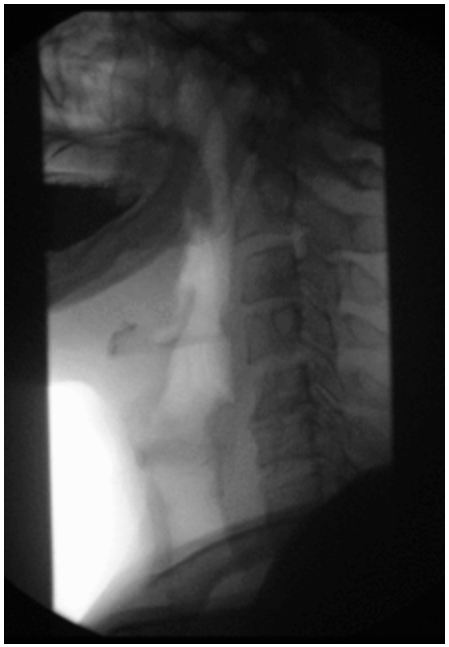
LUNG IMAGING

Imaging methods

Fluoroscopy

Fluoroscopy involves the use of a continuous X-ray beam that allows a dynamic visualization of the structures included in the acquisition plan.



Imaging methods

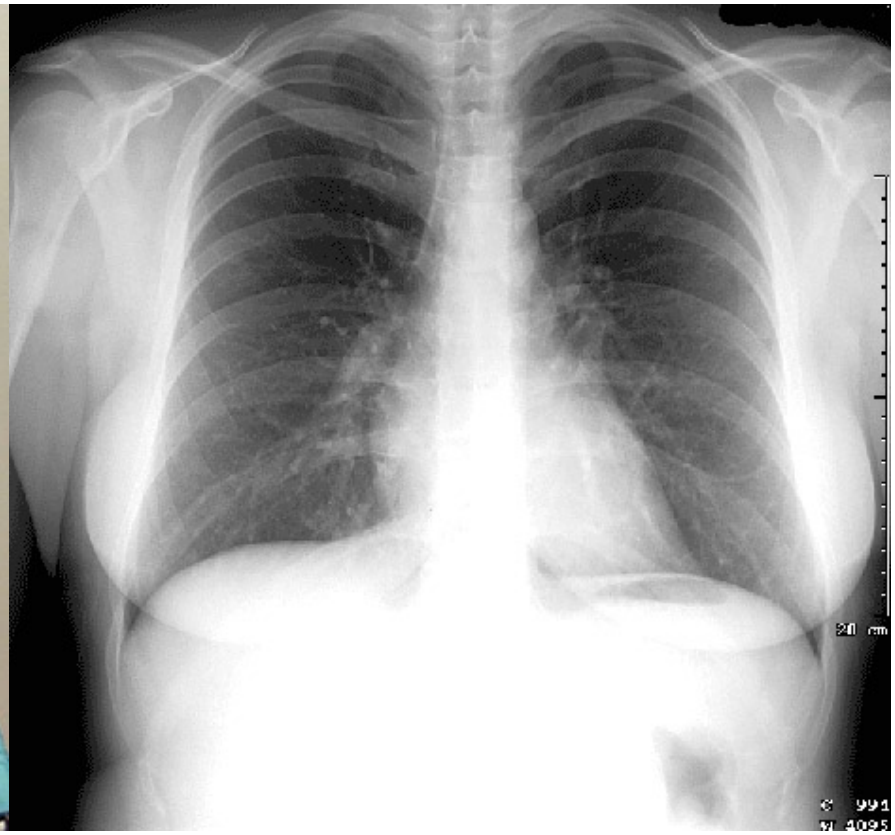
Conventional radiography

Conventional radiography uses X-rays to obtain static images of the examined structures. In order to correctly perform a lung X-ray, the following criteria must be met:

- trachea – through its transparency, only the first 3-4 vertebra should be visualized;
- sternoclavicular joints – radiolucent joint spaces that must be symmetrical and equal;
- scapula – must not overlap the lung areas;
- pulmonary areas – must be completely visualized on the X-ray film;
- mediastinal opacity – must be located centrally;
- contrast – a good contrast between the mediastinal opacity and the radiolucency of the lung areas is required.

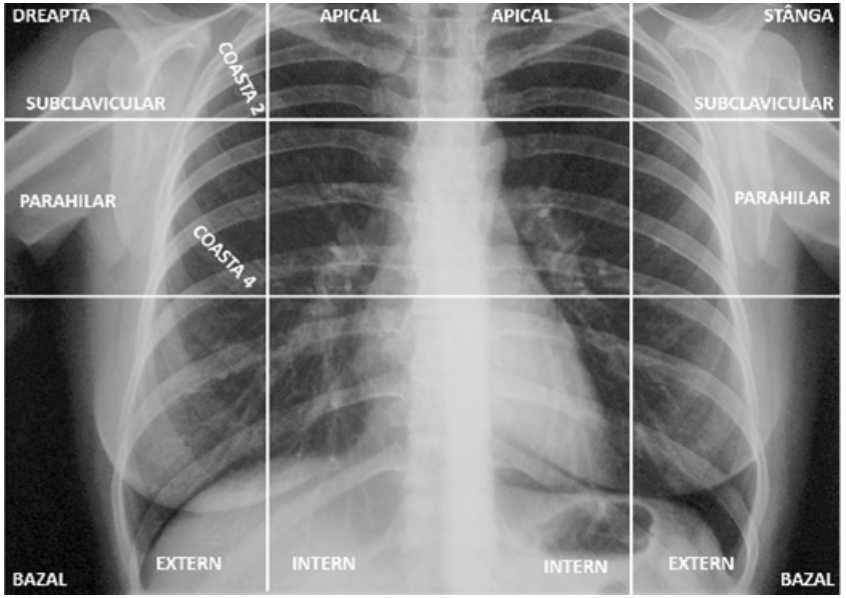
Imaging methods

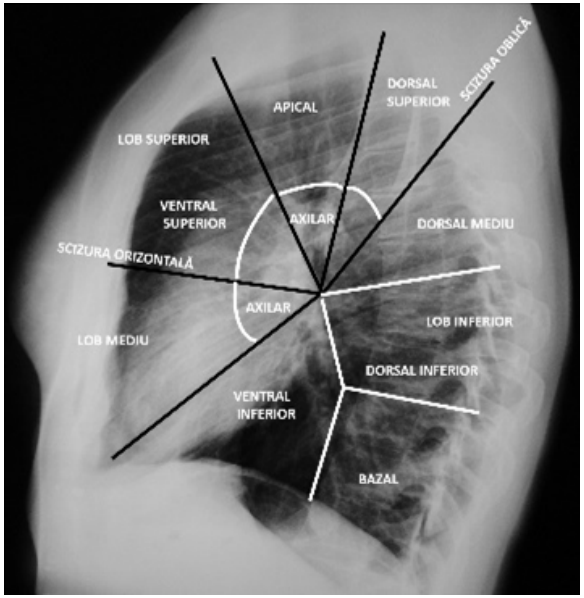
Conventional radiography



Imaging methods

Conventional radiography





Imaging methods

Computed Tomography

Computed tomography (CT) is an imaging technique that involves the use of X-rays and allows multiplanar acquisition of very high-precision sections that can be processed 2D or 3D.

CT indications in thoracic pathology are similar to conventional radiography and include: suspicion of thoracic lesions, thoracic extension of malignant lesions, better localization of lesions, CT-guided biopsy.

Imaging methods

High Resolution Computed Tomography (HRCT)

HRCT involves obtaining thin imaging slices (1-2 mm) that can prove to be useful in the following situations:

- detection, characterization and surveillance of diffuse pulmonary infiltrative diseases;
- detection, localization and evaluation of bronchial lesions;
- detection, characterization and localization of pulmonary and / or pleural lesions encountered in occupational diseases;
- affecting small airways.

Imaging methods

Angio-CT

The angio-CT technique involves the administration of a contrast agent in a peripheral vein, followed by the acquisition of sectional images through CT. The invasiveness of this technique is significantly lower than conventional angiography.

The angio-CT examination of the thorax provides information about the size and walls of the vessel, the presence of aneurysms or arteriovenous fistulas, stenosis - evaluation of the stenotic degree, specifying the type of occlusion (by thrombus, by embolus or extrinsic compression).

Imaging methods

Magnetic resonance imaging (MRI)

MRI of the thorax is recommended only in several carefully selected cases such as: diseases of the thoracic and mediastinal soft tissues, pathology of the heart and large vessels.

Imaging methods

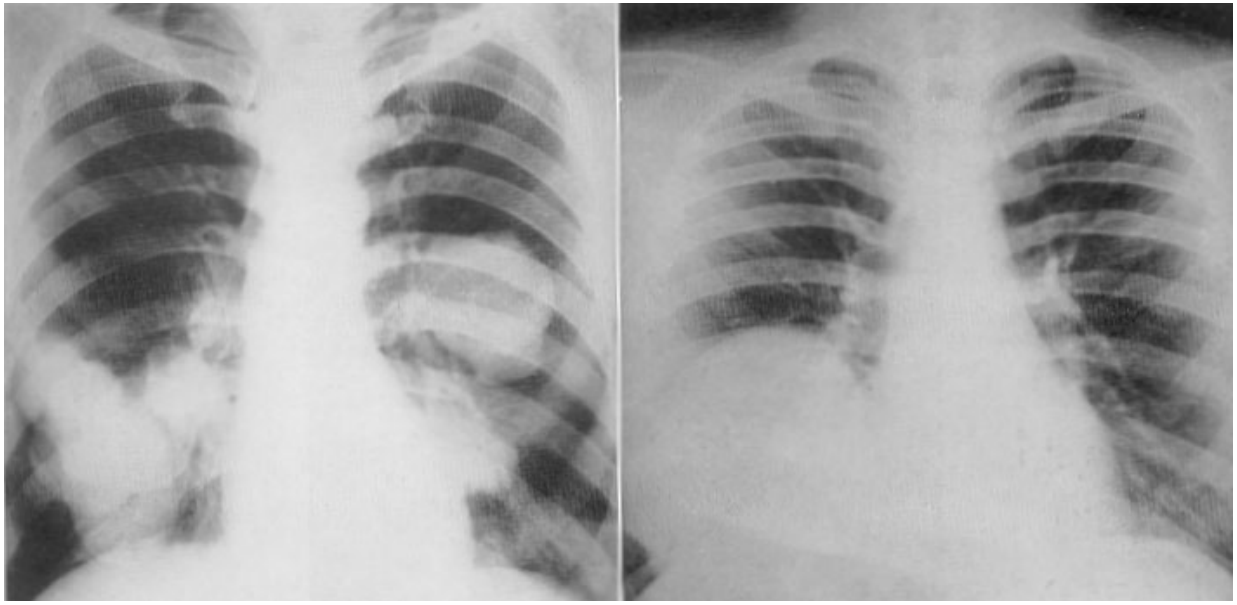
Hybrid imaging – PET/CT, PET/MR

PET-CT and PET-MRI are modern imaging techniques that involve the use of a radioactive tracer. Most commonly, 18F-fluorodeoxyglucose (18F-FDG) is used as a radiotracer. The imaging methods described above can detect lesions that exhibit intense radiotracer concentration due to the intense metabolic activity at this level.

Pulmonary lucency changes

Opacity

- number;
- shape (round, oval, triangular);
- location (lung, lobe, segment);
- size;
- structure (homogeneous/inhomogeneous);
- intensity (compared to mediastinal opacity – inframediastinal/mediastinal/supramediastinal);
- outline (clear/diffuse);
- relationship with the neighbouring structures.

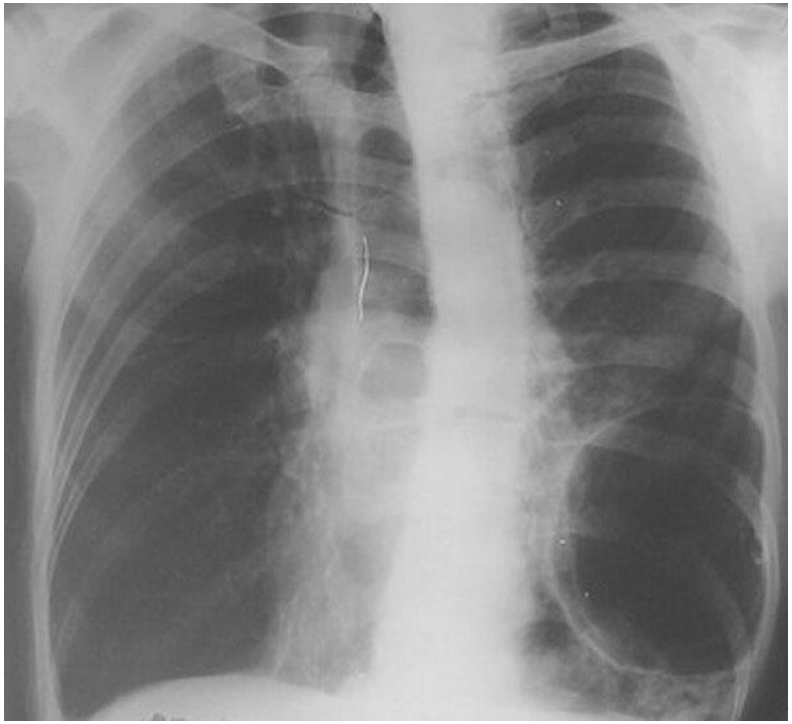


Pulmonary lucency changes

Radiolucency

- number;
- shape (round, oval, triangular);
- location (lung, lobe, segment);
- size;
- opaque ring that circumscribes the lesion (ring law).

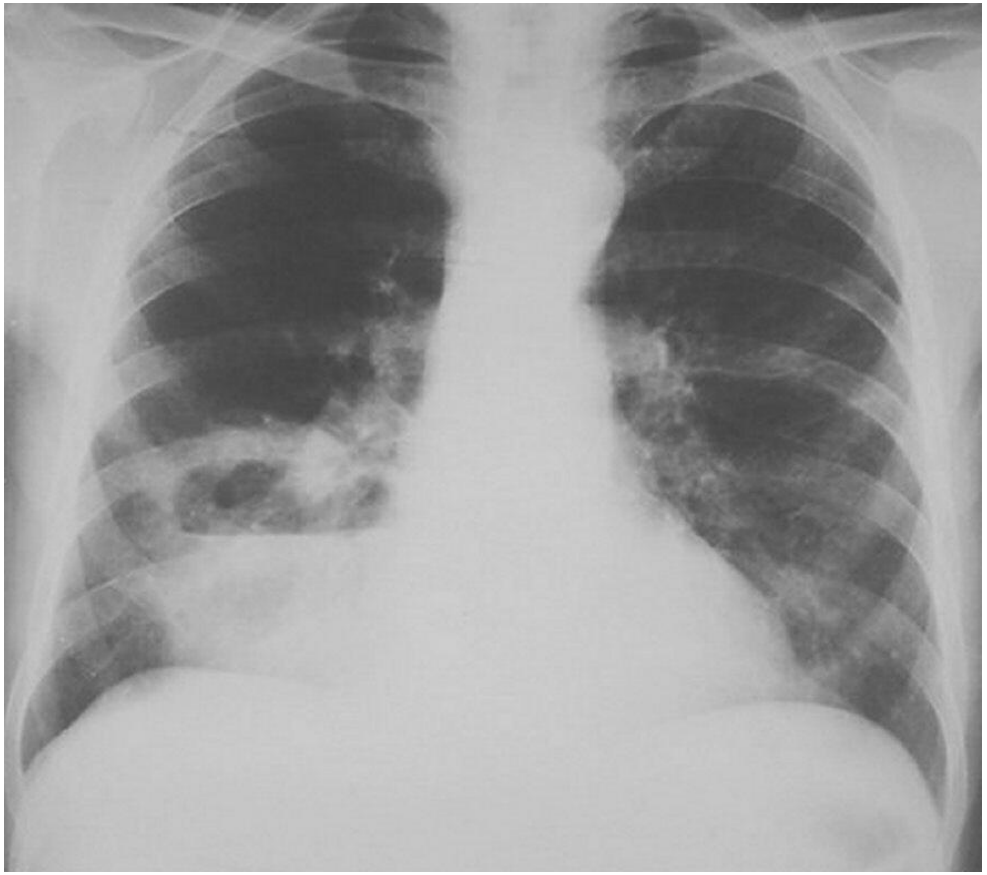
The thicker the opaque ring that deliniates the radiolucency, the lower the intensity and more diffuse external outline, the greater the evolutionary potential of the lesion. The thinner the opaque ring that deliniates the radiolucency, the higher the intensity and more clear external outline, the lower the evolutionary potential of the lesion.



Pulmonary lucency changes

Mixed lesions (air/fluid)

- number;
- shape (round, oval, triangular);
- location (lung, lobe, segment);
- size;
- separation limit (horizontal/waved).

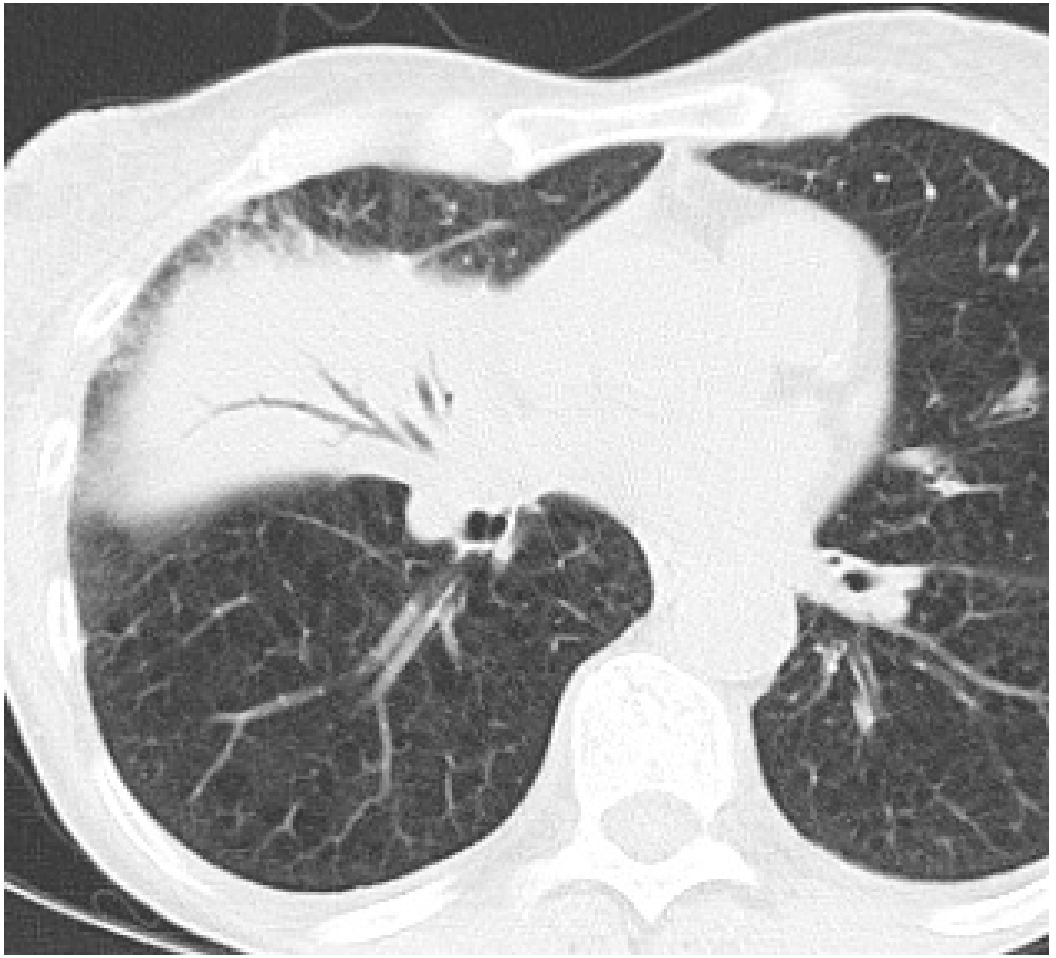


Air bronchogram

Normally, bronchias are not visualized on a conventional X-ray because there is no contrast between the air inside the bronchia and the air inside the adjacent alveolae. There are two major situations where bronchias become visibile:

1. Fluid content fills the lumen of the bronchia and replaces the air that is normally found at this level. The adjacent lung parenchyma appears with normal air content.
2. The lumen of the bronchia remains clear but the air inside the surrounding alveolae is replaced by fluid. Therefore, the bronchias appear as a linear radiolucent area inside a lung consolidation area.

Air bronchogram



Monitoring and life-support devices

The main aspects related to the radio-imaging description of the medical devices for monitoring and support should include the following:

- anatomical path of introduction;
- the correct location of the device as a radiological projection;
- the correct positioning of the distal extremity of the medical device;
- relationships with the adjacent anatomical structures;
- possible complications: subcutaneous emphysema, pneumothorax, mediastinal lesions, pericardial lesions, pulmonary parenchymal lesions, rupture, migration of the device.

Acute infectious pneumopathies

Pneumococcic pneumonia

Streptococcus pneumonia.

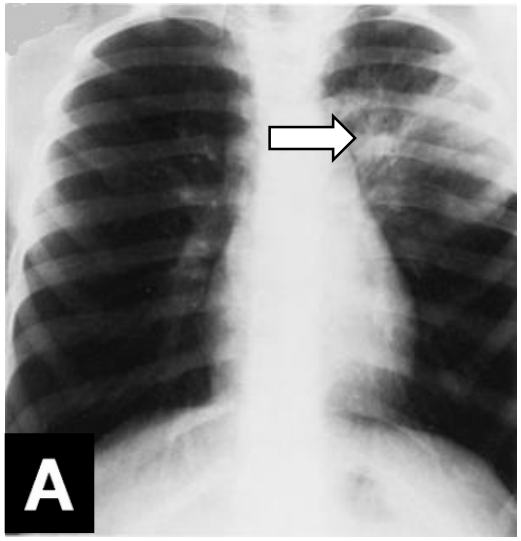
- congestion phase;
- red hepatization phase;
- grey hepatization phase.

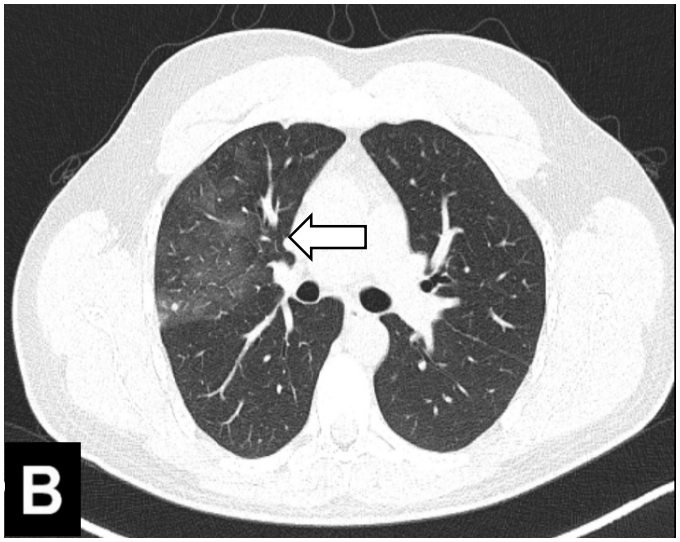
Acute infectious pneumopathies

Pneumococcic pneumonia – congestion phase

RX: diffuse delineated opacity that affects one or more segments or lobes. The intensity of the opacity is reduced and allows the vascular drawing to be seen through it.

CT: reduced lung transparency that affects one or more segments or lobes.





Acute infectious pneumopathies

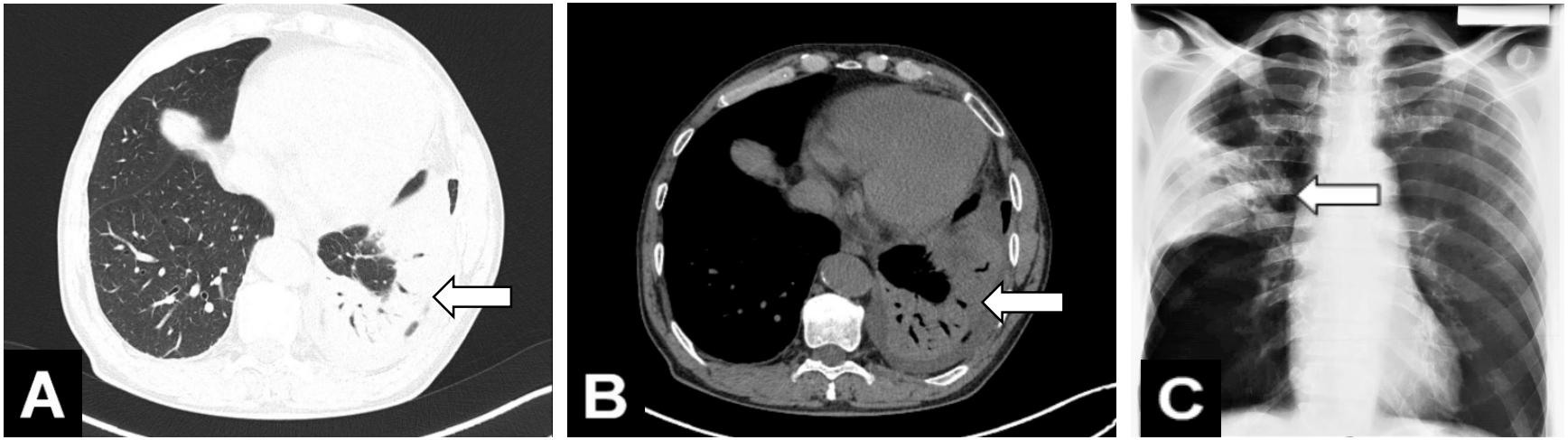
Pneumococcic pneumonia – red hepatization phase

RX: The image described previously in the congestion phase is transformed into a unique triangular opacity, of inframediastinal intensity, which affects one or more segments or lobes. The outline of the opacity is clear when it reaches a fissure (oblique, horizontal) and diffuse when it is lost in the healthy adjacent pulmonary parenchyma. The pathognomonic aspect of this phase is given by the presence of multiple radiolucent linear images represented by the lumen of the bronchi that remains free, unoccupied by the inflammatory exudate. This aspect is the so-called air bronchogram.

CT: Pneumococcic pneumonia in the red hepatization phase is evidenced as a moderately iodophilic consolidation area, with air bronchogram and characteristics similar to those shown on conventional radiography. In addition, the CT examination can detect inflammatory mediastinal and hilar lymph nodes, associated pleural or pericardial effusion, as well as possible complications such as pulmonary abscess.

Acute infectious pneumopathies

Pneumococcic pneumonia – red hepatization phase

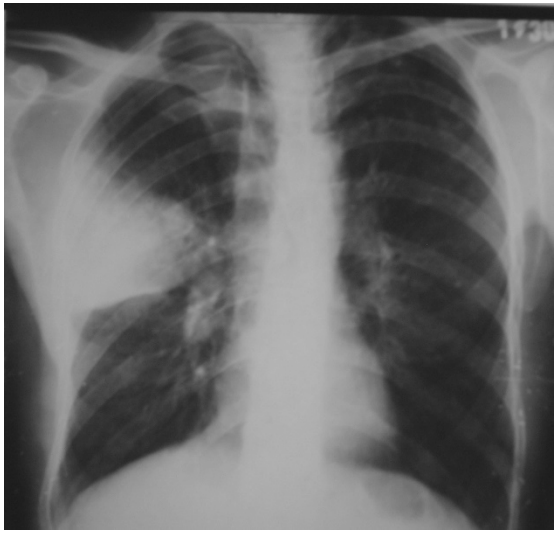


Acute infectious pneumopathies

Pneumococcic pneumonia – grey hepatization phase

RX: The opacity previously described in the red hepatization phase now has a homogeneous appearance and an increased intensity. In this phase, the inflammatory exudate occupies the bronchial lumen and air bronchogram can no longer be seen.

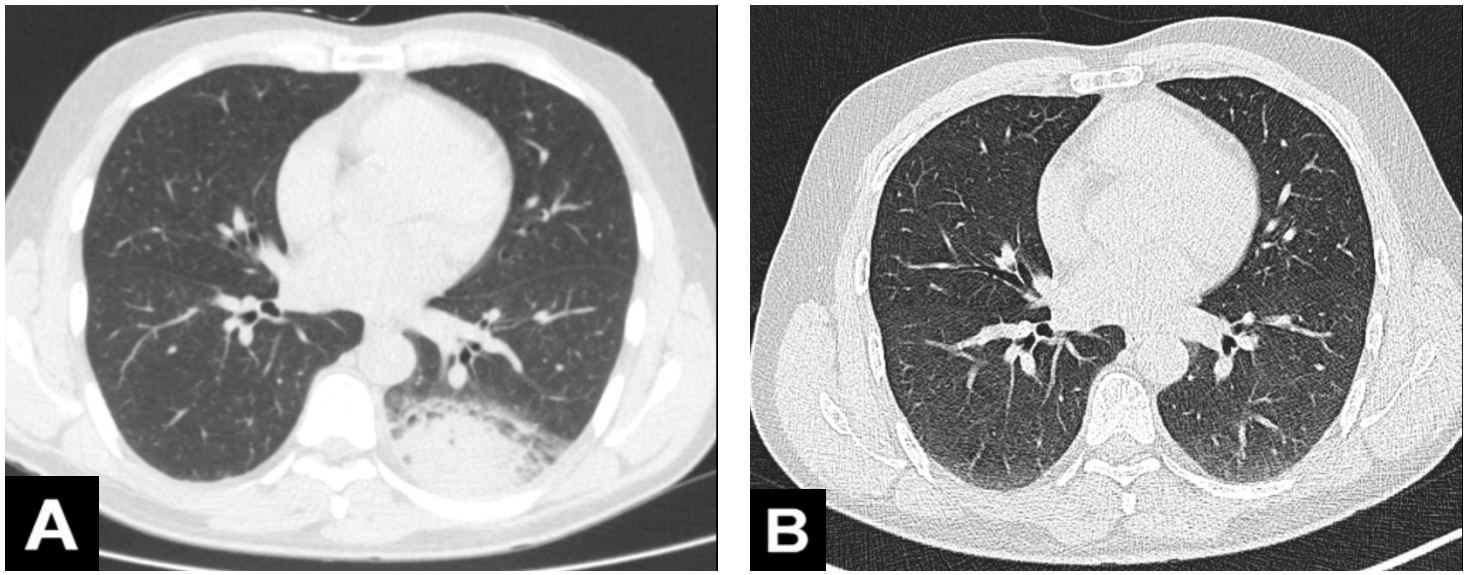
CT: the consolidation area has a homogeneous appearance, without air bronchogram.



Acute infectious pneumopathies

Pneumococcic pneumonia – evolution

Favorable: the pneumonic opacity decreases in size and intensity in 10-14 days until it reaches normal lung transparency - *restitutio ad integrum*.



Acute infectious pneumopathies

Pneumococcic pneumonia – evolution

Unfavorable: chronicization/abscess.

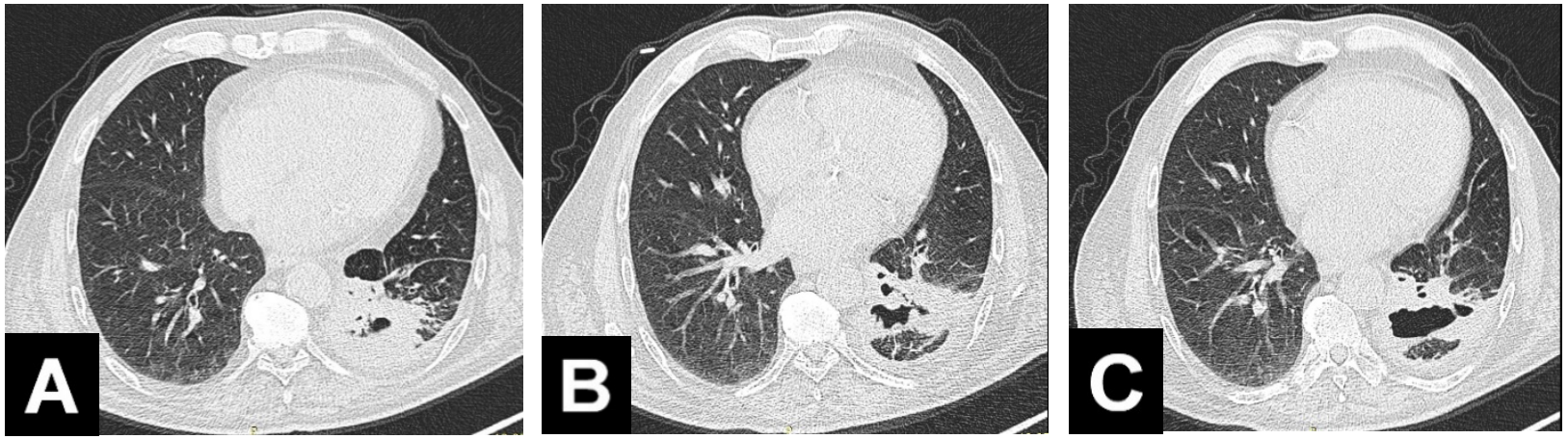
In case of chronicization, the pneumonic opacity persists and has an inhomogenous aspect given by the presence of radiolucent areas alternating with linear opacities represented by the lesions of interstitial fibrosis. The consequence of these fibrotic lesions is the retraction of the ribs, the mediastinum and the diaphragm, developing emphysema and bronchiectasis.

In case of abscess, one or more air-fluid images appear within the consolidation area after a coughing effort accompanied by vomica.

Acute infectious pneumopathies

Pneumococcic pneumonia – evolution

Unfavorable: chronicization/abscess.



Acute infectious pneumopathies

Any correctly treated pneumonia that does not resolve in 2-4 weeks is considered a malignant tumor until modern imaging techniques and complementary invasive investigations prove otherwise !!!

Acute infectious pneumopathies

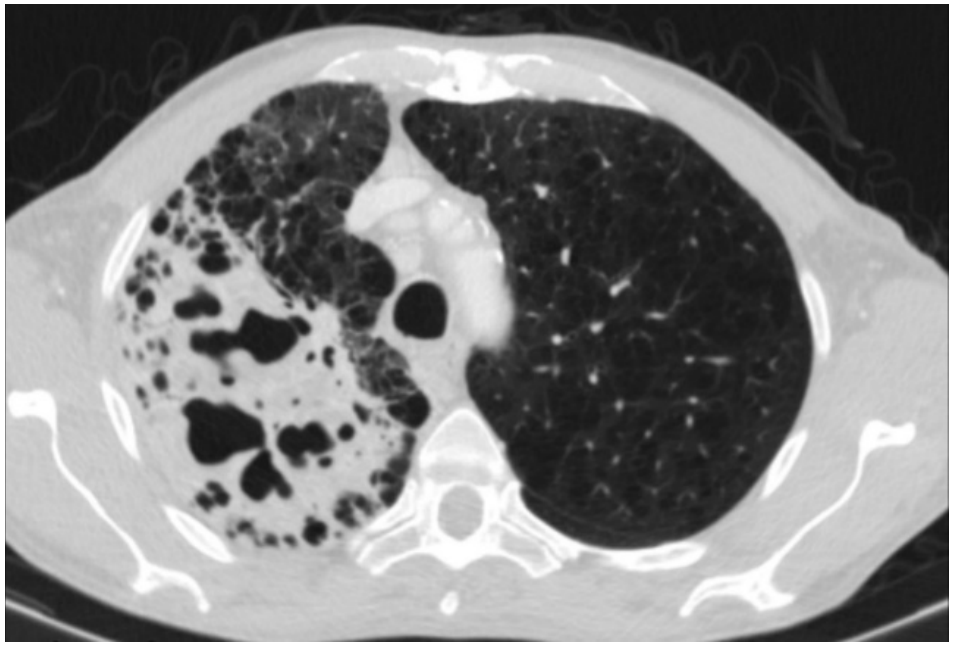
Klebsiella pneumonia

From a radiological point of view, this type of pneumonia usually affects the upper lobes and the aspect is similar to the pneumococcal pneumonia (lobular / segmental opacity of mediastinal intensity that can present air bronchogram in evolution). In addition, this type of pneumonia is characterized by a marked tendency to abscess and form cavities and is frequently associated with pleural effusion.

At CT examination, Klebsiella pneumonia is frequently detected in the upper lobes in the form of a consolidation area that may present with air bronchogram in evolution. Also, this type of pneumonia is usually associated with the presence of pleural effusion and an increased tendency to abscess and form cavities.

Acute infectious pneumopathies

Klebsiella pneumonia



Acute infectious pneumopathies

Pseudomonas pneumonia

This type of pneumonia is usually encountered in diabetic patients and also in patients undergoing treatment with corticotherapy and antibiotherapy for a long period of time. From a radiological standpoint, this time of pneumonia appears as confluent micronodular and nodular opacities that lead to macronodular opacities. Also, Pseudomonas pneumonia can evolve in a similar way compared to pneumococcic pneumonia.

Streptococcal pneumonia

This type of pneumonia usually affects the lower lobes and frequently associates empyema.

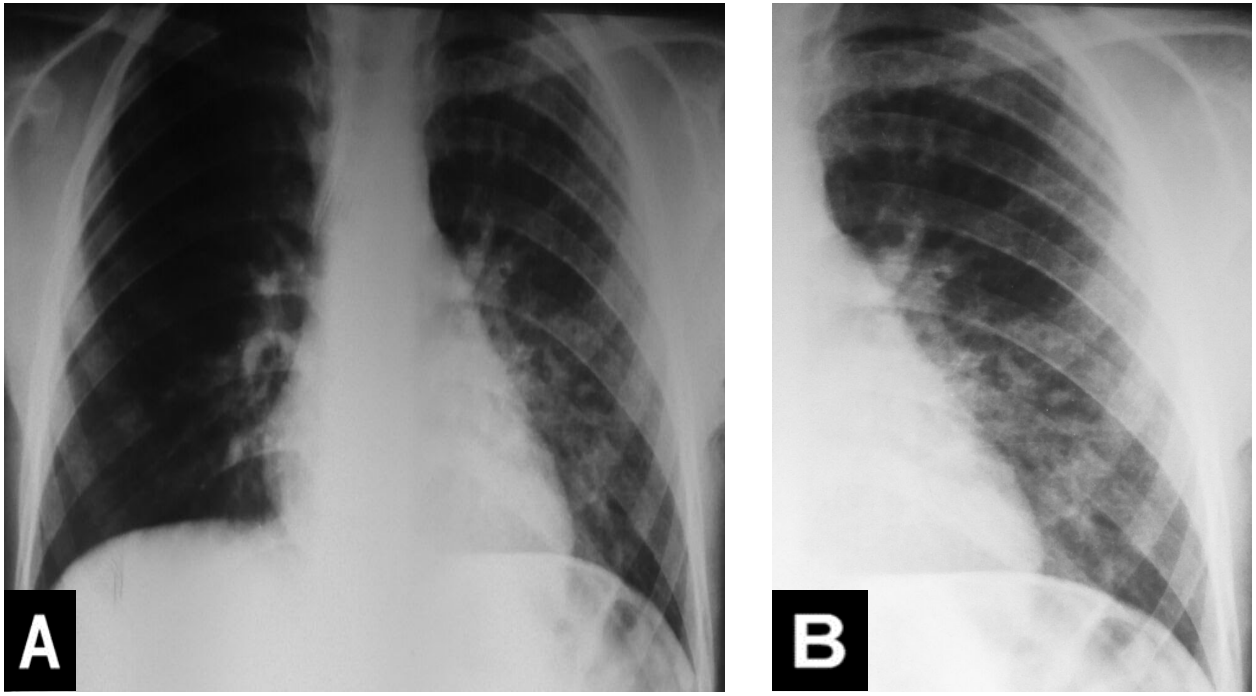
Acute infectious pneumopathies

Viral pneumonia

Viral pneumonia is commonly found in the lower lobes. From a radiological standpoint, it appears as uni- or bilateral accentuation of the perihilar peribronhovascular drawing, with the presence of fine, linear opacities that start from the lung hilum and go towards the pulmonary bases. Along these fine, linear opacities, punctiforme opacities are visualized. It is important to note that radiological changes often precede the onset of clinical symptomatology and may be exacerbated in the event of bacterial overinfection.

Acute infectious pneumopathies

Viral pneumonia



Acute infectious pneumopathies

COVID-19 is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2);

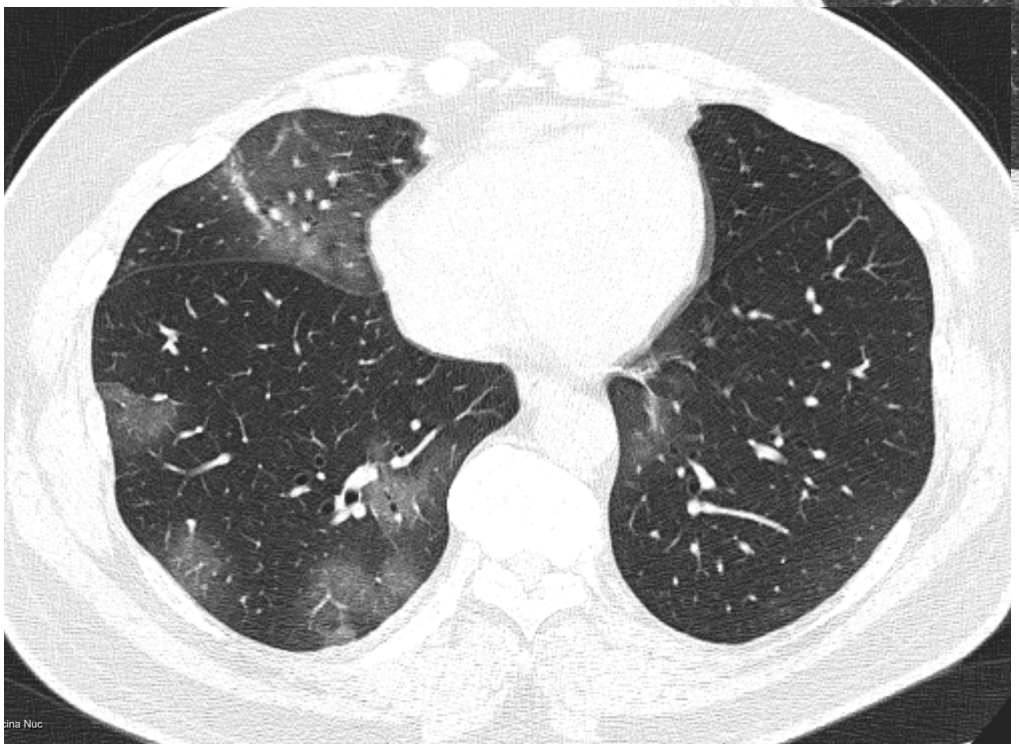
Definitive diagnosis of COVID-19 requires a positive RT-PCR test.

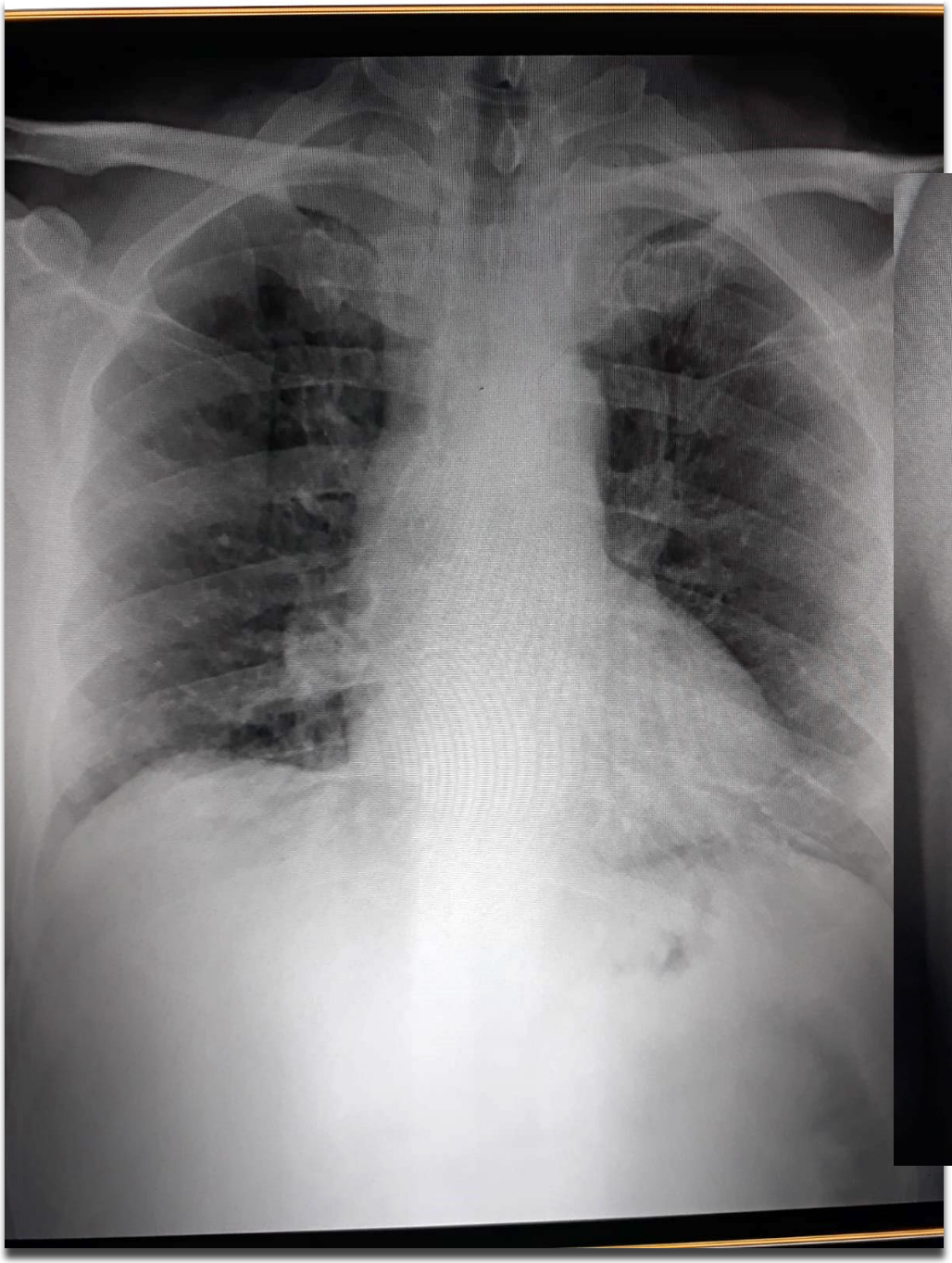
X-RAY: consolidation and ground-glass opacities;

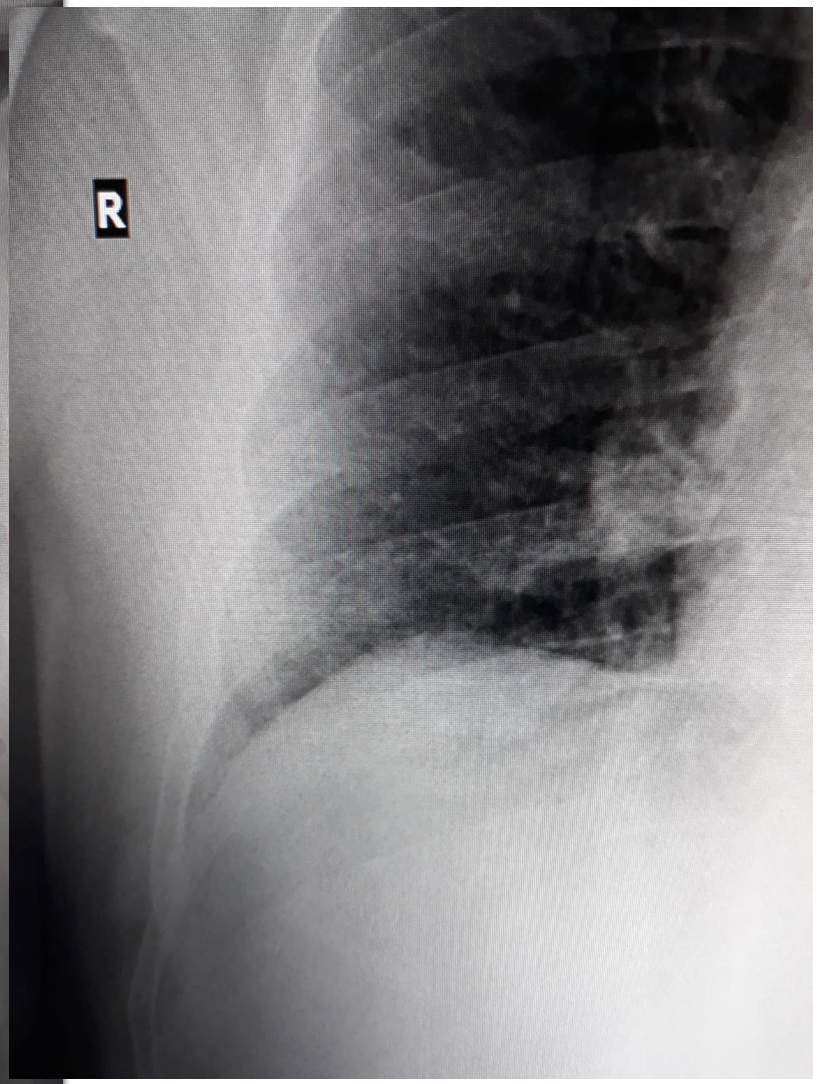
CT:

- ground-glass opacities (GGO): bilateral, subpleural, peripheral
- crazy paving appearance (GGOs and inter-/intra-lobular septal thickening)
- air space consolidation
- bronchovascular thickening in the lesion
- traction bronchiectasis

COVID-19



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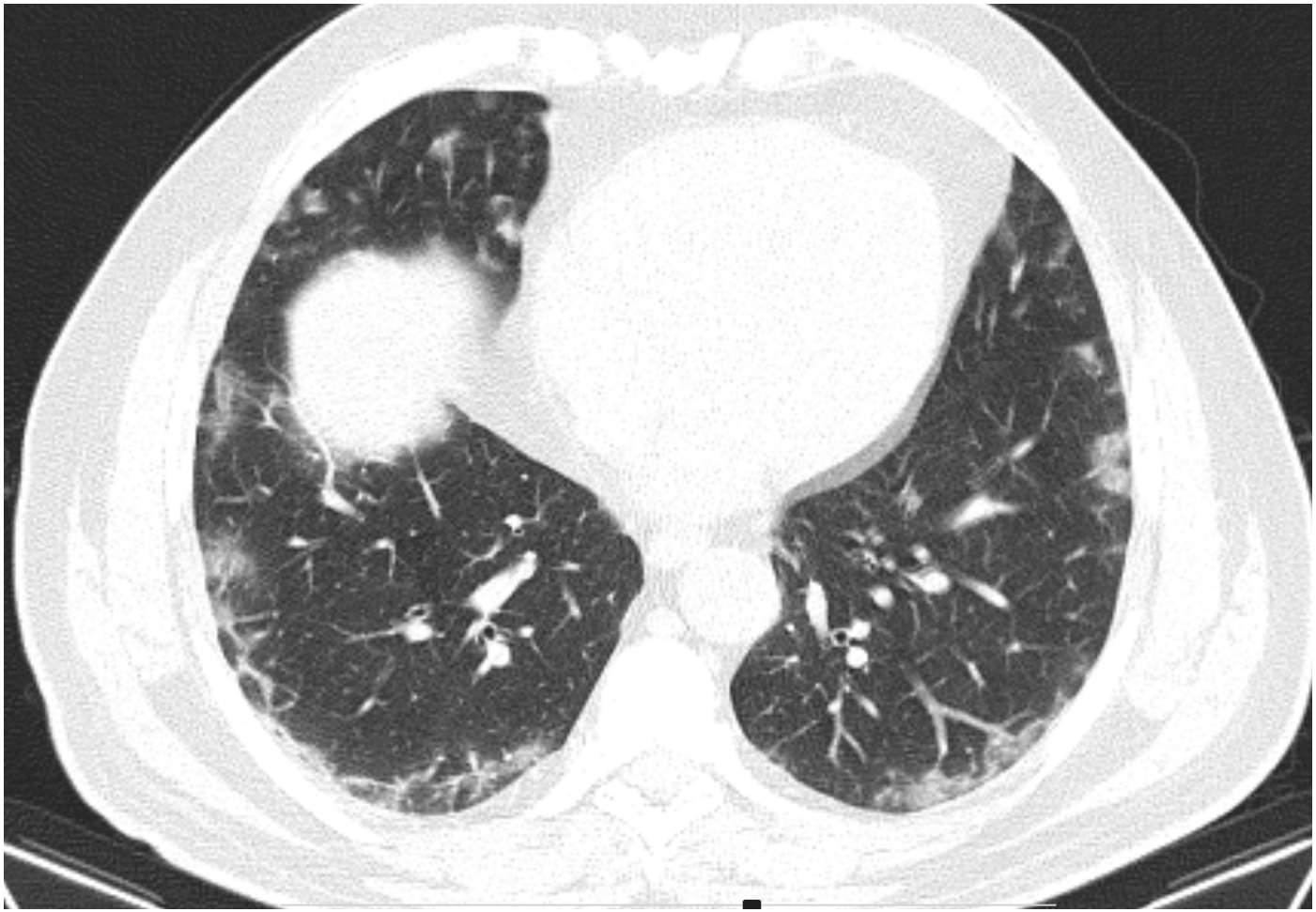


Acute infectious pneumopathies

Nosocomial pneumonia

According to the Thoracic American Society, nosocomial pneumonias are defined as pneumonias that develop after more than 48 hours of hospitalization.

Regarding epidemiology, nosocomial pneumonias are diagnosed in patients admitted to intensive care, intubated and mechanically ventilated. Nosocomial pneumonias can affect both sexes and all age groups, but the highest incidence is noted in elderly patients.

The nosocomial pneumonias can have an ***acute onset*** (in less than 4 days after hospitalization) or an ***insidious onset*** (in more than 5 days after hospitalization).

Acute infectious pneumopathies

Bronchopneumonia

From a radiological standpoint, bronchopneumonias are characterized by the presence of confluent nodular opacities of variable dimensions, uni- or bilateral, with high central intensity and diffuse outline.

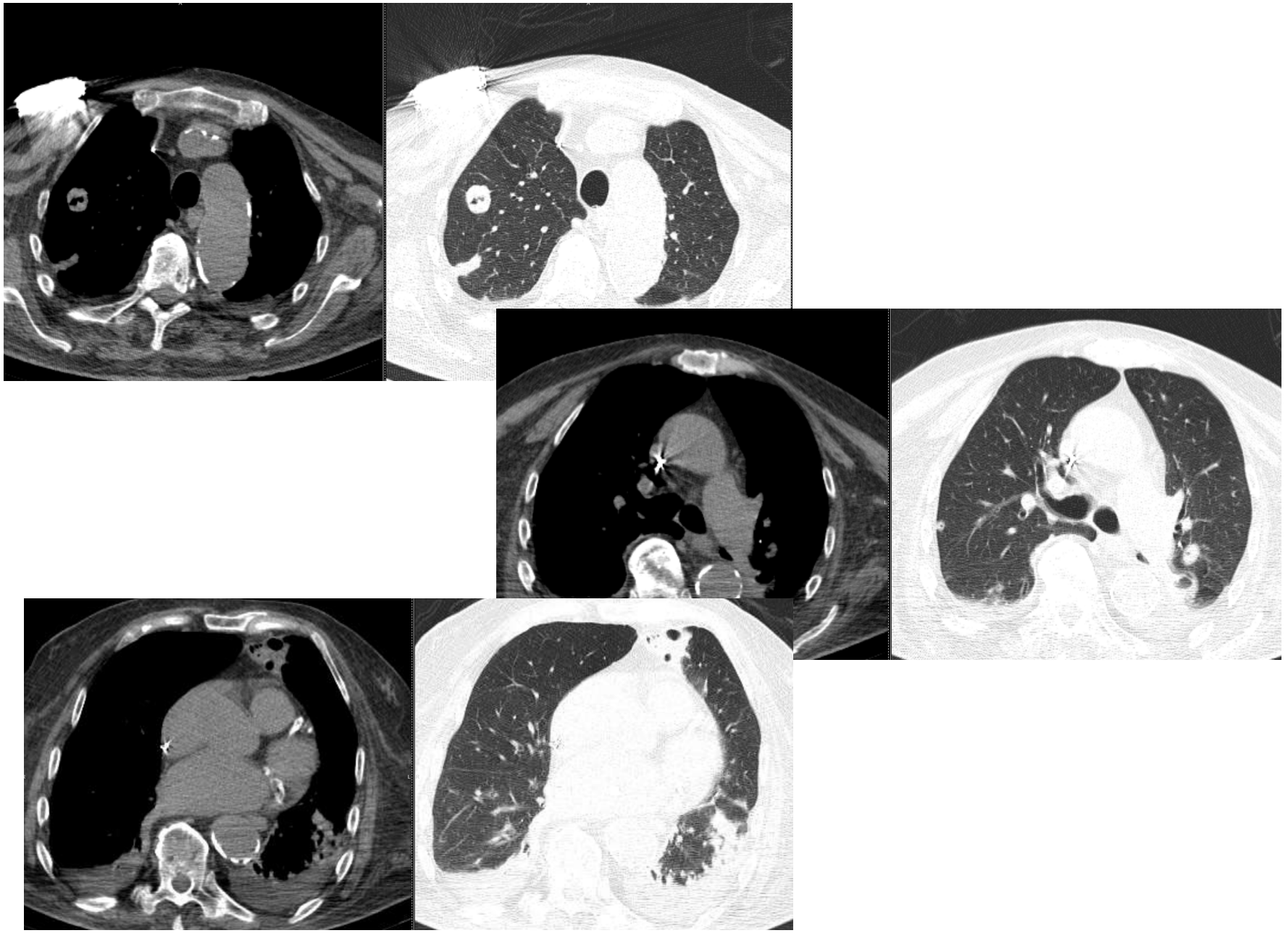
Acute infectious pneumopathies

Staphilococcal bronchopneumonia

From a radiological point of view, this type of bronchopneumonia is characterized by the presence of nodular opacities of variable dimensions, with homogeneous appearance in the initial phases, well deliniated by a clear outline. In evolution, by eliminating pus content from these opacities, they become radiolucent, well-deliniated focal images, called ***pneumatoceles***. When located subpleurally, the pus content is eliminated in the pleural space.

Staphylococcal bronchopneumonia is characterized by a great variability of the radiological image from one day to another generated by the development of new bronchopneumonic opacities or focal radiolucent images (pneumatoceles). Complications of this pathology include piothorax, piopneumothorax and the presence of pleural effusion.

Staphilococcal bronchopneumonia



Lung parasitosis

Hydatid cyst

Tenia Echinococcus.

- closed hydatid cyst;
- opened hydatid cyst;
- calcified hydatid cyst.

Lung parasitosis

Closed hydatid cyst

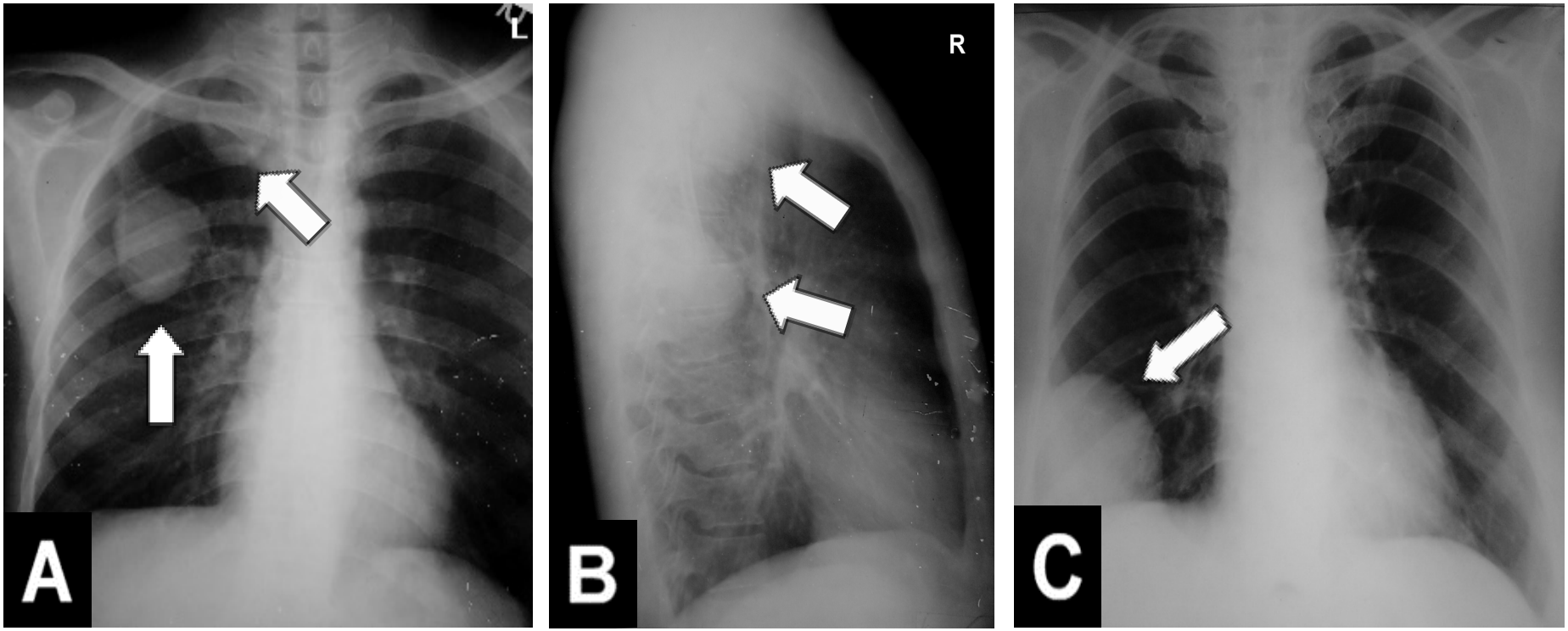
Unique round-oval opacity, well deliniated by a clear outline, which allows the vascular drawing to be seen through it. At fluoroscopic examination, the dimensions of the hydatid cyst vary depending on the respiratory phases - it enlarges during inhale and returns to normal during exhale (a solid lung tumor does not change its dimensions according to the respiratory phases).

From the radiological point of view, in the upper part of the opacity, a semilunar radiolucency can be seen (Morquio sign) which is represented by the detachment of the proligerous membrane at this level.

The CT examination performed in this stage reveals one or more round-oval lesions, with cystic type densities, with variable dimensions, located uni- or bilaterally, well delineated by a iodophilic wall. It is also possible to notice the presence of the proligerous membrane inside the lesion. After vomica, the opened hydatid cyst results.

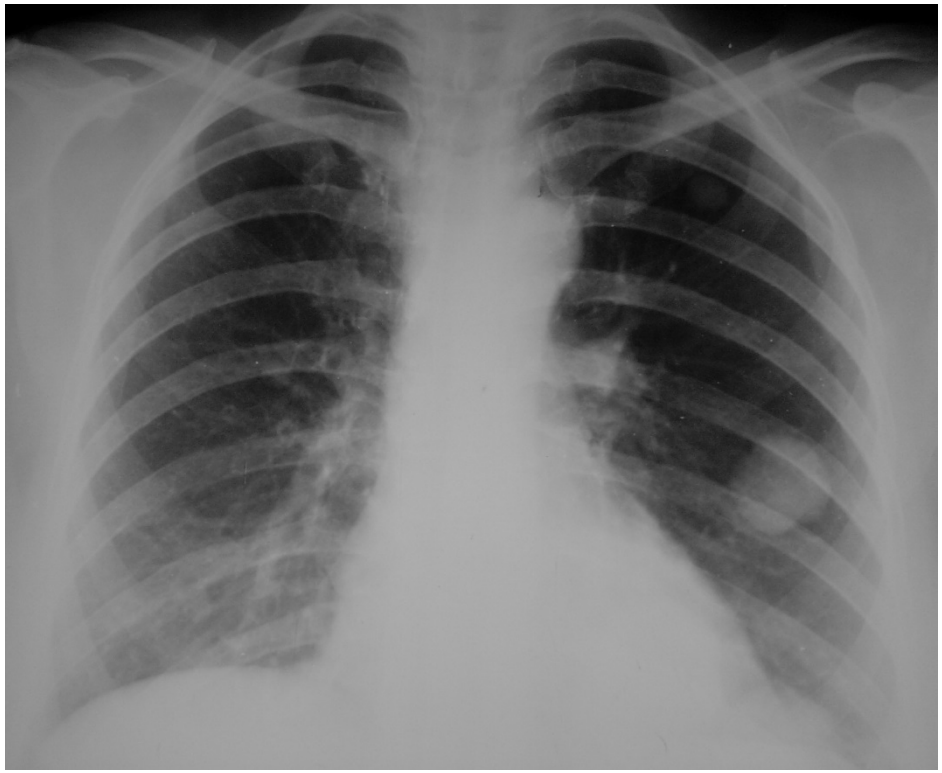
Lung parasitosis

Closed hydatid cyst



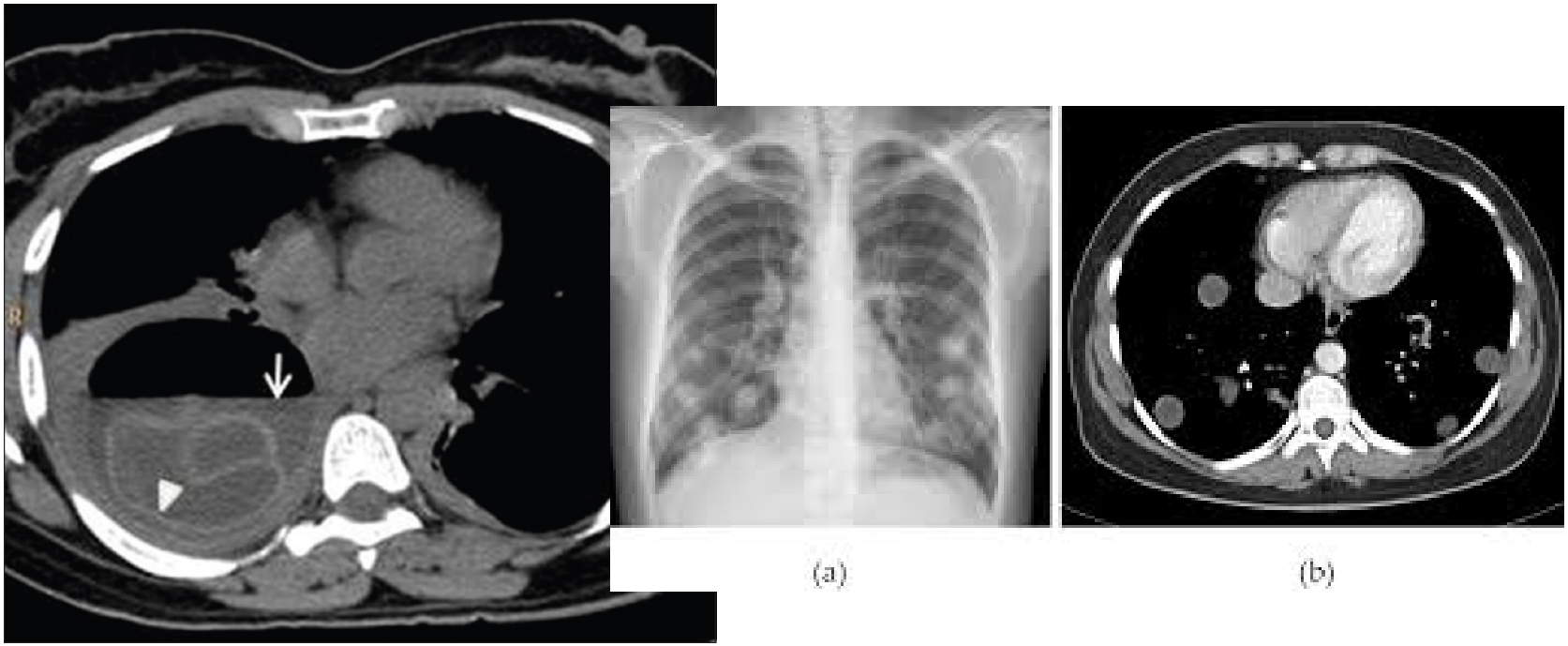
Lung parasitosis

Closed hydatid cyst



Lung parasitosis

Closed hydatid cyst



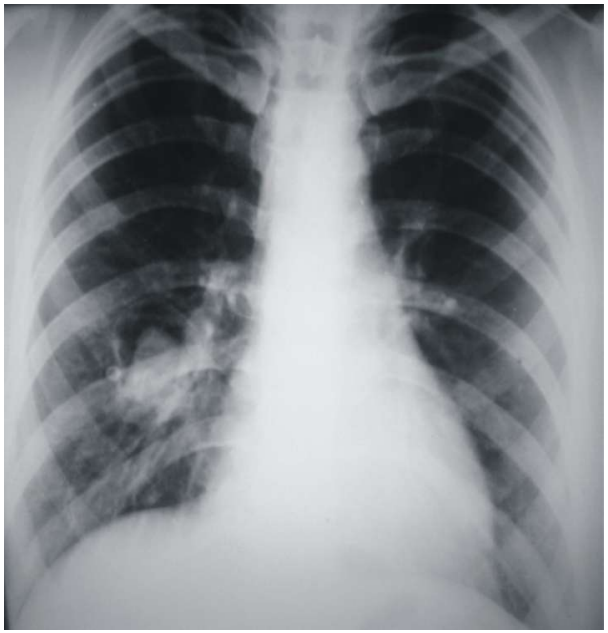
https://www.intechopen.com/books/current-topics-in-echinococcosis/radiological-characteristics-of-pulmonary-hydatid-cysts

Lung parasitosis

Opened hydatid cyst

The radiological aspect of the hydatid cyst in this stage is represented by a mixed content lesion with air-fluid level and a waved separation limit between the two.

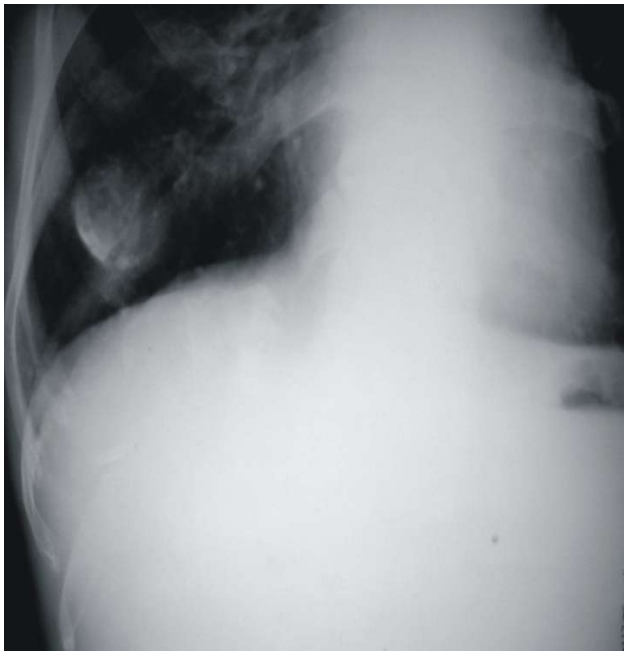
The CT aspect of the lesion is similar to the one described on conventional radiography.



Lung parasitosis

Calcified hydatid cyst

The parasite dies and the lesion decreases in size and becomes calcified. In this phase, the CT appearance is similar to the one described on conventional radiography.



Lung micosis

Pulmonary aspergillosis

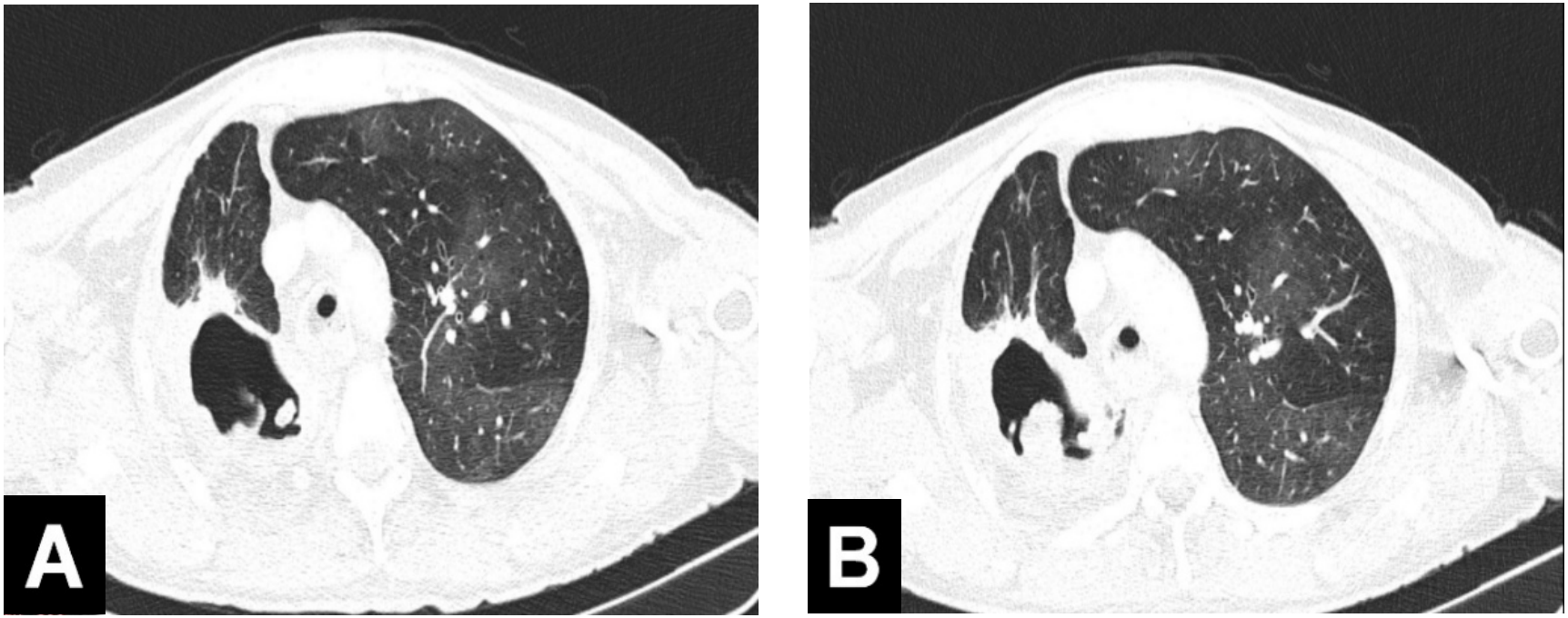
Pulmonary aspergillosis occurs frequently in immunocompromised patients, as well as after prolonged antibiotic and corticosteroid therapy. In order for this lesion to develop, there must be a pre-existing cavity.

From a radiological standpoint, pulmonary aspergillosis involves the existence of an intracavitary mycelial mass (mycetoma) seen as a well-deliniated round-oval opacity, with homogeneous structure and mediastinal intensity, that moves inside the cavity as the patient changes his/her position.

The CT examination reveals a cavity area of variable dimensions, with a contrast enhancing round-oval lesion inside (mycetoma), well delineated, with soft tissue densities, mobile inside the cavity with the patient's movements, surrounded by a semilunar area of aerial content. In certain situations, the mycetoma may cause the cavity to be completelly filled.

Lung micosis

Pulmonary aspergillosis



Bronchopulmonary suppuration

Lung abscess

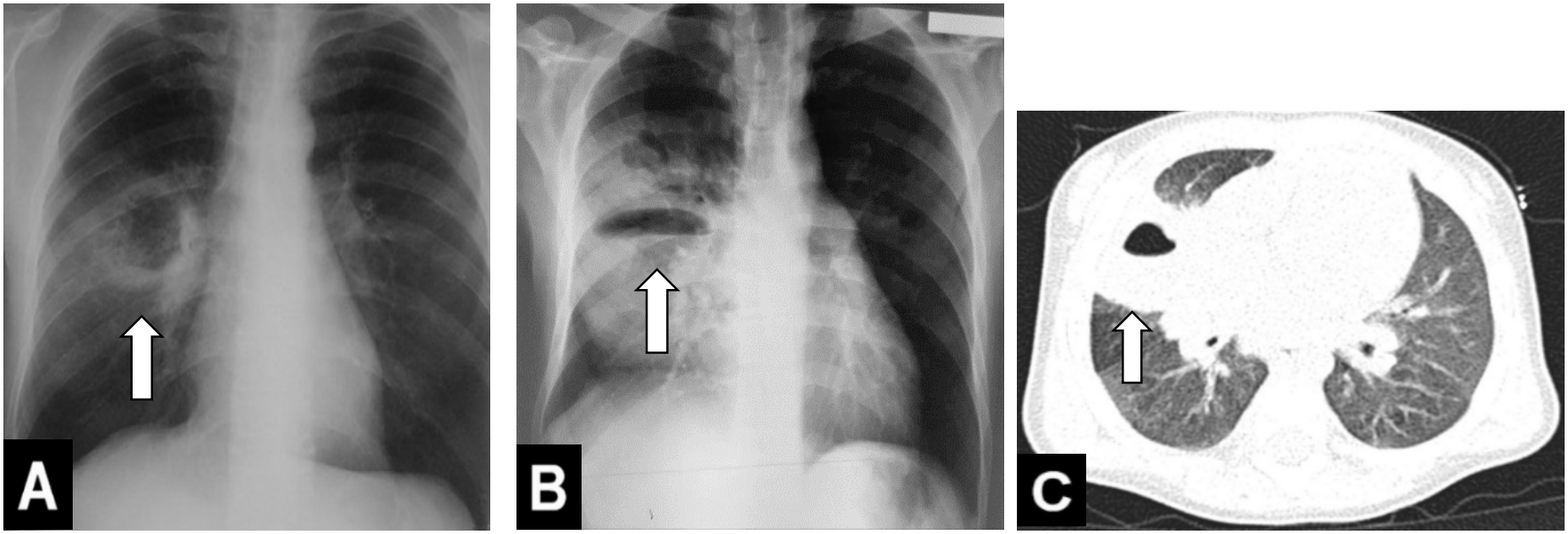
Pulmonary abscess is a localized suppuration in the lung parenchyma resulting from an acute inflammatory process (pneumonia, bronchopneumonia).

RX: the pulmonary abscess implies an initial phase of formation, represented by the pneumonic opacity that increases in intensity and becomes inhomogeneous, with diffuse outlines. Later, after vomica occurs, the air-fluid image appears due to the air that gets inside the lesion from the adjacent bronchia. In this phase, the pulmonary abscess has radiolucent air content in the upper portion and opaque fluid content in the lower portion, with a horizontal separation limit between the two. In the initial stages, the abscess is delimited by a thick, diffuse, low intensity outline that, in evolution, will become clear. The radiological aspect of the pulmonary abscess changes from one moment of the day to another or from one day to another.

CT: the non-evacuated pulmonary abscess appears as a round-oval hypodense lesion with fluid densities inside. Following the evacuation of the pus, the air-fluid image appears, and the aspect is similar to the one identified in conventional radiology.

Bronchopulmonary suppuration

Lung abscess



Lung emphysema

Pulmonary emphysema involves ***pulmonary hyperinflation*** and ***pulmonary perfusion changes***.

On a PA pulmonary radiography, ***pulmonary hyperinflation*** determines the following changes:

- lowering and flattening of the hemidiaphragms;
- increased cardiophrenic and costodiaphragmatic angles;
- increased longitudinal diameter of the thorax;
- verticalization of the cord;
- enlargement of the intercostal spaces;
- horizontalization of the posterior rib arches;
- verticalization of the anterior rib arches.

Lung emphysema

On a profile pulmonary radiography, ***pulmonary hyperinflation*** determines the following changes:

- increased anteroposterior diameter of the thorax;
- accentuation of the thoracic kyphosis;
- increased size of the clear retrosternal space;
- the diaphragmatic domes appear rectilinear or concave superiorly.

Pulmonary perfusion changes are radiologically translated by:

- increased diameter of the pulmonary arteries in the hilum;
- the vascular drawing appears "amputated" in the periphery of the lung, (the pulmonary vessels end at distance from the thoracic lateral wall).

Lung emphysema

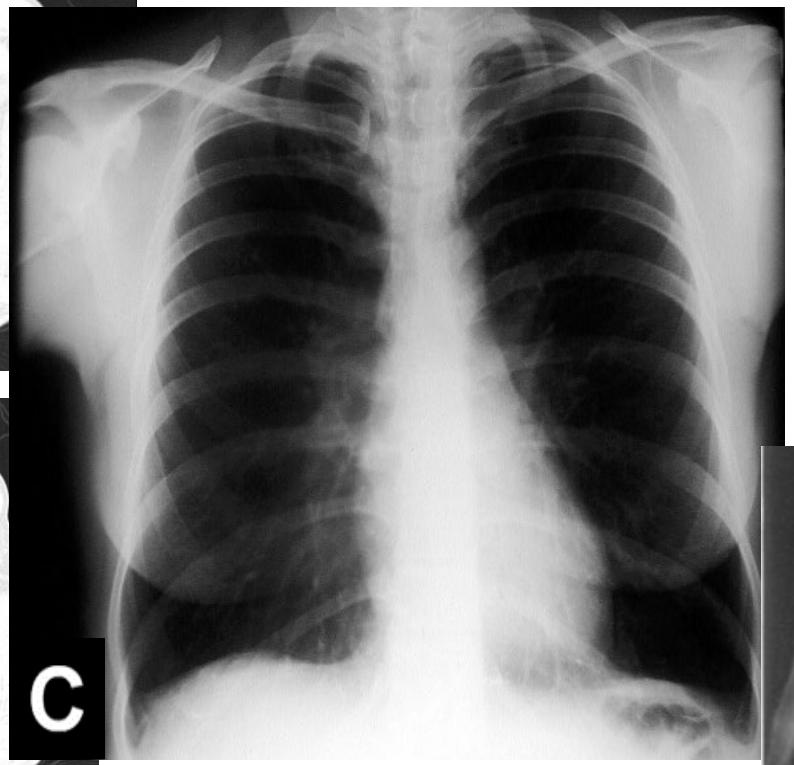
CT: changes similar to those described on conventional radiography. In addition, one of the main advantages offered by this imaging method is the possibility to differentiate between the different types of pulmonary emphysema (centrilobular, paraseptal and panlobular).

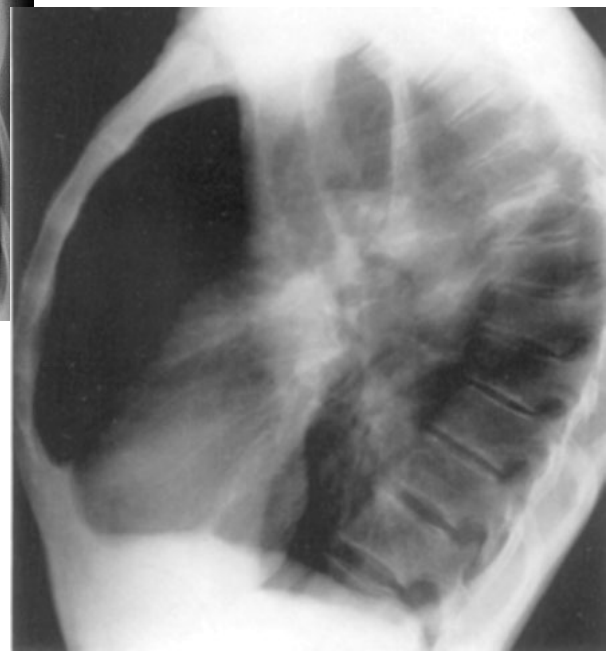
Centrilobular emphysema is most commonly encountered and is characterized by the central distribution of emphysematous changes in the pulmonary lobe.

Paraseptal emphysema associates emphysematous changes in the vicinity of the pleura and the septum.

Panlobular emphysema causes uniform emphysematous changes in the lung lobe.

Lung emphysema





Bronchiectasis

Bronchiectasis represents abnormal, irreversible bronchial dilatations due to an extremely varied etiology. Most commonly, bronchiectasis occurs in the context of a chronic inflammatory process and can be detected by conventional radiography or CT examination.

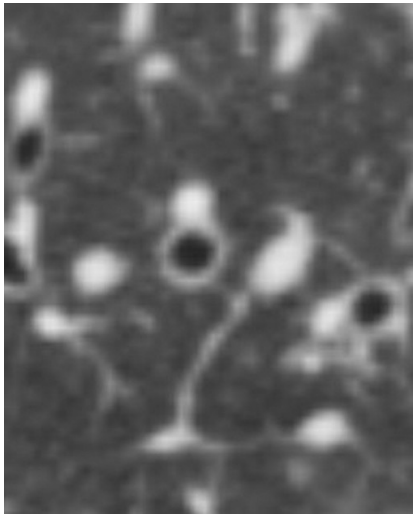
The pulmonary arteries (main, lobar, segmentary etc.) are accompanied by the corresponding pulmonary arteries (main, lobar, segmentary etc.), having similar diameters (broncho-arterial index = 1). A broncho-arterial index of 1-1.5 (bronchial diameter up to 1.5 times the diameter of the corresponding pulmonary artery) can be seen as normal in individuals living in high altitude areas.

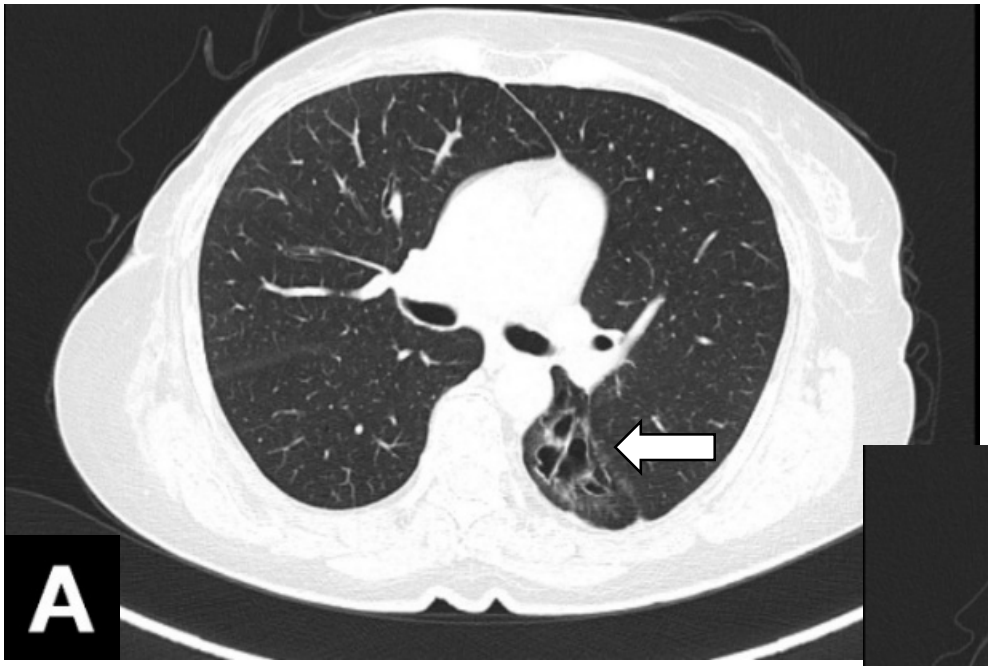
The diagnosis of bronchiectasis is established when the broncho-arterial index is greater than 1.5 (the bronchial diameter is over 1.5 times the diameter of the corresponding pulmonary artery).

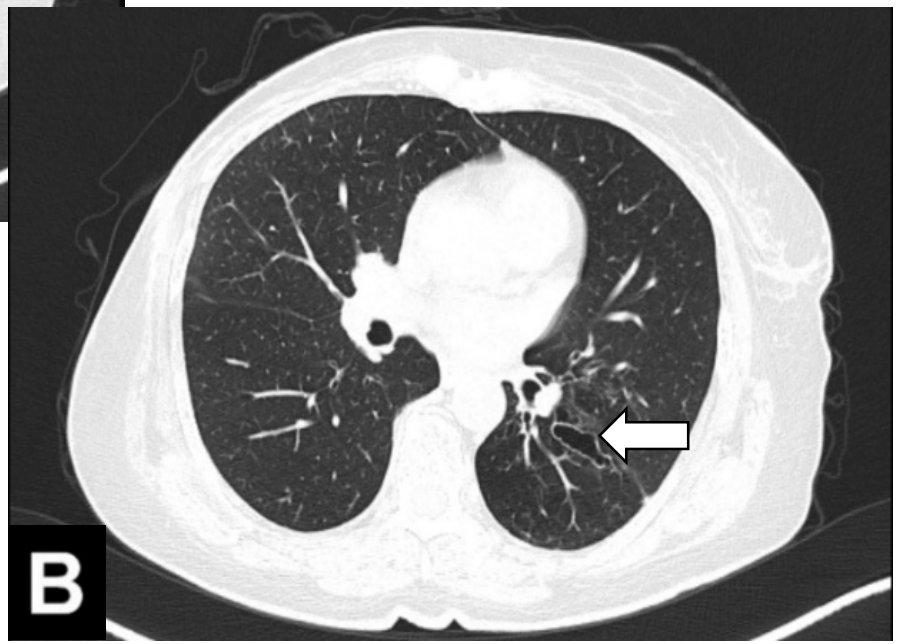
The CT examination allows the identification and characterization of bronchiectasis with an accuracy far superior to conventional radiography. In addition, CT examination can determine the type of bronchiectasis (cylindrical, varicose, cystic).

https://radiopaedia.org/articles/bronchiectasis

Bronchiectasis







Pneumoconiosis

Silicosis is a condition caused by the penetration of silicogenic powders into the lung alveoli. For diagnosis, RX and CT examination can be used.

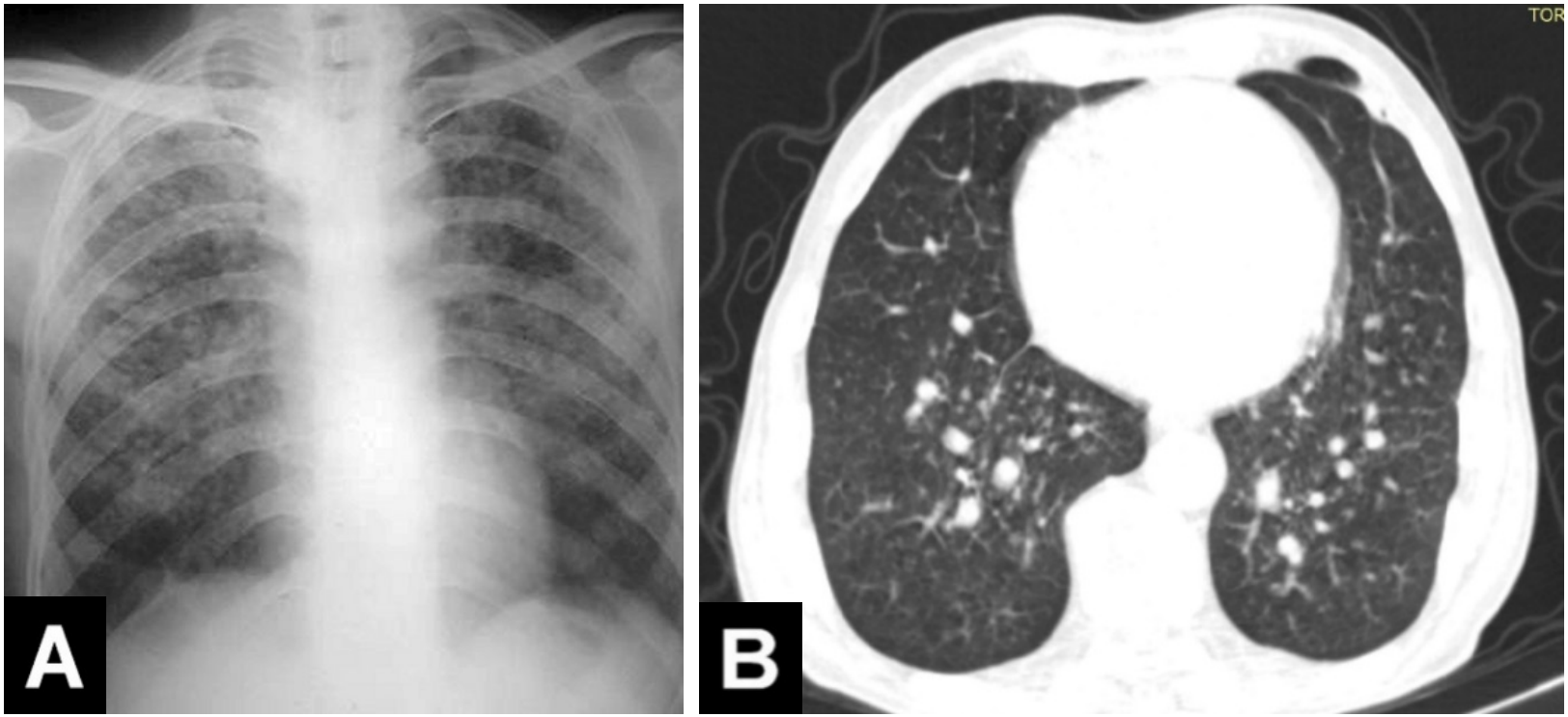
The following stages of evolution are distinguished:

- *stage I:* punctate and micronodular opacities, well deliniated, low intensity, located bilaterally, predominantly in the middle lung areas;

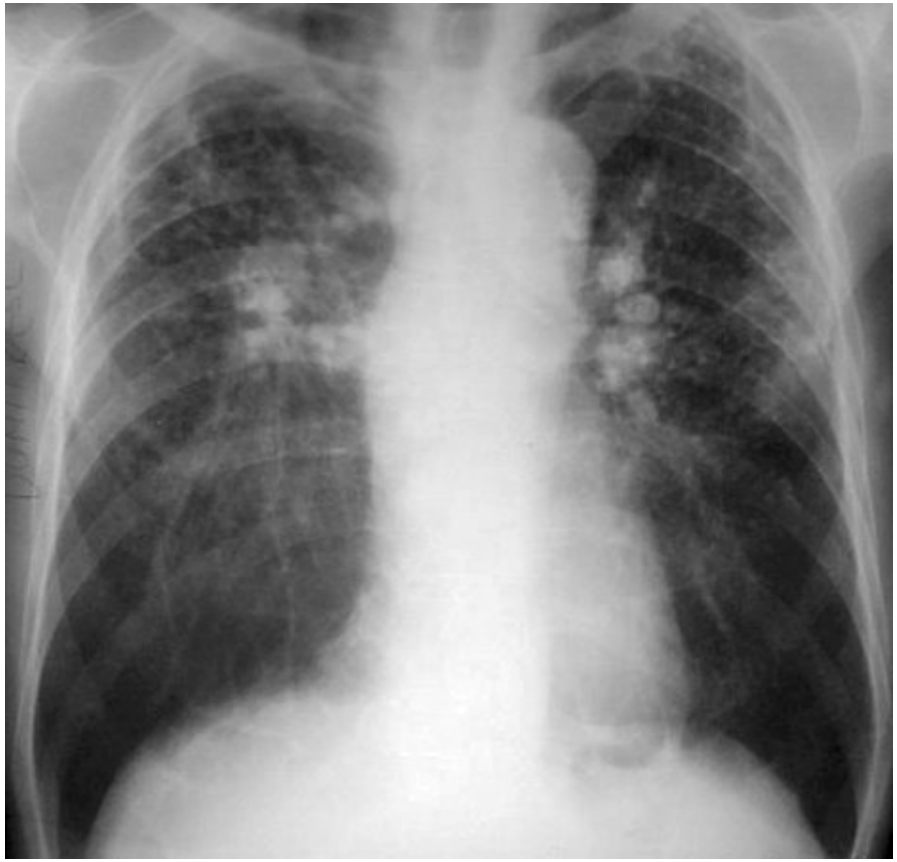
- *stage II:* nodular opacities increase in intensity, as well as in number and size and cover both pulmonary areas almost entirely, without affecting the apex;

- *stage III:* the nodular opacities become confluent and form macronodules, the pulmonary hillums have an enlarged projection surface, fibrotic lesions, bronchiectasis and eggshell calcifications of mediastinal lymphadenopathies.

Pneumoconiosis



Pneumoconiosis



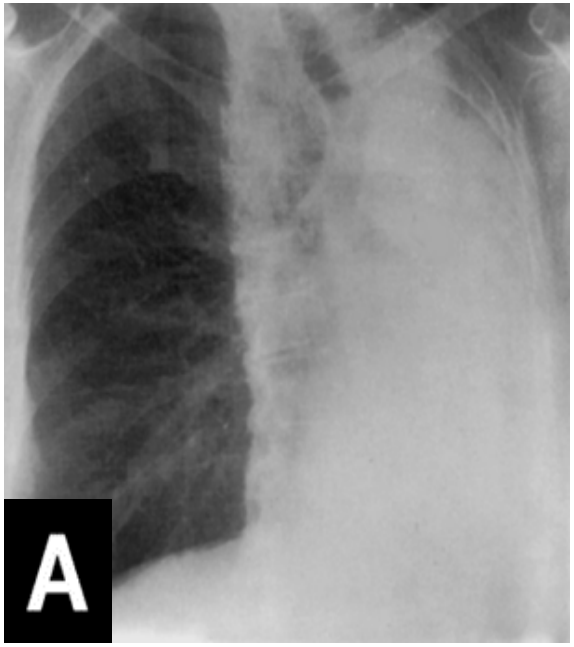
Atelectasis

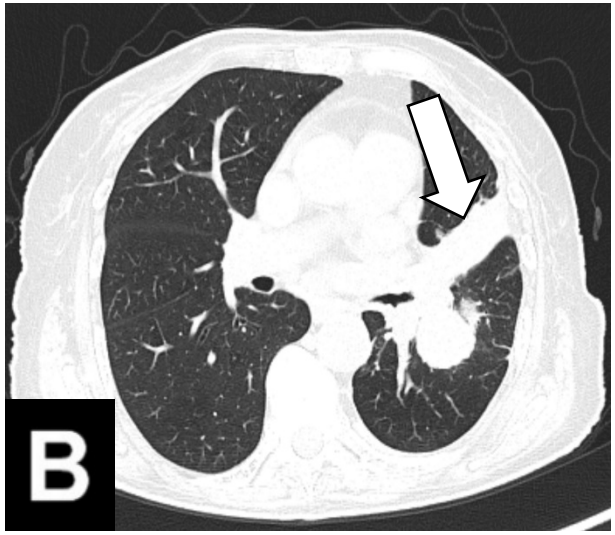
Atelectasis involves a total obstruction of the bronchia that ventilates a certain lung territory. Due to the complete blocking of the air passage through the bronchia at the level of the atelectatic area, the remaining air from this level will be resorbed in the blood. For the diagnosis, conventional radiography and CT examination can be used.

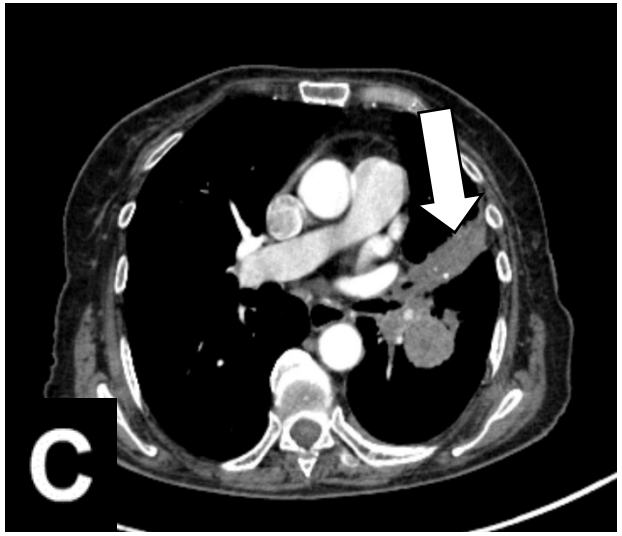
RX: atelectasis appears as an opacity of variable dimensions depending on the size of the obstructed bronchia (segmentary opacity, lobular opacity, opacity affecting several lobes or the entire lung) which manifests a retractable effect on the fissures (horizontal, oblique), mediastinal structures, diaphragm, ribs and intercostal spaces. If the complete resorption of air in the blood has not yet been performed, air inclusions may be highlighted at the level of the atelectasis zone. Also, by losing the normal volume of the segment, of the lobe or of the entire affected lung, the pulmonary vessels that irrigate the atelectatic area appear conglomerated at this level.

Atelectasis

The CT examination, in addition to conventional radiography, can achieve a more complete characterization of the atelectasis area and can identify associated pulmonary pathological changes that may indicate the etiology of this condition.







Lung collapse

Pulmonary collapse involves the collapse of the pulmonary parenchyma (segment, lobe, or entire lung) due to extrapulmonary causes (eg, pleurisy or pneumothorax).

In pulmonary collapse, the collapsed territory is not functionally excluded, but has a diminished function. Communication with the bronchia that ventilates this territory is maintained, which is why the air is not resorbed in the bloodstream, and the affected pulmonary area has a tendency to expansion, not retraction. After removal of the etiological factor, it is possible to re-expand the lung parenchyma.

For the diagnosis, conventional radiography and CT examination can be used.

In some situations, conventional radiography can highlight the etiological factor (pleural effusion, pneumothorax etc.). In addition, the retraction of the fissures (horizontal, oblique), mediastinal structures, diaphragm, ribs and intercostal spaces to the same side with pulmonary collapse is noted. Also, by losing the normal volume of the segment, the lobe or the entire affected lung, the vessels and airways that serve the collapsed pulmonary area appear conglomerated at this level and the healthy adjacent pulmonary lobes undergo compensatory hyperinflation changes.

The CT examination reveals aspects similar to those described on conventional radiography and can more accurately identify both the etiological factor involved and the permeability of the adjacent bronchia (differential diagnosis with atelectasis).

Lung fibrosis

Pulmonary fibrosis represents either the pulmonary expression of a rheumatic disease or the final healing stage of an inflammatory or infectious disease.

RX: pulmonary fibrosis can be seen as high intensity opacities, which manifest retraction phenomena on the bronchias, fissures (horizontal, oblique), mediastinal structures, diaphragm, ribs and intercostal spaces.

Lung infarction

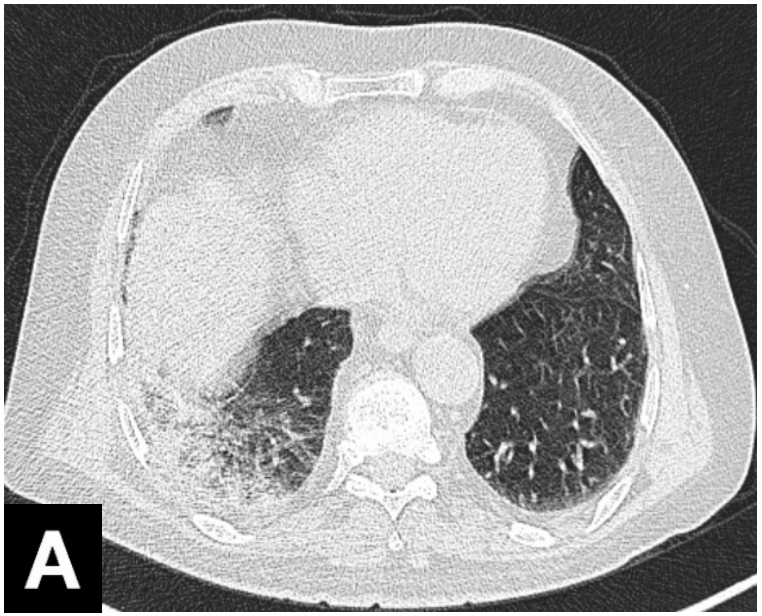
Pulmonary infarction occurs as a result of obstruction of blood flow to one or more branches of the main pulmonary artery. The size of the infarction is variable depending on the size of the obstructed pulmonary artery.

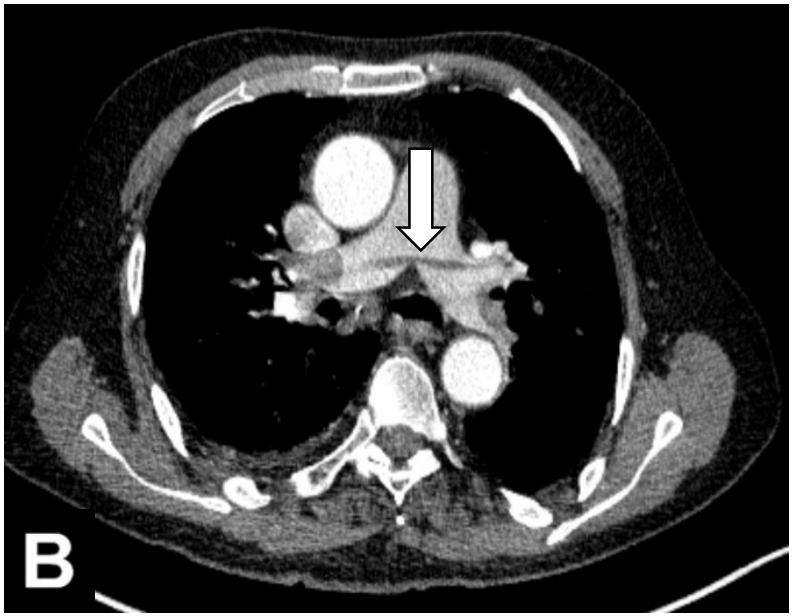
For diagnosis, conventional radiography and CT examination can be used.

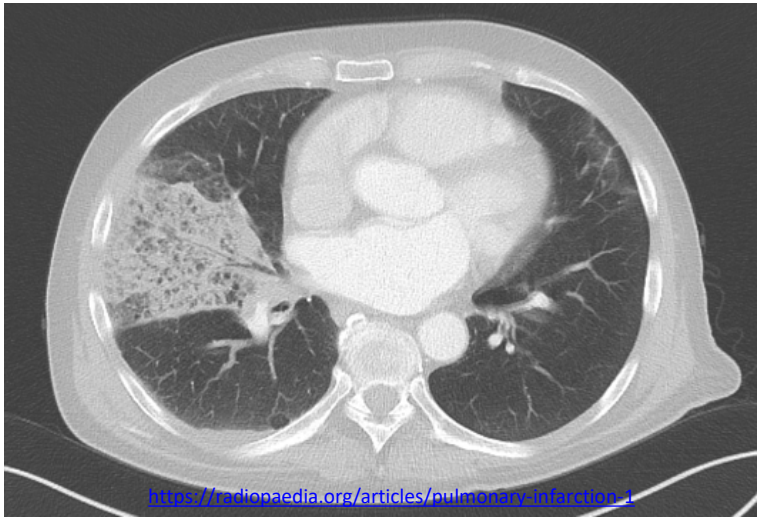
RX: the pulmonary infarction can be seen as a single or multiple opacities of triangular shape and mediastinal intensity, with the tip oriented towards the hil and the base towards the periphery, with homogeneous structure and regular outline. This radiological aspect appears between several hours to several days from the time of infarction.

Contrast enhanced CT identifies the presence of the thrombus in the involved vascular structure.

Lung infarction







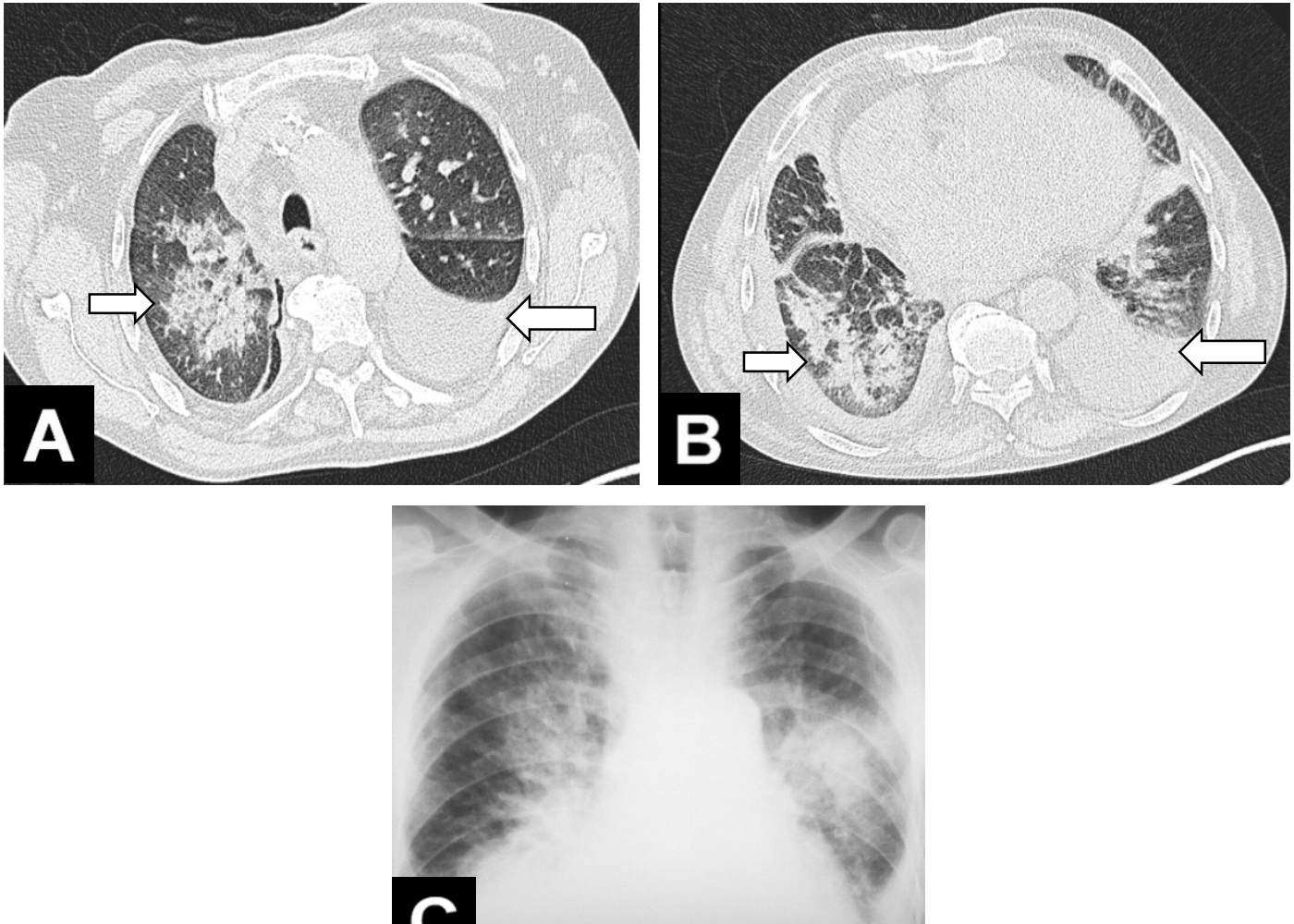
https://radiopaedia.org/articles/pulmonary-infarction-1

Acute pulmonary edema

Acute pulmonary edema involves an increased pressure at the pulmonary capillaries above a critical level. For diagnosis, conventional radiography and CT examination can be used.

RX: acute pulmonary edema is visualized in the form of confluent peribronchial infiltrates, developed bilaterally near the hilum, with the so-called aspect of "butterfly wings“. Frequently, acute pulmonary edema is associated with global enlargement of the heart and pleural and/or pericardial effusion.

Acute pulmonary edema



Pulmonary tuberculosis

Primary tuberculosis

Primary tuberculosis represents the first contact of the organism with the Koch bacillus and is characterized by the presence of the ***Ranke primary complex (Ghon nodule, lymphangitis, hilar lymphadenopathy).*** For diagnosis, conventional radiography and CT examination can be used.

Pulmonary tuberculosis

Primary tuberculosis

1. Ghon nodule (primary affect) is the main lesion developed in the pulmonary parenchyma and is radiologically seen as an opacity of variable dimensions, usually as a single lesion, usually seen in the lower 2/3 of the pulmonary areas.

The evolution of primary affect can be ***favorable*** or ***unfavorable***.

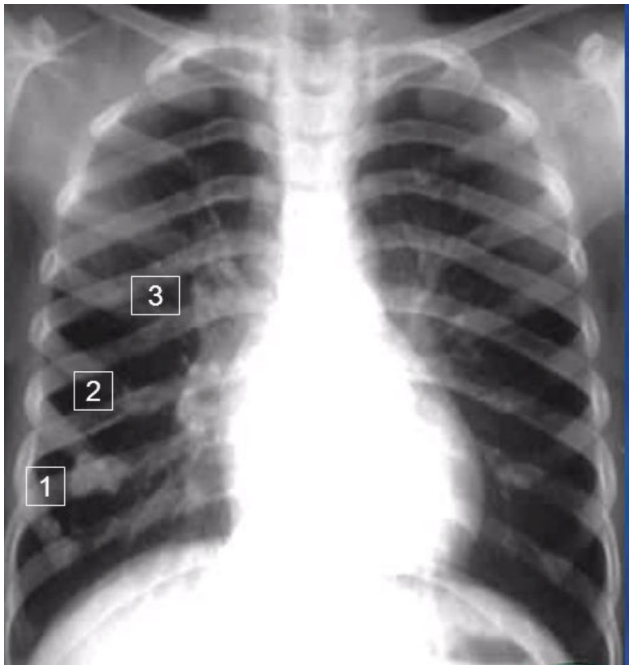
In case of favorable evolution, the primary affect decreases in size and intensity until it disappears (*restitutio ad integrum*). Also, the primary affect can decrease in size and become calcified (the lesion is inactive).

In case of unfavorable evolution, the primary affect increases in size and intensity. In evolution, the content eliminated leads to the formation of the primary cavern which can be distinguished from the caverns developed in secondary tuberculosis by the presence of hilar lymphadenopathies.

Pulmonary tuberculosis

Primary tuberculosis

2. Lymphangitis is radiologically highlighted in the form of fine linear opacities, which connect the Ghon nodule with the pulmonary hilum.



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Pulmonary tuberculosis

Primary tuberculosis

3. Hilar lymphadenopathy is probably the most important element of the primary complex and, not infrequently, represents the only radiological change detected in primary pulmonary tuberculosis.

RX: the hilar lymphadenopathy is highlighted in the form of a well-delimited round-oval opacity, of mediastinal intensity, with homogeneous structure.

The evolution of hilarious adenopathy can be ***favorable*** or ***unfavorable***.

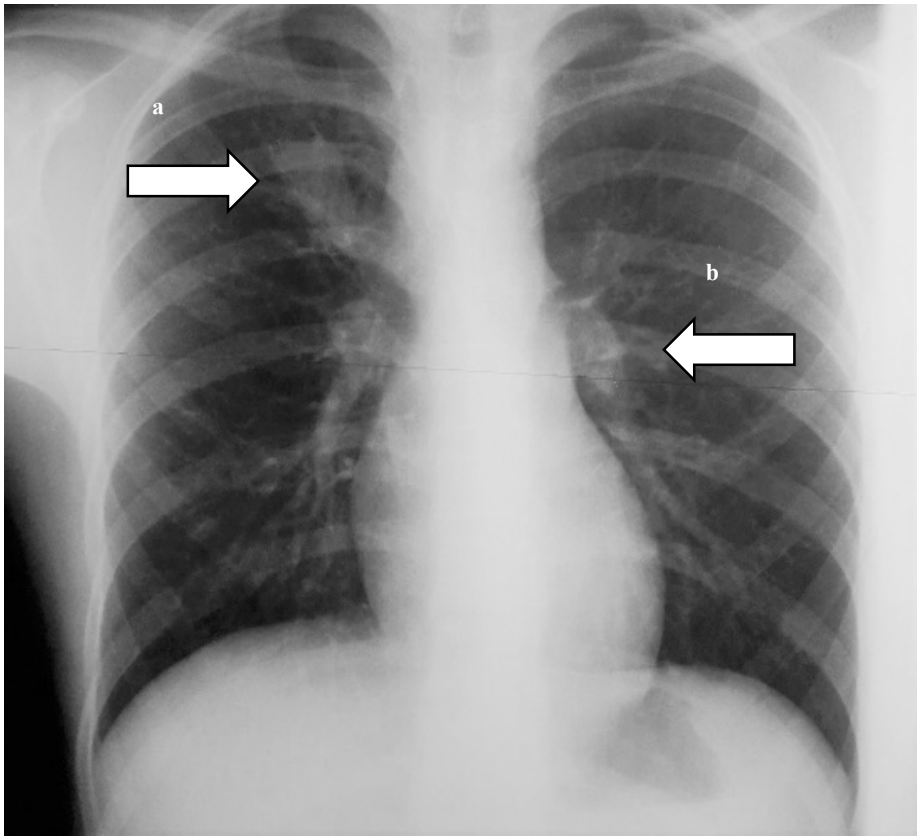
In case of favorable evolution, the hilar lymphadenopathy reduces its size until it disappears.

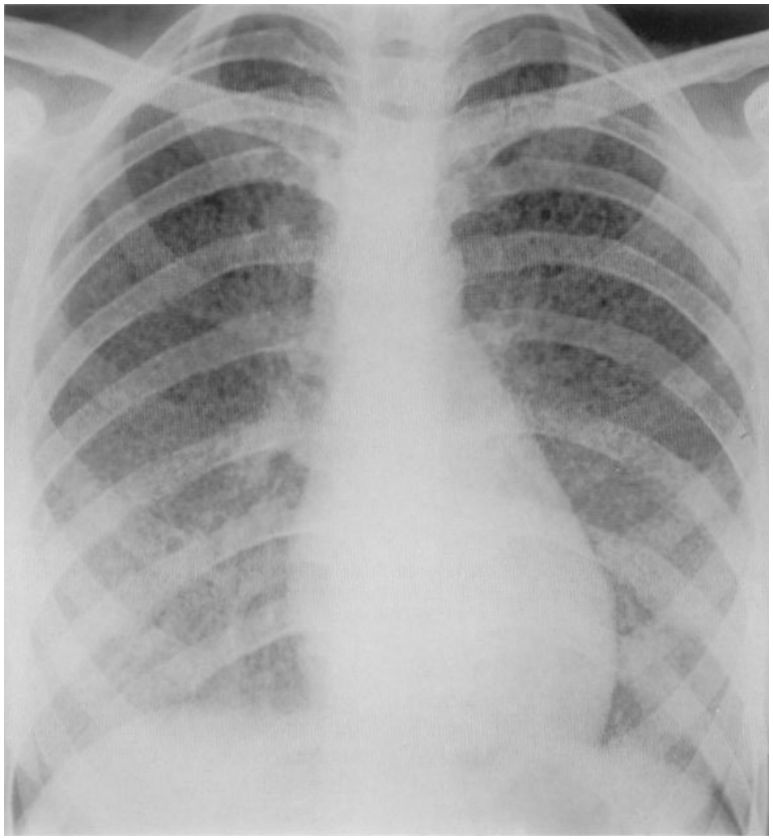
In case of unfavorable evolution, the hilar lymphadenopathy can increase in size and acquire a pseudotumoral appearance. Another possibility of unfavorable evolution of the hilar lymphadenopathy is adenobronchial fistula (elimination of adenopathic contents in the lumen of a bronchia) or endovascular fistula (elimination of adenopathic contents in a vascular branch, with the installation of hemoptysis and hematogenous spread) .

CT examination reveals aspects similar to those described in conventional radiography, but allows a more detailed characterization of mediastinal and hilar lymphadenopathies and pleural and / or pericardial effusions.

Pulmonary tuberculosis

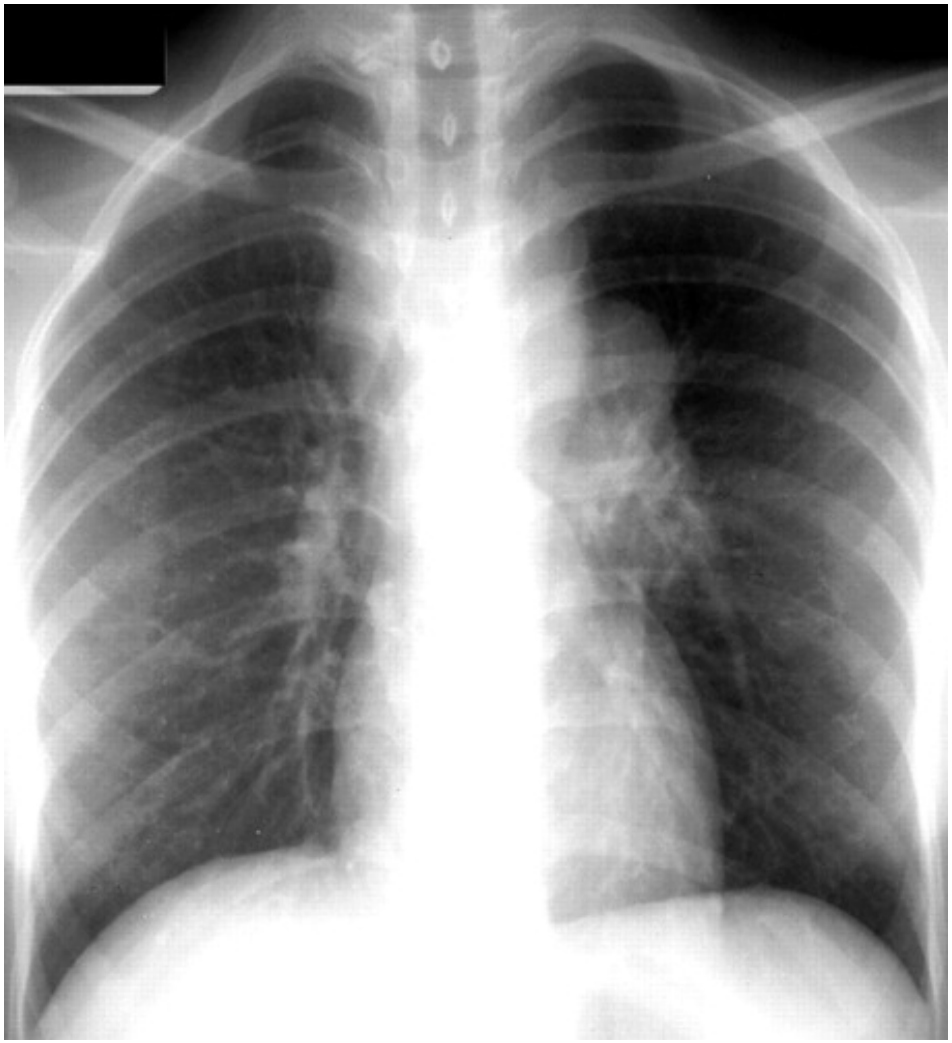
Primary tuberculosis





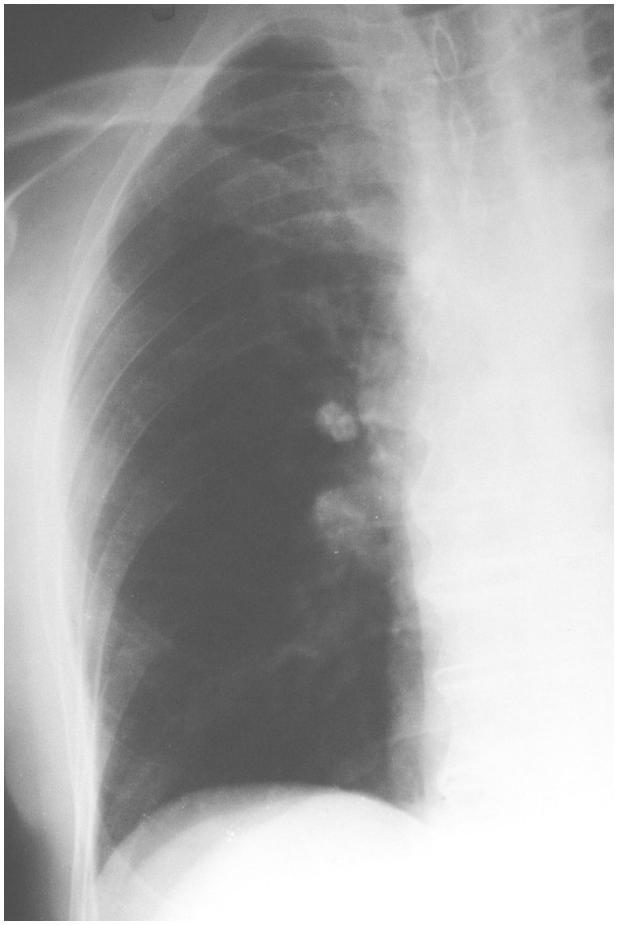
Pulmonary tuberculosis

Primary tuberculosis



Pulmonary tuberculosis

Primary tuberculosis: calcified Ghon nodule and adenopathy

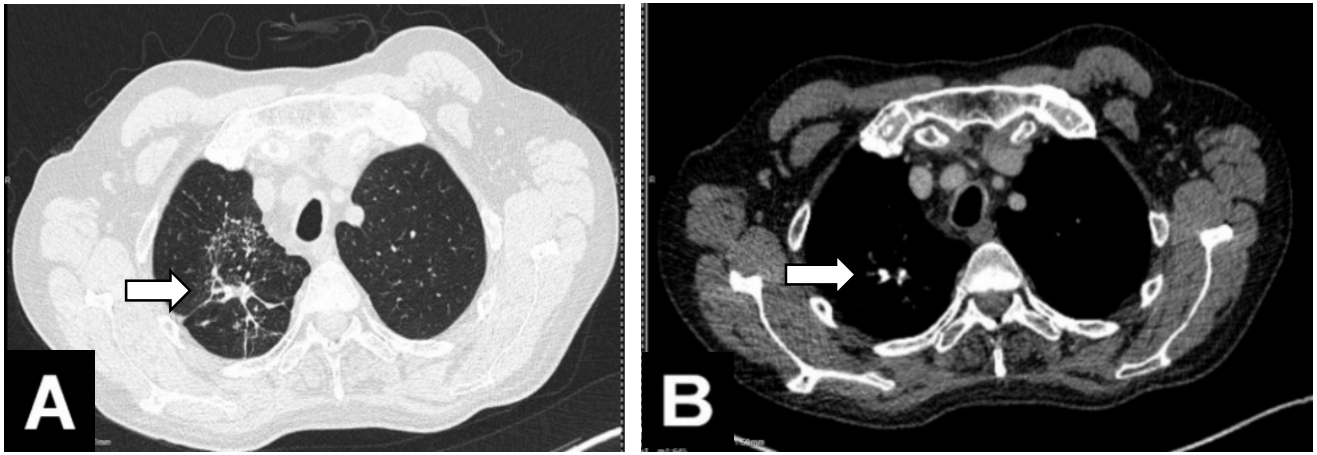


Pulmonary tuberculosis

Primary tuberculosis

Among the most important sequelae of primary pulmonary tuberculosis are post-apical nodules (Simon-Abricosov nodules) that are radiologically seen as micronodular, well-delimited, irregular, apically located opacities.

These nodules have phthisiogenic potential and represent the link between primary pulmonary tuberculosis and secondary pulmonary tuberculosis.



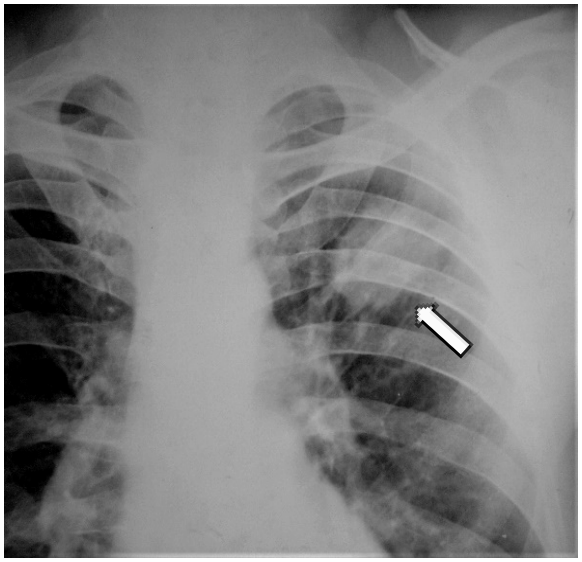
Pulmonary tuberculosis

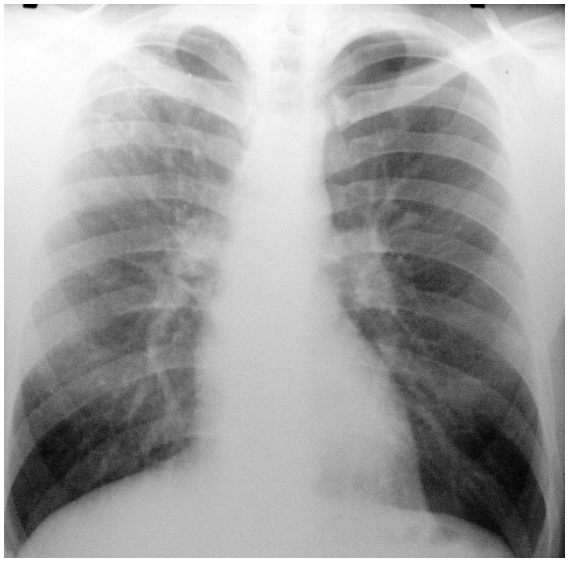
Secondary tuberculosis

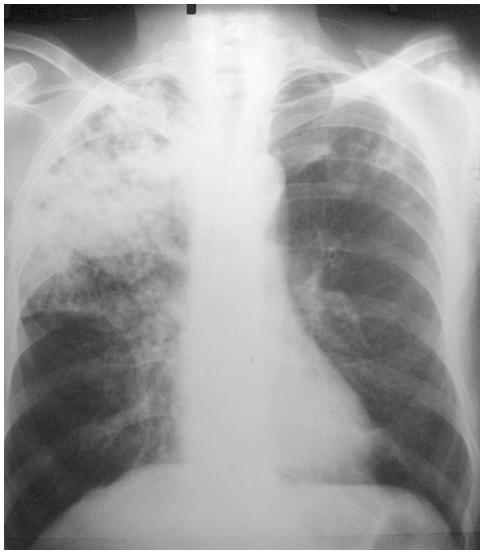
Secondary tuberculosis or phthisis occurs as a result of reactivation of post-apical foci when the body's resistance is low. For diagnosis, conventional radiography and CT examination can be used.

Secondary tuberculosis begins with the appearance of early infiltrates.

Most commonly, the Assman infiltrate appears, radiologically visualized as a round-oval opacity, located subclaviculary, of variable dimensions, with homogeneous structure, well delimited by a clear outline, with reduced intensity.







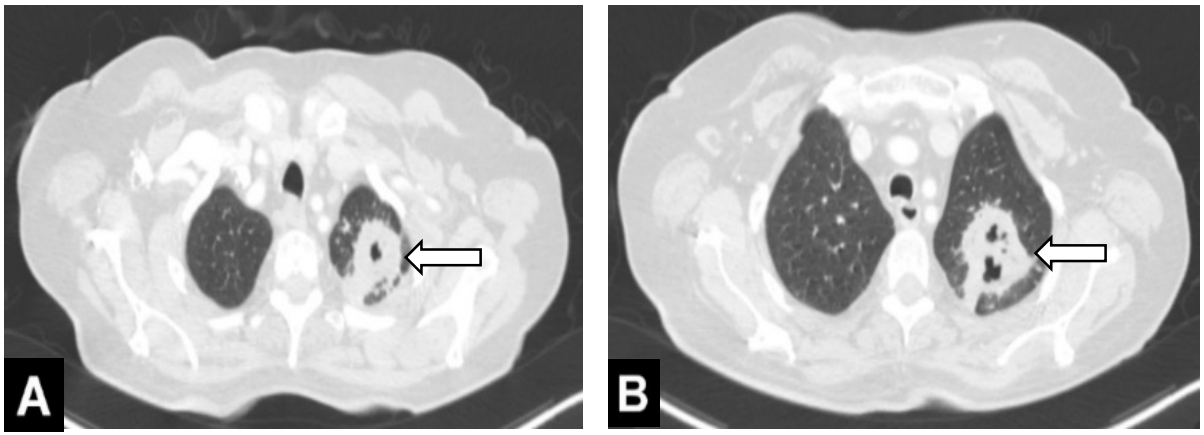
Pulmonary tuberculosis

Secondary tuberculosis

The evolution of pulmonary infiltrates may be ***favorable*** (restitutio ad integrum) or ***unfavorable***.

In case of an unfavorable evolution, the content of the infiltrate can be eliminated in the adjacent bronchia and can be seen radiologically in the form of linear opacities that connect the infiltrate to the pulmonary hilum.

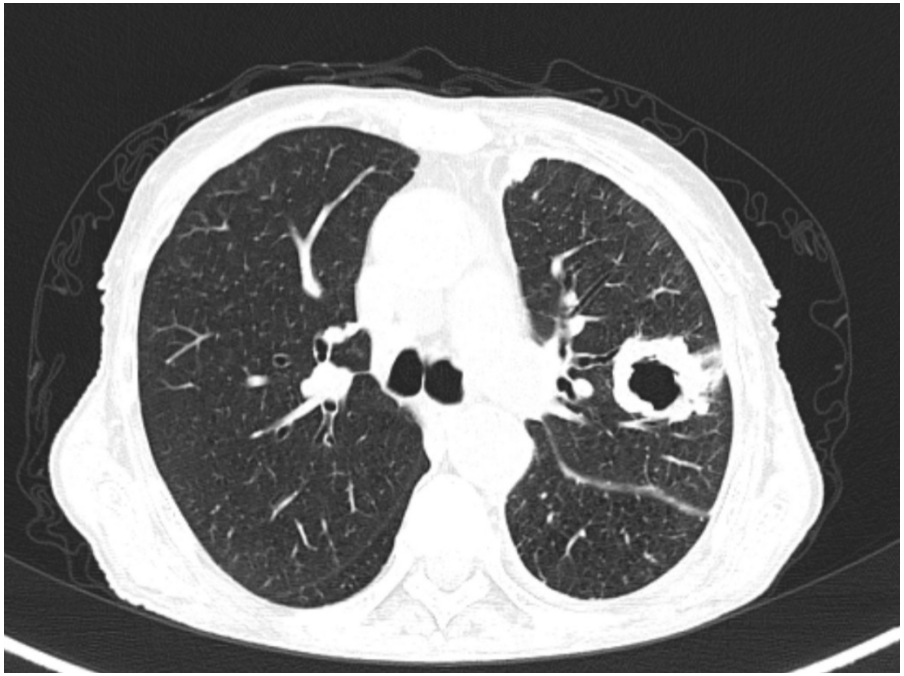
As the content of the infiltrate is eliminated in the adjacent bronchia, radiolucent areas appear within the infiltrate, generating the so-called “moth-eaten” aspect. This is how a grade I cavern appears. A grade I cavern does not have walls of its own.



Pulmonary tuberculosis

Secondary tuberculosis

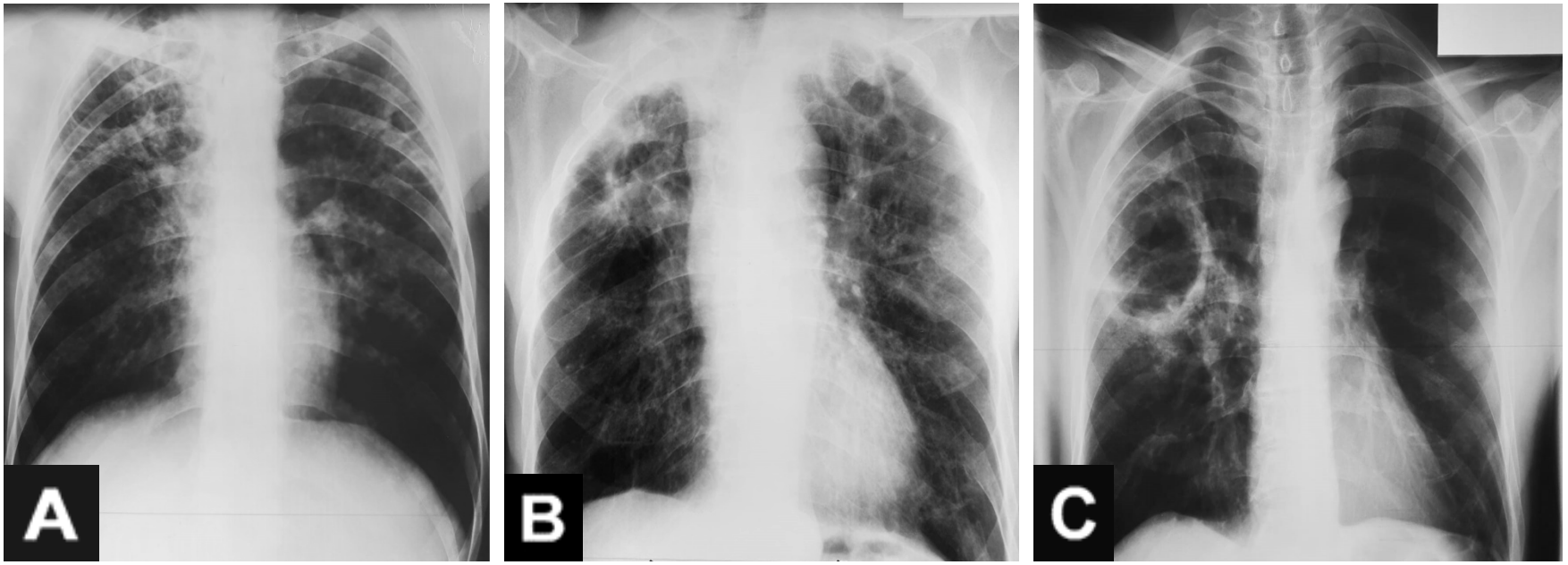
Subsequently, the recent cavern forms its own wall, which in the initial stages is thick, with low intensity and has a diffuse external outline. Thus, a grade II cavern is formed.



Pulmonary tuberculosis

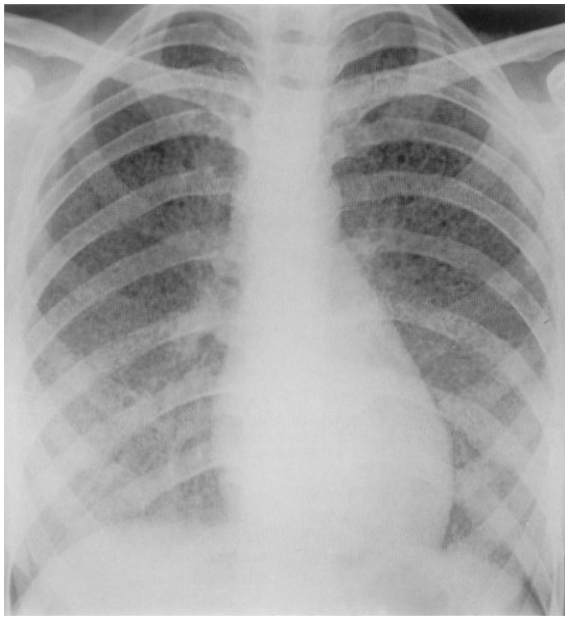
Secondary tuberculosis

In evolution, the wall of the grade II cavern becomes thinner, increases in intensity and presents a clear external outline. Thus, a grade III cavern is formed.

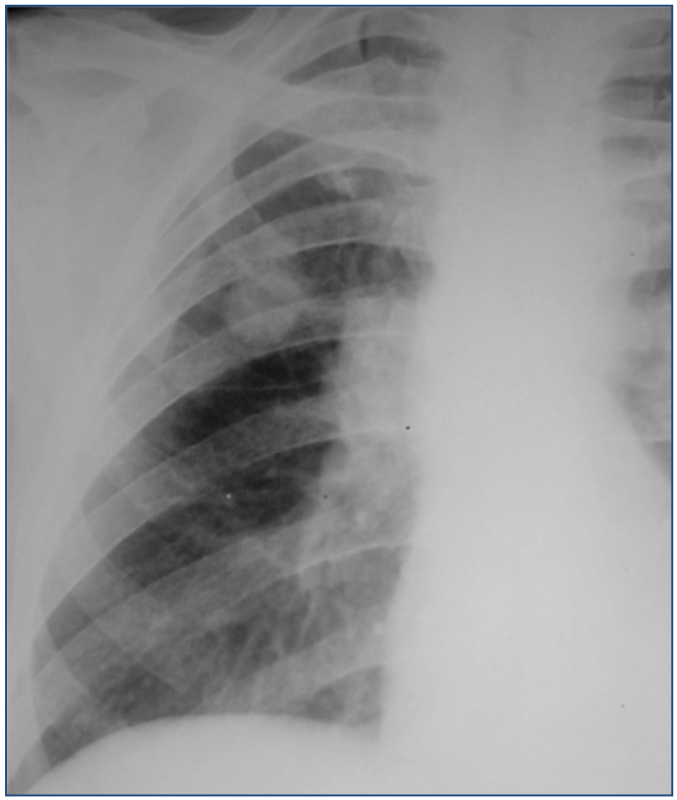


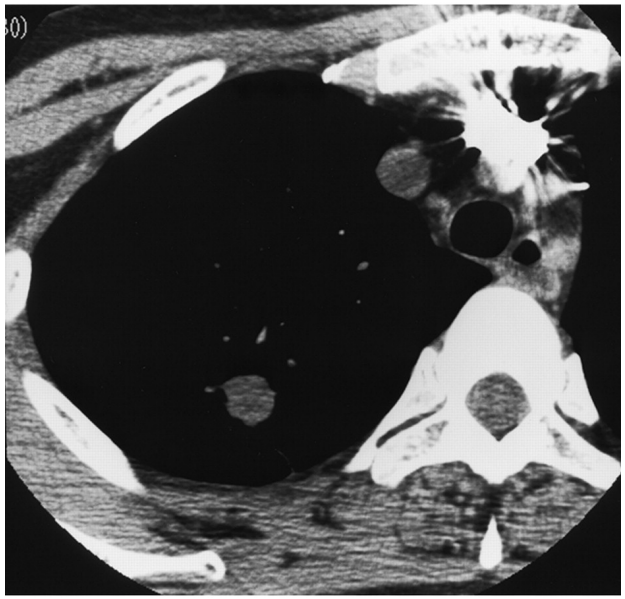
Secondary tuberculosis

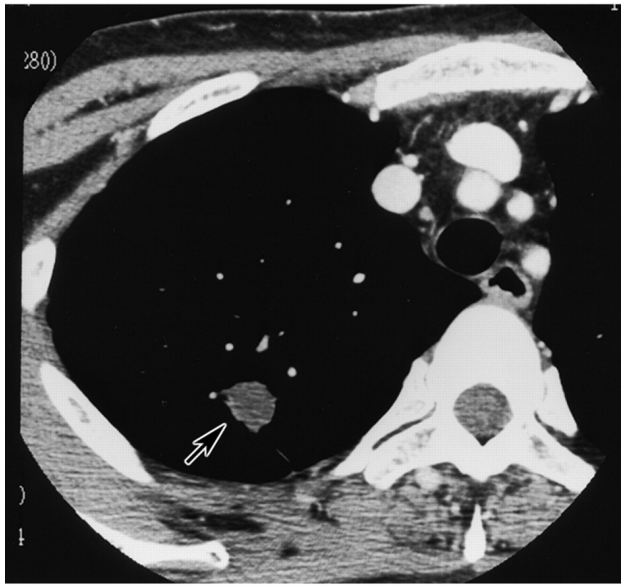
Miliary tuberculosis represents the miliary spread of the Koch bacillus within the lungs and is most often identified in immunocompromised patients or children. It occurs after hematogenous dissemination of uncontrolled tuberculosis infection and presents a severe prognosis. In miliary tuberculosis, the opacities are relatively symmetrical (butterfly appearance) and are most often distributed at the apical level (hematogenous seeding).



Tuberculoma

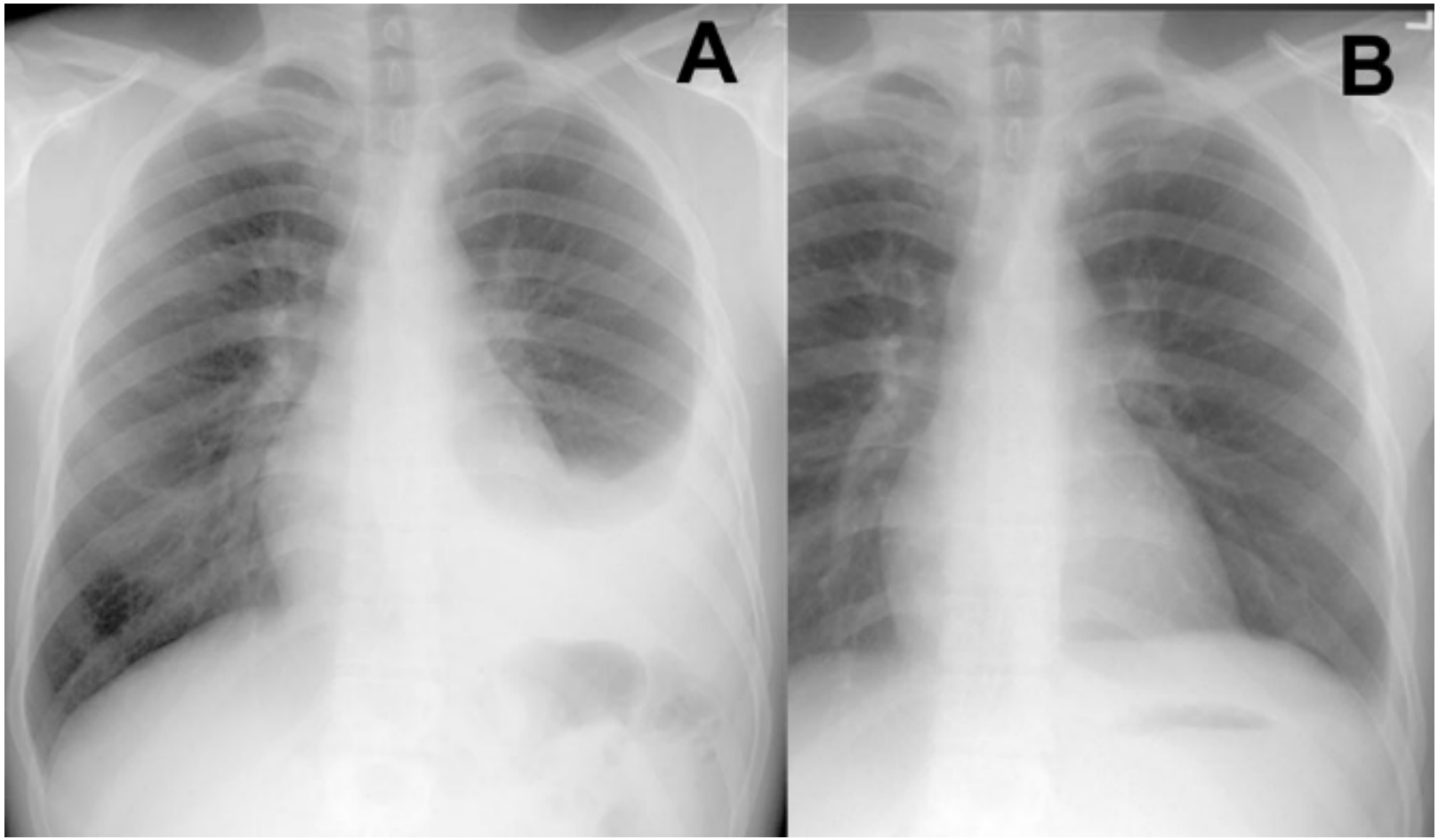






- 5% of patients with post-primary TB
- Sharply marginated round mass measuring 1-4 cm;
- Single lesion in 80%
- Satellite lesion common
- Stable or decrease in size with RX;
- Calcification if present (20%) = pathognomonic sign

Pleural effusion



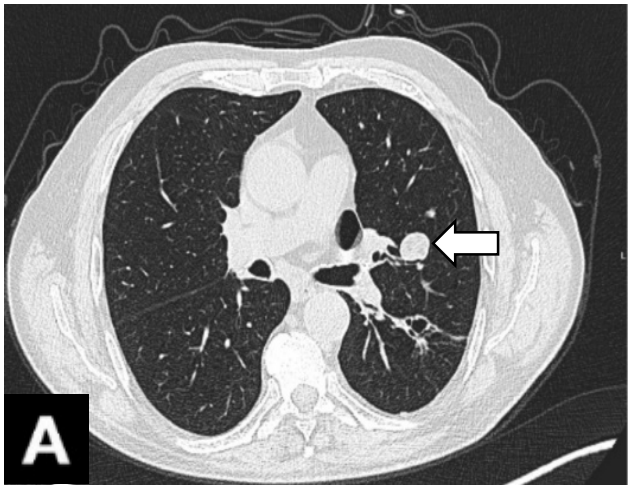
- Most common in post-primary TB than primary TB;
- Pleural effusion as a manifestation of primary TB occurs more often in adults than children
- Typical a large unilateral effusion

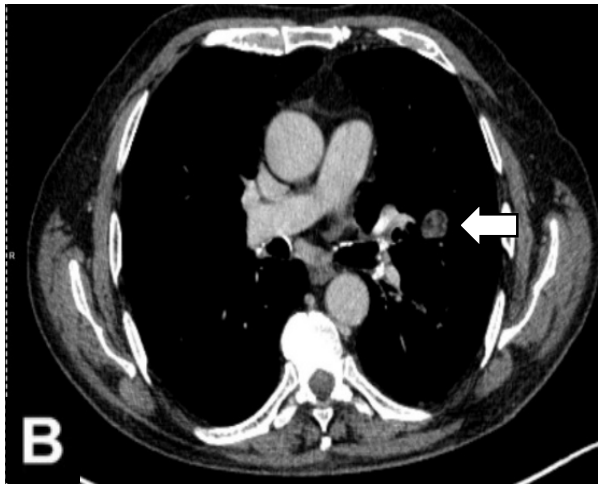
Fibrothorax

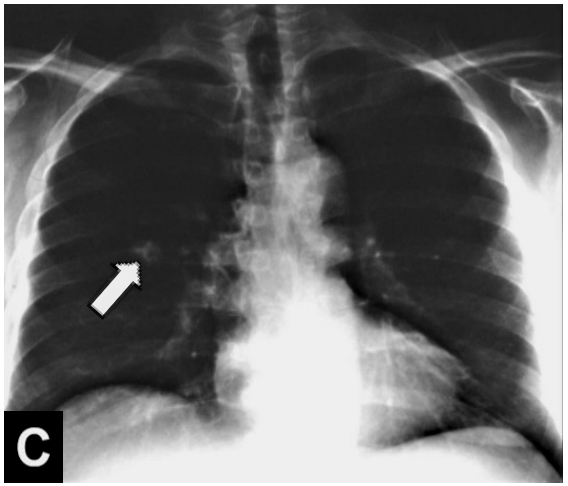
- Is the *great destroyed lung* = inhomogeneous opacity with mediastinal intensity, with retraction effect exerted on the surrounding structures. It represents the most advanced form of one-sided dense fibrous tuberculosis, or extensive fibrocaviatry phthisis consequence of unilateral pleural effusion accompanied by massive and /or abandoned pneumothorax.

Benign lung tumors

Benign pulmonary tumors are rarely encountered and are radiologically evident in the form of round-oval opacities, of variable dimensions, homogeneous structure, mediastinal intensity, well delimited by a net contour. For diagnosis, conventional radiography and CT examination can be used. Examples of benign pulmonary tumors: hamartoma, adenoma etc.







Malignant lung tumors

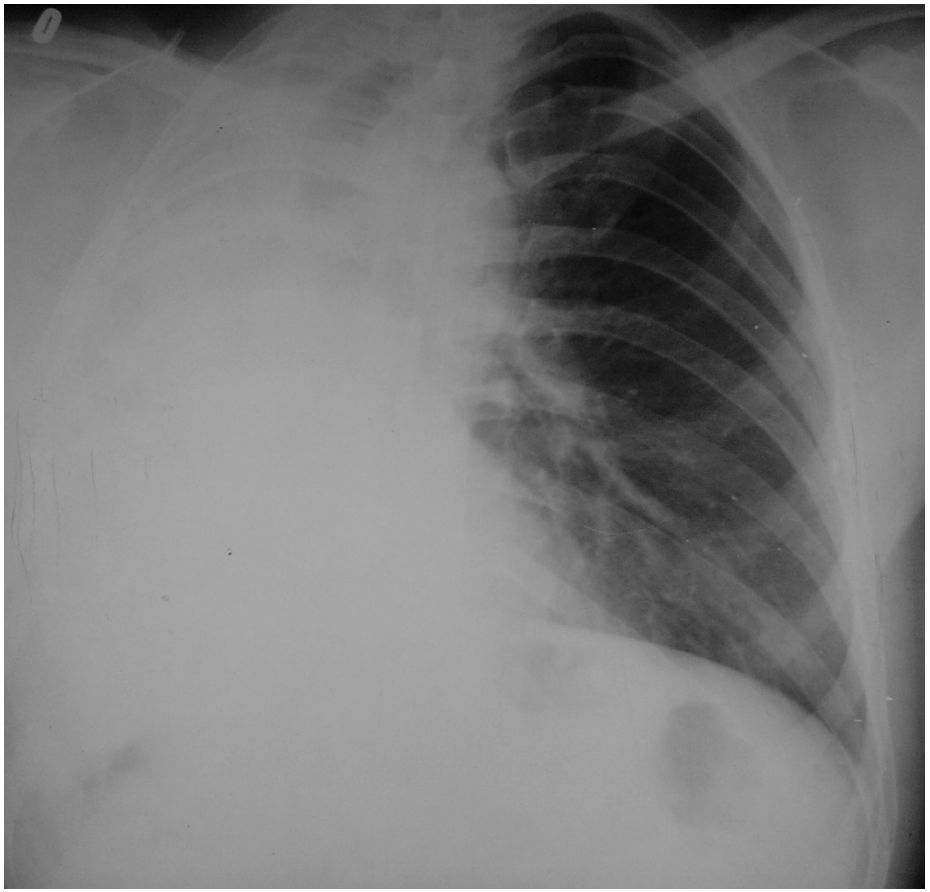
Malignant lung tumors can be primary or secondary (metastatic lesions).

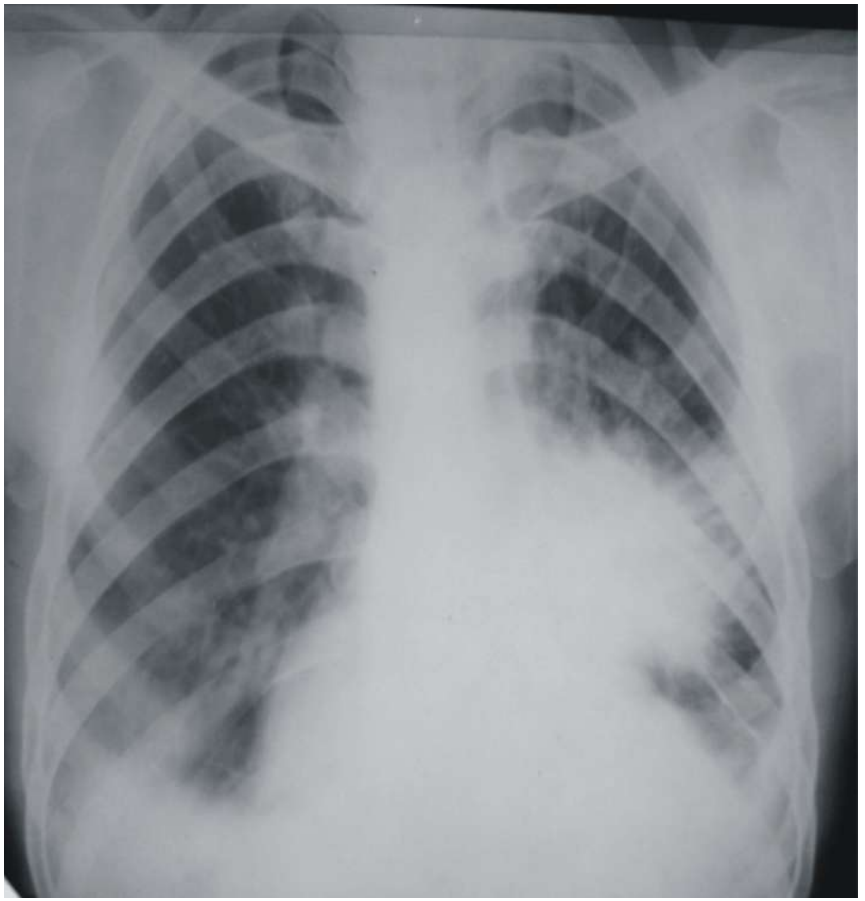
In case of bronchopulmonary cancer, the chest radiograph shows a unique opacity located in the pulmonary parenchyma, which has a spiculated or irregular outline, variable dimensions and mediastinal intensity. When it is located near a bronchia, the tumor may determine partial and subsequently complete obstruction of the bronchial lumen, with installation of atelectasis in the territory served by the bronchia. Also, the chest radiograph can highlight the presence of pleural / pericardial effusion and osteolytic changes in the vertebral bodies and / or rib arches depending on the location.

The CT examination accurately characterizes the three elements of oncological interest: primary tumor, mediastinal and hilar lypmhadenopathies, secondary lesions.

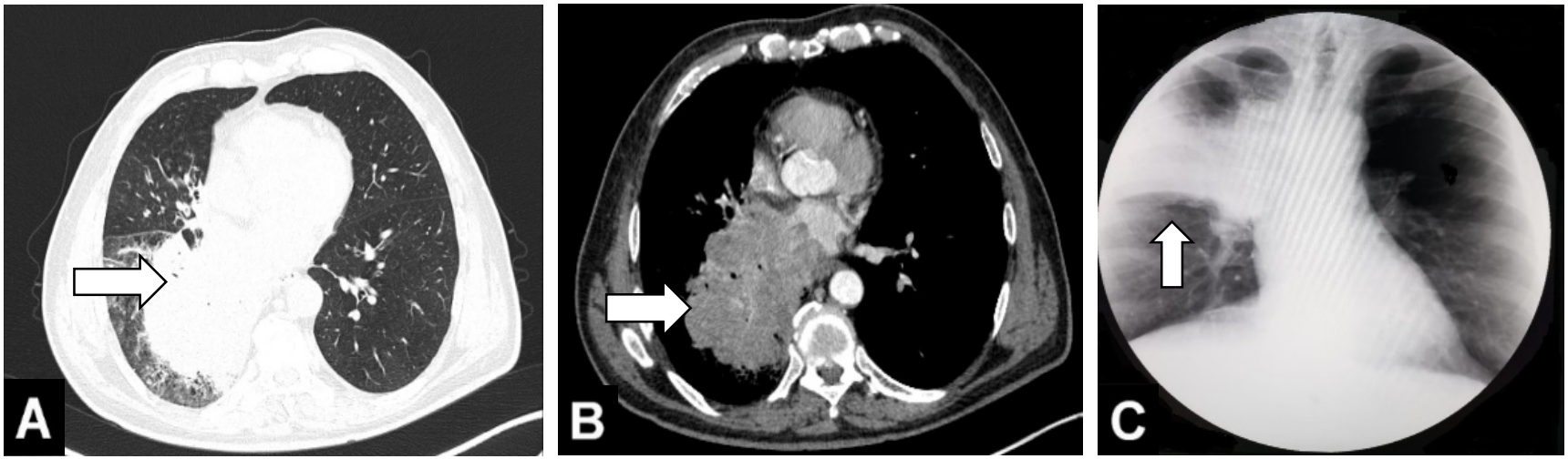
Through CT it is possible to accurately locate the primary tumor, as well as to identify important features of it (dimensions, structure, relationships with the neighboring anatomical structures). The number, location, dimensions, internal structure of the mediastinal and hilar lypmhadenopathies and their relationships with the neighboring anatomical structures are vital information that guide the subsequent therapeutic management of these patients. Last but not least, the detection of secondary lesions is possible through a CT scan of the chest, abdomen and pelvis (± brain).

Malignant lung tumors

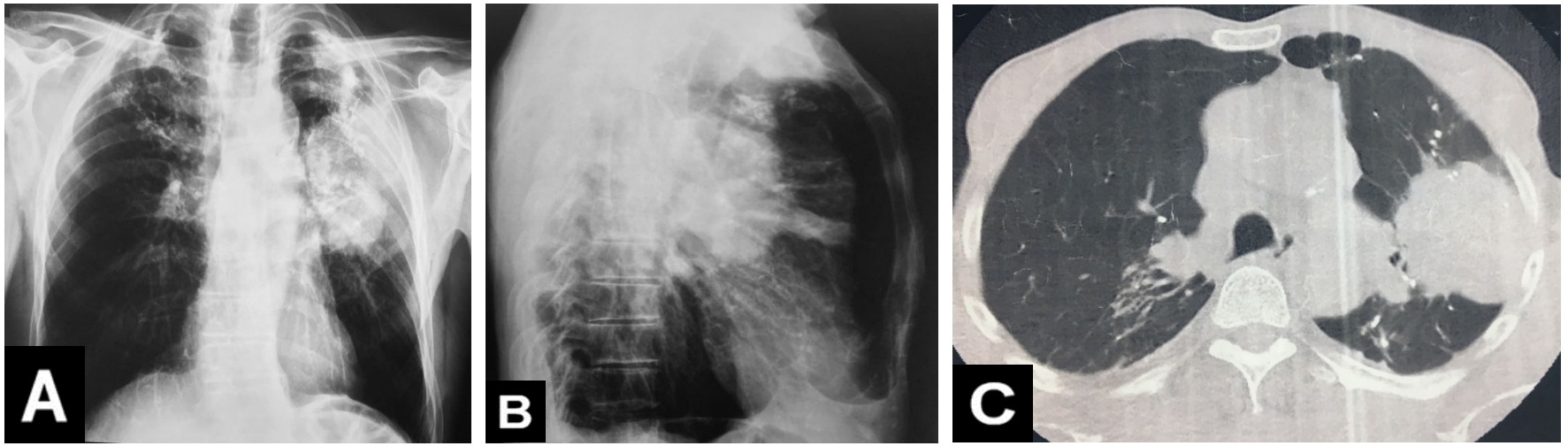




Malignant lung tumors



Malignant lung tumors



Malignant lung tumors

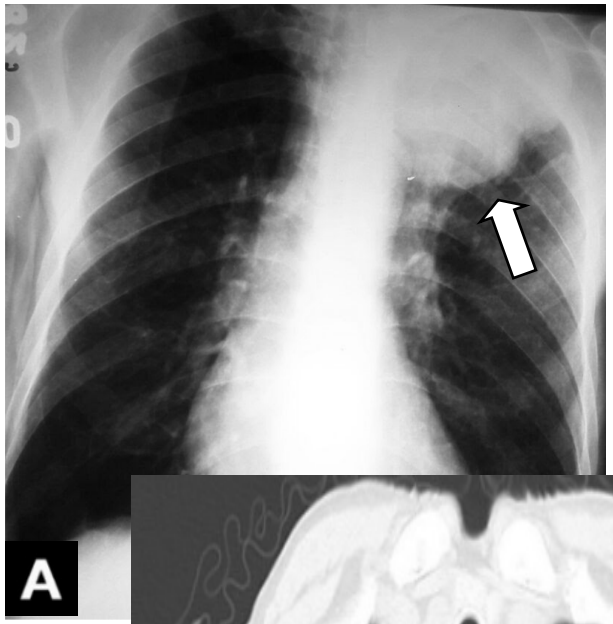
1. Apex lung cancer (Pancoast-Tobias syndrome) is a particular form of bronchopulmonary cancer primarily by its location in the lung parenchyma.

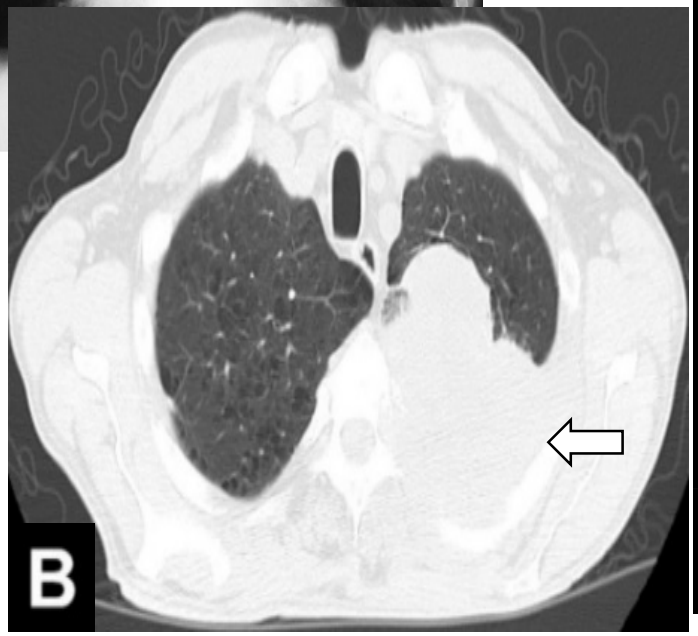
RX: this type of bronchopulmonary cancer is evidenced in the form of a relatively homogeneous opacity, with a diffuse superior contour and a clearly delineated inferior outline, located in the pulmonary apex. In evolution or even at the time of diagnosis, it is possible to highlight osteolytic changes in the first 4 thoracic vertebrae, as well as in the adjacent ribs. Ascension of the ipsilateral hemidiaphragm in a patient with this type of tumor may be an indirect sign of invasion of the phrenic nerve.

The CT examination highlights the imaging aspects of the three elements that allow the patient to be staged and guides the oncological therapeutic behavior: primary tumor, mediastinal and hilar lypmhadenopathies, secondary lesions.

The information provided by a CT examination indicates the structure, dimensions and location of the primary tumor at the level of the pulmonary apex, as well as its relationships with the neighboring anatomical structures (invasion of the brachial plexus, thyroid, brachiocephalic venous trunk, common and / or internal carotid artery, as well as of the internal jugular vein; osteolysis of the vertebral bodies and ribs).

Malignant lung tumors





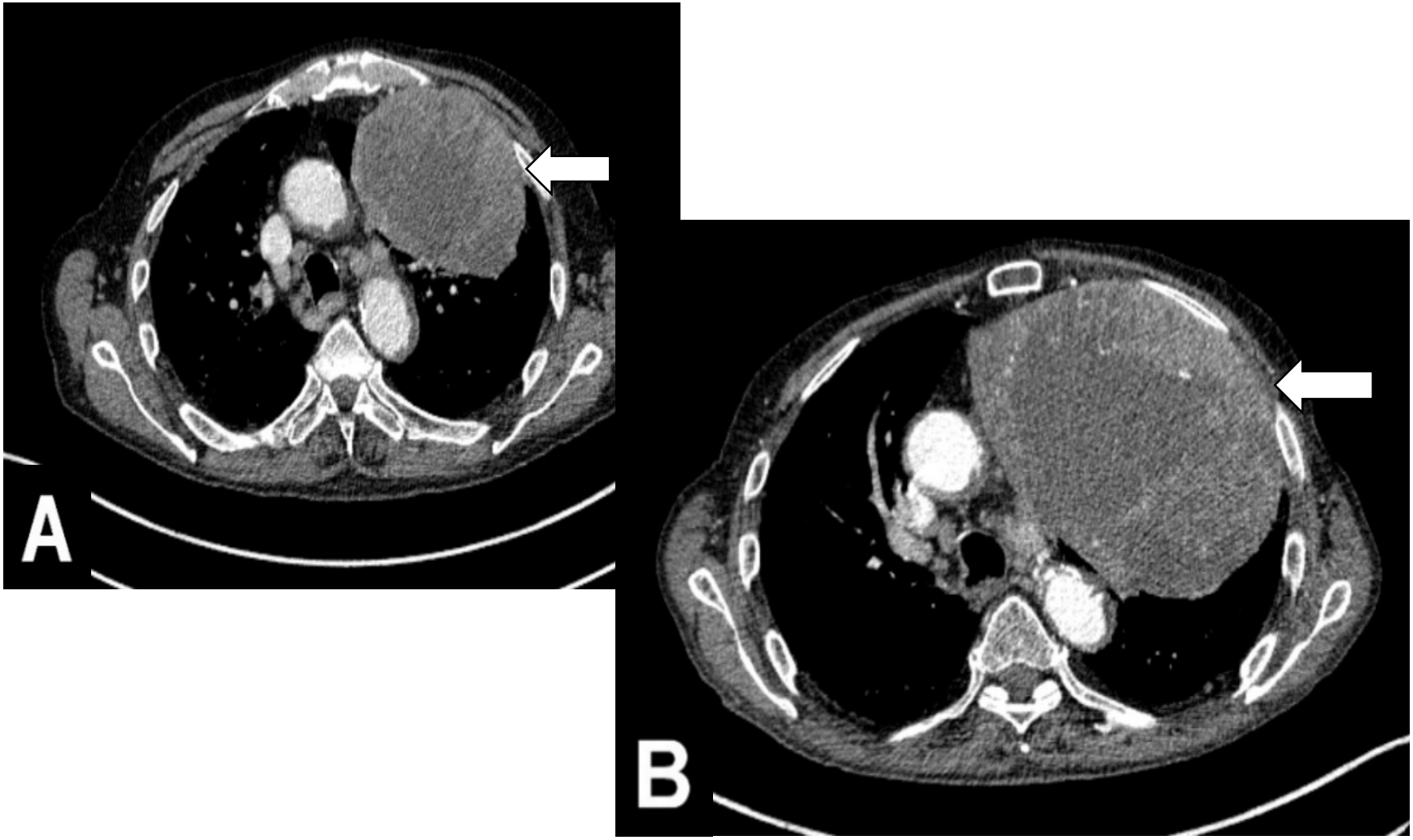
Malignant lung tumors

2. Primitive pulmonary sarcoma

Primitive pulmonary sarcoma is a primitive malignant tumor developed in the lung parenchyma

RX: homogeneous, macronodular opacity of mediastinal intensity, well delimited by a capsule. Due to encapsulation, this type of malignant tumor rarely causes metastases and presents a slow evolution. However, if the capsule integrity is lost, the evolution towards death is accelerated. Its detection is possible on a chest radiograph, but for a complete characterization of the primary tumor and establishing an appropriate lesion balance it is recommended to perform a CT examination.

Malignant lung tumors



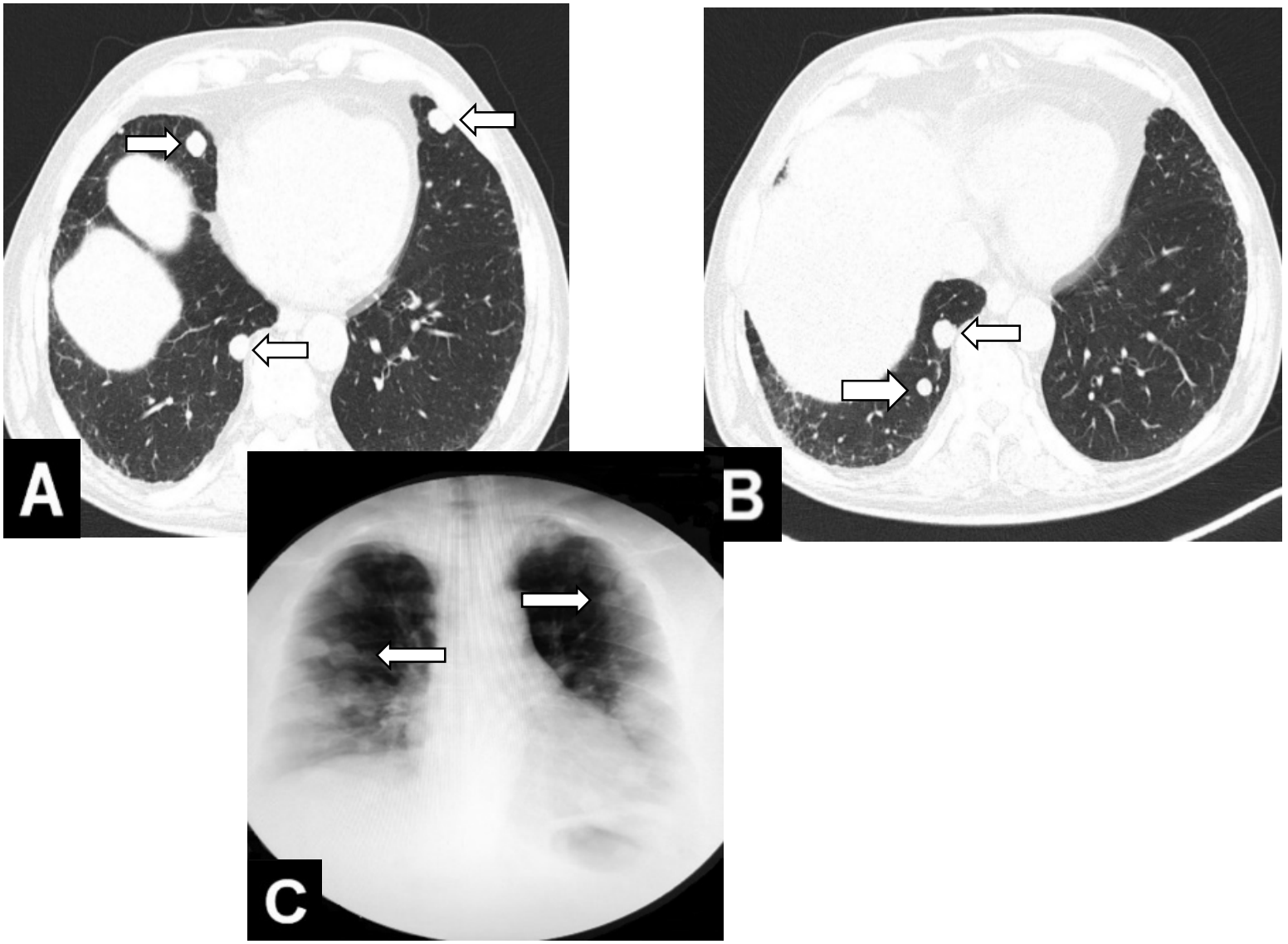
Malignant lung tumors

3. Secondary pulmonary determinations

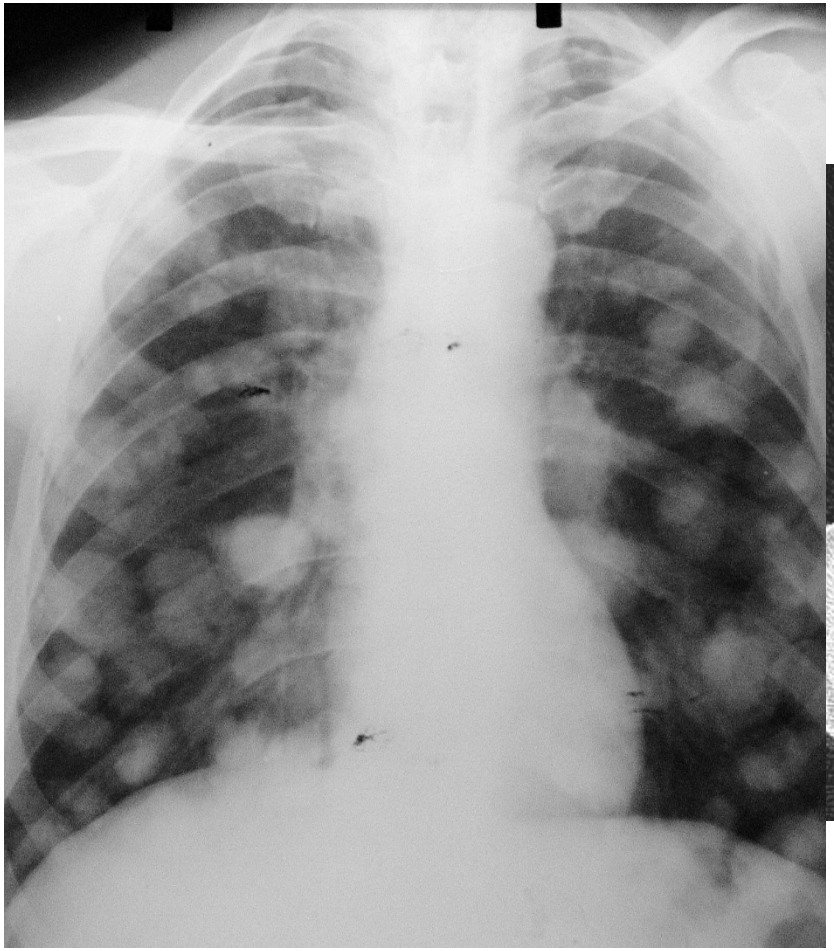
Among the primitive malignancies that frequently cause pulmonary metastases include breast cancer, pancreatic cancer, prostate cancer, and colorectal cancer. Lung metastases usually develop in both lung areas and are presented radiologically as nodular, homogeneous opacities, with different intensity depending on their age. Old lung metastases have a higher intensity, whereas recent pulmonary metastases have a lower intensity.

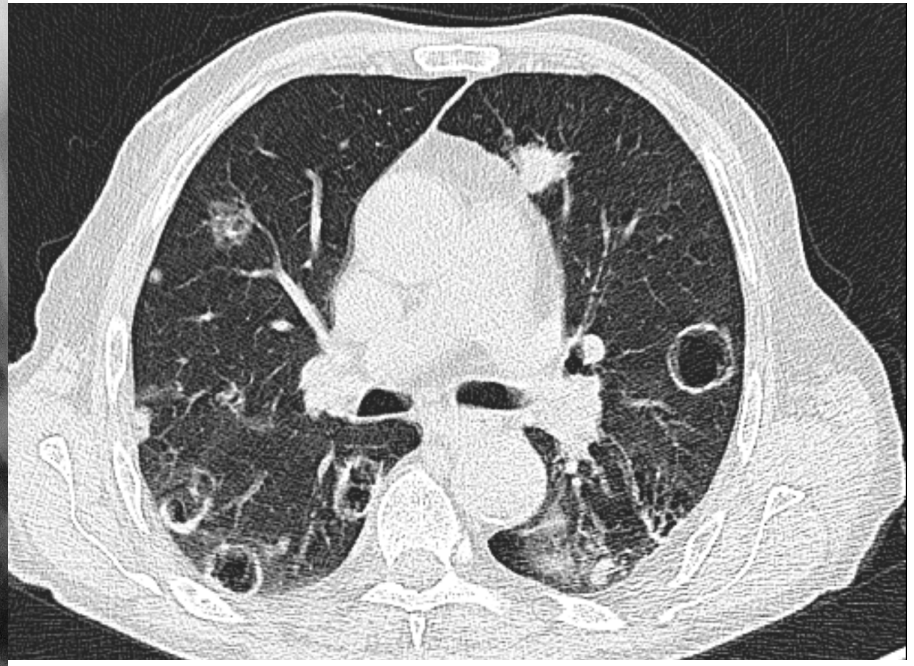
The CT examination is the main exploration used in the evaluation of pulmonary metastases. They appear as nodules with soft tissue density, round-oval shaped, well-delimited, contrast-enhancing, usually located in the periphery of the lung areas. Cavitation and calcifications are rare features of pulmonary metastases.

Malignant lung tumors



Malignant lung tumors





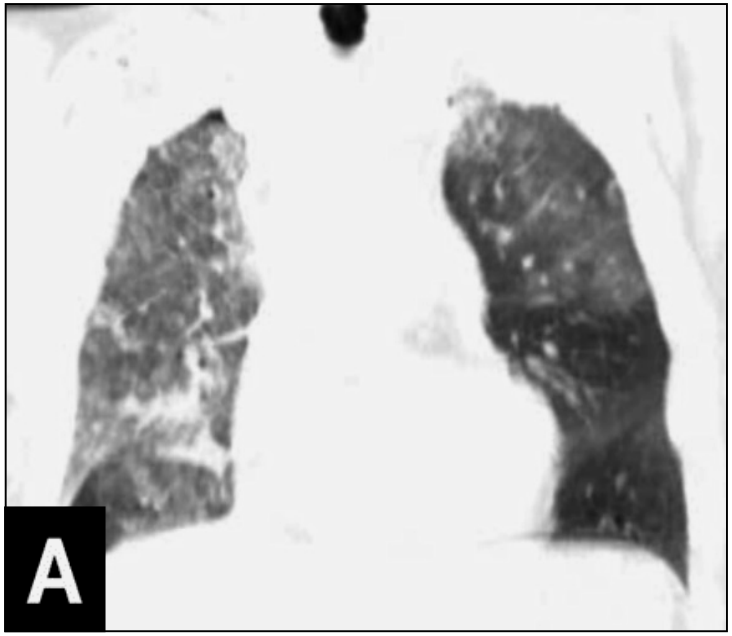
Thoracic trauma

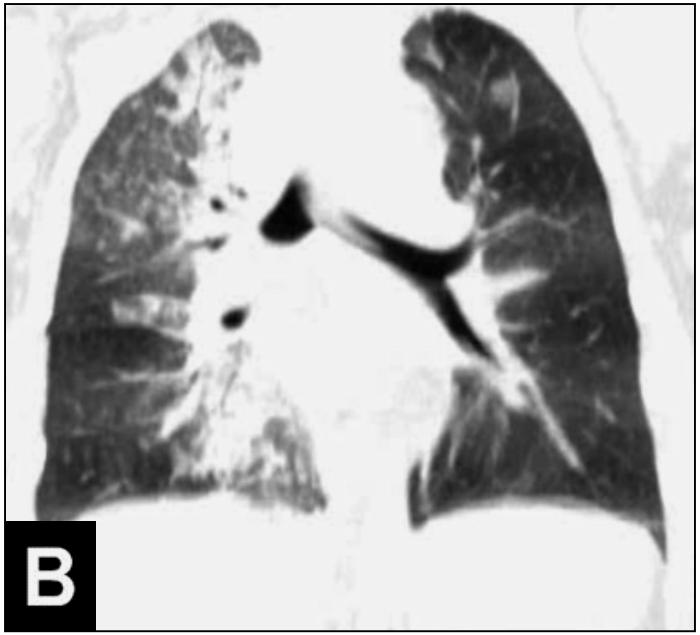
The most common post-traumatic lesions developed in the lung parenchyma are pulmonary contusions. In the first few hours after trauma, the chest radiograph may appear normal. In evolution, a nonspecific consolidation area can develop.

The CT examination usually shows focal areas of consolidation, without a segmental distribution, frequently located in the dorsal segments and in the lower lobes. Radiological changes of the pulmonary contusion recover relatively quickly, given the possibility that after 48 hours from the moment of the trauma the changes can be almost completely recovered. The presence of air inclusions inside the lung parenchyma (pneumatocele) in these patients is suggestive for pulmonary laceration.

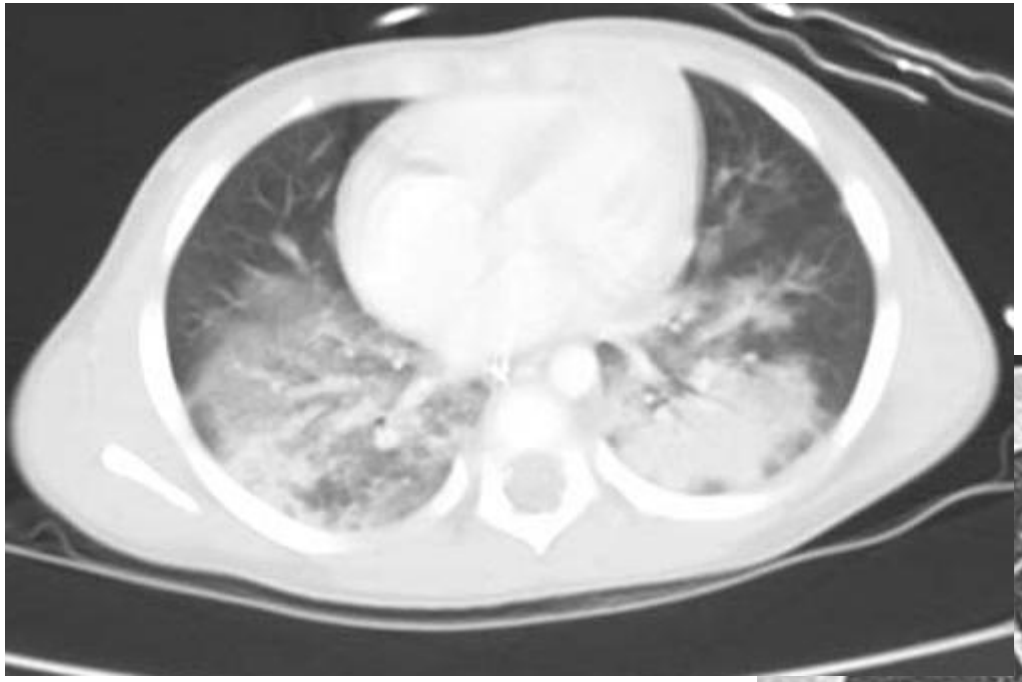
Lung traumatic lesions are frequently accompanied by rib fractures and the presence of pneumothorax and pneumomediastinum. Also, rib fractures can be accompanied by hemothorax, visualized on CT as a pleural collection with hemorrhagic densities.

Thoracic trauma



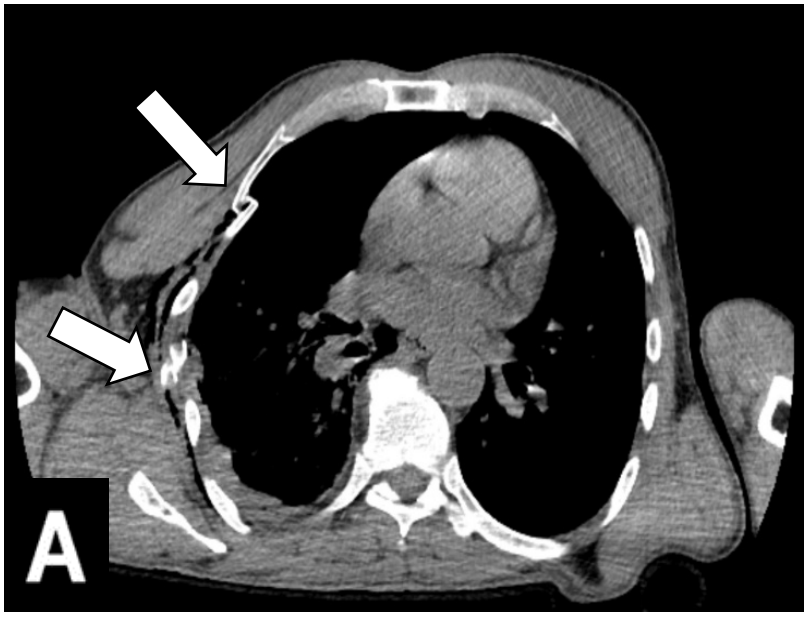


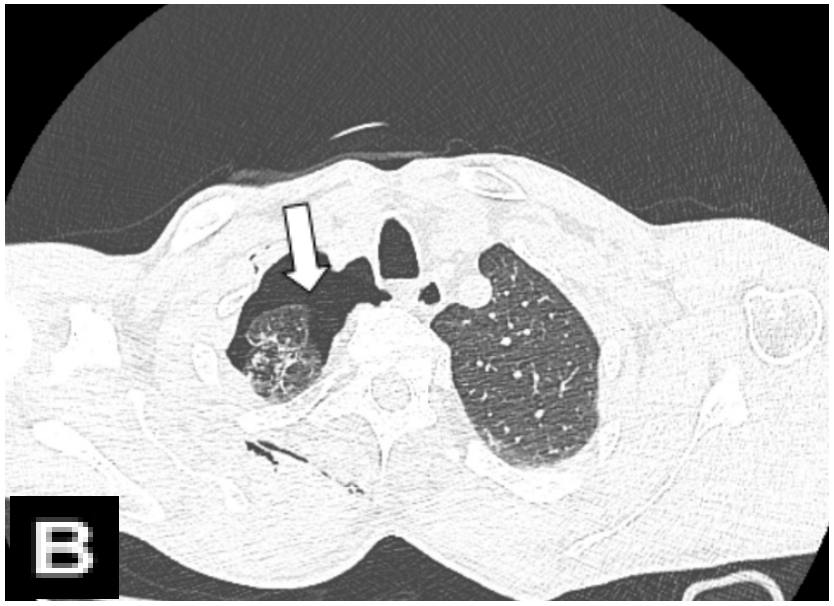
Thoracic trauma

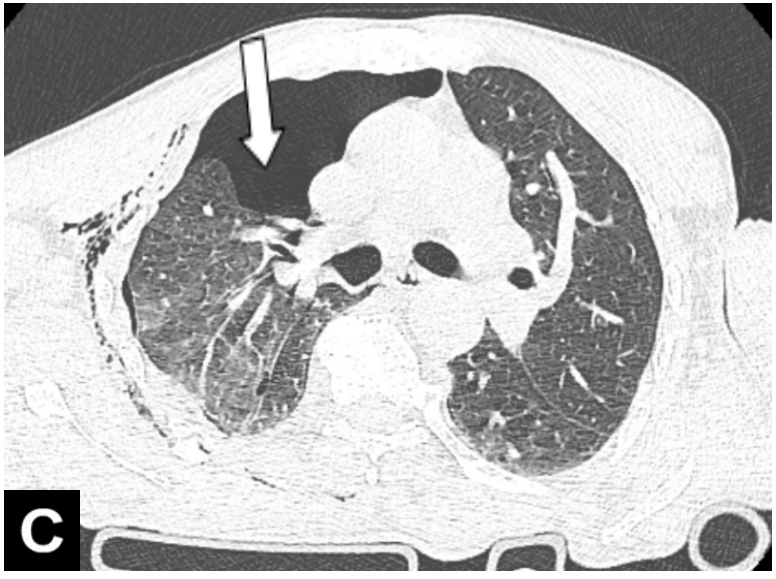


https://radiopaedia.org/articles/pulmonary-contusion

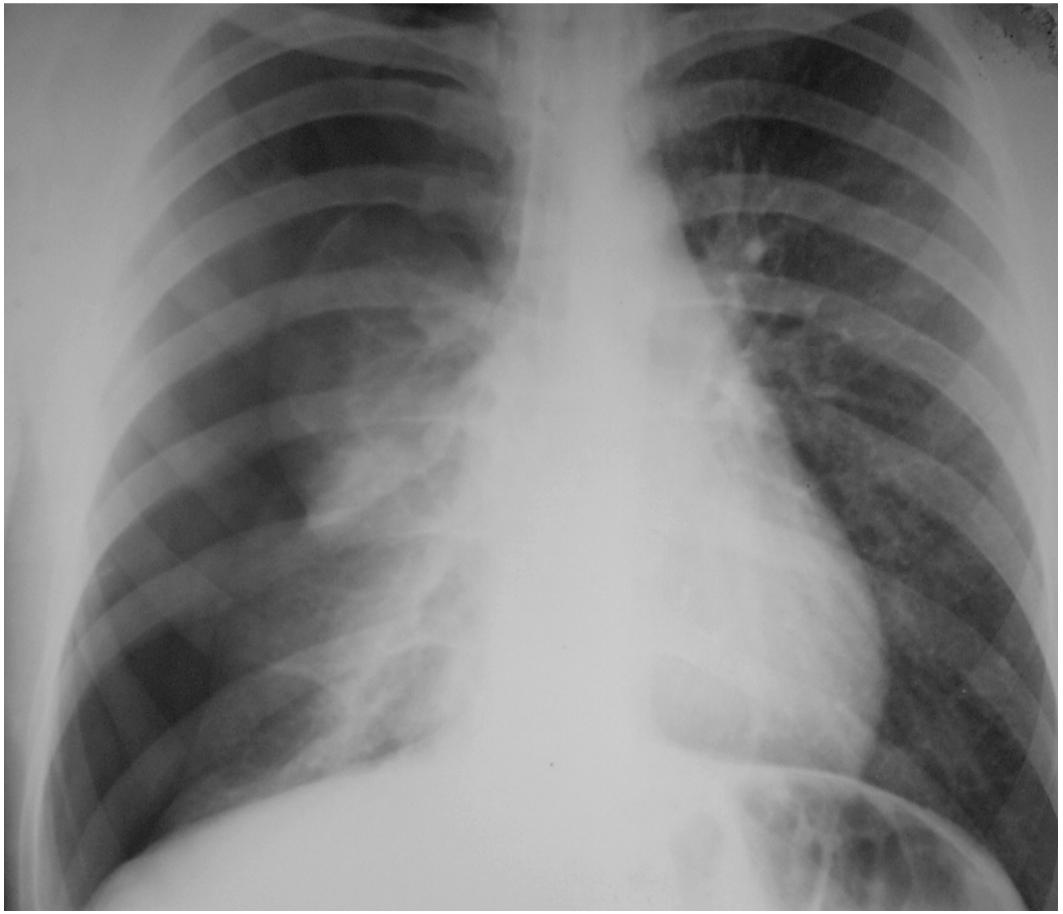
Thoracic trauma







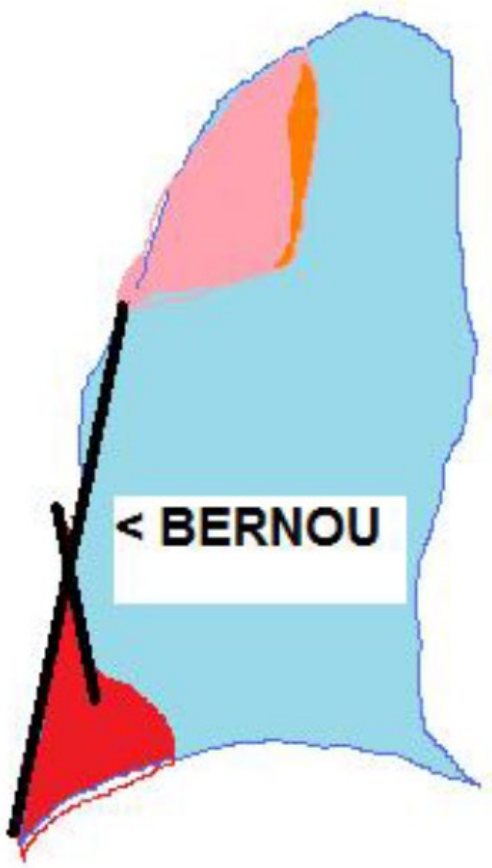
Thoracic trauma



Pleural pathology

Differentiating a pleural pathological process from a pulmonary pathological process can be made easily on both conventional radiography and CT by measuring the angle formed by the pulmonary/pleural pathological process with the thoracic wall.

If this angle is sharp, the pathological process is located in the pulmonary parenchyma. If this angle is obtuse, the pathological process is located in the pleura.



Pleural pathology

Pleural effusion

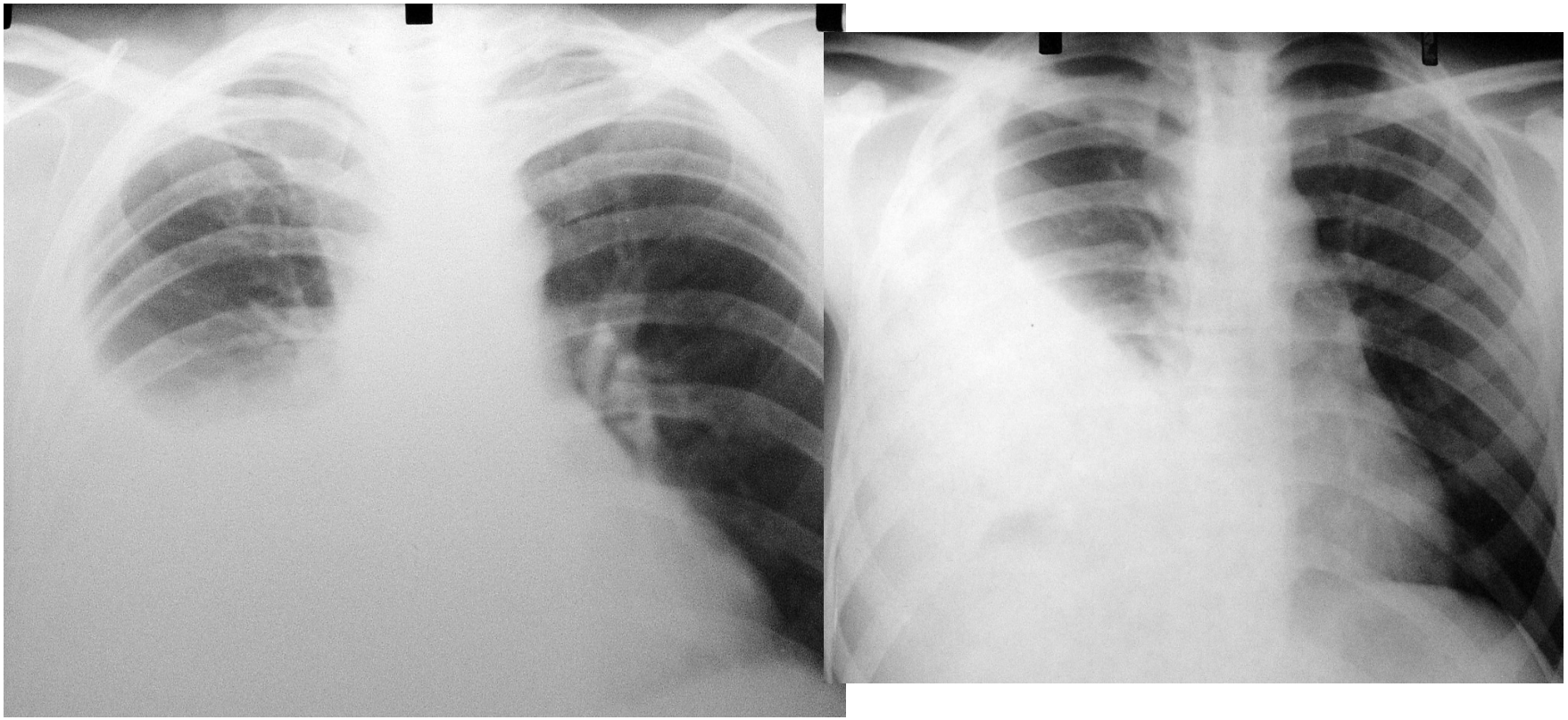
Pleural effusion is radiologically characterized by the following aspects:

- homogeneous opacity that stretches from one edge to the other of the hemithorax and presents maximum intensity in the lowest portion;
- the upper edge of the opacity is concave and ascending towards the thoracic lateral wall;
- visualization of a double contour given by the anterior and posterior margin of the liquid opacity;
- the accumulation of a large amount of fluid causes mass effect on the mediastinal structures that are moved from the affected part towards the healthy part;
- the liquid opacity moves with the patient's position.

The chest radiograph difficultly detects small amounts of fluid accumulated in the large pleural cavity. In these situations, the most useful diagnostic method is CT. Also, CT examination can also identify the cause that led to the development of pleural effusion.

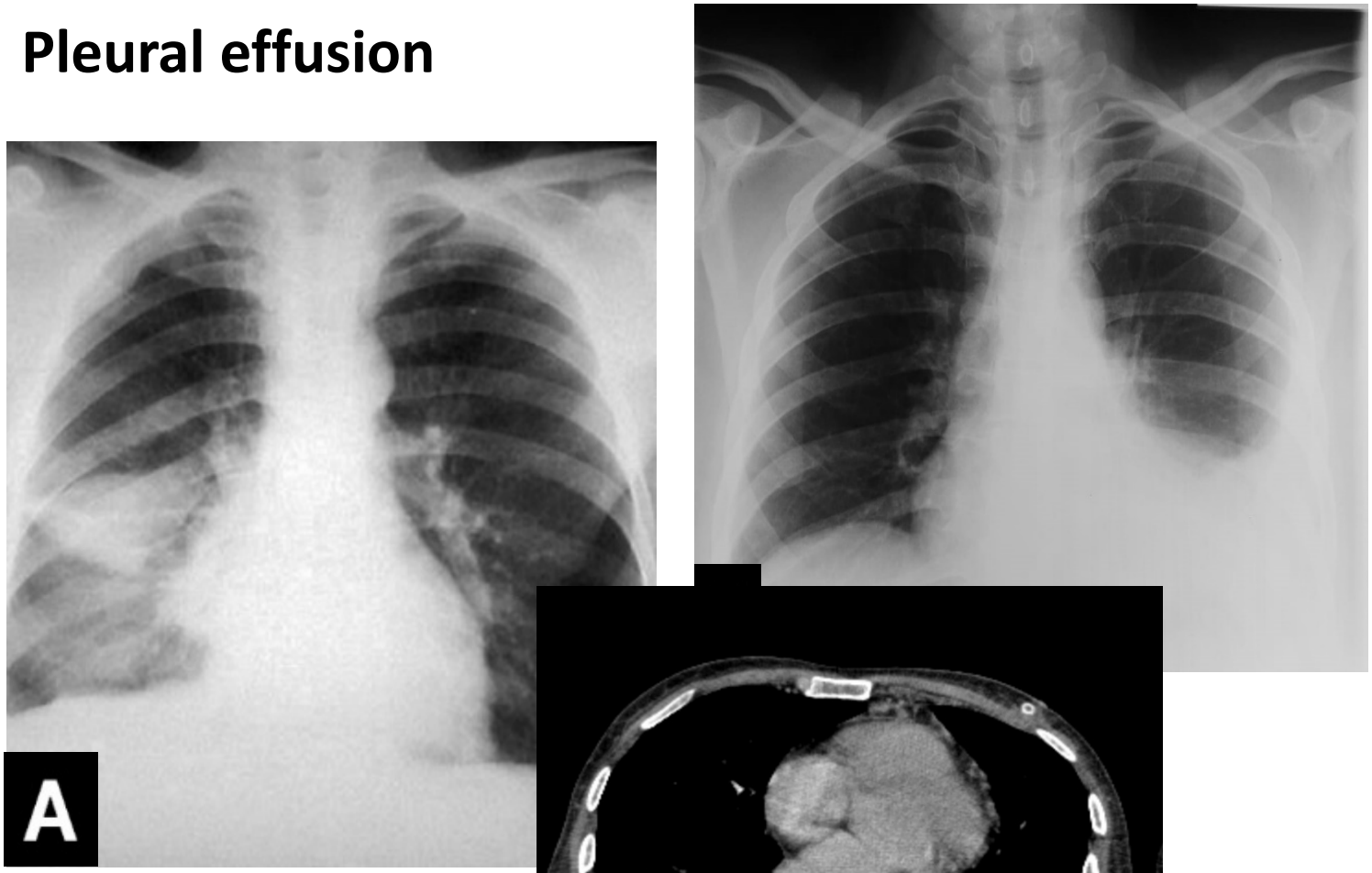
Pleural pathology

Pleural effusion



Pleural pathology

Pleural effusion



Pleural pathology

Pneumothorax

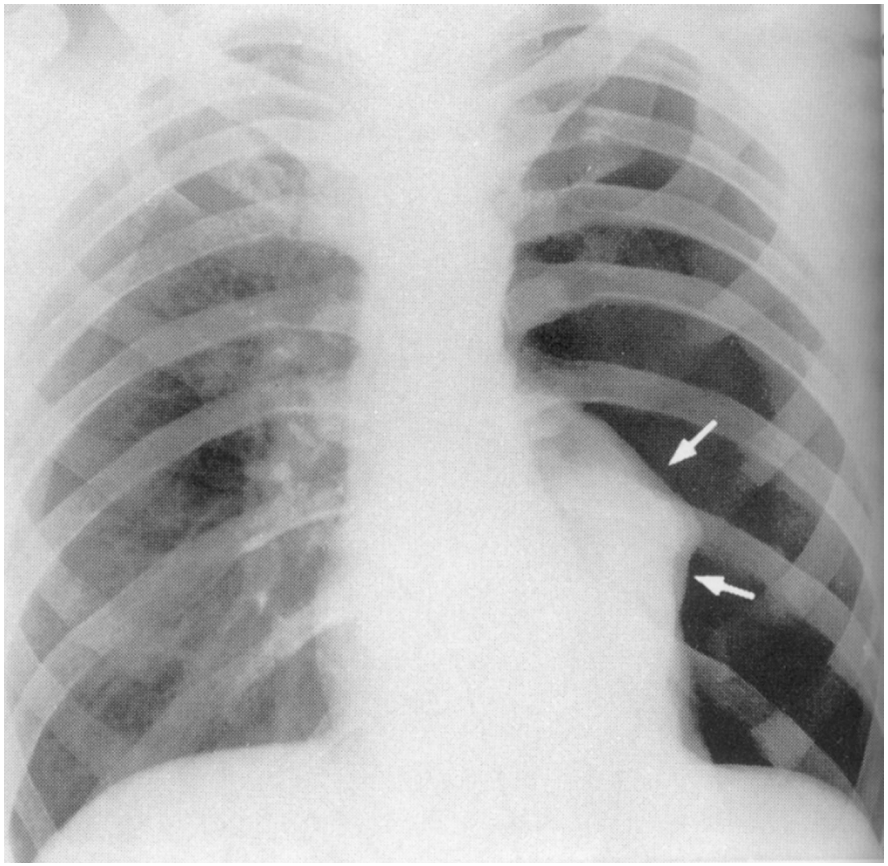
Pneumothorax involves the accumulation of air inside the pleural cavity. For diagnosis, conventional radiography and CT examination can be used.

RX:

- radiolucent air accumulation in the pleural cavity, at the periphery of the lung;
- lack of pulmonary vascularization in the pneumothorax area;
- redistribution of pulmonary vascularization towards the apex;
- the mediastinal structures remain on the midline.

CT examination can detect the presence of air content (UH densities up to -1000) in the pleural cavity, associated with the collapse of the adjacent lung parenchyma. In addition, CT examination can also identify the cause that led to the development of pneumothorax.

Pleural pathology



Pleural pathology

Pleural tumors

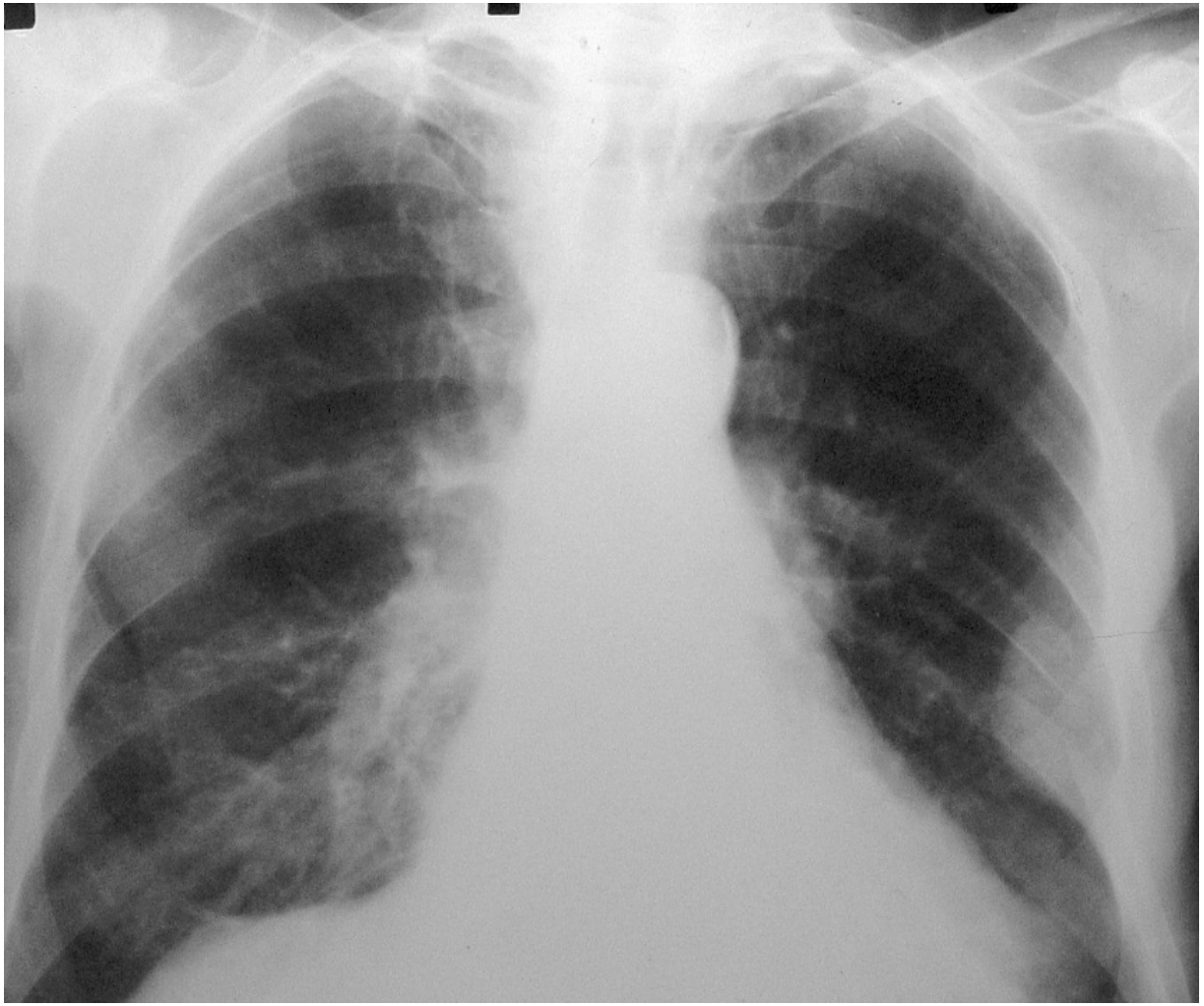
Benign pleural tumors are rare.

The most common malignant pleural tumor is the pleural mesothelioma and its occurrence is frequently triggered after exposure to asbestos.

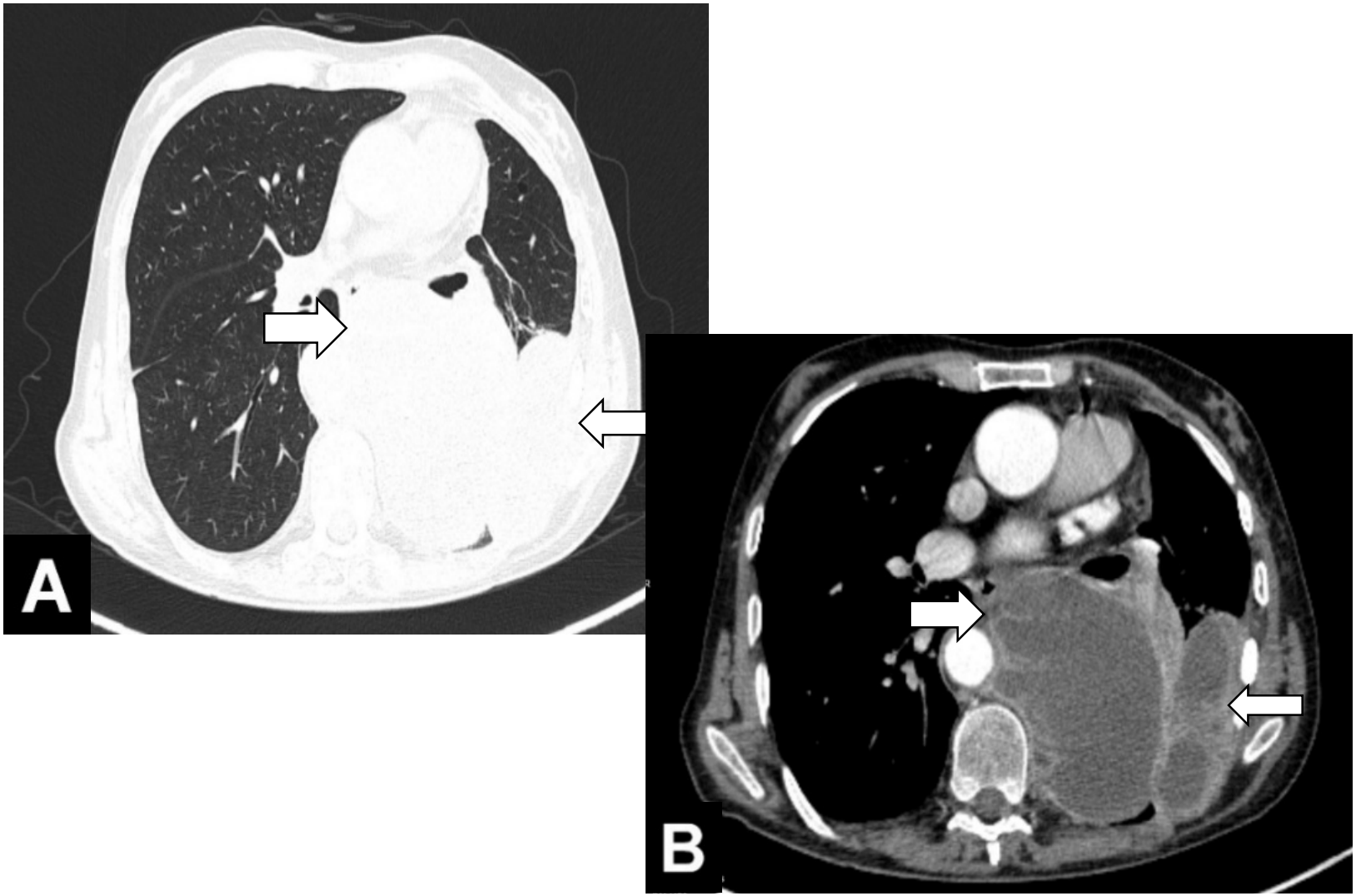
The radiological examination has a low value in the diagnosis of pleural mesothelioma and highlights a pleural opacity that forms an obtuse angle with the thoracic lateral wall and which causes mass effect on the adjacent pulmonary parenchyma.

The CT examination is extremely useful in identifying this pathology by highlighting tissue masses or pleural nodular thickening. Also, CT examination allows a more accurately assessment of the soft parts and neighboring bone structures, as well as of the mediastinal lymphadenopathies. Frequently, mesothelioma causes osteolysis in neighboring bone structures and can extend to the extrathoracic soft parts.

Pleural pathology



Pleural pathology



Mediastinal pathology

Pneumomediastinum

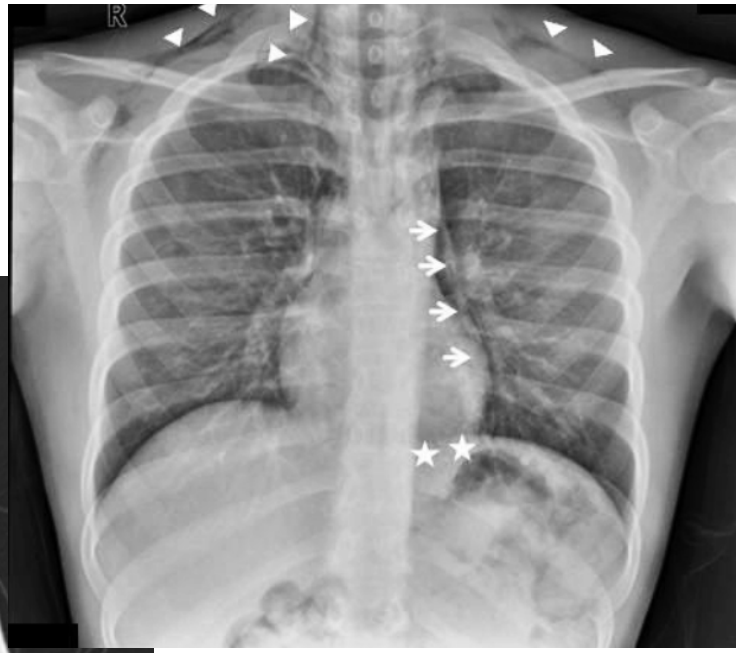
Pneumomediastinum is the presence of air in the mediastinum and appears frequently after trauma affecting the main trachea, esophagus or bronchi.

The conventional radiography in PA incidence shows widening of the mediastinal opacity, with the presence of a radiolucent image located in the mediastinum. A profile chest radiograph locates the radiolucency more precisely in the mediastinum.

The CT examination accurately locates the pneumomediastinum and shows air density at this level (-1000 UH). In addition, it may detect associated changes in structures at this level, such as traumatic tracheal or esophageal lesions, fractures, subcutaneous emphysema etc.

Mediastinal pathology

Pneumomediastinum



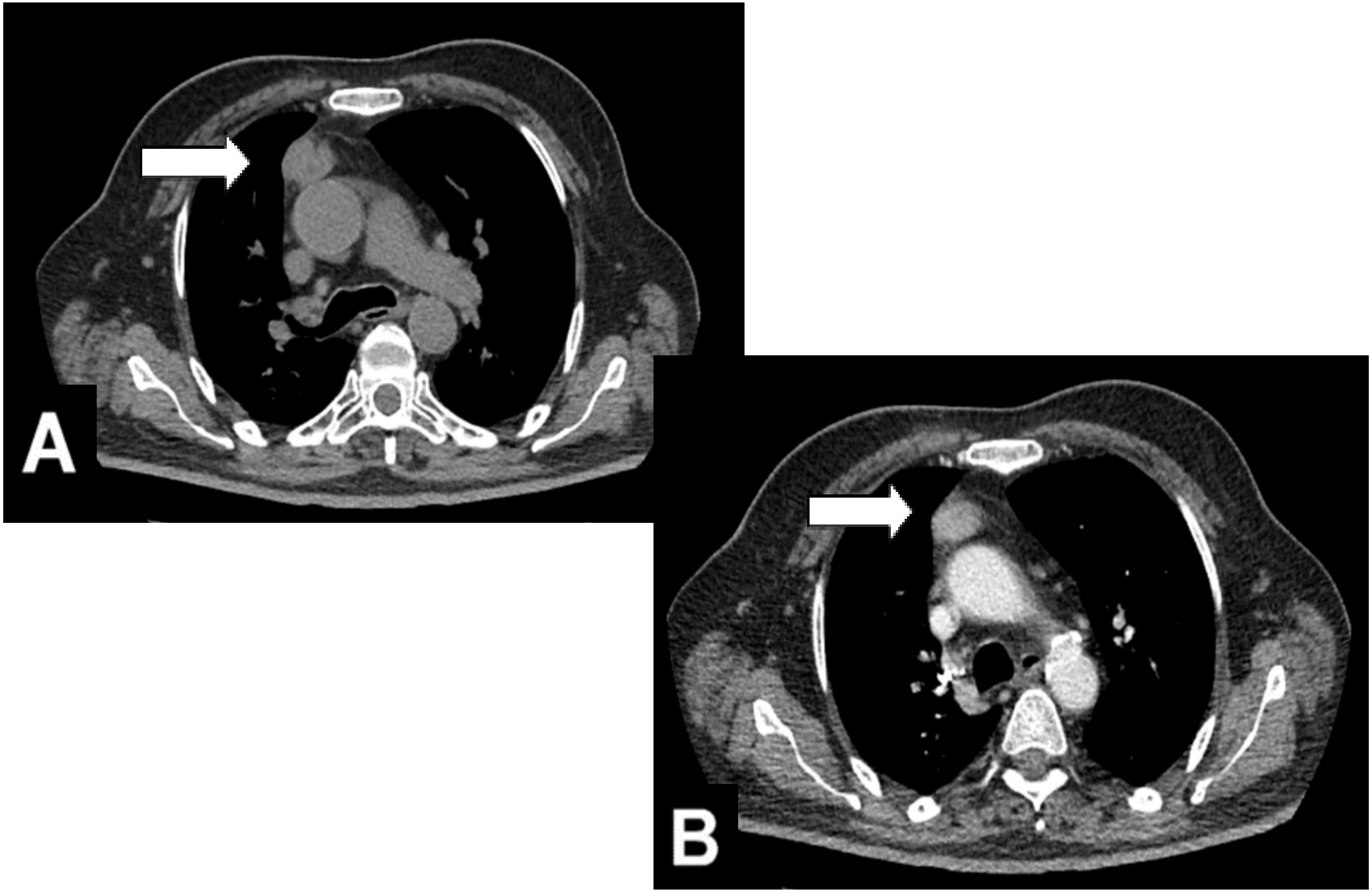
Mediastinal pathology

Thymoma

The chest radiograph reveals large thymic tumors that deform the contour of mediastinal opacity in the PA incidence.

At CT examination, the thymomas are highlighted in the form of well-delimited round-oval solid masses of up to 10 cm, showing spontaneous densities similar to the normal thymus and moderate postcontrast intravenous iodophilia. In patients with myasthenia gravis, the appearance of a thymoma may be an indication for thymectomy.

Mediastinal pathology



Mediastinal pathology

Aortic dissection

In case of aortic dissection, the contrast-enhanced CT examination accurately quantifies the length of the dissection, as well as the presence of the false lumen and the true lumen.