Detailed analysis of passive atelectasis secondary to pleural effusion or pneumothorax to find an underlying associated pathology

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Learning objectives

The presence of a passive atelectasis associated to a pleural effusion or pneumothorax is usual in patients with lung tumors, complicated pneumonias and other pathologies. A careful examination of the atelectatic lung may help characterize the underlying pathology.
Background

Passive atelectasis usually associated to pleural effusion or, as an exception, pneumothorax, is a frequent finding when we study thoracic X-rays and CT scans. A detailed analysis of the collapsed lung is necessary when we look for an underlying pathology in CT studies. It is also particularly relevant to identify tumor pathology.
The presence of passive atelectasis associated to pleural effusion is quite common in patients suffering from lung tumours, complicated pneumonias or other pathologies. The radiologist must examine the affected lung exhaustively, looking for findings in order to identify the underlying cause, particularly tumour pathology.

In daily practice radiologist are used to detect lung atelectasis associated to pleural effusion. In this setting, if the diagnosis is uncertain, computerized tomography (CT) is indicated to identify the possible reasons of the loss of volume and pleural effusion (fig 1).

Atelectasis, has different etiologies such as obstructive/compressive, passive, cicatrization or adhesive, being the first one the most common type. For this reason, in the presence of a new atelectasis associated to pleural effusion or pneumothorax, bronchial compression or obstruction must be ruled out, usually by means of CT (fig 2).

Once the obstructive origin is discarded, we must assume that it is a passive atelectasis. It is precisely in this setting that further analysis of the atelectasis may bring additional information.

In this study, we try to present some radiological findings that can help us discern pathologies inside the collapsed lung. These findings include:

1. **Lack of bronchovascular structure**: in atelectasis, the bronchovascular markings are not disturbed, and a usual size can be observed. An underlying tumour can cause irregularities, sharpening (leafless tree sign) or bronchial and arterial displacement. When the tumour involves the bronchi and major arteries, a compressive effect can appear and sometimes it can cause complete stenosis (fig 3-7).

2. **Low contrast enhancement**: A tumour enhances 30-60 UH, meanwhile atelectasis enhances 80-100 UH. This difference is maximum when the acquisition is done between 40 seconds and 2 minutes after the contrast injection (venous phase). This difference is caused by an increment of vascularization due to the vascular grouping in the atelectasic lung.

In contrast, the tumoural area is vascularized by small bronchial arteries (fig 8). It should be emphasized that in non-contrast exams, density differences between atelectasis and tumour are almost indistinguishable; that means (fig 9).
3. **Internal structure:** atelectasis is defined as an area with an homogeneous density due to broncovascular grouping; meanwhile tumour is mainly heterogeneous as there may be necrotic areas within it (fig 10).

4. **Contours:** Lung collapses are well-defined by fissures and pleura, and their contours are smooth and plain (fig 11). The presence of lobulated irregular contours is a finding in favour of tumoural etiology.

5. **Bulging of the fissure:** (the Golden S sign) the lung mass causes a prominence in the morphology of the collapsed lobule. The displaced fissure shows a smooth convexity towards the healthy lung due to the lung mass in the atelectatic area (fig 12).

Apart from the mentioned findings, we can encounter other secondary signs in a CT scan whose presence has to alert us and make us give priority attention to the atelectatic area. These signs include:

1. **Pulmonary infarction.** Central tumours can occlude arteries and therefore be associated to distal pulmonary infarction (fig 13).

2. **Pulmonary tromboembolism.** The presence of occlusion of the major pulmonary arteries may be because of the procoagulant factor of the tumour. However, its presence is not always specific (fig 14).

3. **Pleural enhancement.** If there is pleural effusion associated to atelectasis, pleural enhancement will show us that the pleural effusion is an exudate. There are different causes of exudates including a tumoral etiology. The presence of pleural metastasic implants lead to exclude a primary neoplastic origin (fig 15).

4. **Adenopathies and metastasis.** The presence of these findings is highly suggestive for a hidden neoplasia that, in the case of lung cancer, could be hidden in the atelectatic area. (fig 16).

In spite of these signs, there are several reasons that may difficult the differentiation, even with optimum CT images.

- If the tumour is well vascularised and the necrosis is limited, the tumour could enhance as the atelectatic adjacent lung.
b-If the collapsed lung has a large amount of water and mucus (drowned lung) or there is an obstruction of the arterial flow, the atelectatic area will not enhance sufficiently to differentiate it from the tumour.

Magnetic resonance (MR) and recently by PET-CT scans can help in this differentiation. Several studies have shown that this capacity in MR diffusion images and increased uptake in PET-CT. Nevertheless MRI and PET-CT are less available and costly in many cases. (Fig 17)
Images for this section:

**Fig. 1:** Example radiography that we can find in the usual practice showing an opaque right hemithorax with ipsilateral mediastinal shift.

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Fig. 2: Axial CT image with IV contrast showing a carcinoid tumor occupying the left bronchial lumen.

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Fig. 3: Axial CT image where there is not clearly differentiated tumor area but there are stenosis of the left pulmonary artery, we should suspect tumor cause.

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**Fig. 4:** Axial CT image with IV contrast showing a medial bow from a branch by a vascular nodule suggestive of malignancy within the collapse.

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**Fig. 5:** Coronal CT image showing alteration in bronchial structures inside the atelectasis suggestive of an underlying tumour.

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Fig. 6: Contrast-enhanced CT image shows sharpening of the pulmonary vasculature (leafless tree sign).

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**Fig. 7:** Axial CT image in the disruption of the structure by a bronchial carcinoma within atelectasis.

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Fig. 8: CT image with IV contrast showing low uptake of tumor zone from atelectásica area.

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Fig. 9: Axial CT images without contrast administration and after showing the difficulty in differentiating the tumor area in a study without contrast.

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Fig. 10: CT image showing a large tumor consolidation of RIL.

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**Fig. 11:** CT image with IV contrast showing a hypodense lesion with irregular contours within atelectasis of LUL.

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**Fig. 12:** Axial CT image with IV contrast showing the Golden S sign.

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Fig. 13: CT image showing an area of consolidation with air bubbles inside suggestive of pulmonary infarction.

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Fig. 14: Pleural enhancement will show us that the pleural effusion is an exudate.

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Fig. 15: CT angiography of pulmonary arteries shows left filling defect if we inquire into the lung collapse there are a hypocaptating nodular zone suggestive of neoplasia.

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Fig. 16: Axial CT image shows a pleural nodule.

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Fig. 17: PET-CT image where increased tracer uptake is observed which targets a tumor-infectious origin of the consolidated area.

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Conclusion

A detailed analysis of passive atelectasis secondary to pleural effusion or pneumothorax is essential and necessary to detect or rule out important underlying pathologies (tumoral or infectious) in CT scans.
References


