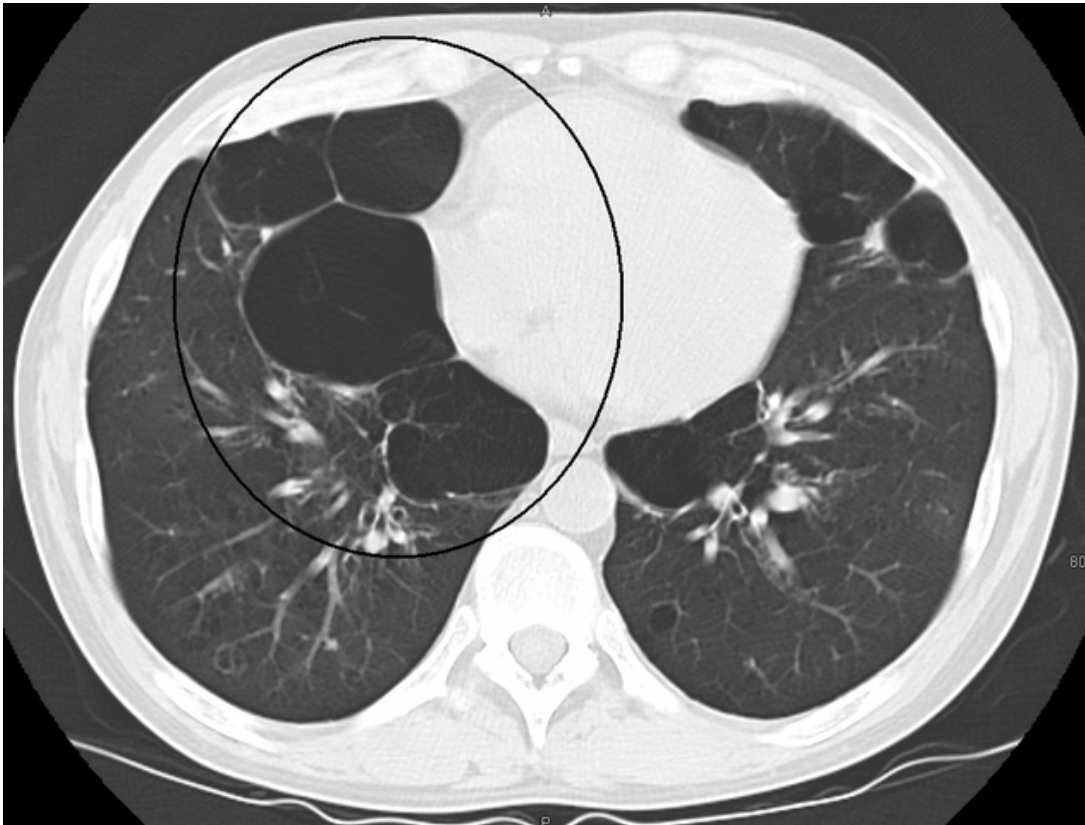


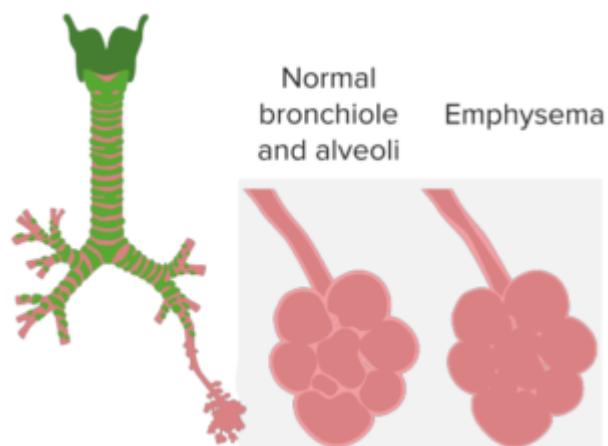
# Radiographic Evaluation of Hyperinflated Lungs

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## Definition of Emphysema

Emphysema is defined as the **destruction of the airways distal to the terminal bronchiole especially thinning and damage of the alveoli**. It comprises of chronic obstructive pulmonary disease (COPD) caused due to mainly cigarette smoking. Emphysema can be classified into centrilobular, panlobular, and paraseptal based on the pattern of airway destruction.



## Centrilobular emphysema

Centrilobular emphysema, also known as **centriacinar emphysema**, is characterized by the **localized breakdown of alveolar walls within the central part of the acini (acinus)** while sparing the peripheral portions of the acini and the lobule. Centrilobular emphysema typically involves the **upper lung zones**. This type of emphysema is commonly seen in patients with chronic **obstructive lung disease with long-standing cigarette smoking**. Centrilobular emphysema might evolve into panlobular emphysema.

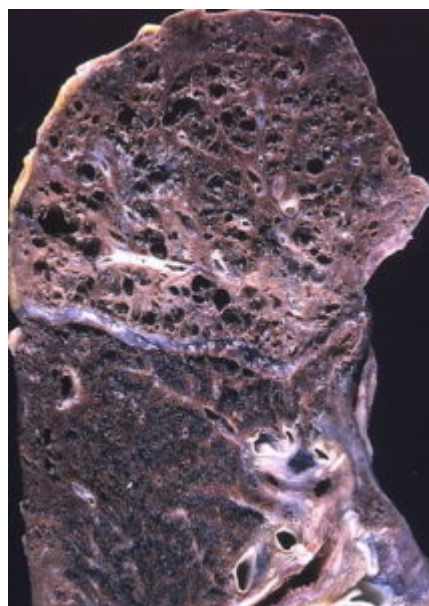


Image: "Emphysema, centrilobular (4562642073)" by Yale Rosen. License: [CC BY-SA 2.0](https://creativecommons.org/licenses/by-sa/2.0/)

## Panlobular emphysema

Panlobular emphysema, on the other hand, is defined as the **destruction of all parts of the lobule up to the periphery**. Panlobular emphysema is more commonly seen in the lower zones of the lungs. Panlobular emphysema is the type of emphysema you commonly see in **patients with homozygous alpha-1 protease deficiency**.

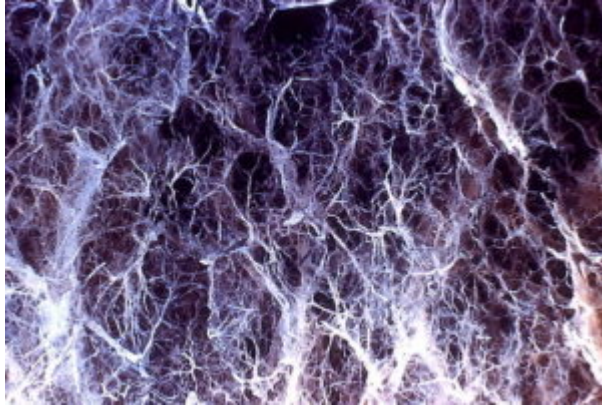


Image: "Panlobular emphysema (5176420298)" by Yale Rosen.  
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## Paraseptal emphysema

Paraseptal emphysema is characterized by the **presence of well-demarcated spaces within the periphery of the lobule because of tissue destruction**. Therefore, the central parts of the lobules are not affected by this type of emphysema. When there is focal destruction of the airways without confinement to any lobule, the term **bulla** is used. Paraseptal emphysema is **usually seen in patients with centrilobular emphysema or panlobular emphysema**. They are associated with past lung infections and inflammations.

## Imaging Studies in Emphysema

The different types of emphysema typically present with hyperinflation. Therefore, the **main finding on imaging studies of emphysema is hyperinflation** which can be assessed and identified on conventional chest radiography (Chest x-ray). Other [imaging modalities](#) such as multidetector and high-resolution computed tomography are also used in the radiographic evaluation of minor abnormalities in patients with chronic obstructive pulmonary disease.

## Chest Radiography in the Evaluation of Emphysema

The most **common finding** of emphysema on the chest x-ray is the presence of a **flat and horizontal diaphragm**. This is best appreciated on a lateral view chest x-ray film. The flattening of the diaphragm is caused by hyperinflation of the lungs. Bulla can be seen in chest x-rays indicating emphysema.

### Increased anteroposterior diameter

The **anteroposterior diameter of the chest is increased** in patients with emphysema, again because of hyperinflation. An increased anteroposterior diameter of the chest can be confirmed by the presence of an enlarged retrosternal distance between the sternum and the ascending aorta (> 2.5 cm). Another finding suggestive of increased anteroposterior diameter of the chest is an increase in the range between the diaphragm and the anterior chest wall.

### Oligemia or vascular attenuation

A significant number of patients with hyperinflation of the lungs due to emphysema have

**oligemia or vascular attenuation.** The presence of oligemia or avascular regions on the chest x-ray without any evidence of **emphysematous** changes should alert the radiologist to the **possibility of pulmonary embolism.**

### **Bulla**

A **bulla** can be also seen on the chest x-ray in a patient with emphysema. Bullae have no vessels within them and have a clear line of demarcation between the airspace and the rest of lung parenchyma. Bullae can be also seen independently from emphysema. The main cause of the formation of bullae in emphysema is the **chronic effect of positive intrapleural pressure during expiration** which is found in patients with chronic obstructive lung disease.

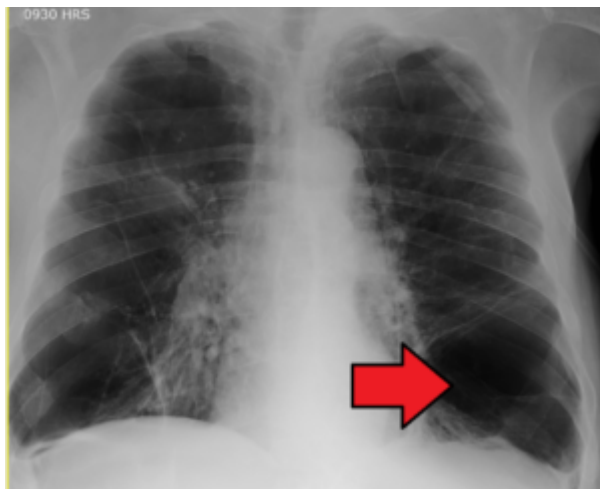


Image: "BullousEmphysemaMark" by James Heilman, MD.  
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### **Bronchovascular markings**

Patients with emphysema and secondary pulmonary hypertension might have an **increase in the bronchovascular markings of the lower zones of the lungs.** It is hypothesized that the increased markings are caused by bronchial wall thickening due to **peribronchial** inflammation.

### **Right-sided heart failure**

Patients with severe pulmonary hypertension due to emphysema **can develop right-sided heart failure.** The chest x-ray will reveal hyperinflation of the lungs, cardiomegaly, and vascular engorgement. Pleural effusions are also common at this stage.

Chest radiography has limitations in the diagnosis of the emphysema. It can detect only mild emphysema with the clear visibility of the bullae but cannot clarify the severity of emphysema.

## **Computed Tomography in the Evaluation of Emphysema**

### **Innovations**

High-resolution computed tomography (**HRCT**) has introduced a new disease entity in emphysema, known as **anatomical emphysema.** HRCT has made it possible for us to diagnose anatomical emphysema which is very limited that the patient is expected to be

completely asymptomatic at this stage. Additionally, HRCT has shown evidence that a significant proportion of patients with **alpha-1 protease deficiency have upper lung zones panlobular emphysema instead of the involvement of lower zones.**

HRCT can detect **small lung holes** due to emphysema as long as the diameter of the hole is larger than 5 mm. Therefore, pathologies that result in smaller abnormalities in the early stages might be missed on an HRCT.

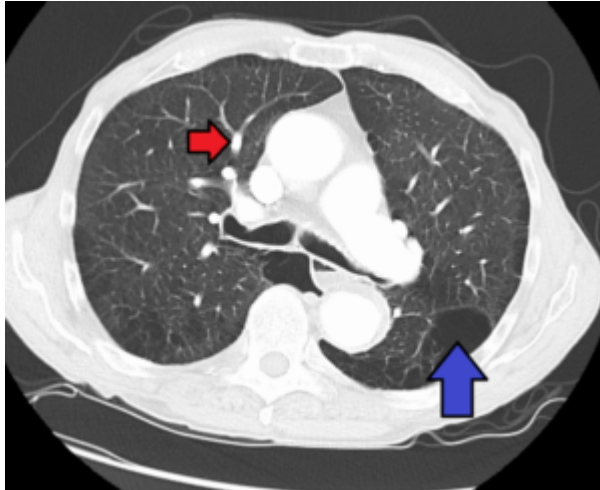


Image: "PulArtHyperandEmphysemaMark" by James Heilman, MD.  
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HRCT can detect centrilobular emphysema and lung surrounding lesions. It can reveal uniform pulmonary destruction in panlobular emphysema and small focal low-density areas in centrilobular emphysema. Paraseptal emphysema can be easily seen on HCRT and well defined thin walls can be seen. The emphysema pattern comprises of saw-tooth appearance that can be seen clearly in HCRT only.

### The qualitative analysis

The qualitative analysis of thin **HRCT slices during inspiration is best** for the detection and characterization of emphysema. The displacement and attenuation of blood vessels can be also assessed on the individual HRCT slices. The patient should limit or stop breathing during the short acquisition time as respiratory motion can obscure emphysematous changes in the lungs.

### Subjective and objective manner

The quantitative analysis of HRCT images of the lungs in a patient with emphysema can be performed in a subjective or objective manner. Subjective analysis is based on the visual inspection of each region of the lung. Each region of the lung is rated from 0-4 based on how emphysematous they appear.

The following table summarizes the **five-point scale used in the visual inspection of HRCT in emphysema.**

| Score | Description   |
|-------|---|
| 0     | A completely normal region without any evidence of emphysematous changes. |
| 1     | Emphysematous changes are present in less than 25 % of the area.          |
| 2     | Emphysematous changes are seen in 26-50 % of the area of the region.      |

|          |  |
|----------|--|
| <b>3</b> | Emphysematous changes are recognized in 51-75 % of the area of the region. |
| <b>4</b> | More than 76 % of the region has emphysematous changes.                    |

### Outcome prediction

While this scoring system might be of value in predicting those who are more likely to develop pulmonary hypertension, impaired pulmonary function tests, or be symptomatic, it was not correlated with post-surgical outcome after lung volume reduction surgery. The **most important predictor of post-surgical outcome** after lung volume reduction surgery was the **location of the region involved with emphysema**. Patients with upper lung zones emphysema generally did well after lung volume reduction surgery compared to those with lower lung zones emphysema.

## Bulla and Blebs

A **bull**a is a **thin-walled subpleural cavity that is air-filled** and is found within the lung parenchyma. These cavities are larger than 1 cm in size and are seen in patients with paraseptal emphysema. **Centrilobular emphysema can also be associated with bullae**.

**Blebs**, on the other hand, are **not related to emphysema**. They are less than 1 cm in size and are found **within the visceral pleura**. They are usually found in the apical portions of the visceral pleura. Bursting of bulla or Blebs might cause pneumothorax.

## References

Friedman PJ. "[Imaging Studies in Emphysema](#)." *Proceedings of the American Thoracic Society*. 2008;5(4):494-500. doi:10.1513/pats.200708-128ET. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/18453361>

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