Cavitated lung lesions. A diagnostic approach

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Learning objectives

Describe the radiologic characteristics of cavitary lung lesions, reviewing the pathologies associated with these lesions. This allows an approach to the differential diagnosis.
Background

Cavitary lung lesions include a wide variety of both benign and malignant entities. First of all, we must establish what we understand by pulmonary cavitation and take care of a number of features for their evaluation in order to establish an approximate diagnosis.

- CYST VERSUS CAVITY

Both terms refer to an anomalous air-containing space of the lung surrounded by a defined wall. Often they are used interchangeably, although this is erroneous because they have different meanings and imply different possible diagnoses. In our case:

- If the wall is thin (# 4 mm) # Cyst
- If the wall is thick (> 4 mm) # Cavity

Also we call the air-containing lesion that is surrounded by an infiltrate and/or a mass cavity.

It is important to keep this in mind, as cystic lesions, such as we have defined them, rarely are malignant, whereas with cavitary lesions a malignancy should be our first diagnostic option particularly in middle-aged or older adults with a significant history or cigarette smoking.

- RADIOLOGIC CHARACTERISTICS OF CAVITARY LESION

Once we are focused on cavitated lesions, we will attend to a series of features in order to approach to the diagnosis secondly.

- Wall thickness: generally
  
a > wall thickness # > probability of malignancy

- Characteristics of the inner contour
  
Nodular or irregular # usually in case of neoplasms
Poorly defined/shaggy # usually corresponds with abscesses
Smooth # cavitary lesions of other etiology
- Internal content

Air Liquid

Solid Air-fluid level

The presence of an air-fluid level does not correlate with the benign or malignant nature of the lesion, and the solid content can be seen both in infectious processes, such as invasive aspergillosis, as in necrotic tumors.

- Number and location

Some locations guide to the possible etiology of the cavitary lesion, for example lesions in the upper lobes are typical of tuberculosis.

- Others findings

Directly related to the cavitated lesion or not that help to establish the most likely diagnosis (areas of "ground glass" attenuation, pulmonary opacities, interstitial disease, thickened septos, "honeycomb" pattern…)

  • FOCAL / MULTIFOCAL DISEASE VERSUS DIFFUSE (Table 1 and 2)

Considering the cavitary lesion and/or associated findings, we will determine if it is a focal/multifocal affectation or diffuse disease, which will guide us to the most approximate diagnosis.

  • VALUATION OF CLINICAL CONTEXT AND THE TIME OF THE DISEASE PROCESS

As in other processes is important to consider the clinical scenario in which we are moving (age, sex, history or cigarette smoking, drugs and other environmental or occupational toxic, immunocompetence, underlying diseases, etc).

The possible diagnostic etiologies also depend on the duration and evolution of the referred clinical and symptomatology, as well as if the objectived lesion is acute, subacute or chronic (if it is more than one month in duration). Therefore it is important to compare with previous studies to value possible changes in their characteristics.

- Acute or subacute lesions with a relatively short period of evolution (days or a few weeks) # usually suggest infection or other progressive inflammatory diseases, cardiovascular disorders (such as embolism) or traumatic causes.

- Chronic lesions with large evolution # are more probably malignant, long-standing inflammatory or fibrotic disorders or congenital lesions.
The **DIFFERENTIAL DIAGNOSIS** of cavitary lesions is therefore very broad and includes neoplastic pathology (primary tumors such as bronchogenic carcinoma, lymphoma, metastases), many types of infectious processes and abscesses (bacterial, mycobacterial, fungal, parasites), pulmonary infarcts and septic embolism, vasculitis, rheumatoid nodules, congenital diseases… We discuss some of these entities:

- **NEOPLASMS** (FIG 1-5)
  - Isolated cavitary lung lesions correspond in most cases to a **bronchogenic carcinoma**, which cavitates in 10-15% of cases associating a worse prognosis. Cavitation occurs more commonly with **squamous cell carcinoma** than with other histologic types of carcinomas. Typically, it is a lesion of variable size, spiculated, with irregular and thick walls (>4 mm), associated with a mass and other findings like lymphadenopathy, invasion of mediastinic structures and thoracic wall.
  - Some **lymphomas** and **Kaposi sarcoma** may also cavitate, especially in HIV + population.
  - On the other hand, it is possible to find **metastatic cavitated lesions** of primary tumors with different origin than the lung. In this case, they are usually multiple small lesions with smooth and regular contour simulating cysts.

- **INFECTIOUS PATHOLOGY** (FIG 6-10)
  - **Necrotizing bacterial pneumonia**: caused by *Staphylococcus aureus*, gram-negative bacteria and anaerobic bacteria. They appear like a pulmonary consolidation that can associate cavitation inside. In the case of **anaerobic bacteria**, it is common to develop abscesses with thick and irregular walls containing air-fluid levels.
  - **Postprimary tuberculosis**: its most common manifestation (40% of cases) is the presence of infiltrates with multiple satellite nodules and cavitary lesions. These findings are located preferentially in the upper lobes and in the apical segments of the lower lobes. The cavities have inner walls that can be both smooth and more irregular and thick (which occurs more often). Also other nontuberculous mycobacteria may develop cavitated lesions.
  - Among **fungal infections**, endemic (histoplasmosis, blastomycosis, mucormycosis…) especially in cases of chronic disease and opportunistic fungal infections (such as aspergillosis and cryptococcosis), may manifest as cavitary lesions with walls of variable thickness. In the case of **aspergillosis**, the radiologic manifestations vary depending on the disease and patient’s immune status; one of the most frequently reported findings is the presence of cavitary lesions with thick walls, isolated or multiple, in the upper lobes associated with focal opacities and diffuse infiltrates. Occasionally these cavities may be invaded by aspergillus conditioning the
development of aspergillomas-mycetomas, which have solid content and air forming the sign called "air - crescent".

- AUTOIMMUNE - IMMUNOLOGIC PATHOLOGY (FIG 11)

Many autoinmune systemic diseases can affect the lungs but rarely are characterised by the presence of cavitated lesions. An exception is Wegener granulomatosis and rheumatoid nodules.

• **Wegener granulomatosis**: it is a systemic necrotising vasculitis that affects the upper and lower respiratory tract. Radiologically it manifests with multiple and bilateral nodules or mass, transitories and recurrents, which may cavitate either by itself or by necrosis secondary to arterial occlusion.

• **Rheumatoid arthritis**: systemic disease related to connective tissue, which mainly affects women between 20 - 50 years old. Among thoracic manifestations, pleural disease is the most common. There are described bilateral and multiple lung nodules, usually small in size and with subpleural location, that may cavitate.

- OTHERS ETIOLOGIES (FIG 9-10, 12-13)

• **Pulmonary embolism**: the pulmonary thromboembolism of vascular origin, due to the presence of a thrombus in the lumen of pulmonary arteries, may manifest as lung infarction that cavitates in 7% of cases more or less. These cavities can be present for a long time until their complete resolution and in most cases remain aseptic. Usually they are unique, with subpleural location, and triangular morphology with the apex directed towards the lung hilum. Cavitation also can be objectified in pulmonary embolism secondary to neoplasms, fat (generally in posttraumatic context), air or in septic embolism. These are multiple small nodules (1-3 cm), with peripheral subpleural location in the lower lobes and in various stages of cavitation. We have to think of them in the case of valvular endocarditis, drug addiction, congenital heart disease, carriers of endocardial catheters and pacemakers.

• **Organising pneumonia**: both cryptogenetic of unknown etiology and those related to toxic exposure, autoimmune diseases. May cavitate in 6% of cases. It usually manifests as "ground-glass" opacities with patchy areas of consolidation, peripheral distribution and nodules that may cavitate. Both clinical and radiologic findings are nonspecific, so that biopsy is necessary for definitive diagnosis.
<table>
<thead>
<tr>
<th>Cystic lesions</th>
<th>Cavitary lesions</th>
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<tr>
<td>Bullae and y blebs</td>
<td>Neoplastic</td>
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<td>Pneumatoceles</td>
<td>Bronchogenic carcinoma</td>
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<td>Congenital lesions</td>
<td>Metastases</td>
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<td>Bronchogenic cyst</td>
<td>Lymphomas</td>
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<td>congenital adenomatoid malformation</td>
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<tr>
<td>Infections</td>
<td>Infections</td>
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<td>Coccidioidomycosis</td>
<td>Bacteria: staphylococcus aureus, gram-negative,</td>
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<tr>
<td>Pneumocystis carinii</td>
<td>pneumococcus, mycobacteria, anaerobes,</td>
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<tr>
<td>Hydatid disease</td>
<td>actinomycosis, nocardiosis</td>
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<td>Traumatic cysts</td>
<td>Fungi: histoplasmosis, coccidioidomycosis,</td>
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<td></td>
<td>blastomycosis, aspergillosis, mucormycosis,</td>
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<td>cryptococosis, P. carinii</td>
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<td>Parasites: hydatid disease, paragonimiasis,</td>
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<td>Immunologic</td>
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<td>Wegener granulomatosis</td>
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<td>Rheumatoid nodule</td>
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<td>Thromboembolism or septi embolism</td>
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<td>Progressive massive fibrosis (pneumoconiosis)</td>
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<td>Bronchiectasias, localized</td>
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<td>Congenital lesions</td>
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<td>Sequestration</td>
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<td>Congenital adenomatoid malformation</td>
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</tbody>
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Table 1. Causes of focal/multifocal involvement

**Table 1:** Table 1. Focal/multifocal involvement

### Table 2. Causes of diffuse disease

**Table 2:** Table 2. Diffuse involvement


<table>
<thead>
<tr>
<th>Pulmonary lymphangioleiomyomatosis</th>
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<tbody>
<tr>
<td>Pulmonary Langerhans cell histiocytosis</td>
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<tr>
<td>Honeycomb lung</td>
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<tr>
<td>- Idiopathic pulmonary fibrosis</td>
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<tr>
<td>- Connective tissue disease-related pulmonary fibrosis</td>
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<tr>
<td>- Asbestosis</td>
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<tr>
<td>- Chronic hypersensitivity pneumonitis</td>
</tr>
<tr>
<td>Advanced sarcoidosis</td>
</tr>
<tr>
<td>Bronchiectasis, diffuse</td>
</tr>
<tr>
<td>Metastatic disease (rare)</td>
</tr>
</tbody>
</table>
Lung neoplasia in apical segment of LII with cavitation and bilaterales cavitated small nodules, probably of metastatic nature. (figuras 1a, 1b, 1c)

**Fig. 1**: Fig 1a

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Lung neoplasia in apical segment of LII with cavitation and bilaterales cavitated small nodules, probably of metastatic nature. (figuras 1a, 1b, 1c)

Fig. 2: Fig 1b

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Fig. 3: Fig 1c

Lung neoplasia in apical segment of LII with cavitation and bilaterales cavitated small nodules, probably of metastatic nature. (figuras 1a, 1b, 1c)

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Isolated and spiculated pulmonary nodule in left upper lobe with central cavitation corresponded with neoplasm.

Fig. 4: Fig 2

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Right transitional cell carcinoma with lung metastasis, one of these in the left lower lobe with cavitation.

Fig. 5: Fig 3

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Necrotizing pneumonia in right upper lobe with progressive pneumatization and response to treatment, showing thinning of its wall.

**Fig. 6:** Fig 1

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Fig. 7: Fig 2

Endobronquial spread of tuberculosis with miliary pattern and foci of consolidation with cavitation in left upper lobe.

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Apical cavitated bilateral lesions with fungal superinfection, in relation to bilateral lung mycetomas with “air crescent” sign.

**Fig. 8: Fig 3**

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Cavitated consolidation in right base with air-fluid level and progressive disappearance, in patient with thromboembolism (fig 4a and 4b)

**Fig. 9:** Fig 4a

© Hospital Txagorritxu - Vitoria-Gasteiz/ES
Cavitated consolidation in right base with air-fluid level and progressive disappearance, in patient with thromboembolism. Differential diagnosis between cavitated pulmonary infarction or cavitary pneumonia (fig 4a and 4b)

**Fig. 10:** Fig 4b

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Consolidation in right lower lobe surrounded with thick walls, cavitation and hypodense content, that corresponded with a granulomatous mass in patient with Wegener Granulomatosis.

Fig. 11: Fig 1

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Multiple bilateral cavitated nodules in relation to septic emboli.

Fig. 12: Fig 2

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**Fig. 13:** Fig 3

A 32 slice CT is used to obtain exams.
Conclusion

In the evaluation of cavitated lung lesions, we have to keep in mind both the characteristics of the lesion (size, morphology, number, location...) and other associated findings that may be objectified, the CT being a very useful diagnostic tool for it.

Moreover we have to correlate the findings with clinic context, disease history and previous information, to establish an approximate diagnosis and/or prioritise the most likely differential diagnoses that will guide the subsequent management of these cavitated lesions.
Fig. 14: Esquema 1

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Fig. 15: Esquema 2

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References