Thoracic calcifications: beyond granulomatous disease. Review and keys for differential diagnosis

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Learning objectives

The purpose of this review is to describe and illustrate the main radiological features of the most common entities determining intrathoracic calcifications by means of different techniques (RX, MDCT)

Provide key data for differential diagnosis
Background

The presence of intrathoracic calcifications whether pulmonary or extrapulmonary are very common. Most of them have a residual origin, although there are tumors associated with calcifications that should be taken into account. Calcifications are usually well recognizable on a chest radiograph and generally an incidental finding. Computed tomography (CT) has a key role for the identification of small calcifications and their morphology as well as for improving the differential diagnosis.
Findings and procedure details

Thoracic calcifications are calcium accumulations deposited on a normal or pathological tissue, associated with a wide variety of diseases, clinical and laboratory situations.

Calcification may be pathophysiologically "dystrophic" in which the calcium deposition in the lung often occurs on a previously damaged tissue (necrosis, scarring); or the "metastatic", phenomenon where the calcium is deposited in normal lung pulmonary parenchyma due to increased alkalinity tissue conditioned by low partial carbon dioxide tension. Within the physiological causes it is very common those of the costal cartilages, walls of the trachea and bronchi.

Also it must be considered physiological calcification, those atherosclerotic plaques of the aortic arch in elderly patients. The pathological calcifications can be localized in the lung parenchyma, mediastinum, pleura and chest wall.

Calcifications can be detected in reparative phases of inflammatory processes (TBC, varicella), malignant tumors (bronchial carcinoma, metastases), benign tumors (hamartoma) or either due to inhalation or metabolic diseases. (Table 1)

1. FOCAL CALCIFICATIONS

1.1 GRANULOMATOUS DISEASES

Focal calcifications are generally the result of a residual granulomatous lesion.

A calcified granuloma is the most common cause of pulmonary nodule and its origin lies in an infection as tuberculosis and less frequently others like histoplasmosis or coccidioidomycosis infection. In our background the granulomatous diseases constitute the first possibility to consider when we found a well circumscribed lesion or small foci of high-density on lung parenchyma. (Fig. 1)

Tuberculosis is an infection spread by air, caused by a mycobacterium, Mycobacterium tuberculosis. The incidence of this disease has resurfaced in non-endemic countries mainly due to immigration, HIV and drug resistance.

Pulmonary involvement is the most frequent. Ranke complex, as a manifestation of a previous primary tuberculosis, is constituted by a high density pulmonary granulomatous lesion (complex Gohn), accompanied by its corresponding hilar or mediastinal lymph node satellite. It is important to know that there can be viable bacilli within a calcified granuloma. (Fig. 2)
In the chest radiograph they look like nodular lesions of varying size, high density that may be unique or multiple and generally localized in the lung apices.

The diffuse micronodular form (miliary) can become calcified over time and its radiographic appearance is the same as it can be seen in some lung fungal infections such as histoplasmosis, or sarcoidosis.

1.2 HAMARTOMA

It is the most common benign lung tumor and usually considered as a malformation composed of an abnormal mixture of different tissues. It may contain cartilage, fat tissue, epithelial or stromal fibromyxoid.

They are usually asymptomatic and are an incidental finding in a study of image made for other reasons. They are more frequent in men in their sixth decade of life and older.

In the chest radiograph they are well defined nodular morphology lesions with high density, generally solitary, which can be rounded or lobed and are generally peripherals. They usually have a size up to 2.5 cm but there are reported cases of giant hamartomas of 30 cm. The presence of cartilaginous elements with "popcorn" image is a diagnostic finding, but less frequent. Calcifications are found in only a 15%, being more common in larger lesions.

CT is more sensitive in detecting calcifications and fat, being this an important criterion for differential diagnosis, although fat is only observed in 60% (localized or diffuse) and fat with calcifications is observed in 30%. On CT scan, the hamartoma has a smooth, rounded or lobulated contour. (Fig. 3)

There is a less common condition called Cowden syndrome. This syndrome is characterized by the presence of multiple hamartomas, being the main locations: the skin, thyroid, breast, gastrointestinal tract, brain and uterus.

1.3 MALIGNANCIES

The lung is a common site of neoplastic processes either primary or metastatic. Radiologically the usual presentation is as a lesion of varying size, single (primary lesion) or multiple (hematogenous metastases).

Pulmonary calcified nodule is a finding that has been traditionally regarded as a benign lesion, but can also occur in malignant neoplastic processes, and metastasis of osteosarcoma and chondrosarcoma. Metastatic nodules from Choriocarcinoma treated, colon carcinoma, breast, ovary and thyroid cancer, may calcify.

It may be the case that a lung cancer encompassing an existing calcified granuloma, in this case the calcification within the lesion adopts an eccentric location.
There are various mechanisms responsible for these calcifications. Either by formation of bone (osteosarcoma and chondrosarcoma); dystrophic calcification (thyroid and treated metastasis) or mucoid calcification in the case of gastrointestinal mucinous adenocarcinoma and breast.

1.4 CARCINOID TUMOUR

They are neuroendocrine tumours originated from the enterochromaffin cells (Kulchitsky). They are relatively rare and commonly located in the gastrointestinal tract (66.9%) followed by the tracheobronchial tree (24.5%). They have usually slow growing and painless evolution.

Carcinoid tumors account for only 1-2% of lung neoplasms. There are two types we can differ: the typical carcinoid (80-90 %) and atypical carcinoid (10-20 %)

Typical carcinoid tumours occur in a wide range of ages with a average age of 45 years old. The incidence is similar in men and women, being the most common in children. Clinically, patients present with cough, wheezing, hemoptysis and chest pain. Carcinoid syndrome is rare (2-5 %) and is caused by the release into the systemic circulation of vasoactive substances, causing flushing and diarrhea clinic more frequently.

Atypical carcinoid tumours are more common in men and occur much later than typical, these are associated with the cigarette smoking and have a worse prognosis.

Radiologically characterized by a hilar or parahilar, well defined, generally round or oval mass. Rarely signs of invasion of neighboring structures. The eccentric calcifications are common especially in centrally located tumors. Cavitation is rare. They are highly vascularized lesions that will submit intense and homogeneous enhancement after administration of intravenous contrast in CT. The atypical tumors show an enhancement less uniform and more irregular contour. (Fig. 4)

These tumors may also manifest as endobronchial nodule and grow extending adjacent parenchyma, with predominated extraluminal component (injury iceberg). They may produce bronchial obstruction. Carcinoid tumour may manifest as a solitary peripheral pulmonary nodule in 20 % of the cases.

1.5 HYDATID CYST

Hydatid disease is a common parasitic disease in humans and other mammals. The causal agent is granulossus echinococcus. It is an endemic disease in rural, agricultural and pastoral areas.

The dog is the most common of the final reservoirs and man, cattle, sheep and pigs are intermediate reservoirs. The disease is transmitted by direct contact with infected feces
or by eating contaminated water or food parasite eggs. The incubation period is usually several years.

Hydatid disease primarily affects the liver (50-80%) and secondary involvement can occur due to hematogenous spread and can develop at any anatomic location, such as lung (20%). The disease is usually asymptomatic.

The chest radiograph is the main radiological test for diagnosis and is defined as a rounded, homogeneous lesion with well-defined contours, variable size which is surrounded by healthy lung or areas of atelectasis. May be single or multiple.

The growing of hydatid cyst may erode adjacent bronchioles, conditioning the air passage to the cyst and/or the evacuation of the cystic content.

In the natural evolution of the cyst, a calcification of all components occurs and it involves the death of the parasite.

Calcification of a hydatid cyst in the lung is rare, contrary to liver injury, where calcification is common. (Fig. 5)

The CT is useful to locate the lesion. It also allows the determination of the extent of lung involvement and anatomy and radiological characteristics of the cyst.

1.6 BRONCHOLITH

A broncholith is a calcified hilar adenopathy eroding the walls of an adjacent bronchus, to perforate and introduce, wholly or partly, in its lumen.

Sometimes broncholiths may ulcerate walls of adjacent lung or bronchial vessels and cause hemoptysis that can be fatal.

If they block the bronchial lumen, and it is associated to inflammatory / infectious processes, they may be common cause of chronic atelectasis.

Radiologically, broncholith is frequently not visible on chest radiographs. On CT scan the small calcifications are usually readily evident, in addition CT demonstrates the distal complications.

2. DIFFUSE PULMONARY CALCIFICATION

2.1 VARICELLA PNEUMONIA

Chickenpox (Varicella) is a highly contagious rash illness caused by primary infection of varicella-zoster virus. It most often affects children and only affects 1-2% of adults.
Clinical manifestations include fever, malaise, headache and a typical rash in different developmental stages.

The more frequent and severe complication in adults is varicella pneumonia, occurring 90% of them in over 19 years. Risk factors are male sex, older age, smoking, pregnancy (third trimester), hematologic malignancies, patients in treatment with corticosteroids or antibiotics. There is usually clinical-radiological dissociation with a nondescript auscultation.

The varicella pneumonia most often occurs as a bilateral interstitial infiltrate with nodules 2-10 mm stores in bases and the perihilar region, but it may also have a honeycomb pattern. These findings may take months to disappear or move towards residual calcification. The pleural effusion and mediastinal lymph nodes are rare. (Fig. 6)

Calcified mediastinal lymph nodes are not characteristic of varicella pneumonia.

2.2 SILICOSIS

Silicosis is an occupational lung disease caused by inhalation of silica or silicon dioxide, affecting a wide range of professions.

The silica particles are inhaled being the crystalline forms as the quartz a major cause of disease; usually the larger ones are expelled through the mucociliary system. Particles reaching the epithelium of the respiratory bronchioles pass the adjacent gap, where they are deposited inside macrophages and cause an inflammatory reaction with fibrosis.

There are several clinical forms; acute silicosis, which results from exposure to very large amounts of silica in less than two years period. Simple chronic silicosis, the most common type that we see today, this is the result of the exposure to low amounts of silica over a period of between 2 and 10 years, and finally chronic silicosis complicated with silicosis conglomerates.

In many cases the diagnosis is made by epidemiological and radiological data without histological confirmation.

Chest radiography is the initial diagnostic test. However, spiral CT combined with high-resolution CT (HRCT) have a higher sensitivity for diagnosis of silicosis, especially in the initial stages, to delineate the extent of the disease.

On CT scan, silicosis is characterized by a pattern of "ground glass" or greater consolidation, sometimes with air bronchograms and bilateral perihilar distribution.

In simple chronic form, on the chest radiograph a micronodular, it is appreciated a bilateral interstitial pattern predominantly in the upper lobes. 10-20% shows calcification. They can be perihilar and mediastinal lymph nodes with peripheral or complete calcification.
The CT is more sensitive and can identify a micronodular pattern consisting of small nodules 2-5 mm, centrilobular and subpleural distribution, but can also take a perilymphatic less frequent distribution. This pattern predominates in the upper lobes and apical segments of the lower lobes. It has a symmetrical distribution and may be calcified. Subpleural nodules may coalesce to form pseudoplacas which can also be calcified.

In the chronic form we can also see hilar and mediastinal lymph nodes, which often calcify especially in the periphery of lymph, known as "eggshell calcification", finding highly suggestive of silicosis pattern. This pattern of calcification can also be seen in sarcoidosis, tuberculosis, pneumoconiosis of coal workers and less frequently in lymphoma treated with radiotherapy and amyloidosis. (Fig. 7)

Other patterns of lymph node involvement in silicosis are the presence of nodes without calcifications, with punctate calcifications or completely calcified lymph.

Finally the complicated chronic form is characterized by the presence of silicosis conglomerates, which originate from the confluence of the nodules, forming masses or clusters of spiculated contours, bilateral distribution and predominantly upper fields. They can present calcifications.

2.3 SARCOIDOSIS

It is a multisystem, granulomatous, inflammatory disease of unknown cause. It primarily affects the lungs and lymph nodes of young adults. Pulmonary involvement is characterized by the formation of granulomas, noncaseating, located in the perilymphatic gap.

Clinically, patients may be asymptomatic or present cough and mild dyspnea (clinical-radiological dissociation). Diagnosis is based on clinical and radiological findings and histological evidence of noncaseating granulomas.

According to the radiological abnormalities five stages (Classification of Siltzbach) are distinguished:

0) No alterations
1) Lymph node involvement without pulmonary involvement
2) Lymph node and pulmonary involvement
3) Pulmonary involvement without Lymph
4) Pulmonary Fibrosis
The most common pattern is enlarged hilar and rights paratracheal lymph nodes, bilaterally and symmetrically. The chest radiograph shows the lymphadenopathy bilateral, hilar mediastinal that can calcify in "eggshell" as silicosis, they can also be punctate or amorphous, however this finding is rare (3-10%). Calcifications appear in pathological lymph and are the dystrophic type. (Fig. 8)

Pulmonary involvement is characterized by a nodular or reticulonodular perihilar or upper lobes. They can be mass consolidations and honeycomb pattern all depending on the developmental stage. Calcification of the micronodular involvement is extremely rare.

2.4 METASTATIC CALCINOSIS OR METASTATIC CALCIFICATIONS

Metastatic calcinosis is a rare and usually asymptomatic condition. Typically occurs at an ionic calcium metabolic imbalance that favors these salts deposited on a previously normal tissue, unlike the dystrophic calcifications that make a previously damaged tissue.

Metastatic calcifications are found mainly in the peripheral vascular system, soft tissue, kidneys, stomach and heart, organs that are characterized by alkaline environment, means that favors precipitation of calcium salts. The lung is the organ where these calcifications more often settle.

The most frequent cause of metastatic calcification is chronic kidney failure, especially if treated with hemodialysis; other causes are hyperparathyroidism, hypervitaminosis D, multiple myeloma and sarcoidosis. They are also considered metastatic calcifications the acrylic cement emboli and talcosis, not presented with altered metabolism of calcium or phosphorus. (Fig. 9)

In the chest radiograph it may show a variety of abnormalities. We can observe a lattice-interstitial disease, simulate areas of consolidation or edema. These findings predominate in the upper lobes since it is an environment of higher alkalinity in relation to the fields below.

On CT it can be observed dense nodular opacities or calcified ones that may coalesce and predominate in the upper lobes. Although the distribution is centrilobular, pathologic examination reveals that the calcium deposit is interstitial. Calcium salts deposit zones are the alveolar septa and the walls of the bronchi and arterioles.

2.5 ALVEOLAR MICROLITHIASIS

Pulmonary alveolar microlithiasis is a rare idiopathic pulmonary disease of unknown cause. An autosomal recessive inheritance pattern has been proposed in view that there is a frequent incidence in members of the same family. Clinically it is typical the clinical-radiological dissociation with little symptomatic impact against severe morphological alteration.
It is characterized by the existence of multiple diffuse calcified nodules, subcentimeter size (0.01 to 3 mm), calcium phosphate compounds, known as microliters; these are typically within alveolar spaces while the walls thereof are normal. Interstitial fibrosis can be seen in the stages of disease progression.

In the chest radiograph it is characterized by the presence of multiple calcified micronodules, diffuse and bilateral distribution which form a pattern called "in sandstorm" that predominates in the lower lobes.

Sometimes the density of alveoli microliters is so high that the pleural space appears relatively hypodense (sign of pleural black line)

The CT may identify multiple nodules with calcium density and diffuse bilateral distribution predominantly in the posterior segments of the lower lobes. We can observe dense consolidations or confluent areas of calcification and thickening and / or calcification, probably due to the accumulation of microliters in the periphery of the secondary lobe interlobular septa.

A common finding is the presence of subpleural cysts, and apical bullae.

2.6 AMYLOIDOSIS

Amyloidosis is a predominant rare disease in men, characterized by extracellular deposition of amyloid. It can affect a particular organ or affect them a set of focal or diffuse.

Clinically there are two types; systemic way respiratory involvement is less expressive and localized amyloidosis affects an organ or system. A thoracic level can affect the lung parenchyma and airway, the mediastinal lymph nodes and pleura.

According to the specific protein there are two groups:

1) AL amyloidosis (light chain fragment) is the most common primary amyloidosis. There is a lung disease in 70-90% of patients. Approximately 30% of patients develop multiple myeloma.

2) AA amyloidosis associated with chronic inflammatory diseases.

In the lungs it can be manifested radiologically as a reticulonodular interstitial pattern, bilateral, predominantly basal and subpleural areas of consolidation as solitary or multiple nodules or masses that can calcify (50%). The traction bronchiectasis mediastinal lymphadenopathy and pleural effusion are frequent. (Fig. 10)

The tracheobronchial involvement is the most common form of small deposits of amyloid focal or diffuse. It can cause stenosis and calcification is frequent.
3. MEDIASTINAL CALCIFICATIONS

The mediastinum is the extrapleural space between both lungs, sternum front, thoracic outlet upper limit; the diaphragm as the lower limit and the dorsal vertebrae in the back portion.

Calcifications in the mediastinum, including lung parenchyma, are very common. It has been previously commented about various pathologies affecting the mediastinum, usually in the form of lymphadenopathy, and that can calcify (pneumoconiosis, sarcoidosis, tuberculosis, lymphoma aftercare).

This section will discuss other pathologies that may show calcifications in its natural evolution, especially of thyroid origin (goiter) and tumor (teratoma, thymoma).

The heart, that is part of the mediastinum, will be commented apart.

3.1 CALCIFICATIONS OF THYROID ORIGIN

Up to 3% of tumors of the thyroid can be extended to the thorax through the thoracic outlet.

Intrathoracic goiters account for 5-10% of mediastinal resected masses and are the most common cause of anterior mediastinal mass in adults; however an intrathoracic thyroid may also be secondary to ectopic tissue, and less frequently to carcinoma.

80% of intrathoracic goiters are anterior and shift the trachea posterolaterally. Frequently grown to the right.

Chest radiography shows curvilinear calcifications, annular or amorphous up to 25% of cases.

On CT it appears as a well-circumscribed mass connected to cervical thyroid tissue and it is much more sensitive in identifying calcifications. (Fig. 11)

3.2 THYMOMA

It is the most common primary tumor of the thymus and anterior mediastinum. 70% of these tumors occur between 50 and 70 years old. In most cases it is a benign lesion, but sometimes it may show invasive behavior.

Clinically it may be asymptomatic and about 50% are discovered incidentally when a chest radiograph. Sometimes it can show symptoms by compression of adjacent structures.
Approximately 15% of patients with myasthenia gravis have thymoma, while 35% of patients with thymoma have myasthenia gravis.

The chest radiograph may show from subtle mediastinal contour abnormalities to large mediastinal masses that sometimes mimic cardiomegaly or cardiac masses. In lateral projection it can be observed occupation of retrosternal space. Sometimes calcifications of diverse morphology are detected, they can be peripheral capsular, linear or be within the tumor. The calcifications are more frequent in benign tumors and detected in 25% of cases after performing CT. (Fig. 12)

### 3.3 GERM CELL TUMORS

These tumors arise from germ cells. The commonest site are the gonads, but are Extragonadal in 1-3%, mainly affected the anterior mediastinum. Represent 15% of mediastinal tumors in adults and 24% in children. The 70% of these tumors are benign or mature teratomas.

Benign teratomas occur in young adults with the same incidence in men and women. They are asymptomatic in up to 50% of patients and are discovered incidentally on chest radiograph showing generally well defined lesion and imaging characteristics are related to the components masses. Often have central, curvilinear or peripheral calcifications. Identification of teeth is pathognomonic.

Is also specific for the presence of a liquid-fat level that is more easily detected on CT scan. It may identify the different components (fluid, fat, and soft tissue areas of calcium)

Teratomas calcifications can be arcuate wall tumor, globular or correspond to teeth; there may also be mature bone.

### 3.4 HODGKIN LYMPHOMA AFTER TREATMENT RADIOTHERAPY

Lymphoma can appear in any mediastinal compartment, but the lymphoma type is most often lies in the anterior mediastinum and is the most common cause of lymphadenopathy in this anatomic space.

Treatment of this condition is determined by the stage of disease at diagnosis and includes radiotherapy and chemotherapy.

After treatment with radiotherapy mediastinal lymph nodes may calcify, and rarely without this background. Calcifications are generally visible after 1-9 years of treatment, and they are dystrophic type, that occurring as a result of tissue necrosis. This finding is indicative of a better prognosis.
4. CARDIOVASCULAR CALCIFICATIONS

Classically considered that vascular calcification is a passive and degenerative process that occurs frequently in elderly patients and associated with other diseases such as atherosclerosis and metabolic diseases (DM, hypertension, IRC); however now, they are considered vascular calcification as an active process regulated similarly to metabolism and bone mineralization.

It is important to reiterate that atherosclerosis and cardiovascular complications remain a major problem since there is a high morbidity and mortality in industrialized countries, not only by association with risk factors, but also by the aging population, constituting one of leading cause of death.

Classically, the types of arterial calcification were classified according to where calcium is deposited:

1) intimal calcification (associated with atherosclerotic plaque)

2) medial calcification (known as Mönckeberg sclerosis) that would be linked to vascular stiffness by mineralization of elastic fibers and atherosclerosis.

Cardiovascular calcifications, usually chest dystrophic calcifications, appear on a degenerated tissue, with no alterations of calcium metabolism. The most common are the calcifications of the aortic arch, the descending aorta and coronary arteries, the latter often best seen in CT radiograph.

The main pulmonary artery and its proximal branches may calcify in case of pulmonary hypertension, less often calcify other vessels of the thorax as usually secondary to subclavian artery atherosclerosis or vasculitis. The mammary arteries can calcify in a longstanding aortic coarctation.

Regarding cardiac hydatid cysts and tumors are rare causes of calcification. Within the atrial myxoma tumors the most common tumor that may calcify, others also can do it: fibroids, Rhabdomyomas, angiomas and osteosarcomas.

Aortic calcifications: usually occur secondarily calcium deposit on atherosclerotic plaques, although there are other less common causes such as aortic dissections, post-traumatic and iatrogenic aneurysms. The calcification of the ascending aorta occurs less often and is typical of certain conditions such as Marfan syndrome, syphilis, aortic dissection, mycotic aneurysms and Takayasu arteritis. (Fig. 13)

Coronary calcifications: are more frequent in patients with stroke or myocardial ischemia and are associated with stenosis. Frequently they are in their most proximal segments and increase with age. The extent and density of calcification are proportional to the presence of angina or myocardial infarction, coronary artery calcification was
observed in 54% of patients with symptomatic ischemic heart disease. May also calcified vascular grafts, coronary bypass side to addition of primary coronary aneurysms pseudoaneurysms.

In the PA chest radiograph coronary calcifications are usually identified on the left between the spine and heart shape (triangle of coronary calcification) but are best visualized on the lateral view, observing a tubular morphology calcification overlying the cardiac silhouette. (Fig. 14)

With the development of multislice CT, there is a breakthrough in cardiac imaging, especially in the morphological study of the coronary arteries allowing the study of these non-invasively. One of its clinical application is the measurement of coronary calcium by measuring the total area of coronary calcified plaque; however also allows the evaluation of the plates individually in volume, mass and density.

**4.1 PERICARDIAL CALCIFICATIONS**

The pericardial calcifications are usually secondary to an inflammatory process that is organized and calcified, there are other less common causes (Table 2).

The chest radiograph shows an increases high density and linear morphology located more frequently in right heart chambers, in atrioventricular and rarely left ventricular grooves. (Fig. 15)

**4.2 MYOCARDIAL CALCIFICATIONS**

In the myocardial calcifications are usually secondary to ischemic processes and more often it is ventricular aneurysms infarction in these cases calcification will be located in the anterolateral wall of the left ventricle (heart tip) and this helps to differentiate it from the pericardial calcifications as previously mentioned most affect right cardiac cavities. (Fig. 16)

Less frequently appear in the apical portion of the left ventricle and sometimes may also appear at the bottom, top or posterior portion; these locations suggest rare congenital etiologies as post-traumatic aneurysms or diverticula. (Fig. 17)

You can also see myocardial calcifications in the left atrium in rheumatic fever. If calcification has a clumpy can be a calcified mural thrombus. There are other less common causes of myocardial calcifications (Table 3).

**4.3 VALVULAR CALCIFICATIONS**

The mitral valve with aortic heart valves are most often calcify, it is more common in people over 60 years. It is usually due to a degenerative process.
Radiologically are usually seen as a dense ring, incomplete or horseshoe. To differentiate it, a line running from the carina to the sterno-diaphragmatic angle is plotted; the mitral valve is below to this line and the aortic valve is above, however if growth cardiomegaly or cavities, these locations may vary.

Etiologically rheumatic fever is the most common cause of calcification of the mitral valve in isolation and the most frequent cause of calcification of the mitral and aortic valve together. The mitral valve calcification failure occurs more frequently and aortic stenosis. (Fig. 18)

Other causes of mitral valve calcification are endocarditis and atherosclerosis. In the case of the aortic valve are syphilis, ankylosing spondylitis, Reiter's syndrome, rheumatoid arthritis and atherosclerosis. Calcification of the pulmonary valve and tricuspid are less frequent. (Table 4)

5. PLEURAL CALCIFICATIONS

The pleural cavity is a virtual space formed by two very fine leaves, the parietal and visceral pleura, separated by a minimum amount of liquid between them.

Pleural calcification pathologies occur secondarily to promote the same thickening and fibrosis. These pathologies are generally empyema, hemothorax and exposure to dusts such as asbestos and talc that favor pleural irritation. (Fig. 19)

Exposure to asbestos fibers can cause lung and pleural disease. Asbestosis is called when there are lung disease with fibrosis. Asbestos exposure causes pleural plaques with or without calcification and it is the most common manifestation of the disease, it appears in the middle areas of the costal pleura, mediastinal or diaphragmatic respecting the vertices and the costophrenic angle. In the case of asbestosis pleural plaques they are localized pleural thickening seen in the periphery of the thorax and corresponding to fibrous proliferation of the pleura, secondary to irritation of this by inhaling asbestos fibers. Its latency is at least 20 years and often appear in the parietal pleura, if they are calcified are easier to recognize and geographical aspect gives the key to diagnosis. (Fig. 20)

Cases with small pleural plaques are difficult to see by simple and easily demonstrated by CT is the radiology image of choice.

6. CHEST WALL CALCIFICATIONS
The chest wall is constituted by the ribs, sternum, shoulder, the spine, diaphragm, neck and soft tissue; all these structures surrounding the lung parenchyma and mediastinum. (Fig. 21) (Fig. 22)

Calcifications in the chest wall are very common, among the most frequent causes are the costochondral calcifications and the prevalence increases with age; is present in 6% of individuals between 20 and 29 years and about 50% in individuals over 70 years.

At the level of the ribs may be secondary calcifications or secondary callus costal fracture either primary or secondary neoplastic processes. Within benign osteochondroma and fibrous dysplasia are most benign lesions that are located in the ribs.

Osteochondroma (exostosis) is the most common of these injuries, their typical appearance is that of a bony prominence on the rib deformity or expansion occurs with calcification of the cartilaginous head when the cartilaginous cap containing dense calcifications or disorganized, or greater than one centimeter, suspect degeneration to chondrosarcoma.

Fibrous dysplasia is an abnormality of skeletal development, is the most common benign lesion of the ribs. Chest radiograph showing a fusiform thickening and deformity with thickened cortical and increased stranding rib.

Within malignancies, chondrosarcoma, neoplasia of cartilage lineage, is characterized by a lesion with irregular contours produce bone destruction and there intratumoral calcifications that may be dashed in floc or rings. CT and MRI are more sensitive in determining the cartilaginous nature of the injury since it identifies not visible calcifications on plain radiography, especially in small tumors.

Soft tissue calcifications may be secondary to parasitic infections such as cysticercosis caused by Taenia solium, identifying himself as oval or spindle-shaped calcifications, usually sub-centimeter (4-10 mm) and 2-5 mm wide, oriented with its longitudinal axis parallel to the muscle fibers. (Fig. 23)

They can also be extensive calcification in calcinosis universalis. In myositis ossificans progressiva where there ossification of the fascia, tendons, fascia and muscles of the chest and neck, accompanied by alterations in the hands and feet.
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<tbody>
<tr>
<td>- Pericardial calcifications</td>
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<td>- Myocardial calcifications</td>
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<td>- Endocardial calcifications</td>
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<th>Pleural calcifications</th>
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<td>- Residual origin (empyema, hemothorax)</td>
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<td>- Exposure to asbestos</td>
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<th>Chest wall calcifications</th>
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<td>- Calcifications cost-chondral</td>
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<tr>
<td>- Dermatomyositis</td>
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<tr>
<td>- Posttraumatic calcifications</td>
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</tbody>
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**Table 1:** Table1. Differential Diagnosis of thoracic calcifications

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Fig. 1: Calcified granuloma in a 68 years-old man. (A, B) Posteroanterior chest film shows high-density nodule in the right upper lobe (circle and arrow).

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Fig. 2: Tuberculosis in a 63 years old man. (A) Posteroanterior chest film shows a high density nodules in both upper lobes with residual fibrous tracts and volume loss associated. (B, C) Axial and coronal reconstruction CT scan show pleural calcifications.

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Fig. 3: Hamartoma in an asymptomatic and ex-smoker 73 years-old man. (A, B) Posteroanterior chest film shows a well defined nodule in the left upper lobe with small focal areas of calcification (arrow). (C, D) Chest CT scan shows a heterogeneous, well defined margins nodule with focal areas of calcification and fat.

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**Fig. 4:** Carcinoid tumour in a 76 years-old woman. (A, B) Posteroanterior and lateral chest radiograph shows a lobulated mass in the left lower lobe, with some focal calcification. (C, D) Axial CT scan demonstrates a lobulated mass of soft tissue attenuation and eccentric foci of calcification.

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**Fig. 5:** Pulmonary hydatid cyst in a 60 years-old woman. Axial and coronal reconstruction CT scan shows a rounded and well-defined lesion on the right low lobe and demonstrates linear concentric calcifications.

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**Fig. 6:** Residual varicella infection in a 53 years-old woman. (A) Posteroanterior chest film shows a micronodular involvement densely calcified (B, C) Axial CT scan demostrates numerous small well defined and calcified nodules.

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Fig. 7: Silicosis in a 78 years old man. (A, B) Posteroanterior and lateral chest film shows a high density nodules in perihilar regions and residual fibrous tracts changes in both upper lobes. (C) Axial CT scan shows the characteristic "egg-shell" calcification of mediastinal nodes.

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Fig. 8: Sarcoidosis in a 60 years-old man. (A, B) Axial CT scans demonstrates gross focal and peripheral nodal calcification in the mediastinum and both hilum.

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**Fig. 9:** Pulmonary cement embolism in a asymptomatic 63 years-old woman. (A, B, C) Posteroanterior and lateral chest film shows dense opacities with a tubular and branching shape that were distributed diffusely (arrows). Vertebroplasty Changes are also observed (circle). (D, E) Axial CT scan shows high attenuating emboli. (F) Close-up chest CT scan shows the extruded cement within the epidural veins (arrow).

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**Fig. 10:** Tracheo-bronchial amyloidosis in a 64 years old man. Axial CT scan shows mucosal thickening with calcification of the trachea. The posterior membrane is also classically involved (arrows).
**Fig. 11:** Thyroids calcifications in a 68 years-old woman. (A, B) Posteroanterior chest film shows a well defined and calcified left paratracheal node. (C) Thyroid ultrasound confirms calcified nodule.
Fig. 12: Thymoma in a 53 years-old woman. Axial CT scan shows a rounded soft tissue attenuation mass with calcifications, located in anterior mediastinum.

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**Fig. 13:** Calcification of the aortic arch and descending aorta in a 88 years-old man. (A, B) Posteroanterior and lateral chest radiograph show cardiomegaly and marked calcification atheromatous of the aortic arch and descending aorta (arrows).

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**Fig. 14:** Coronary artery calcification in a 89 years-old man. (A, B) Lateral radiograph shows a tubular morphology calcification overlying the cardiac silhouette (circle). (C) Sagittal reconstruction CT scan shows the coronary artery calcification.

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<tr>
<th>Category</th>
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<td>Inflammation</td>
<td>• infection (tuberculosis, histoplasmosis, syphilis, gonococcal)</td>
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<td>• Asbestosis</td>
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<td></td>
<td>• Autoimmune diseases (rheumatic fever, AR)</td>
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<td>Tumors</td>
<td>• Teratoma</td>
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<td>• pericardial cyst</td>
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<td></td>
<td>• Gaucher Disease</td>
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<td>Others</td>
<td>• Chronic Uremia</td>
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Table 2: Table 2. Causes of pericardial calcifications

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**Fig. 15:** Pericardial calcification in a 62 years-old woman. (A) Lateral radiograph shows a linear opacity surrounding the cardiac silhouette. (B) Axial CT scan demonstrates the Pericardial calcification.

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**Fig. 16:** Myocardial calcification in a 69 years-old woman. (A, B) Posteroanterior chest radiograph shows a gross calcification at the cardiac apex. (B) Axial CT scan demonstrates intramyocardial calcification in the left ventricle.

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**Fig. 17:** Calcified left ventricular aneurysm in a 71 years-old woman. (A, B) Posteroanterior and lateral chest radiograph shows a linear opacity surrounding the left ventricle silhouette. (C) Coronal reconstruction CT scan demonstrates the calcified left ventricular aneurysm (arrow).

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Table 3: Causes of myocardial calcifications

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Fig. 18: Calcified mitral valve in a 89 years-old man. (A, B) Posteroanterior chest radiograph shows a gross calcification with "incomplete ring" morphology, overlying the
cardiac silhouette (Circle). (C) Axial CT scan shows marked calcification of the mitral valve annulus.

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**Table 4:** Table 4. Causes of valvular calcifications

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**Fig. 20:** Calcified pleural plaques in a 78 year-old woman with a history of asbestos exposure. (A, B) Posteroanterior and lateral chest radiograph show multiple high density irregular opacities and bilateral calcified pleural plaques.

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**Fig. 19:** Diffuse pleural thickening in a 50 year-old woman with history of allergic bronchopulmonary aspergillosis, sarcoidosis, respiratory failure and chronic pleural effusion. (A) Posteroanterior radiograph shows diffuse and bilateral calcified pleural thickening with fiber tracts and volume loss in both upper lobes. At the basal portion is observed the pleural effusion and peripheral calcification (arrows). (B) Axial chest CT
scan shows bilateral pleural effusion and pleural calcification in both visceral and parietal pleura.

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Fig. 21: Calcified left cervical lymphadenopathy in a 75 years-old man. (A, B) Posteroanterior radiograph shows high density nodules in the soft tissue of the left cervical region. Marked signs of chronic pulmonary disease, predominantly emphysematous with bullae bulky in the middle and upper lung fields are observed.

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Fig. 22: Calcified breast implants in a 57 years-old woman. (A, B) Posteroanterior and lateral chest radiograph show rounded linear calcification, superimposed on both breasts.

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Fig. 23: Cysticercosis in a 83 years-old woman. (A, B) Posteroanterior and lateral chest radiograph show ovoid calcified nodules on soft tissue of the thorax with the typical "rice grain" morphology.

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Conclusion

Chest calcifications are produced by a wide range of pathologies can be located anatomically in the lung, mediastinum, pleura and the chest wall.

The etiology of thoracic calcifications will be determined by anatomic location, characteristics of calcification, the accompanying radiological findings, clinical and epidemiological data partners.

The most common cause is caused by granulomatous diseases such as tuberculosis and granuloma is undoubtedly the most common in the lung calcification.

Chest radiography is the first radiology test that most calcifications are detected, usually as an incidental finding, with CT helps us when making an appropriate differential diagnosis.
References


