experienced trauma or surgery. Shorted rib is diagnosed if the lateral margin of the affected rib is more than 4 mm medial to a tangent drawn between the lateral margins of the adjacent ribs. This finding occurs in 16% of the population, it is more common on the right and is seen bilaterally in 7% of patients. It has only been reported in sixth, seventh and eighth ribs. The explanation for this variant is related to rib development and maduration, as early fusion of the epiphyseal center could cause a shortening of the rib arch (Fig. 7).

1d. INTRATHORACIC RIB

Both intrathoracic and pelvic ribs are rare isolated anomalies. Intrathoracic rib is usually supernumerary and extremely rare, it is more common in right side and it involves middle thorax. Although is generally asymptomatic, this anomalous rib may have a fibrous diaphragmatic attachment, which can restrict ventilation. Pelvic rib may involve any pelvic bone.

2. PECTUS EXCAVATUM OR FUNNEL CHEST

This anomaly is the most frequent congenital deformity of the sternum (incidence of 1 case in 300-400 live births). It is a depression of the sternum, so that the ribs in each side protrude anteriorly more than the stenum itself. It is often progressive, and the depth of sternal depression increases as the patient grows. Boys are more frequently affected than girls (3:1).

Funnel chest can be associated with other congenital anomalies, such as scoliosis (15%) or cardiac disease (2%).

Patients with this anomaly are usually asymptomatic or present chest or back pain. Lateral chest film clearly shows the position of the sternum, which allows to easily make the diagnosis. At frontal chest film this deformity demonstrates several characteristics: a) indistinct right heart border, b) left displacement and rotation of the heart, c) decreased
heart density, d) spurious cardiomegaly and d) accentuated downward angulation of the anterior portion of the ribs (Fig. 8) on page .

The severity of the defect can be best assessed with CT or MRI, using the pectus index (transverse thoracic diameter / anteroposterior thoracic diameter). An index > 3.5 usually requires surgical treatment.

3. PECTUS CARINATUM OR PIGEON BREAST

It is a deformity of the chest wall in which the sternum exhibits an abnormal anterior protrusion. It usually involves the body of the sternum, and rarely the manubrium (Fig. 9) on page . This variant is less common than pectus excavatum (1:5) and accounts for 5-7% of all chest wall deformities. Although it occurs in isolation, pigeon breast is also usually seen in association with cyanotic congenital heart disease.

4. KYPHOSCOLIOSIS

This deformity consists in an abnormal posterior and lateral curvature of the thoracic spine. Approximately 80% of the cases are idiopathic. In this group the scoliotic curvature is usually convex to the right. The main secondary causes are congenital diseases (type I neurofibromatosis, hemivertebra, Morquio’s syndrome) and paralytic diseases (poliomyelitis, muscular dystrophy, cerebral palsy).

Severe forms of kyphoscoliosis cause decreased compliance of the thoracic cage, resulting in restrictive lung disease. In these patients the chest radiography is difficult to evaluate because rotation of the thorax and heart (Fig. 10) on page .

5. SPRENGEL DEFORMITY

This anomaly consists in unilateral or bilateral elevation of the scapula. It is commonly associated with Klippel-Feil syndrome (fusion of two or more cervical vertebrae). An omovertebral bone connecting the scapula and vertebrae can be seen in 30% of patients with fixed elevated scapula.

6. PSEUDOLESIONS

Some normal radiological images can be mistaken for true lesions. The following are examples of this group of findings:
* The conoid tubercle is an anatomic variant of the clavicle consisting in a bony protuberance of varying size often present along the posteroinferior border of the distal third of the clavicle (Fig. 11) on page . It provides attachment to the conoid portion of the coracoclavicular ligament. At times, an articulation may be present between the conoid tubercle and the coracoid process. Bony bridging may be seen between these two structures if the coracoclavicular ligament undergoes ossification, usually secondary to trauma.

* A prominent rhomboid fossa (an irregular concavity near the medial end of the clavicle along its inferior surface where the costoclavicular ligament is attached) may be mistaken for an osteolytic lesion.

* The medial end of the clavicle may appear cupped and irregular before adolescence, simulating a destructive process.

* Hypertrophic chondrocostal junction of the first rib with calcification of the costal cartilage is a common finding that sometimes leads to misdiagnosis, as it may simulate a pulmonary nodule (Fig. 12). on page

* The projection of the humeral head on the radiograph as a circumscribed area of radiolucency or pseudocyst, may simulate a destructive lesion (Fig. 13) on page .

B. PATHOLOGICAL CONDITIONS

In this wide group of entities we can distinguish three categories of radiological findings:

a) Non relevant lesions. Many of them have a typical radiological appearance, but sometimes can simulate pulmonary disease. In these cases a CT exam usually solves the problem. A common example of this type of findings is bone island or enostoses, that appears radiologically as single or multiple intraosseous sclerotic areas with discrete margins in asymptomatic individuals. These lesions have a predilection for the pelvis, proximal femur and ribs (Fig. 14A) on page (Fig. 14B). on page

b) Osseous pathologic findings that can be explained in the clinical setting or that may be clues to the diagnosis of a systemic disease. A typical example of this group is Paget disease, in which radiographs are frequently sufficiently characteristic for diagnosis (Fig. 15A) on page on page (Fig. 15B) on page .

c) Relevant lesions, that need additional examination, such as osseous neoplasm. In this situation, the radiologist should suggest the proper imaging method.
When a bone lesion is discovered in a chest film, some questions should be answered:

* Is there any doubt concerning its skeletal origin?

In this case additional radiographic projections, including lordotic, oblique and /or spot views, can help. CT can be performed if we need to assure the origin of the lesion.

* Is it an isolated anomaly or are there any more lesions?

* Are the additional lesions skeletal or involve other thoracic structures?

* Oncologic patient?

In these situations a bone scintigraphy should be done. In many cases MRI can also help, especially if nuclear medicine is negative or reveals a solitary lesion.

* An aggressive solitary bone lesion or an osseous primary neoplasm is suspected?

In most cases, MRI can define accurately its features, such as local extent and signs of aggressiveness. Sometimes, CT can add information, particularly in tumors with calcified matrix.

We propose the following diagnostic algorithm (Fig. 16). on page

In order to review and to show examples of skeletal lesions in the thorax, we are going to categorize them into several groups:

**1. CONGENITAL SKELETAL DYSPLASIAS**

1a. **Osteopetrosis** ("Marble bone disease") usually poses no problem in diagnosis since the bones of the thoracic cage are uniformly dense, with no differentiation of cortex and medulla. A "bone in bone" appearance classically may be observed in advanced cases in the thoracic vertebrae and sternum, with the inner segment of bone representing the fetal remnant (Fig. 17) on page .

1b. **Pycnodysostosis** is also an sclerosing osteodysplasia characterized by diffuse and uniform osteosclerosis. On the chest radiograph, hypoplasia or aplasia of a segment of a clavicle, if present, gives a clue to the diagnosis.
1c. **Cleidocranial dysostosis** is characterized by incomplete ossification of the clavicle and defective development of the pubic bones, vertebral column and long bones. On chest radiography the clavicles may be absent or minimally hypoplastic, but most often they are underdeveloped and frequently appear as two separate hypoplastic segments.

1d. **Multiple hereditary osteochondromas** (*diaphyseal aclasia*) is a relative common cartilaginous dysplasia. The rib and scapula are often envolved by one or more osteocartilaginous exostosis.

1e. **Maffucci’s syndrome** is a nonhereditary mesodermal dysplasia characterized by multiple enchondromas of bone and cavernous hemangiomas in soft tissues. The thoracic cage is frequently spared in this disease.

2. **ARTROPHATIES**

2a. In the **seronegative spondyloarthropathies**, significant radiologic changes in the thoracic spine may lend a clue to the correct diagnosis.

In **ankylosing spondylitis** spine involvement typically starts at the thoracolumbar or lumbosacral junctions. As the disease progresses, the remainder of the thoracic and lumbar spine as well as the cervical spine become envolved.

The first radiographic sign is the development of small erosions (Romanus lesions) and adjacent sclerosis (shiny corner) in the enthesis where the annulus fibrosus outer fibers merge directly with the vertebral body. Next, either new bone formation occurs along the anterior aspect of the vertebral body leading to a barrel-shaped or square vertebral body on the lateral radiographic view. As the disease progresses, syndesmophytes form along the anterior fibers of the annulus fibrosus, leading to the bamboo spine appearance (Fig. 18) on page . The interspinous ligaments can ossify, causing the dagger sign. Ankylosis of the facet joints occurs, described as the tram track sign. In addition, in the fused spine, there may be dystrophic calcification of the intervertebral discs.

In **Reiter disease and psoriatic arthritis** the syndesmophytes are usually asymmetric and spotty in distribution. In addition, broad non-marginal syndesmophytes are a common finding. Radiologic studies of the hands and feet often help in the diagnosis.

2b. **Diffuse idiopathic skeletal hyperostosis** (*DISH*) is a common disorder characterized by increased bone formation at multiple sites in the spine and peripheral
skeleton. In the spine, radiographic findings are most common in the thoracic region, especially in 7th to 11th vertebrae. Three diagnostic criteria described by Resnick include:

* Flowing calcification/ossification along at least four contiguous vertebral levels.
* Relative preservation of disk height.
* Absence of joint ankylosis or erosions.

Ankylosing spondilytis is easily distinguished from DISH by the presence of thinning of intervertebral disks and syndesmophytes that occur at disparate levels, and not in a continuous fashion as in DISH (Fig. 19).

2c. *Degenerative disease of the spine*

A variety of degenerative processes involve the thoracic spine. Each is characterized by distinctive radiographic manifestations:

* intervertebral osteochondrosis is associated with disc space narrowing, vacuum phenomena and reactive sclerosis of the vertebral body.
* spondylosis deformans is associated with osteophytosis (Fig. 20).
* costovertebral and apophyseal joint osteoarthritis leads to joint space narrowing, bone sclerosis and hypertrophia and rarely osseous fusion (Fig. 21A), (Fig. 21B).

2d. *Rheumatoid arthritis* characteristically affects synovial joints, and the shoulder joints are often involved. Subarticular erosions, cysts and paraarticular osteoporosis are typical (Fig. 22A), (Fig. 22B). Chronic tears of the rotator cuff with superior subluxation of the humeral head are seen in 30% of patients. The discovertebral junction of the thoracic spine is rarely affected.

Extraarticular manifestations include erosions of the superior margins of the ribs, particularly in the upper thorax, and resorption of the outer margins and undersurface of the distal ends of the clavicles.

**3. OSTEOARTICULAR INFECTIONS**

3a. *Infectious spondilytis*
Vertebral osteomyelitis is usually caused by hematogenous spread to the vertebral body.

Radiographically, the hallmarks of *pyogenic infection* are disc narrowing and destruction of the vertebral endplates, both of which occur early in the course of the disease, usually within the first few weeks of infection. In contrast, *tuberculosis of the spine* shows market osteopenia and bone destruction but with relative sparing of the disc space and endplates until late in the course of the disease, typically over several months (Fig. 23) on page .

In tuberculosis, involvement of the spine at multiple levels is more common than in pyogenic infection. Focal paraspinal masses are frequently encountered in both pyogenic disease an tuberculosis. Calcification in a paraspinal mass is virtually characteristic of tuberculosis.

3b. **Sternal osteomyelitis.**

Among the most common complications found in the chest wall are those that follow median sternotomy, including sternal dehiscence, osteomyelitis and mediastinitis. Pyogenic osteomyelitis of the sternum is generally associated with an adjacent soft tissue mass, loss of deep tissue planes and periosteal elevation. Conventional radiography plays a limited role in the evaluation of post-sternotomy osteomyelitis. CT is used to assess the extension and depth of infection and can be useful for surgical planning (Fig. 24) on page .

**4. METABOLIC BONE DISEASES**

Osteopenia refers to "too little bone" and is subdivided into various conditions, such as osteoporosis, osteomalacia and hyperparathyroidism.

**4a. Osteoporosis** the most common of all metabolic disorders. It is very frequently associated with postmenopausal or senile status and it is chiefly reflected in the axial skeleton.

Radiologically increased radiolucency of the axial skeleton, including the bones of the thoracic cage, is seen. In the spine relatively early disappearance of the horizontal trabeculae and dissolution of many vertical trabeculae with secondary thickening of the remaining vertical trabeculae give rise to sharp differentiation between the cortex and the medullary cavity. While the cortex retain its density but loses its thickness, the medullary cavity becomes increasingly lucent. As a result, end-plate compression and wedging and collapse of the affected body occur (Fig. 25) on page .

The ribs also show thinning and fracture easily, even by physiologic actions of coughing.
4b. **Primary hyperparathyroidism** results on occasion from hyperplasia and more often from tumor (adenoma, carcinoma) of one or more parathyroid glands.

Only 15-20% of individuals with primary hyperparathyroidism show skeletal abnormalities.

In **secondary hyperparathyroidism**, functional abnormalities of parathyroid glands (induced by a sustained hypocalcemic stimulus) usually result from chronic renal failure.

Radiological manifestations include bone resorption (subperiosteal, intracortical, endosteal, trabecular, subchondral and subligamentous), brown tumors, bone sclerosis and chondrocalcinosis.

Osteosclerosis predominates in the axial skeleton. In the thoracic cage superior and inferior portions of the vertebral bodies (rugger-jersey spine) and ribs are frequently involved.

Brown tumors or osteoclastomas are typical of primary hyperparathyroidism, although they are also noted in secondary hyperparathyroidism. The ribs are a common site of involvement. Radiographically they appear as single or multiple well defined lytic lesions, often excentric or cortical, that cause osseous expansion and endosteal scalloping. After treatment of hyperparathyroidism, brown tumors may heal with calcification, sclerosis and lesion desappearance, or the lytic area may persist (Fig. 26A) on page , (Fig. 26B) on page .

5. **PAGET DISEASE**

**Paget disease** of bone is a common disorder, that affects approximately 3-4% of the population over 40 yo. It is characterized by an excessive and abnormal remodelling of bone. Three phases have been described: lytic (incipient and active), mixed (active) and blastic (late-inactive).

Radiographic appearance reflects these pathologic phases: initially there is osteolysis in the skull (osteoarosis circunscripta) and subchondral long bones, subsequently trabecular and cortical thickening with enlargement of bone develops, and lately sclerotic bone is seen.

The disease can involve a single bone (monostotic) or many bones (polyostotic).

Axial skeleton is predominantly affected.
The most common sites of involvement are the spine (30-70%), pelvis (20-75%), skull (25-65%) and long bones (25-35%).

A less common location is the shoulder girdle (humerus 31%, scapula 24% and clavicle 11%) (Fig. 27A) on page , (Fig. 27B) on page . Ribs are infrequently involved.

Complications of Paget disease include fractures and bone deformities (as a result of osseous weakening), arthritis, neurologic symptoms and neoplastic degeneration (particularly sarcomatous transformation).

6. SAPHO SYNDROME

The term SHAPO syndrome was coined in 1987, and includes synovitis, acne, palmoplantar pustulosis, hyperostosis, and osteitis. Not all these components need to be present for a diagnosis, as osteoarticular involvement can manifest without skin lesions. Its etiopathogenesis remains unknown. The radiologist should be aware of this unusual syndrome to avoid misdiagnosis, unnecessary surgery and antibiotic therapy.

The sternoclavicular region is the most frequently involved area (70-90% of patients). Hyperostosis, usually associated with osteosclerosis, is the main finding. Osteolysis can be observed sometimes, especially at the beginning of the disease. Soft tissue involvement around the hyperostotic bone can be found. Associated arthritis and ankylosis of the adjacent articulations are also frequent (Fig. 28A) on page , (Fig. 28B) on page .

The spine is the second most common site of disease, being involved in one third. Three radiologic manifestations, often combined, are seen: sclerosis of one or more vertebral bodies, paravertebral ossifications, and lesions at the discovertebral junction that simulate infectious spondylitis.

7. BONE TUMORS AND PSEUDOTUMORAL LESIONS

In general, osseous tumoral lesions of the chest cage are uncommon. Primary skeletal neoplasms of the thorax only represent 5% of all osseous and joint tumors. Most of them are seen in the ribs.

7a. BENIGN TUMORS AND PSEUDOTUMORAL LESIONS
* **Fibrous dysplasia** is a skeletal developmental anomaly of unknown origin in which the medullary bone is replaced by fibrous tissue. There are two forms of the disease: monostotic (80% of cases) and polyostotic (20%, sometimes associated to Albright syndrome).

Monostotic form occurs more commonly in the ribs (28%), and appears radiographically as a well defined, elongated lytic lesion in the medullary cavity of bone. It often shows a ground glass appearance due to homogeneous matrix. As the lesion grows, the cortex become attenuated, but usually remains intact. In advanced cases a lobulated appearance, with endosteal scalloping, can be seen. Periosteal reaction is absent, but the lesion can be surrounded by a layer of sclerotic reactive bone. CT and MRI allow more accurate assessment of its morphology, location and extent.

* **Osteochondromas** are relatively common skeletal neoplasms (10-15% of all bone tumors) that originate from aberrant growth of normal tissue. In the ribs they occur more frequently in the costovertebral junction and appear as pedunculated osseous protuberances arising from the surface of the parent bone. Radiographs may show a cap of calcified cartilage and CT can optimally depict continuity between the lesion and cortical or medullary bone (Fig. 29A) on page , (Fig. 29B) on page . On MRI cartilaginous cap appears hyperintense on T2-w images. Complications include fracture, vascular or neural compression and malignant transformation.

* **Enchondroma** constitutes about 10% of all benign bone tumors. Radiography is usually sufficient to demonstrate the lesion and to establish its chondroid character. In short tubular bones, enchondromas are often entirely radiolucent, but in long bones they may display visible calcifications (Fig. 30). on page

* **Other benign lesions**: less frequent tumors include chondromixoid fibroma, giant cell tumor, aneurysmal bone cyst and osteoid osteoma.

* **Mesenchymal hamartoma** is a rare lesion of early infancy characterized by benign proliferations of skeletal tissue with prominent cartilaginous component and hemorrhagic cavities. It always arises from one or more ribs. The most common presentation is a deforming chest wall mass, often noted at birth.

The typical radiographic manifestation is a large extrapleural, partially calcified soft tissue mass, with associated destruction and distorsion of the adjacent ribs (Fig. 31A) on page , (Fig. 31B) on page . Hemorrhagic cystic components, representing secondary aneurysmal bone cyst, are also a characteristic finding. Although these features suggest an aggressive process, mesenchymal hamartomas are benign lesions, with no reports of recurrence or metastasis following complete resection.
Diffuse cystic angiomatosis is a rare disorder involving the skeleton and internal organs. The angiomas may be hemangiomas or lymphangiomas. Ribs, humeri and vertebrae are commonly affected by predominantly lytic lesions, generally small and well defined. In the rib, the typical lesion is elongated, presenting with a honeycombed pattern (Fig. 32A) on page , (Fig. 32B) on page , (Fig. 32C) on page . Sclerosis, cortical involvement and periosteal reaction are infrequent findings.

7b. MALIGNANT BONE NEOPLASMS

* **Chondrosarcomas** are the most common malignant primary tumors of the chest cage and usually arise from the anterior part of the wall (costochondral arches or sternum). Most of them are primary lesions, but 10% arise from preexisting benign tumors. On chest radiograph bone destruction, irregular contours, and intratumoral mineralization are characteristic but variable features.

The degree and type of calcification may vary, including rings and arcs, occult or stippled calcification, or dense calcification. CT is more sensitive than radiography and MR imaging for delineation of chondroid matrix calcifications.

* **Osteosarcomas** are malignant mesenchymal neoplasms that rarely occur in the thorax. The rib, scapula, and clavicle are the most frequent sites of origin. Lesions usually manifest in young adults as painful masses, and may be accompanied by extrapleural masses. Local recurrence and metastatic spread to the lungs and lymph nodes are frequent in osteosarcomas of the chest wall, compared with those in the extremities, and contribute to poor survival.

Radiographs typically show calcification or lytic or sclerotic osteoid bone matrix in the mass. An important feature on CT scans is the spatial distribution of areas of mineralization, which is greatest at the center of the lesion and least at the periphery.

* **Hematologic neoplasms** include multiple and solitary myeloma, and lymphoma.

Plasmocytoma and multiple myeloma are plasma cell tumors that manifest, respectively, as single mass or with diffuse marrow involvement.

**Solitary plasmocytoma** may progress over time to multiple myeloma. It manifests radiologically as a multicystic expansile mass or purely osteolytic focus without expansion (Fig. 33) on page .

**Multiple myeloma** usually produces osteolytic lesions with discrete margins, typically located in vertebral column, ribs or clavicles. Sclerosis generally develops in the osteolytic
lesions after pathologic fracture, irradiation or chemotherapy, but occasionally can be seen in untreated lesions (Fig. 34A) on page , (Fig. 34B) on page .

**Primary bone lymphomas** are rare (comprising 3-4% of all malignant bone tumors). Lymphomas are considerer primary of bone only when there is no evidence of extraosseous or nodal disease for at least 6 months after the discovery of the osseous focus. Diffuse large B-cell lymphoma is the more frequent subtype of primary lymphoma that affect the chest wall.

The radiological appearance of malignant lymphoma can vary widely. Lytic forms may show a geographic, moth-eaten or permeative pattern. Sclerotic pattern includes an ivory bone appearance, a picture commonly seen in vertebrae or flat bones. A soft tissue mass, often disproportionately large, is a common associated finding (Fig. 35A) on page , (Fig. 35B). on page

* **other malignant primary neoplasms** of bone, such as Ewing´s sarcoma and primitive neuroectodermal tumor.

* **Bone metastases:** metastatic deposits from carcinoma are by far the commonest malignant tumors affecting the skeleton. In metastatic disease both osteolytic and osteoblastic forms may be encountered; not infrequently a mixed pattern is seen. The most common primary foci are in the lung, breast and ovary in women, and in the lung, colon and prostate in men. Other less frequent primary sites are thyroid and kidney.

Certain neoplasms produce specific types of metastases: prostate carcinoma - blastic lesions (Fig. 36A) on page , (Fig. 36B) on page , renal cell carcinoma - lytic expanding lesions (Fig. 37) on page , and bronchogenic carcinoma - cookie cutter cortical lesions (Fig. 38). on page

Metastases are generally multiple, and they are most often found in the axial skeleton and other sites of residual red marrow (vertebrae, pelvis and proximal femora, skull, ribs and proximal humeri). Peripheral metastases are rare, being bronchial carcinoma the commonest origin, characteristically to the bones of the hands.

* **bronchogenic carcinoma** may directly invade the chest wall causing destruction of adjacent bones, particularly ribs and vertebrae (Fig. 39A) on page , (Fig. 39B) on page .

8. MISCELLANEA
8a. **Scheuermann’s disease** is an osteochondrosis of the spine (discovertebral junction) leading to lower thoracic kyphosis. Most cases occur in young people (onset at puberty).

Radiographic criteria require the presence of abnormalities of at least three contiguous vertebrae, each with wedging of 5 degrees or more. Undulant superior and inferior surface of affected bodies is associated with Schmorl’s nodes. The degree of endplates irregularity is variable, but when severe, can be accompanied by loss of intervertebral disc heigh (Fig. 40).

8b. **Rib notching** usually affects the lower margin of one or more ribs and may be seen in a wide variety of conditions. Generally it results from enlargement of some elements of the neurovascular bundle. Because rib notching is caused by chronic pressure on the rib, the inferior cortex often shows reactive sclerosis.

Coarctation of aorta typically produces notching several centimeters lateral to the costovertebral junction on ribs three to nine. The notches result from rib erosion by dilated intercostal arteries.

8c. **Neurofibromatosis** is an inherited disorder resulting from dysplasia of the neuroectodermal and mesodermal tissues. The thoracolumbar spine is involved in almost all the cases.

Typical findings on chest radiography include:

* scalloping of the posterior margin of vertebral bodies
* angular scoliosis
* ribbon ribs (twisted or ribbon like deformities)
* notching or erosion of the superior and inferior margins of ribs, due to intercostal neurofibromas (Fig. 41)
* tapering of distal portion of clavicles.

8d. **Ehler-Danlos syndrome** is a familial disorder of the connective tissue characterized by hyperelasticity and fragility of the skin, hyperlaxity of the joints and a bleeding diathesis.

The findings in the chest radiograph are nonspecific: the thorax can be asymmetric, with pectus carinatum and prominence of the costochondral junctions. The upper ribs may slant sharply downward. Scoliosis and kyphosis are frequent, with occasional wedge
shaped vertebral bodies. Subluxation of sternoclavicular joint may also be encountered (Fig. 42) on page 8e.

**8e. Marfan’s syndrome** is a rare familial disorder of connective tissue that primarily involves the eye (subluxation of the lens), the skeleton (abnormally long extremities) and the cardiovascular system (particularly aortic dilatation and dissection).

The most common chest radiographic manifestations are a long thin body habitus, scoliosis and pectus excavatum. Scoliosis occurs in 40-60% of cases and pectus deformity in around 40%. Posterior scalloping of the vertebral bodies, attributed to dural ectasis, is also found (Fig. 43). on page

**8f. Gorham’s syndrome** *(or vanishing bone syndrome)*: this uncommon disease is probably caused by multiple hemangiomas and / or lymphangiomas, and it mainly occur in young adults. Initially a single bone can be involved (virtually always lytic) and, as the process evolves, adjacent bones are affected with resorption and complete disappearance of the involved segment. The ribs and spine are not uncommonly affected. In addition, the ribs may be extremely thin.
Conclusion

When interpreting chest radiographs, a wide spectrum of skeletal findings can be discovered.

The knowledge of normal variants and non-relevant pathologic conditions can avoid further unnecessary evaluation.

If a concerning bone lesion is detected, the radiologist should suggest the appropriate imaging management.
Personal Information

jacostabatlle@yahoo.es
References


