Thoracic radiology in immunocompromised patients: What does the radiologist need to know?

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Learning objectives

To recognize the multiple diseases that might affect the lung in the immunosuppressed patient.

To show the most typical radiological forms of presentation.
Background

Immunodeficiency is defined as the situation in which the host response to an external antigen is not appropriate.

Although there are some congenital forms of presentations, most of them are acquired and the most frequent ones are: neutropenia, leukemia, lymphoma, cancer, transplant, AIDS, chronic diseases (diabetes, alcoholism, chronic renal insufficiency), and patients with immunosuppressive treatments. The most frequent cause of pulmonary disease in immunodeficient patients is infection. It might be caused by habitual germs or opportunistic ones. Nevertheless, there are other causes of pulmonary involvement such as the original disease itself, the side effects of the treatment (drugs, radiotherapy, blood transfusions...), pulmonary embolism, bleeding or pulmonary edema.

Simple radiography, and specially Computed Tomography (CT) are helpful tools to categorize them apart. Despite the existence of certain grade of overlapping in the findings of different diseases, there are some highly characteristic radiological patterns. They are essential in order to lead the clinicians to the correct diagnosis due to the long time it takes for the microbiological diagnosis to be available.

There are different radiologic patterns of affection that are classified in consolidations, nodules, diffuse affection and adenopathies.

We describe the different types of infections which may occur in the immunocompromised patients, Clinical-radiological features of pulmonary infections which occur in HIV (Human Immunodeficiency Virus) patients are described in an isolated point because of increasing of this kind of infection at present.

1. Bacterial pneumonias:

Bacteria are the most common cause of infection in patients who are treated with chemotherapy and lung transplant recipients. The most causative agents are gram-negative organism (Klebsiella or Pseudomona aeruginosa) or gram-positive bacteria (Staphylococo aureus).

The main radiological findings are:

Thorax X-ray: Bilateral and diffuse opacities.

Thorax CT: Findings include "ground glass opacity", lobar or segmental consolidations (figure 1), thickening bronchial walls, nodules with "tree in bud" pattern (figure 2), pleural effusion or lymphadenopathy.
There are some radiological findings which may suggest a specific etiological diagnosis:
Neumatocele: Staphylococo aureus

2. Fungal pneumonia:
Aspergillus is the most common cause, mainly in solid organ transplant recipients.
Airway invasive aspergillosis is one of the most often in immunocompromised patients.
Radiological findings include centrilobular nodules which have a patchy distribution in the lung and nodular areas with a "tree in bud" appearance, this term means nodules with an increased attenuation (Figure 3).
As neutrophils begin to recover, nodules may undergo central cavitation (air crescent sign), a finding indicating a favorable prognosis [1].
Angioinvasive aspergillosis is also a kind of aspergillosis which occurs almost in in immunocompromised patients such as people who have unergone bone marrow transplantation or have hematologic malignancies like leukemia or even people who have been treated with new intensive chemotherapy regimens. The main radiological findings are nodules which tend to have a halo of "ground-grass" attenuation in the CT. It's called "halo sign" and shows hemorrhagic pulmonary areas (figure 4). Other typical findings are wedge-shaped areas of consolidation, which correspond to infarcts.
Other fungal organisms which can cause infections in immunocompromised patients are Candida, Nocardia, Criptococo and Pneumocystis.

Pulmonary candidiasis can cause infection by hematogenous spread or by aspiration. The hematogenous type shows military nodules or larger nodules in a random distribution. However, candidiasis which is disseminated by aspiration manifests as peribronquial distribution [2].

About Cryptococcosis, the most common CT finding is solitary or multiple nodules, well margnated. About 40% patients present "ground glass" opacity [3].
At last, the characteristic CT finding of Pneumocystis Jirovecci is "ground-glass opacity" with perihiliar distribution and upper lobes predominance. Pneumatoceles develop in a third of patients [4].

3. Viral pneumonia:

Citomegalovirus is the most common viral agent encountered in immunocompromised patients, mainly in solid organ recipient.

The radiological findings include "ground glass" opacity with lobar or diffuse distribution consolidations, small nodules and septal thickening (figure 5). Differential diagnosis between Citomegalovirus pneumonia and Pneumocystis pneumonia is very difficult [5].

Radiological findings of other viral pneumonias (influenzae, parainfluenzae, adenovirus...) are quite similar to Citomegalovirus and bacterial infections.

4. Human Immunodeficiency Virus (HIV) infection:

HIV infection is increasing because of improved survival and continued spread of disease. The most frequent site of HIV infection is the respiratory tract [6]. Nowadays, pneumonia is one of the most frequent causes of morbidity and mortality in these HIV patients. The risk of developing pneumonia depends on the CD4 T lymphocyte count (degree of immunosuppression) and using prophylaxis against common associated microorganisms.

The most common infection in these patients is bacterial pneumonia. If the CD4 T lymphocyte count decreases, the incidence increases. The most common pathogen which causes pulmonary infection in HIV patients is Streptococo pneumonia. Other bacteria which cause pneumonia are Staphylococo aureus, Haemophilus influenzae, Pseudomona aeruginosa, Legionella or Nocardia. Radiological findings are quite similar to bacterial pneumonia that occurs in other immunosuppressed patients.

Pneumocystis jiroveci pneumonia remains the most common opportunistic infection in patients with CD4 T lymphocyte count less than 200 cell/mm3. However, it has decreased in our countries because of the use of prophylaxis. The most common symptoms which the patients have are nonproductive cough, fever and dyspnea. The main radiological findings at CT are "ground glass opacity", pulmonary cysts, pleural effusion and centrilobular nodules (figure 6). Other fungal infections which can occur in HIV patients are caused by Histoplasma capsulatum, Coccidoides immitis, Coccidioides posadasii, Histoplasma capsulatum and Invasive aspergillosis. They are more frequent when CD4 T lymphocytes counts less than 100cells/mm3.
HIV infection is an important risk factor for developing tuberculosis. It is frequent with CD4 T lymphocyte counts less than 200 cells/mm3. Nevertheless, the incidence of infections caused by nontuberculosis mycobacteria like Mycobacterium avium complex (MAC) is also increasing. MAC infections are more frequent with CD4 T lymphocyte counts less than 100 cells/mm3. The most typical symptoms are fever, weight loss, abdominal pain or diarrhea. The main CT findings in pneumonias caused by tuberculosis mycobacteria are unilateral consolidation in upper lobes, thickening bronchial wall, centrilobular nodules, cavities and adenopathies (figure 7). If there is a hematogenous dissemination (not airway dissemination) the main radiological findings include smaller nodules with diffuse distribution. Radiological findings in nontuberculosis mycobacteria infection are quite similar to tuberculosis mycobacteria infection.

At last, Citomegalovirus is infrequent in HIV patients. It usually occurs with CD4 T lymphocyte counts less than 50 cells/mm3. Diagnosis is established by bronchoscopy and bronchoalveolar lavage [7]
Fig. 1: Male, 71 years-old with chronic lymphatic leukemia progressing despite several treatment. Thorax CT, axial scan: Mediastinal lymphadenopathy and alveolar consolidation in lower left lobe. Hemocultures were positive to E.coli. The patient died two days after receiving antibiotic treatment.

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Fig. 2: Nodules with "tree in bud" pattern.

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**Fig. 3:** Immunossupresed patient with acute bronchopneumonia: A) and B) Patchy bilateral areas of consolidation and nodules. C) Photomicrograph (original manifestation x100 PAS staining) shows multiple fungal hyphae.

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**Fig. 4:** 42 years-old man with myelogenous leukemia. A), B), C) and D) coronal and axial chest-CT reveal a round consolidation with a wide halo of ground-glass attenuation representing adjacent hemorrhage. The patient died despite antifungal treatment.
Fig. 5: A 67 years old female organ solid transplant recipient with Citomegalovirus pneumonia. A) Chest x-ray shows fine opacities with peribronchial predominant distribution. B) Axial CT scan shows peribronchial ground-glass opacity.

Fig. 6: A 32 years old HIV male who presented at emergency department with cough and dyspnea because of Pneumocystis Jiroveci pneumonia. Axial scan of thorax CT showed bilateral "ground glass opacity" and multiple cysts(orange arrows).
Fig. 7: Tuberculosis in a HIV patient: Coronal scan of thorax CT which shows bilateral small nodules and a cavity located in the left upper lobe.

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Findings and procedure details

We show different cases diagnosed in our hospital which illustrate that it remains essential incorporate clinical information into the radiologic features in order to make a narrow differential diagnosis.
Conclusion

Infection is the most frequent cause of pulmonary disease in immunodeficient patients. There are some characteristic radiologic patterns. The combination of the clinical data, the type of immunodeficiency and the findings in image are going to help us to achieve the correct diagnosis and being able to treat the patient quickly.
References


