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**Obstructive & Restrictive Pulmnary diseases**

Depending on the **pulmonary function test**, chronic noninfectious diffuse pulmonary diseases can be classified into **two categories**:

1. **Obstructive diseases (OPD),** (or airway diseases), characterized by an increase in resistance to airflow due to partial or complete obstruction at any level, from the trachea and larger bronchi to the terminal and respiratory bronchioles.

**FVC:** normal or slightly decreased.

**FEV1**: significantly decreased.

**Forced expiratory volume at 1 second (FEV1):** measure how much air person can exhale during a forced breath , can measured during one second of breath.

**Forced vital capacity (FVC)**:It is total amount of air that can be forcibly exhale from the lungs after taking deepest breath in FEV test.

 An FEV1/FVC ratio of less than 0.7 generally indicates obstructive disease.

1. **Restrictive diseases (RPD**), characterized by reduce expansion of the lung parenchyma, with decrease total lung capacity.

**FVC: reduced**

**FEV 1: normal or reduced**

**Total lung capacity:** maximum amount of air that can full the lungs.

FEV1/FVC ratio remains normal.

**Examples of restrictive diseases:**

1) Chest wall disorders:(e.g., severe obesity, pleural diseases, kyphoscoliosis, and neuromuscular diseases such as poliomyelitis)

2) chronic interstitial and infiltrative diseases, such as pneumoconiosis and interstitial fibrosis**.**

**Obstructive diseases (OPD):**1-emphysema. 2-Chronic bronchitis. 3-Asthma. 4 - broncheactasis.

**Chronic Obstructive Pulmonary Disease(COPD*)***

Emphysema and chronic bronchitis are often clinically grouped together under the term **chronic obstructive pulmonary disease (COPD),** which is one of the leading causes of death.

The irreversibility of airflow obstruction of COPD distinguishes it from asthma (reversible obstruction)

**The hallmark is a decreased expiratory flow rate, usually measured by forced expiratory volume at 1 second (FEV1)**

Total lung capacity and forced vital capacity (FVC) … either normal or increased.

 The ratio of FEV1 / FVC is characteristically decreased.

* **Emphysema:** abnormal permanent enlargement of the airspaces distal to the terminal bronchioles, accompanied by destruction of their walls .
* **Overinflation**: enlargement of airspaces is NOT accompanied by destruction. For example, compensatory overinflation in opposite lung in patient with unilateral pneumonectomy.

**Types of emphysema:** According to the anatomic distribution in the lobule:

* 1- centriacinar. 2-Panacinar. 3-distal acinar (Paraseptal). 4-Irregular.
* **Note**: the acinus is the structure distal to terminal bronchioles, and a cluster of 3 to 5 acini is called a lobule

**1- Centriacinar emphysema :**

* Involve the **central or proximal** parts of the acini (formed by the respiratory bronchioles), sparing the distal part.
* More common in the **upper lobes.**
* This type is most commonly associated with **heavy cigarette smoking** often in association with chronic bronchitis.
* The wall often contains large amount of black pigment.

**2- Panacinar:**

* the acini are uniformly enlarged from the level of the respiratory bronchiole to the terminal blind alveoli.
* More commonly in the **lower zone** of the lung, and most severe in the bases.
* Associated with **alpha1 antitrypsin deficiency.**

**3- Distal acinar:**

* The distal part is predominantly involved.
* Occur adjacent to the areas of fibrosis, scarring, or atelactasis.
* Characteristically, there are multiple, adjacent, enlarged airspaces up to 2 cm or more in diameter, sometimes forming cystic structures referred to as **bullae**. This type of emphysema probably underlies many of the cases of spontaneous pneumothorax in young adults due to **bullae rupture.**

**4- irregular emphysema:**

* Acinus irregularly involved.
* Airspaces enlargement with fibrosis
* Almost invariably associated with **scarring.**
* Usually asymptomatic and insignificant.

**Pathogenesis of emphysema :**

Emphysema is associated with heavy cigarette smoking.

The current theory favors emphysema arising as a consequence of two coexisting imbalances

1. **Proteases—antiproteases imbalance.**

 **2. Oxidant------Antioxidant imbalance.**

**Proteases**: are enzymes which digest the tissue.Normally proteases secreted by neutrophils and macrophages , Most important one is **elastase**.

**Anti-proteases:** are the counteracting enzymes that stop the action of digestion, important one is antielastase (α-1 atni-trypsin), which is normally present in serum, tissue fluids, & macrophages.

**So the development of emphysema occurs**:

1. When there is **increase in elastase** activity as in smoking.
2. When there is **decrease in anti-elastase** activity as in:
* **Hereditary:** α-1 anti- trypsin deficiency.
* **Acquired**: as in smokers due to the effect of nicotine, O2 free radicals that inhibit the release of anti-elastase.
* **The effect of smoking in the development of emphysema (role of smoking in emphysema pathogenesis)**:

I-Smoking both increased elastase availability and decreased antielastase activity occur in smokers because :

 1-It increased the no. of neutrophils, macrophages, in the alveoli.

 2-Nicotine is a chemotactic substance for neutrophils.

 3-It stimulates the elastase activity.

II-Smoking also cause oxidant- antioxidant imbalance, tobacco smoke contains abundant amount of free radicals (reactive oxygen species which deplete antioxidant mechanisms in the lung, inciting tissue damage

**Morphology:**

**Gross features: The** diagnosis and classification of emphysema depend on the gross appearance of the lung.

voluminous lungs, large blebs or bullae may be seen

* **Microscopic features:** there are abnormally large alveoli separated bythin and destroyed alveolar walls**.**
* With advanced disease, adjacent alveoli coalesce, creating large airspaceswith focal centriacinar fibrosis.

**Course & prognosis**

The eventual outcome of emphysema is the gradual development of secondary pulmonary hypertension, arising from both hypoxia-induced pulmonary vascular spasm and loss of pulmonary capillary surface area from alveolar destruction and stretching.

 **Death from emphysema is related to**: either pulmonary failure, or right-sided heart failure (cor pulmonale).

**Chronic bronchitis:**

The diagnosis of chronic bronchitis is **clinical;** it is defined as**:
“the presence of a persistent productive cough for at least 3 consecutive months in at least 2 consecutive years** in the absence of any other identifiable cause”.

Chronic bronchitis is common among cigarette smokers

**Pathogenesis.**

Two distinctive etiological factors of chronic bronchitis:

1 **Chronic irritation by smoking, air pollutants** (sulfur dioxide, nitrogen dioxide which result in followings

* I. **Hypersecretion of mucus due to hypertrophy of submucosal mucus glands & goblet cells……. Excess mucin production** that contributes to airway obstruction.
* It is thought that both the enlargement of submucosal glands and the increase in numbers of goblet cells are **protective reactions** against tobacco smoke or other pollutants
* **II.** These irritants also cause **acute and then chronic inflammation** marked by the infiltration  **of inflammatory cells neutrophils ,MQ, &lymphocytes ………** (In contrast with asthma, **eosinophils are not seen** in chronic bronchitis). **. Continuous inflammation……. Tissue destruction.** Long-standing inflammation and accompanying **fibrosis** can also lead to **chronic airway obstruction**

**2. Microbial infection :**

 Infection **does NOT initiate** chronic bronchitis, but it play a significant role in maintaining it and may be critical in producing acute exacerbations

**Role of cigarette smoke in chronic bronchitis pathogenesis:**

1- It damage airway-lining cells, leading to chronic inflammation,

2-it interferes with the ciliary action of the respiratory epithelium, preventing the clearance of mucus and increasing the risk of infection.

**Morphology.**

 **Grossly,** hyperemia, swelling and edema of the mucous membranes with excessive mucinous or mucopurulent secretions on the epithelialsurfaces.

**MIC**.:**The characteristic histologic features of chronic bronchitis are:**

◘ chronic inflammation of the airways (predominantly lymphocytes and macrophages)

◘ Enlargement of the mucus-secreting glands of the trachea and bronchi.

The most striking change is an increase in the size of the mucous glands. This increase can be assessed by the ratio of the thickness of the mucous gland layer to the thickness of the wall between the epithelium and the cartilage (**Reid index** , normally 0.4) is increased in chronic bronchitis.

◘ Although the numbers of goblet cells increase slightly, the major increase is in the size of the mucous glands

◘The bronchial epithelium may show **squamous metaplasia** and **dysplasia** due to the irritating and mutagenic effects of substances in tobacco smoke.

◘There is marked narrowing of bronchioles caused by **goblet cell metaplasia**, **mucus plugging**, i**nflammation**, and **fibrosis.**

* **Clinical Features.** The cardinal symptom of chronic bronchitis is a **persistent productive cough** ….**after years** .. dyspnea on exertion develops .
* **With time**, and usually with continued smoking, other features may appear, including **hypercapnia**, **hypoxemia**, and **mild cyanosis**.
* With progression, chronic bronchitis is complicated by **pulmonary hypertension** and **cardiac failure**.
* Recurrent infections and respiratory failure are constant threats.

. ***Bronchectasis:***

**Ectasia: dilatation**

* Define as "**the permanent dilation of bronchi and bronchioles caused by destruction of the muscle and elastic supporting tissues, resulting from or associated with chronic necrotizing infections.**"

• To be considered bronchiectasis, dilation should be permanent.

* Because reversible bronchial dilation often accompanies viral and bacterial pneumonia.

**Clinical features**:

severe, persistent cough; expectoration of copious amounts of foul-smelling, mucopurulent sputum.

 sometimes bloody sputum; dyspnea and orthopnea in severe cases.

Because of better control of lung infections, bronchiectasis is now an uncommon condition.

 But may still develop in association with certain conditions

 **Etiology and Pathogenesis**.

It is NOT a primary disease, is secondary to persisting infection or obstruction caused by a variety of conditions.

***Predispose conditions to Bronchiectasis* include the following:**

* The disease is **secondary *to persisting infection or obstruction*** caused by a variety of conditions.
* **1- Severe necrotizing or Suppurative pneumonia** caused by bacteria, viruses, or fungi; this may be a single severe episode or recurrent infections.
* **2- Bronchial obstruction**, due to tumor, foreign bodies, and occasionally mucus impaction.
* **3-Congenital or hereditary conditions**: that predispose to chronic infections, like :

. ***In cystic fibrosis****: viscid mucus lead to obstruction & pulmonary infection which end with bronchiectasis.*

* ***In immunodeficiency states e.g. immunoglobulin deficiencies result in repeated bacterial infections and bronchiectasis.***
* ***Kartagener syndrome***, an *autosomal recessive disorder*, develop *impair mucociliary clearance in the airways & reduce mobility of spermatozoa* leading to persistent infections and *bronchiectasis, and sterility in male*
* Diagnosis: depends on an appropriate **history** along with **radiographic demonstration** of bronchial dilation.

**Morphology:**

**Gross features**

* The airways are **dilated (cylindroid, fusiform or saccular distention**) up to 4 times their usual diameter.
* On the cut surface of the lung, the transected dilated bronchi appear as **cysts filled with mucopurulent secretions**

**Microscopic features**

vary with the activity and chronicity of the disease

**Active case:**

1- There is intense acute and chronic inflammatory exudate within the walls of the bronchi and bronchioles.

2-desquamation of the lining epithelium and extensive areas of necrotizing ulceration.

 There may be squamous metaplasia of the remaining epithelium.

**In chronic cases** there is fibrosis of the bronchial and bronchiolar walls and peribronchiolar areas.

**Complications:**

* 1-In some instances, the necrotizing inflammation destroys the bronchial or bronchiolar walls and forms a **lung abscess**.
* 2-In cases of severe, widespread bronchiectasis **hypoxemia, hypercapnia, pulmonary hypertension,** and (rarely) **cor pulmonale occur**.
* 3- **Metastatic brain abscesses** and **reactive amyloidosis** are other, less frequent complications.
* current treatments with better antibiotics and physical therapy have improved outcomes considerably