

## Diseases of the respiratory system / Patho #2

The lung diseases which affect the bronchi are divided into obstructive and restrictive lung diseases.

	Obstructive lung diseases	Restrictive lung diseases
Characterized by	Limitation of air flow due to partial or complete obstruction (something obstructed the air from coming in and out of the lungs)	Reduced expansion of lung parenchyma accompanied by decreased total lung capacity
Respiration problem with	Expiration (because there is no use of muscles as in inspiration, we expire passively)	Inspiration (mainly due to fibrosis, and any diseases affects the interstitium such as granulomatous diseases mainly sarcoidosis)
Examples	<ul style="list-style-type: none"> <li>*COPD (chronic obstructive lung diseases):</li> <li>- Emphysema</li> <li>- Chronic bronchitis</li> <li>*Bronchiectasis</li> <li>*Asthma</li> </ul>	<ul style="list-style-type: none"> <li>*ILD(interstitial lung diseases):</li> <li>- Fibrosing alveolitis</li> <li>- Idiopathic pulmonary fibrosis</li> <li>-Interstitial pneumonia</li> <li>-Pneumoconiosis</li> <li>-Sarcoidosis</li> <li>*Chest wall neuromuscular diseases</li> </ul>
Total lung capacity	Normal or slightly decreased	Decreased due to fibrosis
Forced vital capacity (FVC)	Normal	Reduced
Expiratory flow rate, measured as (FEV <sub>1</sub> )	Reduced	Normal or reduced
FEV <sub>1</sub> \FVC ratio	<0.80 decreased	Normal
	The FEV <sub>1</sub> is reduced due to an obstruction of air escaping from the lungs FVC is normal Thus the FEV <sub>1</sub> \FVC ratio will reduce	The FEV <sub>1</sub> and FVC are equally reduced due to fibrosis or other lung pathology so the ratio is normal

**A spirometer** : is an apparatus for measuring the volume of air inspired and expired by the lungs.

**FEV<sub>1</sub>** : volume that has been exhaled at the end of the first second of forced expiration.

**Forced vital capacity (FVC)**: the volume of air breathed out after a maximally forced expiratory effort.

**Vital capacity** : is the maximum amount of air a person can expel from the lungs after a maximum inhalation.

**FEV<sub>1</sub>/FVC ratio** : also called Tiffeneau-pinelli index, is a calculated ratio used in the diagnosis of obstructive and restrictive lung diseases. It represents the proportion of a person's vital capacity that they are able to expire in the first second of expiration.

-Normal values are approximately 80%

-Predicted normal values depend on age, sex, height, mass and ethnicity as well as the research study that they are based upon

### **Obstructive lung diseases**

- 1- COPD : Emphysema and Chronic Bronchitis
- 2- Asthma
- 3- Bronchiectasis

## **Chronic obstructive pulmonary diseases include (COPD)**

Emphysema and Chronic Bronchitis are completely two different diseases, but they both are caused by smoking, so the patient with chronic bronchitis most likely to have emphysema and vice versa.

Differences between emphysema and chronic bronchitis (very important)

	Emphysema	Chronic Bronchitis
Cause of obstruction	Dilatation of alveoli (alveolar membranes break down)	- Inflammation - Excess mucus
Site of obstruction	(smallest airways) mainly alveoli and some parts of respiratory bronchioles (distal to terminal bronchioles)	(largest airways) bronchi and bronchioles
Diagnosis	Morphologically (dilated alveoli)	Clinically (productive cough)

### **Emphysema**

Abnormal, permanent enlargement of air spaces distal to terminal bronchioles (acinus) along with destruction to their walls without significant fibrosis

The area of (acinus) : respiratory bronchiole + alveolar duct + alveolar sac

**Types of emphysema** : (depending on the site of destruction)

1-Centriacinar (centrilobular) emphysema :

- affects the central part of the acinus (respiratory bronchioles and parts of the ducts but does not affect the alveoli)
- more severe in the upper lobes of lungs
- Smoking associated

2-Panacinar emphysema :

- affects all the acinus
- mostly affects lower lung zones
- associated with  $\alpha$ -1 antitrypsin deficiency

\* centriacinar and panacinar emphysema are symptomatic because they are diffused in both lungs (bilateral)

\* centriacinar is more common than panacinar

3-Irregular emphysema :

- affects any part of acinus
- associated with scarring (fibrosis)
- the most common cause of emphysema
- localized
- asymptomatic

4-Paraseptal emphysema :

- affects distal part of acinus
- can occur adjacent to fibrosis, scarring or atelectasis
- usually asymptomatic

- forms big airspaces up to 2cm (bullae) which is not important clinically unless they reapture then they can cause spontaneous **pneumothorax** that can be life-threatening

**Morphology of emphysema:** Dilated sacs

**Histopathology of emphysema :**

- there is no inflammation
- there is no fibrosis
- there is a dilatation of the alveoli (in emphysema without chronic bronchitis)

In emphysema, there is no obstructed lumen, inflammation, or mucus plug, then why does the obstruction occur ?

- exhalation is difficult because of loss of elastic tissue in the walls of alveoli (they get the air in but it is difficult to get it out)
- radial traction in small airways is reduced so they collapse during expiration
- so its functional obstruction, not anatomical

**Pathogenesis** (how does smoking or  $\alpha$ -1 antitrypsin deficiency cause emphysema ?)

- the main toxic materials of smoking :
  - \* Nicotine : it's a chemotactic agent of neutrophils (inflammation)
  - \* Reactive oxygen species (free radicals) : causes inactivation of antiproteases (functional  $\alpha$ -1 antitrypsin deficiency)

- the activity of neutrophil elastase increases because there is nothing to counteract its action
- elastase causes destruction of the interstitium and elastic tissue of the alveoli
- the alveoli will fuse together to form a dilated big sac
- destruction and dilatation of the alveoli will occur even with normal levels of elastase if there is  $\alpha$ -1 antitrypsin deficiency
- people who have  $\alpha$ -1 antitrypsin deficiency and they smoke will have emphysema earlier than people with  $\alpha$ -1 antitrypsin deficiency without smoking

### Tissue destruction ..... so why there is no fibrosis?

- There is a problem in repair in emphysema
- The loss of mesenchymal cells in the interstitium doesn't produce fibrous tissue (no extracellular matrix)
- Emphysema is the only lung disease where the inflammation doesn't end in fibrosis

### **CLINICAL FEATURES**

- 1- Dyspnea: shortness of breath
- 2- Weight loss
- 3- Prolonged expiration
- 4- Blood gases relatively normal
- 5- Pink puffers : a descriptive term for a patient with emphysema only (without chronic bronchitis)

Pink : because the oxygen is still normal

Puffers : because they puff

## CHRONIC BRONCHITIS

- Persistent productive cough for at least **three** consecutive months for at least **two** consecutive years.
- Inflammation and edema cause the obstruction

### Causes

- Smoking related (main cause)
- Air pollution ..SO<sub>2</sub>, NO

### PATHOGENESIS

1- Hypersecretion of mucus:

- due to hypertrophy of mucus secreting glands in trachea and main bronchi .
- increase in mucin secreting goblet cells in the epithelium of small bronchia (goblet cell metaplasia : some of the lining epithelium cells become metaplastic and become goblet cells)

2- Smoking

causes inflammation and infiltration by lymphocytes, macrophages and neutrophils (more inflammatory response than emphysema)

### CAUSE OF AIRFLOW OBSTRUCTION

- The obstruction occurs mainly at the level of small bronchioles (chronic bronchiolitis)

- however chronic bronchitis usually starts in the bronchi and large bronchioles, the obstruction there is less due to the large lumen
- when the disease progresses and affects the small bronchioles causing bronchiolitis, at this stage obstruction becomes more pronounced, this causes significant obstruction

Chronic bronchiolitis : small airway disease caused by goblet cell metaplasia, mucus plugging, inflammation and fibrosis

## **MORPHOLGY**

- Coexistent emphysema also causes airway obstruction .
- Chronic bronchitis that is accompanied by significant airflow obstruction is almost always associated with emphysema
- Chronic bronchitis without emphysema >> the obstruction is less
- Mucosa of the large airways is hyperemic and swollen and covered by mucinous secretions .
- Enlargement of the mucus secreting glands .

## **REID index**

- Thickness of the mucosal gland layer to the bronchial wall = REID index .
- Normal REID index is 0.4
- REID index increases in chronic bronchitis



## **CLINICAL FEATURES**

- 1- Productive cough .
- 2- Hypercapnia : increase in CO<sub>2</sub> concentration in blood
- 3- Hypoxemia .
- 4- Cyanosis .
- 5- Blue bloaters
- 6- No weight loss

## **COMPLICATIONS**

- 1- Pulmonary hypertension .
- 2- Cardiac failure .
- 3- Recurrent infections .
- 4- Respiratory failure