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RADIOLOGICAL FINDINGS IN THE DIAGNOSIS OF PULMONARY TUBERCULOSIS

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Abstract: Introduction: Pulmonary tuberculosis is a contagious bacterial disease that causes high morbidity and mortality in the world, which produces non-specific symptoms, making its diagnosis difficult. For this, it is necessary to correlate clinical data with laboratory tests and imaging tests, which range from to serve to confirm or rule out the pathology and to classify it according to its pathophysiology. For better study, it is classified pathophysiologically into primary and post-primary tuberculosis depending on the time of exposure to the causal agent. The imaging tests most frequently used are chest x-rays and tomography, providing images suggestive of the presence of the disease, expressed in different ways in relation to its stage. **Goal:** Identify the prevalent radiological findings in pulmonary tuberculosis through a bibliographic review in the last 5 years in the Pubmed database, which allows the doctor to distinguish this condition in an effective way through this update. **Conclusion:** The imaging tools most used for the diagnosis of this pathology are chest x-ray and chest tomography, with tomography being the study with the greatest sensitivity and specificity, but in our environment due to the high cost and low economic level of the population, it is used less frequently. The chest x-ray, although it has less specificity, is essential in the diagnosis of TB, where depending on the radiological findings observed, it can be established at what stage of the disease the patient is experiencing.

Keywords: Pulmonary tuberculosis, radiology, diagnostic imaging, mycobacterium tuberculosis.

INTRODUCTION

Pulmonary tuberculosis is a contagious bacterial disease that causes high morbidity and mortality in the world, which was declared a global epidemiological emergency in 1994 by the World Health Organization (WHO). It affects the general population, but has a predilection for In patients with a low socioeconomic level, it produces non-specific symptoms, making its diagnosis difficult. For this, it is necessary to correlate the clinical data with laboratory tests and imaging tests, which will serve to confirm or rule out the pathology and classify it according to its pathophysiology.[1]

In 2009, approximately 5.8 million new cases of pulmonary and extrapulmonary tuberculosis were reported to the World Health Organization in the world, of which 95% corresponded to cases in developing countries, this without counting cases that were not notified. nor to those patients who were not diagnosed.2 According to epidemiological studies carried out around the world and notified to the World Health Organization, the countries of Latin America are considered to be countries with a serious epidemiological situation, among which one of the main affected countries is Ecuador, this due to risk factors such as low socioeconomic level, malnutrition, poor hygiene, increase in patients with human immunodeficiency virus (VIH).[3] In 2018, 6,094 cases of sensitive Tuberculosis were reported in Ecuador with an incidence of 34.53 per 100,000 inhabitants. The Provinces with the highest incidence of Tuberculosis are Guayas in first place (urban and rural) with 3,354 cases, in second place El Oro with 444 cases of Tuberculosis that constitutes and in third place Los Ríos with 367 cases.[4]

For better study, it is classified pathophysiologically into primary and post-primary tuberculosis depending on the time of exposure to the causal agent.[5] Imaging tests have provided great help in the diagnosis of the disease since they clarify clinical and laboratory doubts that may arise when evaluating a patient. [6]

The studies most frequently used are chest x-rays and tomography, showing images suggestive of the presence of the disease, expressing themselves in different ways in relation to the stage and severity of the disease.[7]

DEVELOPMENT

Tuberculosis (TB) is an infectious and contagious bacterial disease caused by the Mycobacterium tuberculosis complex that includes M. tuberculosis, M. bovis, M. africanum, M. microti and M. Canetti, considered one of the main causes of morbidity and mortality. in the world, which is why it is considered a public health problem. Furthermore, one of the oldest documented diseases and the cause of countless deaths, it mainly affects the respiratory system although it has the capacity to affect other organs. [8]

The contagion of this entity occurs through inhalation of flügge droplets from people with a positive sputum test, where the development or not of the disease will depend on the host and their risk factors.[4]

TYPES OF TUBERCULOSIS

In the physiopathological context we can classify it as: primary TB and post-primary TB, where, in the first, there will be those people who have not been exposed to the bacillus previously, while, the people who have been previously exposed or in whom there is a process reactivation of the disease, will be part of the post-primary TB group.[9]

DIAGNOSIS

In an adult, the diagnosis is based on data from various criteria, among which we have the clinical criteria present in an individual classified as respiratory symptomatic (cough, expectoration for more than 15 days), with or without hemoptysis; There may be the presence of non-specific signs and symptoms, such as temperature rise predominantly in the evening, nocturnal diaphoresis, anorexia, weight loss.[10] In patients who report this clinical picture, TB must be suspected. These patients will continue with the bacteriological criteria and a direct microscopic examination must be performed to detect acid-fast bacilli (AFB) using a sputum test, which still represents a problem for the correct diagnosis, since the results They may be altered depending on the sample collection technique, the time from sample collection to sample processing, the patient's condition at the time of sample collection, etc.[11]

Among the tests currently performed are smear microscopy (BK), the culture that represents an advantage over smear microscopy because it makes it possible to detect this nosological entity in samples with a low number of bacilli that have not been detected by a smear scan, in addition There is the polymerase chain reaction (PCR) or real-time PCR, the latter is more used in vulnerable people or cases suggestive of TB.[12] They allow us to observe the location of the affected lung segment, its extension and even the severity of the lung involvement.[13]

RADIOLOGICAL SIGNS OF PULMONARY TUBERCULOSIS

Imaging tests are essential to assess the state or degree of lung involvement that exists in patients with suspected or established diagnosis of TB. Depending on the stage of the disease and the risk factors of the host, various signs will be presented that can be observed in the different imaging methods performed.[11]

The most used test for the imaging diagnosis of pulmonary TB is radiography since it is the most accessible imaging test and represents the least cost, providing high sensitivity, but low specificity, while computed tomography is used less frequently since it Not all patients have access to it because it represents a higher cost, provides greater specificity and sensitivity. For the diagnosis of TB through imaging, it must be taken into account that there are no pathognomonic signs of the disease and the findings that can be found, they must be correlated with the clinical. [14]

The main advantage of CT is the greater specificity of TB diagnosis; Therefore, CT is often not required in acute situations, especially when the disease is suspected and appropriate precautions and testing have been instituted.[10] This imaging study may better show unique findings, such as cavitation or intrabronchial spread with tree bud nodules, and may be useful in cases where chest x-rays do not show "classic" tuberculosis findings.[15] CT results may also help predict smear positivity for acid-fast bacilli.[16] Even in patients with negative acid-fast bacilli smears, when findings are consistent with active tuberculosis, CT may suggest a patient at risk for a positive tuberculosis culture. By showing abnormal lymph nodes or subtle parenchymal disease, CT may be valuable in severely immunocompromised patients with normal or near-normal radiographs. Finally, CT can also help identify patients with latent TB who are at risk of disease recurrence.[8]

For better study, radiological findings will be considered depending on the pathological condition of the patients.

RADIOLOGICAL FINDINGS IN PRIMARY TB

Parenchymal consolidation can be observed that generally presents unifocal, and rarely can present multilobar. It can affect any lobe or lung segment; it presents with lymphadenopathy that is more prevalent in children and immunocompromised adults.[17] Pulmonary tuberculosis is also called the great simulator, since radiologically it can present as a typical bacterial pneumonia, appearing as homogeneous opacities with poorly defined borders, except when it affects the lung fissures, which is why it must be taken into account. the presence of lymphadenopathy, the absence of systemic involvement, the failure of antibiotic treatment, and the radiological resolution time in primary tuberculosis takes approximately 3 to 9 months, while in typical bacterial pneumonia it takes 3 to 4 weeks.[18]

FIGURE 1. Consolidation of the right upper lobe

SOURCE: Méndez Echevarría A, Baquero-Artigao F. Pulmonary tuberculosis. Integrated Pediatrician 2018;20(2):109–18.

Lymphadenopathy is the radiological sign that will help differentiate between primary and post-primary TB. The most affected lymph nodes are the right paratracheal lymph nodes, the hilar lymph nodes, the subcarinal lymph nodes but less frequently, and the aortopulmonary window lymph nodes.[19]

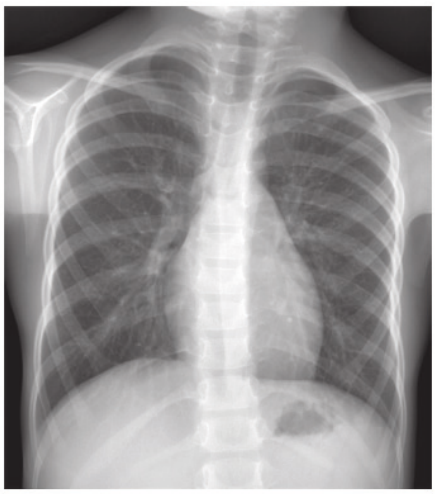

FIGURE 2: Right parahilar nodular opacity with poorly defined borders and presence of left apical reticular opacities.

SOURCE: Orozco-Andrade I, Acosta-Loya JA, Bravo-Rodríguez G, Martínez-Lozano F, Enríquez-Porras A, Espinoza-Hernández M, et al. Topography and radiographic patterns of pulmonary tuberculosis in migrant population. Pneumol Cir Thorax. 2018;77(3):189–97.

Another frequent finding in primary TB is miliary TB, which occurs in 1-7% of patients. It is caused by early hematogenous dissemination. It presents as nodules of between 2 and 3 mm that have no specific location. specific, if not, found diffusely and uniformly in both lungs.[20]

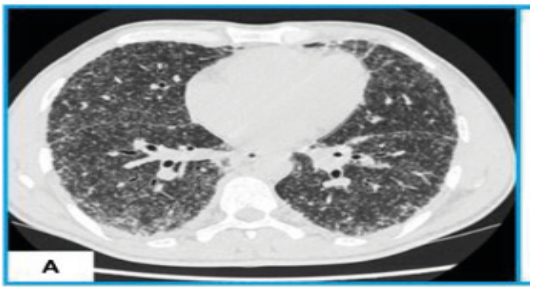

FIGURE 3. Miliary tuberculosis. Visualization of scattered micronodules.

SOURCE: Méndez Echevarría A, Baquero-Artigao F. Pulmonary tuberculosis. Integrated Pediatrician 2018;20(2):109–18.

The typical characteristic of this disease is the presence of hundreds of minute "millet grain" nodules with no preference for anatomical pulmonary location and distributed in both lungs from the vertices to the bases.[21] High-resolution computed tomography helps to more easily visualize the presence of nodules near the fissures and in the pleura.[22]

FIGURE 4. A. *CT* scan shows hundreds of "millet grain" nodules with a typical random distribution.

SOURCE: Rea G, Sperandeo M, Lieto R, Bocchino M, Quarato CMI, Feragalli B, et al. Chest Imaging in the Diagnosis and Management of Pulmonary Tuberculosis: The Complementary Role of Thoraci Ultrasound. Front Med. 2021;8(December):1–9.

Calcifications also occur in this stage of the disease, these occur in the place where the lesions occurred and even in the lymph nodes, a large percentage of these resolve completely, in months and even years without leaving sequelae.[23] The flügge droplets travel through the airways to the terminal alveoli and cause an inflammatory process in the parenchyma called Ghon's lesion. This lesion together with calcifications of the lymph nodes is called Ranke's complex, which are indicative of primary pulmonary TB., although the differential diagnosis with histoplasmosis or other fungal infections must be considered.[15]

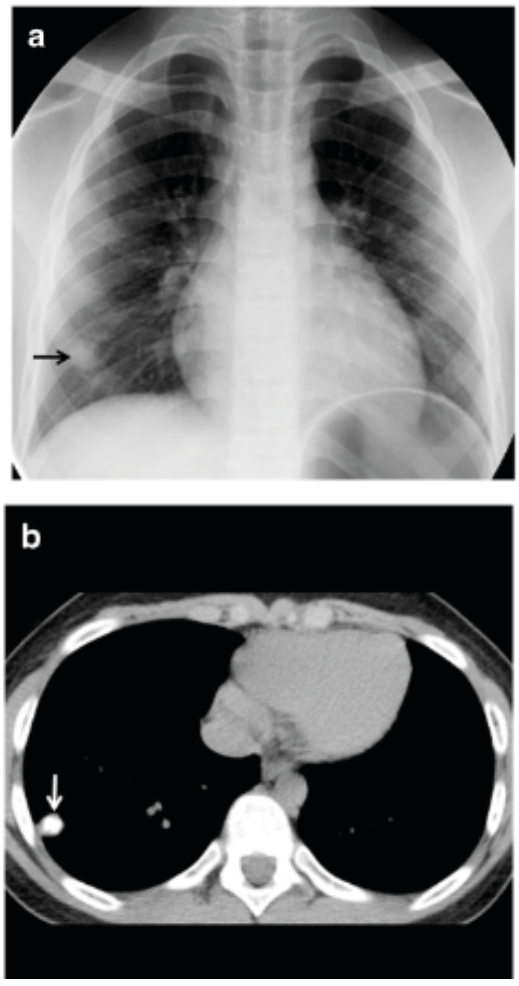

FIGURE 5. ***A.*** *Anteroposterior chest radiograph shows a Ghon focus (arrow) in the right lower lobe. B. Non-contrast axial chest CT demonstrates the focus, which is calcified (arrow).*

SOURCE: Concepcion NDP, Laya BF, Andronikou S, Daltro PAN, Sanchez MO, Uy JAU, et al. Standardized radiographic interpretation of thoracic tuberculosis in children. Pediatr Radiol. 2017;47(10):1237–48.

Tuberculomas present as opaque nodular images with regular and well-defined edges, which are mostly found in the upper lobes. These are findings that indicate cured primary TB and are seen in asymptomatic adults.[8]

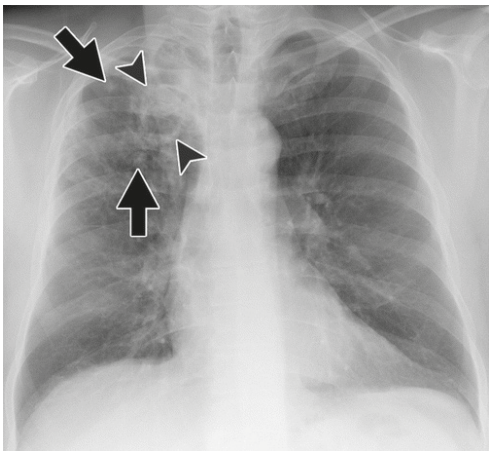

FIGURE 6. ***Tuberculoma. Solitary nodule with well-defined border in the right upper lobe.***

SOURCE: Nachiappan AC, Rahbar K, Shi X, Guy ES, Mortani Barbosa EJ, Shroff GS, et al. Pulmonary tuberculosis: Role of radiology in diagnosis and management. Radiographics. 2017;37(1):52–72.

Cavitations are a rare finding in primary disease, particularly found in children and infants who have been exposed for a long time to the bacillus.[9] Rarely, atelectasis can be observed that is caused by endobronchial obstruction or compression due to lymphadenopathy. It must be taken into account that this finding occurs in children under 2 years of age due to the smaller bronchial caliber.[24]

Pleural effusion is common in young adults and adolescents with primary TB and rarely occurs in children. It manifests more frequently with unilateral predominance and moderate to large amounts, from the third to seventh month after exposure. This radiological pattern It has a good prognosis since it is the one that represents the fewest complications.[25]

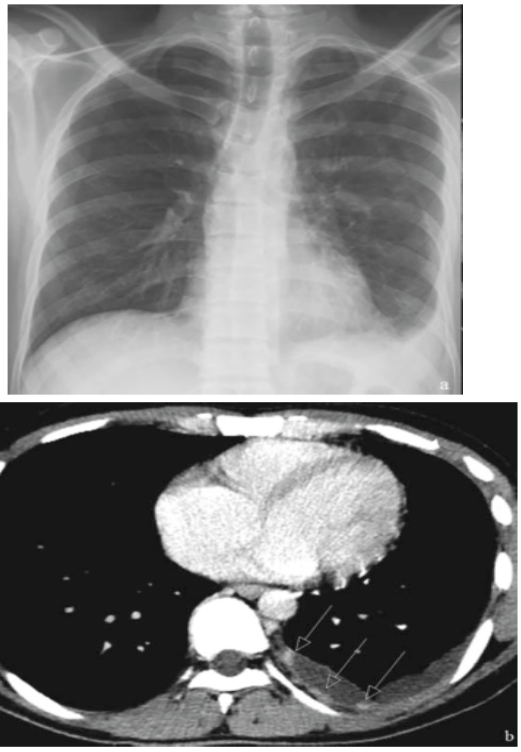

FIGURE 7. ***A.*** *Radiograph a shows no abnormalities except a pleural effusion on the left side. B. The CT scan shows disseminated nodules in both lung fields, in addition to a slight pleural effusion on the left side.*

SOURCE: Inzidenz D, Med T, Dis I, Prim D, Postprim D. Tuberculosis 2019 – a challenge also for radiology Tuberculosis 2019 – a challenge also for radiology Introduction Case description 1. 2019;354–6.

RADIOLOGICAL FINDINGS IN POST-PRIMARY TB

The finding that is seen in its earliest stage is a heterogeneous opacity with poorly defined borders, which can have a confluent or focal distribution, with predominance in the apical or posterior segment of the upper lobe, or mainly in the upper segment of the lower lobe. Once these segments are already affected, these opacities may appear in the anterior or basal segments. These heterogeneous opacities indicate an exudative lesion. Their predisposition to the aforementioned segments helps differentiate post-primary TB

from granulomatous diseases.[26]

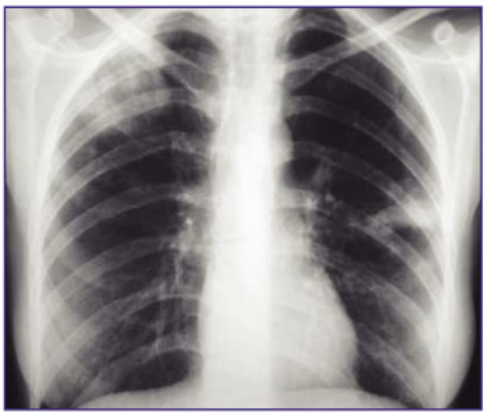

FIGURE 8. *The x-ray shows opacity in the right upper lobe.*

SOURCE: Méndez Echevarría A, Baquero-Artigao F. Pulmonary tuberculosis. Integrated Pediatrician 2018;20(2):109–18.

If adequate treatment of the disease is not performed, these opacities can compromise the entire lobe, thus this lesion will be replaced by reticulonodular opacities with better definition, which represent fibroproliferative lesions.[27]

Healing occurs by replacing tuberculous granulation tissue with fibrous tissue. The lesions may calcify and cause structural distortion of the lymph nodes, scarring atelectasis, and traction bronchiectasis.[28]

Cavitation occurs in 40-87% of patients with post-primary TB. This occurs when the liquefied tissue of the lesions is expelled towards the bronchial tree. This material will be expelled through expectoration.[16] En caso de fibrosis extensa o que exista distorsión de la arquitectura bronquial, el diagnóstico de estas cavitaciones será más adecuado por medio de tomografía, se pueden presentar como cavitaciones múltiples o aisladas y pueden variar en su tamaño.[23] They are located especially in the apices and posterior segments of the upper lobes. When air-fluid levels are observed within the cavitations, an added infection must be suspected, where the probable cause is anaerobic microorganisms.[29]

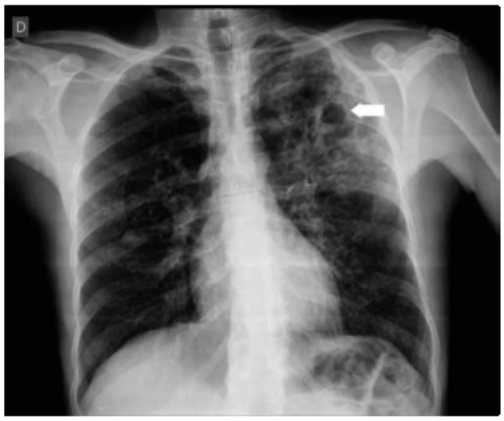

FIGURE 8. *The radiograph shows opacity + cavitation with well-defined borders in the left upper lobe.*

SOURCE: Navarro Ballester A, Marco Domenech SF, Fernandez García P, Moreno Muñoz MR, Gomila Sard B, Ibañez Gual M V. Clinical-radiological predictive model to diagnose active pulmonary tuberculosis. Rev Chil Radiol. 2019;25(2):47–9.

Miliary TB is rare in post-primary TB, although it can present as late TB and is mostly diagnosed after the patient's death, where signs of chronic tuberculosis are seen, such as calcifications and disseminated fibrosis.[30]

Lymphadenopathy is rare in post-primary TB, occurring in around 5-6% of all cases, and is usually accompanied by cavitations and extensive involvement of the parenchyma.[31]

Another radiological finding is fibrosis and bronchostenosis, which is caused by scarring of the lung tissue in patients with TB, where collapse of the lung segments or lobes, hyperinflation, obstructive pneumonitis and even mucoid impaction can be seen. differential diagnosis with lung carcinoma because granular tissue can accumulate simulating endobronchial polypoid masses, which cause obstructive pneumonitis and atelectasis.[32]

FIGURE 9. *Scarring atelectasis of the right upper lobe, associated with pleural cap and basal pleural calcification on the same side.*

SOURCE: Rodr P, Servicio I, Cl H, Coru L. Radiological manifestations of pulmonary tuberculosis. 2002;39(5):192–206.

Tomography is more useful in these cases, observing narrowing of the bronchial tree by long segments, and thickening of the wall, and even complete bronchial obstruction or obstruction caused by neighboring lymph nodes.[23]

Various complications may occur in post-primary TB, such as bronchiectasis, which are caused by fibrosis and destruction of the parenchyma, which will cause irreversible bronchial retraction and dilation, or cause scarring bronchial stenosis with distal dilation.[33] Generally, these bronchiectasis are asymptomatic, but when symptoms occur, the patient most often presents with hemoptysis. When chest x-rays do not reveal signs of bronchiectasis, CT can be used, which may reveal alterations compatible with bronchiectasis.[32]

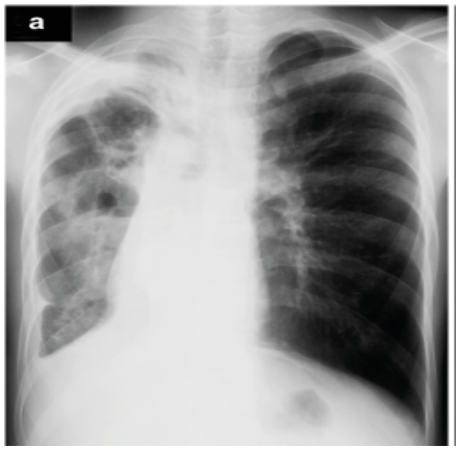

FIGURE 10. Posteroanterior chest radiograph showing cavitations, traction, and cystic bronchiectasis in the right lung

SOURCE: Concepcion NDP, Laya BF, Andronikou S, et al. Standardized radiographic interpretation of thoracic tuberculosis in children. Pediatr Radiol 2017;47(10):1237–1248.

Pleural effusion is not frequent in post-primary tuberculosis and when it appears it is related to parenchymal disease.[34] Empyema is another rare finding that manifests as a circumscribed collection associated with cavitation and extensive disease of the parenchyma. On CT, it is visualized as thickening of the pleurae, separated by pleural fluid in variable amounts, both conditions (pleural effusion and empyema), can be complicated when there are bronchopleural fistulas, which can occur due to rupture of a cavity or empyema, and will be observed on the x-ray as air-fluid levels.[35]

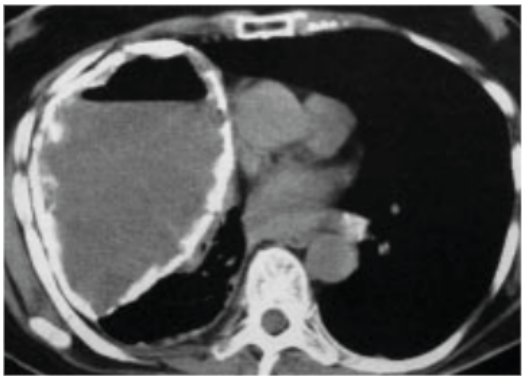

FIGURE 11. Pleural empyema. The CT scan shows a large loculated pleural collection with thickening and calcification of the parietal and visceral pleural, and with the presence of an air-fluid level.

SOURCE: Rodr P, Servicio I, Cl H, Coru L. Radiological manifestations of pulmonary tuberculosis. 2002;39(5):192–206.

Another complication is Rasmussen aneurysms, which are observed as dilations of small and medium-caliber arteries along with the fibrous capsule of the cavitations.[36] They have a high mortality rate since they can cause catastrophic hemorrhage, they occur exclusively in chronic fibrocaseous tuberculosis, and they are located in the upper lobes.[37] On x-ray they appear as a nodule or mass that occurs immediately after a pulmonary hemorrhage.[38]

CONCLUSIONS

Pulmonary tuberculosis is an infectious and contagious disease that has a high morbidity rate and presents with nonspecific symptoms that must be correlated with imaging studies. The imaging tools mostly used for the diagnosis of this pathology are chest x-ray and chest tomography, with tomography being the study with the greatest sensitivity and specificity, but in our environment due to the high cost and low economic level of the population, is used less frequently. The chest x-ray, although it has less specificity, is essential in the diagnosis of TB, where depending on the radiological findings observed, it can be established in what stage of the disease the patient is experiencing, in addition to being more accessible and less expensive. to the population. In the event that the clinical signs and x-rays present doubtful findings, a tomography may be chosen.

The radiological findings will be different depending on the stage of the disease, whether it is primary TB where signs such as lymphadenopathy concomitant with condensation, miliary TB, calcifications, tuberculomas, pleural effusion predominate; or post-primary, where cavitations, opacities with poorly defined borders, bronchiectasis and even complications such as Rasmussen aneurysm will be more frequent.

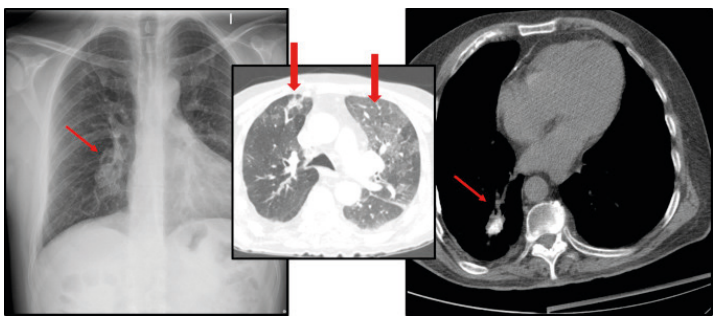

FIGURE 12. Radiography: nodular lesion in the right lower lung field, a finding confirmed on CT: presence of alveolar and ground glass opacities, and in the mediastinum a nodular lesion in the right lower lobe (thin arrows).

SOURCE: Rodr P, Servicio I, Cl H, Coru L. Radiological manifestations of pulmonary tuberculosis. 2002;39(5):192–206.

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