Cavitating lung disease - a CT pictorial essay

Poster No.: C-0152
Congress: ECR 2014
Type: Educational Exhibit
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Keywords: Cavitation, Education, Plain radiographic studies, CT-High Resolution, CT, Thorax, Lung
DOI: 10.1594/ecr2014/C-0152

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Learning objectives

This pictorial essay is written with the aim of improving the understanding of the entities that can result in a cavitating lung lesion. It is primarily targeted for general radiologists and trainees in radiology but may appeal to anyone with a specific interest in cavitating pulmonary pathology.

At the end of reading this pictorial essay, we anticipate that you would be able to

1. Have an understanding of the various conditions that could result in a cavitating lung lesion.
2. Appreciate the overlap in imaging features that can be found with cavitary lesions caused by these differing entities.
3. Have a knowledge of imaging features and associated clinical factors that may assist in your radiological differential diagnosis.

Background

Cavitating lung lesions can result from a large number of disease processes and yet present with similarities on imaging. When faced with the problem of differentiating between these pathologies, certain associated imaging features accompanied by relevant clinical information can be useful in supporting a particular diagnosis or in narrowing your list of possible diagnoses. A sound knowledge of the pathological spectrum of cavitating lung disease would enable you to make an interpretation that is more comprehensive and clinically meaningful for your referring colleagues.

This pictorial essay describes the imaging spectrum of cavitory lung disease and contains CT examples for most conditions. The CT images were sourced from the picture archiving and communicating system (PACS) at Hôpital Albert Calmette, CHRU, Lille, France.

A brief overview of each condition is provided and where possible, distinguishing imaging features for each example are also discussed.

Findings and procedure details

Overview
While you may be able to easily recognise a "pulmonary cavity", the term lacks a clear consensus on its precise definition. It has been described by the Fleischner society as a "gas-filled space, seen as a lucency or low-attenuation area, within pulmonary consolidation, a mass, or a nodule"\textsuperscript{1-2}. A pulmonary cavity may or may not contain an air-fluid level.

In some circumstances, differentiation from a pulmonary cyst can be difficult. As opposed to a pulmonary cyst, a pulmonary cavity is generally thick walled with some publications using wall thickness values of \textgreater4-5 mm to differentiate a cavity from a cyst\textsuperscript{3-4}. However, it must be kept in mind that there are considerable aetiological and pathological overlap between these two entities.

In other circumstances, distinguishing a pulmonary cavity from a necrotic pulmonary mass lesion on imaging alone can also prove difficult. When a cavitary lesion exists as a component of a wider solid mass, it is probably better described as a "necrotic mass with cavitation", rather than as a pulmonary cavity.

Pulmonary cavitary lesions can result from a large number of pathological processes. These can range from de novo cavities arising secondary to underlying necrotic processes (can be infective, ischaemic, inflammatory or mitotic) to a thick-walled cavities arising from complications (e.g. infection) occurring within previously thin-walled cystic lung lesions.

The spectrum of cavitary lung lesions according to different pathological entities can be summarised below

Cavitary lesions associated with malignancy

Primary lung tumours

Primary bronchogenic carcinoma with cavitation

Metastatic lung tumours

Metastatic carcinomatous tumours within cavitation

Metastatic sarcomatous tumours with cavitation

Metastatic transitional cell tumours with cavitation

Other pulmonary tumours - neoplastic lesions
Pulmonary lymphoma
Kaposi sarcoma

Non lymphomatous pulmonary lymphoid disorders
Lymphomatoid granulomatosis

Infective cavitations
Pyogenic cavitary bacterial pneumonia
Cavitating intrapulmonary abscess
Cavitation associated with mycobacterial infection
Cavitation associated with pulmonary tuberculosis
Cavitation associated with non tuberculous mycobacterial infection
Cavities associated with pulmonary Aspergillus infections
Aspergilloma
Chronic necrotising aspergillosis

Other cavitating infections
Pulmonary melioidosis
Pulmonary cryptococcosis
Pulmonary actinomycosis infection
Pulmonary nocardiosis infection
Pulmonary coccidioidomycosis infection
Pulmonary pseudomonas aeruginosa infection
Pulmonary legionella pneumophila infection

Non-infective inflammatory cavitations
Granulomatosis with polyangiitis (Wegener's granulomatosis)

Necrobiotic nodules associated with

Rheumatoid arthritis - cavitatory rheumatoid nodules

Inflammatory bowel disease

Cavitating nodules in pulmonary sarcoidosis - necrotising sarcoid granulomatosis

Cavitation associated with embolic - ischaemic factors

Aseptic pulmonary cavitation following pulmonary infarction

Cavitating septic pulmonary emboli

Cavitary lesions associated with thoracic trauma

Pulmonary lacerations with cavitation

Cavitation associated with pre-existing lung lesions

Infection (or postnatal fluid resorption) within a pre-existing intrapulmonary cyst, bullus or pulmonary airway malformation.

**Cavitation associated with pulmonary malignancy**

**Cavitation associated with primary lung tumours**

The development of cavitation in primary malignant bronchogenic tumours (detected by CT) have been reported in up to a fifth of cases. A malignant lung lesion may simply cavitate due to inherent necrosis without any superimposed infection (Fig. 1 on page 17 and Fig. 2 on page 18). The prevalence of cavitation tends to be more frequent with squamous cell carcinoma than with other histological types. Most cavitating pulmonary malignant tumours tend to present as single lesions and in many instances, the cavitation associated with malignancy manifests as part of a wider necrotic mass. The presence of cavitation within any lung tumour has been associated with a worse prognosis.
The patient's age, clinical risk factors and whether there any clinical infective features are important factors that would be useful in assessing the probability of malignancy in a cavitating lesion.

A malignant cavity may well show evidence of invasion and/or disruption of regional structures. The presence of an irregular internal wall +/- notching within a cavitating lesion have been reported as features that may increase the suspicion of malignancy associated with a cavitating lesion; while a smoother cavity margin, presence of concurrent satellite nodules, bronchial wall thickening, consolidation and/or ground-glass attenuating regions have been reported as features that may decrease the suspicion of lung malignancy associated with it.

However despite the above features, differentiating a malignant cavity from a non-malignant cavity can still prove very difficult on imaging alone. The presence of superinfection can further complicate this task.

Very rarely, other primary tumours occurring in the lung, such as pulmonary lymphoma (Fig. 3 on page 19 and Fig. 4 on page 20) or Kaposi sarcoma may also present with cavitation. These entities need to considered especially in immunocomprised states such those affected with the human immunodeficiency virus. These may present as multiple lesions.

The administration of chemotherapy and radiotherapy can also induce cavitation in a malignant lung lesion.

**Cavitation associated with pulmonary metastases**

Cavitation in metastatic nodules can also occur although this is reported at lower rates than with primary pulmonary malignancies. On plain radiography, the presence of cavitation associated with pulmonary metastases have reported to be around 4%.

A squamous cell histology is again the most common type accounting for cavitating metastases observed on radiographs (these may account for up to 70% of cases on plain film) while on CT, the cavitation rates between squamous and non-squamous cell histological types have not proven to be significantly different. Cavitation has also been described with pulmonary metastatic lesions having adenocarcinoma (Fig. 5 on page 21 and Fig. 6 on page 22), transitional cell carcinoma and sarcomatous (Fig. 7 on page 23 and Fig. 8 on page 24) histologies.

**Non lymphomatous pulmonary lymphoid disorders**
These are a group of conditions of lymphoid lineage that do not possess full blown clonal cell proliferation. Of these, pulmonary lymphoid granulomatosis (angiocentric immunoproliferative lesion) can be a cause of multiple cavitating lung lesions.

**Infective conditions associated with cavitation**

**Bacterial pneumonia associated with cavitation**

A cavitating pneumonia (Fig. 9 on page 25 and Fig. 10 on page 26) is a potential complication of a severe necrotising pneumonia. The two terms (cavitating pneumonia and necrotising pneumonia) can be sometimes used interchangeably in medical literature. Various organisms can cause cavitation although certain organisms such as *Klebsiella pneumoniae* and *Staphylococcus aureus* can have higher rates of cavitation. As a general rule; any organism that can cause extensive necrosis has a greater likelihood of leading to cavitation. A differentiating feature between a cavitating pneumonia and an intra-pulmonary abscess is that the former contains a portion of residual consolidation around the cavity.

**Pyogenic intrapulmonary abscess**

A pyogenic lung abscess (Fig. 11 on page 27 and Fig. 12 on page 28) is another relatively common cause of an infective cavitating lung lesion. Most patients have predisposing risk factors.

In adults, alcoholism is the most frequently reported risk factor. Other factors include poor dentition, a history of aspiration and the presence of underlying lung injury.

Lung abscesses also occur in children, most of whom have immune system compromise or predisposing lung damage.

Lung abscesses are frequently polymicrobial. They can be a direct consequence of a cavitating pneumonia. However, as opposed to a pneumonia with cavitation, a formed intra-pulmonary abscess represents a more established process where there is usually little or no surrounding pulmonary consolidation.

**Pulmonary tuberculosis with cavitation**

Amongst all infective agents, *Mycobacterium tuberculosis* (Fig. 13 on page 29 and Fig. 14 on page 30) is reported to have the highest prevalence of cavitation. Cavitation
is most commonly reported with post-primary pulmonary tuberculosis. The rate of cavitation correlates with higher baseline sputum mycobacterial loads. Cavitation in single or multiple sites may be radiographically evident in up to 40-45% of cases of post-primary pulmonary tuberculosis. The cavity walls associated with pulmonary tuberculosis may vary from being thin and smooth to thick and nodular. Air-fluid levels may be present in 10-20% of tuberculous cavities. The presence of other concurrent imaging features of pulmonary tuberculosis such as granulomatous calcification (Fig. 14 on page 30), tree-in-bud changes and an overall upper lobe predilection are features that could support towards a tuberculous cavity.

Cavitating lung lesions associated with non-tuberculous mycobacterial infection

Cavitating lung lesions can also occur in the "classic form" of non-tuberculous mycobacterial infection. The cavitating lesions in this situation often have a "feeding bronchus sign" which is the appearance of bronchus or bronchiole heading into the cavitation. In contrast to post-primary pulmonary tuberculosis, the disease progresses more slowly and cavities are more likely to be smaller or thinner in terms of wall thickness. It has been suggested that early bronchial wall thickening or peribronchial nodules of non-tuberculous mycobacterial infection evolve into inflamed focal cystic bronchiectasis and thus manifest as cavitary lesions.

Fungal infections

The majority of fungal-associated pulmonary cavities are related to Aspergillus infection or contamination. Aspergilloma and chronic necrotising aspergillosis are the commonest forms that can be accompanied by cavitation. In some situations, angioinvasive aspergillosis can also culminate in cavitation if vascular obstruction occurs with secondary lung infarction and sequestration.

Aspergilloma

An aspergilloma represents an Aspergillus infection within a cavity without tissue invasion (Fig. 15 on page 31 and Fig. 16 on page 32). It comprises of a conglomeration of inter-twined fungal hyphae, mucus and cellular debris within a pre-existent pulmonary cavity or an ectatic bronchus. The underlying pathology associated with the original cavity is frequently tuberculosis, while less common conditions that may be complicated by an aspergilloma include sarcoidosis, bronchogenic cysts, pulmonary sequestrations and pneumatoceles secondary to infections such as Pneumocystis jirovecii pneumonia (the latter is associated with immunocompromised states e.g. from chemotherapy or acquired immunodeficiency syndrome - AIDS).
While aspergillomas can occur anywhere in the lung, there tends to be an overall upper lobe predilection due to the distribution of the pre-existing cavities caused by some of the aforementioned pathologies having such a predilection.

Typically an aspergilloma will demonstrate an air-crescent sign (which is the presence of a crescentric air rim around the fungal ball) as well as gravity dependant positional change of the fungal ball within the cavity between prone and supine acquisitions.

**Chronic necrotising aspergillosis (CNA) - semi invasive aspergillosis**

This is a form of pulmonary aspergillosis where there is local invasion of lung tissue and a pre-existing cavity is not an essential requirement. A cavity with a free fungal ball (which could look like an aspergilloma) may develop as a secondary phenomenon due to fungal destruction. CNA typically affects middle-aged to elderly patients who have underlying chronic lung diseases such as chronic obstructive pulmonary disease (COPD), previous pulmonary tuberculosis, thoracic surgery, radiation therapy, pneumoconioses, cystic fibrosis, lung infarction or sarcoidosis. Due to the presence of these underlying pathologies, image interpretation and a confident imaging diagnosis for a CNA associated cavity can be difficult (Fig. 17 on page 33 and Fig. 18 on page 34). CNA may also occur in patients with relative immunodeficiency (e.g from diabetes mellitus, alcoholism, chronic liver disease, corticosteroid therapy, malnutrition) or those having arthropathies such as rheumatoid arthritis and ankylosing spondylitis.

In severely immunocompromised patients, an aspergilloma may sometimes invade the cavity wall, and cause local parenchymal destruction. This results in overlapping imaging features between CNA and an aspergilloma. Emphasis is therefore placed on the importance of the patient’s immune status when interpreting a suspected aspergillus-associated cavity.

**Other infective cavities**

Cavitating lesions have also been described with pulmonary involvement with various other organisms such as actinomycosis, coccidioidomycosis, nocardiosis, melioidosis, cryptococcosis, pseudomonas aeruginosa (Fig. 19 on page 35) and legionella pneumophila

**Cavitation associated with non malignant inflammatory - rheumatological conditions**
Cavitation associated with granulomatosis with polyangiitis (Wegener's granulomatosis)

Granulomatosis with polyangiitis is a multisystemic chronic granulomatous necrotising vasculitis that primarily involves small and medium-sized vessels. As a thoracic manifestation, patients often develop pulmonary nodules and masses (these may be seen in up to 70% of patients either at presentation or during the course of the disease). These lesions can be single or multiple (but it is uncommon to have a very large number of lesions - e.g. >10). When multiple, the nodules usually have a random distribution. Cavitation can occur in approximately 25-50% of nodules larger than 2cm (Fig. 20 on page 36). The cavity walls are variable from being thin, thick or nodular and therefore cannot be used as a differentiating feature from other cavities. The characteristic waxing and waning of lesions during the course of the disease differentiates this disease from some of the other cavitating conditions (Fig. 21 on page 37).

Cavitation associated with necrobiotic rheumatoid nodules

Pulmonary necrobiotic nodules are a rare thoracic manifestation of rheumatoid arthritis. These can occur in ~1% of patients. These nodules can cavitate (Fig. 22 on page 38 and Fig. 23 on page 39) and even precipitate complications such as haemoptysis or pneumothorax formation. Rheumatoid nodules are generally smooth, well-circumscribed and tend to have a predilection for peripheral and subpleural locations. Cavitation within these nodules often produce thick-walled lesions with smooth inner margins. When cavitation is present within a suspected rheumatoid nodule, infectious aetiological agents (e.g. tuberculosis etc) need to be excluded (especially in patients on immunosuppression). Cavitation in rheumatoid nodules can also be due to non-infectious progression of disease. These nodules also tend to wax and wane with disease activity and treatment. Rheumatoid lung nodules can be also associated with a pneumoconiosis (known as the Caplan syndrome).

Cavitation associated with other non-infective inflammatory conditions

Although uncommon, cavitation can also occur with sarcoidosis variants (without superimposed infection - e.g. necrotising sarcoid granulomatosis) as well as with necrotic lung nodules that can occur in association with inflammatory bowel disease (Crohn's disease and ulcerative colitis).

Cavitation associated with non-infective vascular (ischaemic-embolic) conditions

Cavitation associated with aseptic pulmonary infarction or ischaemic aetiology
An aseptic cavitation (Fig. 24 on page 40 and Fig. 25 on page 41) is a potential complication following a bland pulmonary infarction\textsuperscript{27-28}. Cavitation rates associated with pulmonary infarcts are thought to be around 5\%\textsuperscript{29}. These cavities usually manifest as single lesions and are often preceded by a sizeable area of consolidation (often larger than 4 cm). They usually occur at around two weeks following an embolic event. Most tend to involve the apical or posterior segments of the upper lobes or the apical segments of the lower lobes. The cavities may undergo secondary infection. CT scans may also demonstrate additional direct evidence of pulmonary embolic disease (Fig. 25 on page 41).

Other extremely rare situations where cavitating spaces can arise from underlying ischaemic events include endovascular treatment of pulmonary arteriovenous malformations, cavitating thrombosis from Eisenmenger syndrome and with fibrocavitating processes that can result in patients with varying degrees of pre-existing pulmonary atresia.

**Cavitation associated with septic pulmonary emboli**

Cavitating septic pulmonary emboli (Fig. 26 on page 42 and Fig. 27 on page 43) are most commonly seen in patients with infective endocarditis, infected venous catheters, pacemaker leads or periodontal disease\textsuperscript{30-31}. Characteristic CT findings of septic pulmonary emboli are discrete nodules with varying degrees of cavitation which are typically subpleural and wedge-shaped. These can be seen as heterogeneous areas of increased attenuation and may show rim-like peripheral enhancement. The nodules tend to be more numerous towards the lower lobes. The presence of a feeding vessel sign (i.e. visualisation of a distinct vessel leading directly into the center or around the nodule) is considered a highly suggestive feature of septic embolism\textsuperscript{31}. Pulmonary lesions associated with septic pulmonary emboli can demonstrate rapid changes in both number and morphology on sequential imaging.

**Cavitatory conditions associated with thoracic trauma**

**Pulmonary laceration with cavitation**

Thick walled cavitatory spaces can be associated with pulmonary lacerations (Fig. 28 on page 44 and Fig. 29 on page 45). This is caused by a pull back of the lung due to elastic recoil of lung tissue surrounding the laceration. The traumatic cavities may then fill with air (traumatic pneumatocele), blood (traumatic haematocele or pulmonary haematoma), or a combination (traumatic haemato-pneumatocele)\textsuperscript{32}. If there is a secondary process such as infection, the wall thickness may then increase leading to a
thick walled cavity. These cavities may predominate in laceration prone areas (e.g. costal margins of the lung).

**Cavitation occurring in associated within pre-existing lung lesions**

**Infection and/or postnatal resorption of fluid within a pre-existing intrapulmonary cyst, bullus or pulmonary airway malformation**

Any infective process within a pre-existing thin walled cystic lung lesion such as an congenital intrapulmonary cyst (e.g bronchogenic cyst), a bullus, a congenital pulmonary airway malformation or a sequestration could increase its wall thickness and lead to an appearance of a cavitating lung lesion. In the case of certain congenital pulmonary airway malformations or pulmonary sequestrations, postnatal resorption of fluid (without infection) may also lead to air filled cavitary spaces. Unless there is prior imaging, it is often difficult to determine the pre-existence such lesions.

**Summary**

Once a cavitary lung lesion is accurately identified and possible causes are known, the radiologist's task is to provide the most likely diagnosis or a short list of differential diagnoses. The following table aims to summarise differentiating features of some of the main cavitatory lesions encountered on CT.

<table>
<thead>
<tr>
<th>Underlying condition</th>
<th>Number of lesions</th>
<th>Location within lung</th>
<th>Size of lesion(s)</th>
<th>Patient age</th>
<th>Other factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary lung cancer</td>
<td>Usually one unless there are synchronous tumours</td>
<td>Anywhere with no definite zonal predilection</td>
<td>Variable</td>
<td>Usually adult or elderly</td>
<td>Usually the cavitation occurs as part of a necrotic mass. Look for features of regional invasion or presence of metastatic disease elsewhere in the scan.</td>
</tr>
<tr>
<td>Condition</td>
<td>Manifestation</td>
<td>Location</td>
<td>Age</td>
<td>Associated with</td>
<td></td>
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<td>-----------------------------------------</td>
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</tr>
<tr>
<td>Metastatic cancer to the lung</td>
<td>Usually multiple but can manifest as a single lesion</td>
<td>Anywhere with no definite zonal predilection</td>
<td>Variable</td>
<td>Usually adult or elderly unless there is a known paediatric malignancy</td>
<td></td>
</tr>
<tr>
<td>Kaposi sarcoma or lymphoma</td>
<td>Can be single or multiple</td>
<td>Anywhere with no definite zonal predilection</td>
<td>Variable</td>
<td>Usually adult</td>
<td></td>
</tr>
<tr>
<td>Bacterial pneumonia with cavitation</td>
<td>Usually single but there may be several</td>
<td>Anywhere with no definite zonal predilection</td>
<td>Variable</td>
<td>Any age</td>
<td></td>
</tr>
<tr>
<td>Intrapulmonary abscess</td>
<td>Usually single but there may be several</td>
<td>Anywhere with no definite zonal predilection</td>
<td>Variable but typically large</td>
<td>Any age</td>
<td></td>
</tr>
</tbody>
</table>

The scan may also show concurrent non-cavitatory metastases (often smaller).

Patients are typically immunocompromised.

Unwell patient with co-existing and/or pre-existing pulmonary infection.

There is surrounding consolidative change around the cavity.

Unwell or recently unwell patient with pre-existing pulmonary...

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<table>
<thead>
<tr>
<th>Pulmonary tuberculosis with cavitation</th>
<th>Single or several</th>
<th>Upper lobe and apical segment of lower lobe predilection</th>
<th>Variable</th>
<th>Usually adult</th>
</tr>
</thead>
</table>

- Usually there is little or no surrounding pulmonary consolidation.
- May show concurrent imaging features of pulmonary tuberculosis such as calcification and/or tree-in-bud changes.

<table>
<thead>
<tr>
<th>Granulomatosis with polyangiitis</th>
<th>Single or multiple but not numerous</th>
<th>Anywhere with no definite zonal predilection</th>
<th>Usually larger than 2cm</th>
<th>Usually adult</th>
</tr>
</thead>
</table>

- Can be single or multiple but not numerous
- Usually larger than 2cm
- Usually adult

- A previous history of pulmonary or extra-pulmonary granulomatosis (e.g. sino-nasal and/or renal) may be available.

- There can be concurrent non cavitory lung lesions.
- Follows a waxing and waning infection.
<table>
<thead>
<tr>
<th>Condition</th>
<th>Location</th>
<th>Size</th>
<th>Age</th>
<th>Clinical Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cavitating rheumatoid nodule</td>
<td>Variable</td>
<td>Usually adult - middle aged</td>
<td>Variable</td>
<td>Can occur anywhere but may have a peripheral subpleural predilection. A past history of rheumatoid arthritis may be available. Can show a waxing and waning course with disease activity.</td>
</tr>
<tr>
<td>Aspergilloma</td>
<td>Anywhere but may have an upper lobe predilection depending on underlying aetiology</td>
<td>Variable but typically large</td>
<td>Usually adult or elderly</td>
<td>Usually single but there may be several. Patients often have pre-existing co-morbidities such as tuberculosis. Look for an air-crescent sign or dependant positional change of the free fungal ball.</td>
</tr>
<tr>
<td>Chronic necrotising aspergillosis</td>
<td>Anywhere with no definite zonal predilection</td>
<td>Variable</td>
<td>Usually middle aged to elderly</td>
<td>Usually single but there may be several. Patients often have longstanding pulmonary course with disease activity.</td>
</tr>
<tr>
<td>Condition</td>
<td>Number</td>
<td>Shape</td>
<td>Size</td>
<td>Age</td>
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<td>-----------------------------------------------------</td>
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<td>------------------------</td>
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</tr>
<tr>
<td>Cavitating aseptic pulmonary infarction</td>
<td>Usually</td>
<td>Peripheral and wedge</td>
<td>Often large</td>
<td>Usually adult or elderly</td>
</tr>
<tr>
<td></td>
<td>single</td>
<td>shaped</td>
<td>in size</td>
<td></td>
</tr>
<tr>
<td>Cavitating septic pulmonary emboli with cavitation</td>
<td>Multiple</td>
<td>Most have a peripheral</td>
<td>Typically</td>
<td>Usually adult</td>
</tr>
<tr>
<td></td>
<td></td>
<td>predilection</td>
<td>small in size</td>
<td></td>
</tr>
<tr>
<td>Thick walled cavitation complicating a pulmonary</td>
<td>Usually</td>
<td>Tends to favour</td>
<td>Variable</td>
<td>Any age</td>
</tr>
<tr>
<td>laceration</td>
<td>single</td>
<td>laceration prone areas</td>
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<td></td>
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<td>- e.g. along costal</td>
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<td></td>
<td></td>
<td>margins.</td>
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<tr>
<td>Cavitation associated with a pre-existing lung cyst or cystic malformation</td>
<td>Can be seen as a single lesion or as an aggregation of lesions</td>
<td>Anywhere with no definite zonal predilection</td>
<td>Variable Usually manifests in children and young adults and rarely in middle aged</td>
<td>Often difficult to make the diagnosis on the first scan. Can have a variable appearance based on the nature of the underlying lesion.</td>
</tr>
</tbody>
</table>

Images for this section:
**Fig. 1:** 73-year-old male smoker who presented with a few months history of cough and shortness of breath. The CT scan demonstrates a large rounded left upper lobe cavitating mass lesion. This contains a central low attenuating region (representing necrosis) which is accompanied by a small area of central cavitation within. There is evidence of posterior chest wall invasion. This was proven to be a squamous cell carcinoma on histology.
Fig. 2: Lung windowed image of the same scan as Fig. 1.
Fig. 3: 14-year-old male with known Hodgkin disease who underwent CT re-evaluation for worsening cough and new parenchymal densities on a recent radiograph. The selected CT image demonstrates a left upper lobe cavitating lesion. A thoracoscopic biopsy of this lesion confirmed Hodgkin lymphoma involving the cavity wall with no evidence of super-infection.
**Fig. 4:** Further selected CT image of the same patient as Fig. 3 at a more inferior level. This image demonstrates an additional smaller right upper lobe cavitating lesion as well as multiple bilateral lung nodules.
**Fig. 5:** 41-year old male with known metastatic adenocarcinoma of colon to lung. The selected CT image demonstrates a rounded metastatic lesion in the perihilar left upper lobe which has undergone a small central area of cavitation (arrowed).
Fig. 6: Mediastinal windowed CT image of the same patient as Fig. 5 showing the small cavitating nodule (arrowed).
Fig. 7: 81-year-old male with known lung metastases from a primary soft tissue sarcoma of the forearm. A large cavitory intrapulmonary lesion in the central lingula developed from a pre-existing metastasis during chemotherapy. A smaller non-cavitary metastasis is also shown in the right lower lobe.
Fig. 8: Mediastinal windowed CT image of the same patient as Fig. 7
Fig. 9: 67-year-old male with a staphylococcal pneumonia complicated by cavitation. The initial image shows a large irregular thick walled cavity with an air fluid level. There is also lung consolidation surrounding the cavity.
**Fig. 10:** The subsequent image obtained 3 months after antibiotic treatment of the same patient as Fig. 9 demonstrates a marked reduction in the size as well as the wall thickness of the cavity.
**Fig. 11:** 4-year-old female (child) with an initial streptococcal pneumonia which subsequently formed into an intra-pulmonary abscess. The selected axial CT image (lung window) shows a well defined thick walled cavity with an air-fluid level. This has associated mass effect with displacement of the aorta towards the right. There are also inflammatory changes with thickening involving the left antero-lateral chest wall. There is no surrounding pulmonary consolidation. This abscess considerably improved over the ensuing few weeks following surgical drainage and antibiotic therapy.
Fig. 12: Mediastinal windowed CT image of the same patient as Fig. 11.
Fig. 13: 58-year-old male who presented with a 10-day history of increasing cough accompanied by haemoptysis. The selected CT image demonstrates upper lobe predominant lung nodularity with some occasional tree-in bud changes. A thick walled cavitary lesion in the left upper lobe is also shown (red arrow). The patient had a positive serum Quantiferon test and sputum culture confirmed Mycobacterium tuberculosis. The extent of cavity as well as clinical status of the patient improved considerably following 6 months of anti-tuberculous therapy.
**Fig. 14:** Mediastinal bone windowed image at a slightly superior level of the same patient at Fig. 13. This CT image demonstrates upper lobe predominant lung nodularity with associated calcification (best seen at the right apex).
Fig. 15: 42-year old male with a pathologically proven Aspergilloma. The axial CT image demonstrates a dependant fungal ball with an air-crescent involving a right upper lobe cavity.
Fig. 16: Soft tissue windowed image on same patient as Fig. 15.
**Fig. 17**: 57-year-old male with known background stable stage IV sarcoidosis who was re-evaluated for worsening of symptoms. The CT scan demonstrates background features of fibro-cystic lung disease which was related to the known sarcoidosis. In addition, there is an irregular thick walled cavitating space involving the right upper lobe abutting the chest wall. This was proven to represent chronic necrotising aspergillosis on biopsy.
Fig. 18: Medistinal windowed CT image of the same patient as Fig. 17.
Fig. 19: 59-year old female with a background history of renal transplantation and immunosuppression, who presented with systemic unwellness. The axial CT image demonstrates a cavitating lesion in the middle lobe and occasional ill defined nodular opacities in the right lung. A biopsy of the cavitating lesion revealed Pseudomonas aeruginosa.
**Fig. 20:** 40-year-old male with a history of granulomatosis with polyangiitis with known upper respiratory tract and renal involvement. The axial CT image demonstrates an ovoid cavitating lung lesion at the right base.
Fig. 21: Subsequent CT scan of the same patient as Fig. 20 done six months following combination therapy with Cyclophosphamide, Azathioprine, Prednisone and Rituximab shows near complete resolution. A concurrent decrease in ANCA titres were also observed between this time interval.
Fig. 22: 64-year-old female with known advanced rheumatoid arthritis with a recent history of a cough. The CT scans demonstrate two cavitating lesions towards the lung bases. The lesions have variable wall thicknesses and rather smooth inner margins.
Fig. 23: CT image obtained 6 months after treatment with Methotrexate on the same patient as Fig. 22 which shows regression in size of both lesions (especially the left sided lesion).
**Fig. 24:** 83-year old female who presented with a 4-day history of shortness of breath. An aseptic cavitation within a pulmonary infarct is shown which is represented by peripheral irregular consolidation involving the lateral aspect of the apical segment of the right lower lobe (contains a cavitary component anteriorly - red arrow). This resolved without antibiotics on subsequent imaging.
Fig. 25: Mediastinal windowed CT image of the same patient as Fig 24 additionally shows the presence of acute pulmonary emboli within the right lower lobe pulmonary artery (blue arrow).
Fig. 26: 64-year old male with a history of bacteraemia from Methicillin-resistant Staphylococcus aureus sepsis after a femoro-popliteal bypass. The CT scans show multiple subpleural nodules, some of which are cavitated. Many demonstrate rim-like peripheral enhancement. Concurrent segmental pulmonary emboli are seen in the left upper lobe segmental pulmonary arteries. Clinical and radiological improvement were achieved following intensive antibiotic therapy.
Fig. 27: Lung windowed CT image of the same patient as Fig. 26.
Fig. 28: 36-year-old male who suffered severe chest wall injuries (inclusive of a flail chest) following a motor vehicle accident which was accompanied by pulmonary lacerations dominating in the left lung. This was complicated by a haemo-pneumatocoele in the left lower lobe which then progressed to a thick walled cavity due to superimposed infection (shown on the current CT image performed 6 months following the initial injury).
Fig. 29: Mediastinal windowed image of the same patient as Fig. 28.
Conclusion

In this essay, an overview of the CT imaging spectrum of cavitary lung disease is presented.

We highlight the considerable overlap in imaging findings of cavitating lung lesions from different pathological processes, and discuss imaging features which may aid in narrowing one's differential diagnoses.

We hope that this essay was helpful to you in improving your approach to cavitary lung lesions.

Personal information

References


