Atelectasis

It is lung collapse. So, we lose lung volume due to inadequate expansion of air spaces. Since there is a decrease in lung volume, the process of gas exchange will be affected resulting in shunting of inadequately oxygenated blood from pulmonary arteries into veins. This poorly oxygenated blood will be distributed across the body giving rise to a ventilation perfusion imbalance and tissue hypoxia. We have three types based on:

A) Resorption Atelectasis

Occurs due to total obstruction of a bronchus, thus air cannot reach the distal airways. However, the air that was already present, is absorbed gradually until the alveoli collapse.

Causes: (Resorption Atelectasis)

The most common cause is Obstruction of a bronchus. It could be by:

1. Accumulation of intrabronchial mucous or mucopurelant plugs in post- operative patients
(especially the first 72hrs) so we always recommend these patients to do early ampulation and to use the spirometer

2. Foreign body aspiration
especially in children (children have poorly developed collateral ventilation so once one part is obstructed there's no secondary airway to compensate)

2. Obstructive lung disease
Like bronchial asthma, bronchiectasis, chronic bronchitis.

3. Intrabronchial tumors.

B) Compression Atelectasis

Occurs due to accumulation of fluid/blood/air in the pleural cavity so the increase in pressure causes mechanical collapse of the adjacent lung:

Causes: (Compression Atelectasis)

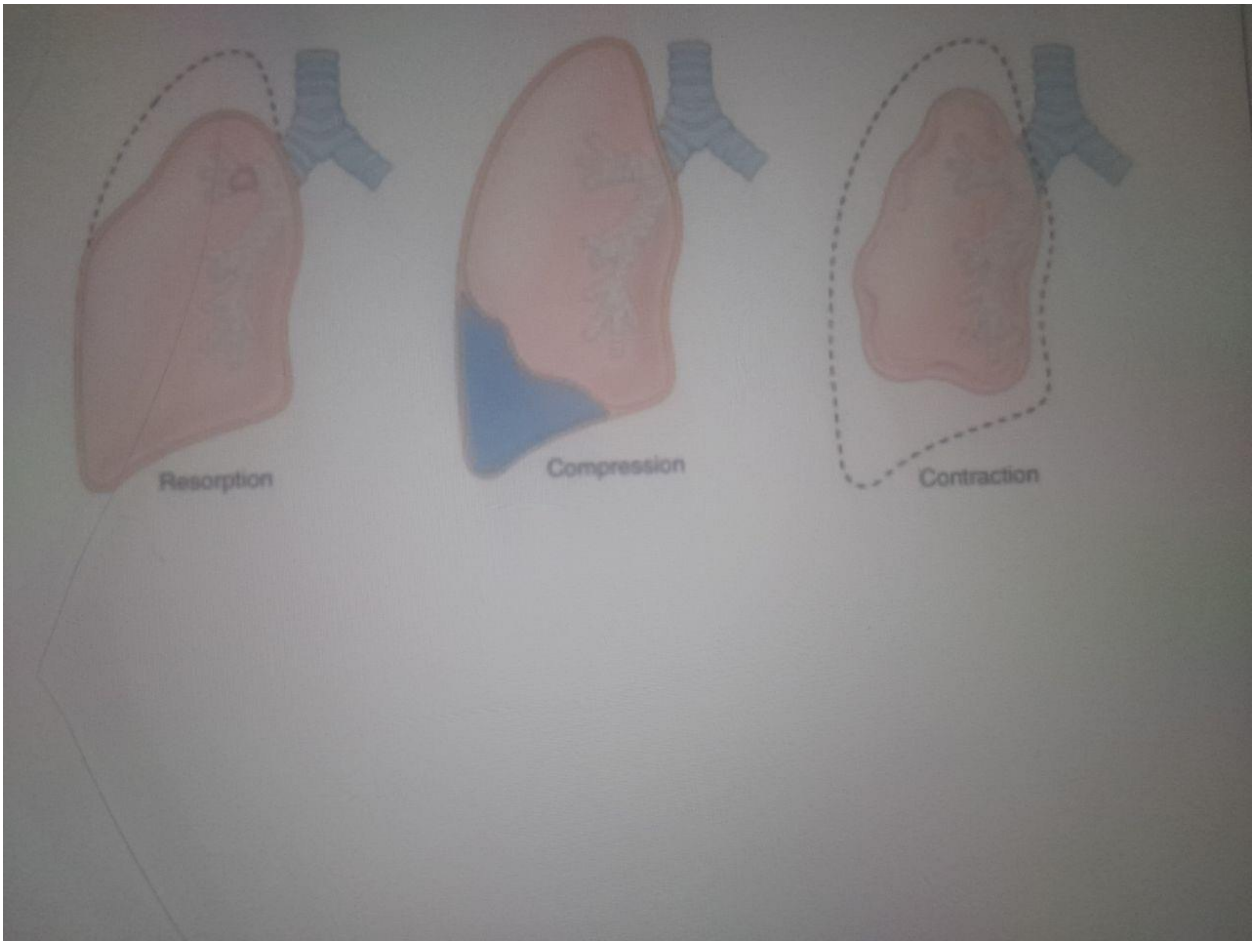
1. Pleural effusion like in Congestive Heart Failure

2. Pneumothorax: air in the pleural cavity due to an injury

C) Contraction Atelectasis (or Cicatrization Atelectasis)

Occurs due to local or generalized fibrosis of the lung or pleura that prevents full expansion of the lung.

Atelectasis (except when caused by contraction) is potentially reversible and should be treated promptly to prevent hypoxemia and superimposed infection of the collapsed lung



Acute Respiratory Distress Syndrome (ARDS)

The epidemiology and definition are evolving:
Previously considered to be the severe end of the spectrum of acute lung injury
But now it is defined as respiratory failure where one or both of gas exchange processes fail, as the integrity of the alveolar-capillary membrane is compromised by endothelial and epithelial injury.
It occurs in your hospitalised patient within 1 week of a known trigger.
. Causes are diverse but all lead to extensive bilateral injury to alveoli known histologically as diffuse alveolar damage (DAD)
Triggers: (clinical insults)
Sepsis (50%)
Lung Infections
Gastric Aspiration
Trauma (including head injury)
Pancreatitis

Pathogenesis:

In the early phase of ARDS, the first 30mins after the acute insult, the pulmonary macrophages increase the synthesis of IL8, IL1, TNF, resulting in neutrophils activation, chemotaxis, sequestration into the alveoli, and also the activation of endothelial cells in the pulmonary capillaries
Activated neutrophils release ROS, proteases that damage the alveolar epithelium and endothelium causing vascular leakiness, hyaline membrane formation, accumulation of edema fluid and loss of surfactant.
As a result, the alveolar unit loses its ability to expand.
The destructive forces are counteracted by endogenous antiproteases and anti- oxidants. The macrophages secrete fibrogenic cytokines (TGF-B, PDGF) which stimulate the fibroblasts to grow with collagen deposition which is the healing phase In the end, it is the balance

between the destructive and protective factors that determines the degree of tissue injury and clinical severity of the ARDS.
Neutrophils have an important role in the pathogenesis. Even early lung biopsies show increased neutrophils, in the capillaries, interstitium and alveoli

Clinical features (of severe ARDS)
Characterized by rapid onset of life-threatening:
Respiratory insufficiency (profound/intense dyspnea and tachypnea) followed by:
1. Cyanosis
2. Severe arterial hypoxemia that may progress to multisystem organ failure.
Hypoxemia may be refractory to oxygen therapy
3. Findings of bilateral opacities on chest imaging. The chest imaging finding is NOT fully explained by effusions, atelectasis, cardiac failure or fluid overload.
Microscopically,
In the acute phase:
[] Lungs are dark red, firm and heavy
[] Capillary congestion,
[] Necrosis of alveolar epithelium
[] Interstitial and intra-alveolar edema and hemorrhage
[] Collections of neutrophils in the capillaries
[] Some alveoli are collapsed while others are distended
[] Many alveolar spaces are lined by bright pink hyaline membrane
[] However, the most characteristic finding is the presence of hyaline membranes. The hyaline membrane consists of fibrin-rich edema fluid mixed with remnants of necrotic epithelial cells (similar to respiratory distress syndrome of the newborn)

(Healing stage):

Type II pneumocytes proliferate to regenerate alveoli.

Hyaline membrane resorption by macrophages(bright pink membrane no longer seen)

Intra-alveolar fibrosis due to organization of the fibrin-rich exudates.

Marked thickening of the alveolar septa due to proliferation of interstitial inflammatory cells and collagen deposition

Most patients who survive the acute insult recover normal respiratory function within 6 to 12 months, but the rest develop diffuse interstitial fibrosis leading to chronic respiratory insufficiency

Poor prognosis:

1. advanced age

2. bacteremia (sepsis)

3. development of multiorgan failure

Obstructive vs Restrictive

Diffuse pulmonary disease can be classified into two Categories:

1- Obstructive airway disease:

Characterized by an increase in resistance to airflow caused by partial or complete obstruction at any level causing expiratory obstruction (emphysema, chronic bronchitis, asthma)

2- Restrictive airway diseases:

Characterized by reduced expansion of lung parenchyma and decreased total lung capacity. And are divided to:

A. Chest wall disorders in the presence of normal lungs:

(Severe obesity, diseases of the pleura, and neuromuscular disorders that affect the respiratory muscles)

B. Acute or chronic interstitial lung diseases:

The classic acute restrictive disease is ARDS.

Chronic restrictive diseases include pneumoconioses, interstitial fibrosis of unknown etiology, and sarcoidosis.

Lecture2

Chronic Obstructive Pulmonary Disease(COPD)

Emphysema and chronic bronchitis are often diagnosed together in one patient. This is called chronic obstructive lung disease (COPD). Especially the fact that both are caused by smoking. They can still be present alone though.

For example: pure emphysema in alpha antitrypsin deficiency

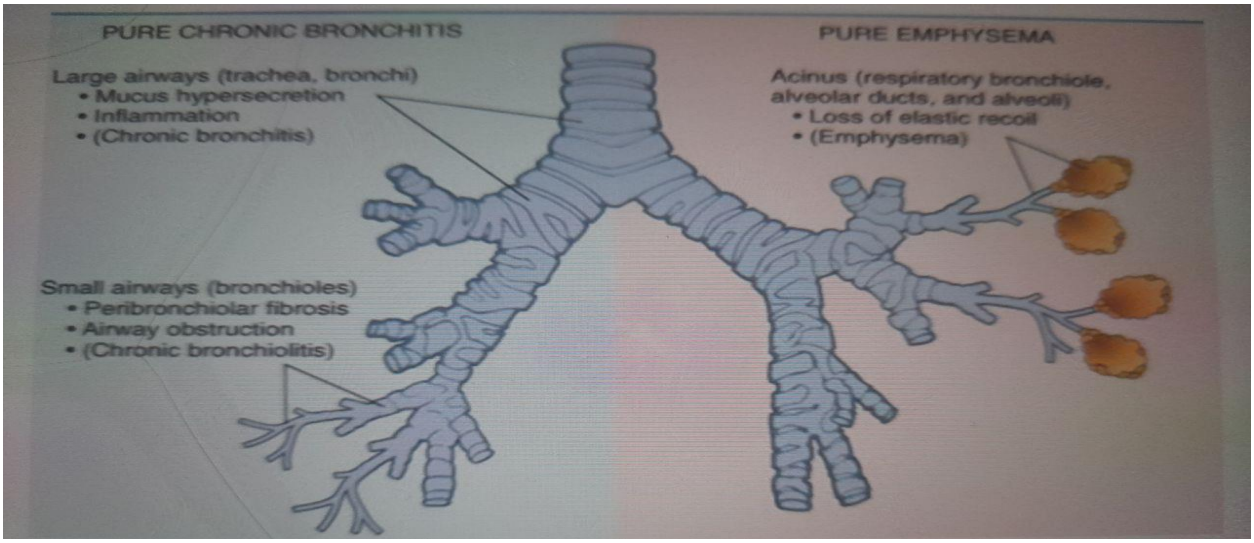
Both diseases are irreversible especially if compared with asthma

In obstructive lung diseases, its hard to get the air out (exhale), So the air accumulates in the lung→lung hyperinflation. So, lung capacity is either normal or increased Imagine this like a pair of socks, when you stretch them they go back to their shape, However, old socks will stretch but won't go back to their shape (obstructive diseases)

So the lungs are easy to fill with air but hard to get out so we will have air trapping due to the decreased elastic recoil and increased compliance

Emphysema is diagnosed on the basis of morphologic and radiologic features

Chronic bronchitis is diagnosed on the basis of clinical features



Emphysema

Permanent enlargement of the airspaces distal to the terminal bronchioles with destruction of their walls mainly due to nicotine, it also destructs the capillaries. Has no significant fibrosis.

Site: Airways distal to terminal bronchioles + Acini are irreversibly damaged

• Classified according to its anatomic distribution

(The significant airway obstruction is mainly associated with the first two types)

1. Centriacinar (centrilobular) emphysema:

• affects the central or proximal parts of the acini first and more severly, formed by respiratory bronchioles, while distal alveoli are spared.

• cigarette smokers - associated with chronic bronchitis

• more common and severe in the upper lobes, particularly in the apical segments

2. Panacinar (panlobular) emphysema:

• the acini are uniformly enlarged, from the level of the respiratory bronchiole to the terminal blind alveoli.

• associated with α1-antitrypsin deficiency (genetic disease may affect lung or liver) • affects entire lung but more prominently in the lower lung zones

3. Distal Acinar (Paraseptal) Emphysema:

• involves the distal portion of the acinus while the proximal part is normal.

• present adjacent to the pleura, along the lobular connective tissue septa, at the margins of the lobules

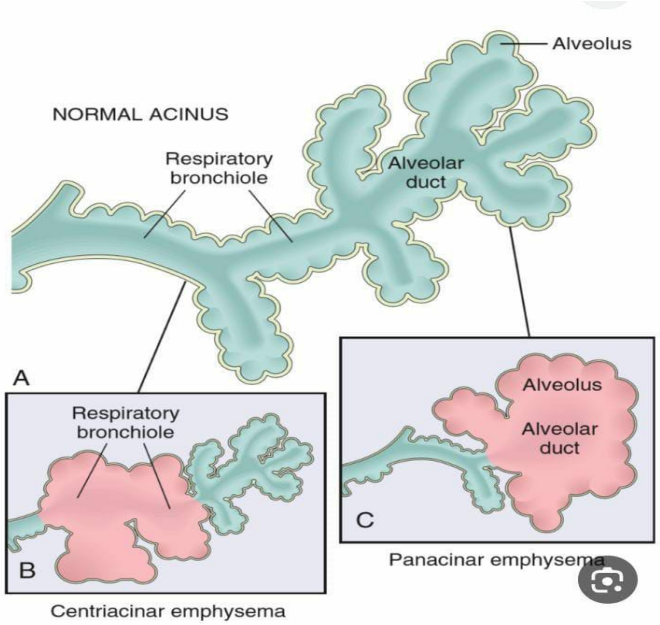
• adjacent to fibrosis, scarring or atelectasis.

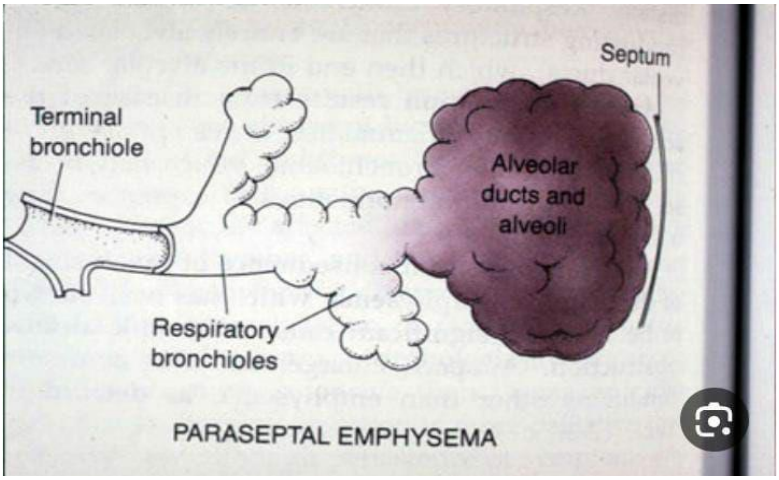
• more severe in the upper half of the lungs.

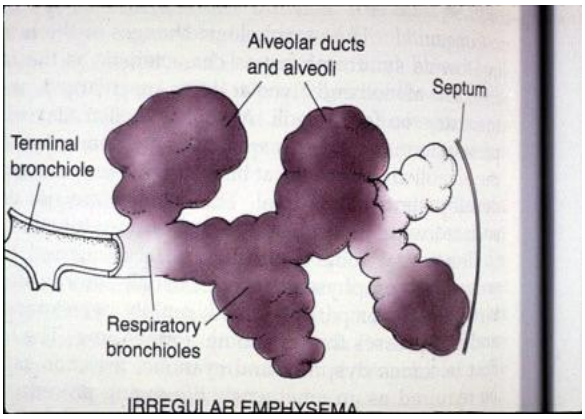
4. Irregular emphysema:

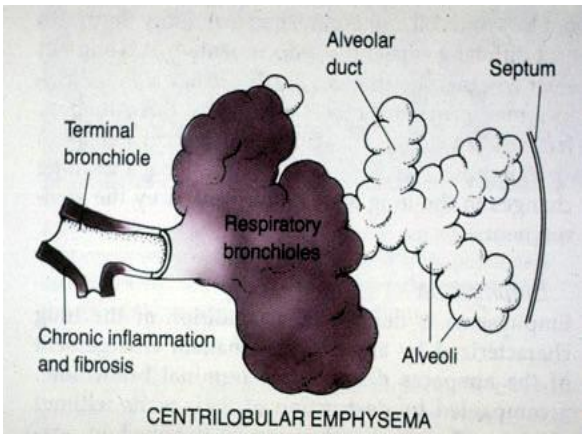
• The acinus is irregularly involved

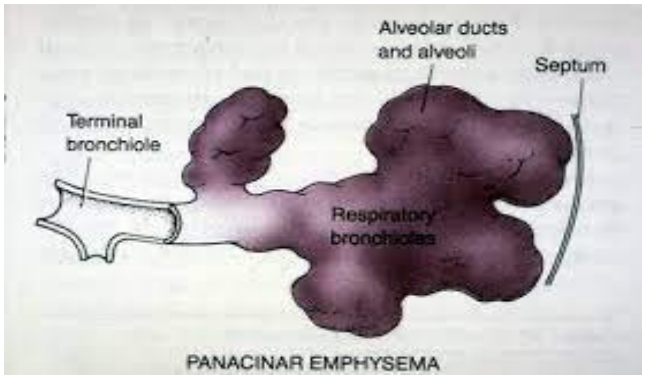
- **almost invariably associated with scarring**
- **clinically it's asymptomatic**
- **considered the most common form of emphysema.**

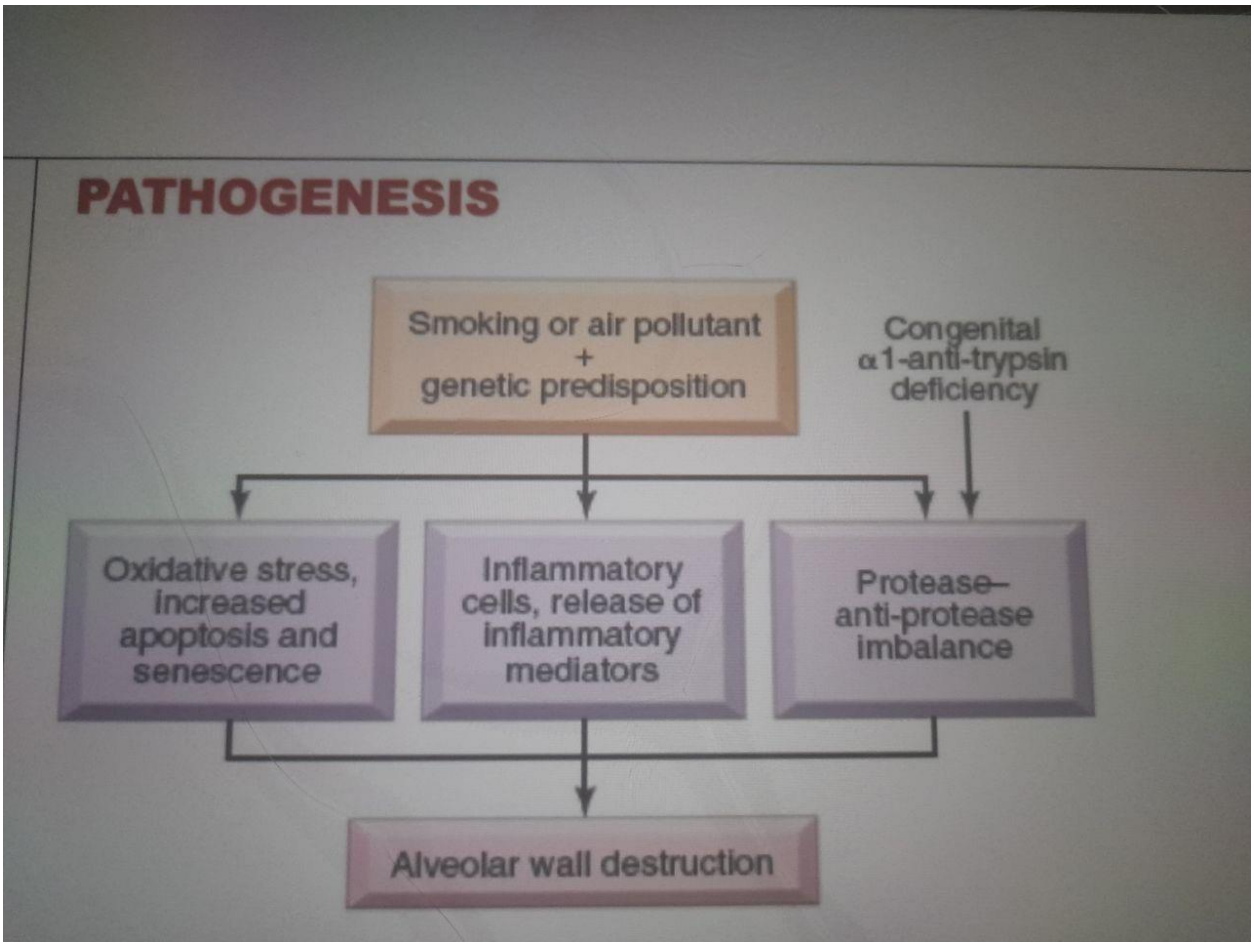












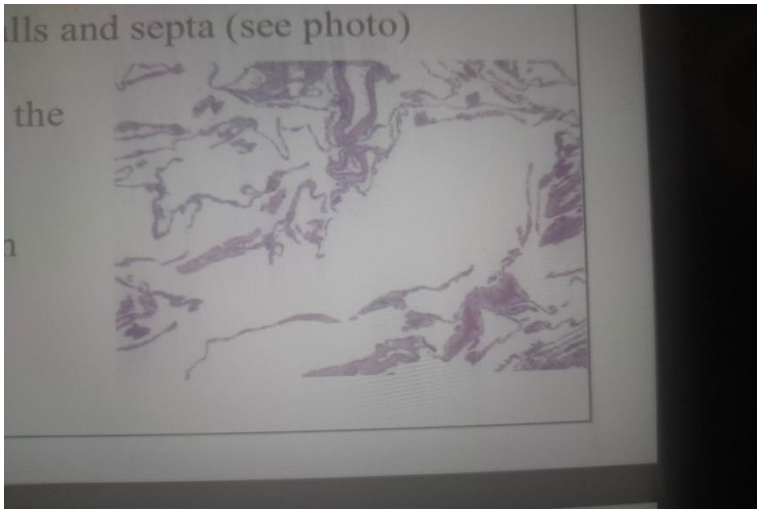
1% of patients with emphysema have alpha1 antitrypsin defciency

Classic presentation of emphysema

Dyspnea
Barrel-chested (increase in anterior-posterior diameter of chest wall)
Prolonged expiration
Sitting forward in a hunched-over position (trying to squeeze the air out in expiration)
Hyperventilation (which is why in early stages, the gas exchange is adequate and they
have prominent dyspnea = "pink puffers.") pink refers to the face and ts good oxygenation while puffer refers to difficult breathing and breathing through lips
Cough and wheezing if coexistent asthma and chronic bronchitis.

Microscopically,

Abnormal alveolea separated by ,thin septa with only focal centriacinar fibrosis



Macroscopic

Voluminous Lungs in severe emphysema

Centriacinar emphysema we have big and normal spaces
Panacinar emphyseama we have only big alveolar spaces (panacinar emphysema inlclude all the pulmonary lobule, destruction the entire acinus)

Chronic Bronchitis

Common in cigarette smokers; air pollutants also contribute.
Persistent productive cough for AT LEAST 3 consecutive months in AT LEAST 2 consecutive years.
• In early stages the cough raises (kicks out) the mucoid sputum so the airflow is not obstructed.
• Heavy smokers: develop chronic outflow obstruction, usually with associated emphysema COPD
• May coexist with hyper-responsive airways with intermittent bronchospasm and wheezing→this is called asthmatic bronchitis

The primary factor is tobacco smoke90% of cases or exposure to dust

Pathogenesis

Depends mainly on mucus hypersecretion ,inflammation,infection and airflow obstruction:
***Mucus hypersecretion is the earliest feature begins in the large airways mainly caused by cigarette smoking or other air pollutants.**
The exposure to these chemicals causes hypertrophy of mucous glands in the trachea and bronchi and increase goblet cells in the epithelial surfaces of smaller bronchi and bronchioles.
***These irritants can also cause inflammation mainly composed of macrophages, neutrophils and lymphocytes but WITHOUT eosinophils.**
Smoking causes cystic fibrosis transmembrane conductance regulator(CFTCR) dysfunction

***Infection:doesn't initiate chronic bronchitis but it is significant to maintain it and it makes acute exacerbation**
Airflow obstruction results from:
1. Small airway disease (chronic bronchiolitis): results in early and mild airflow obstruction. Induced by mucus plugging of the bronchiolar lumen, inflammation, and bronchiolar wall fibrosis
2. Coexistent emphysema: The cause of significant airflow obstruction.

After years from chronic bronchitis ;
***Decrease in lung function**
***Atypical Metaplasia and dysplasia can transform to cancer**
***Chronic bronchitis +wheezing and intermittent bronchospasm lead to asthmatic bronchitis**

Clinical features:
Prominent cough with production of sputum and late dyspnea
• chronic bronchitis and COPD patients show frequent exacerbations, rapid disease progression, and poorer outcomes than emphysema alone.
Morphology:
• Mucosal lining is hyperemic and swollen due to accumulation of edema fluid
• Layers of mucinous or mucopurulent secretions
squamous metaplasia of lung epithelium which is one of the adaptive mechanisms to protect smoker's lining .Lymphocytes can be seen.
Microscopically,
Enlargement of the mucus-secreting glands
squamous metaplasia and dysplasia of lung epithelium which is one of the adaptive mechanisms to protect smoker's lining .
Inflammation (Lymphocytes can be seen.)
• Changes of emphysema often co-exist

Outcomes:

• Progressive disease is marked by the development of pulmonary hypertension, cardiac failure,recurrent infections;and ultimately respiratory failure
•Death due to pulmonary function impairment
•mild and late dyspnea
•hypoxia and cyanosis(due to co2retention)

Appearance
Blue bloaters(cyanotic obese patients)

Pathology questions:

1-A 7-year-old boy accidentally inhales a small peanut, which lodges in one of his bronchi. A chest x-ray reveals the mediastinum to be shifted toward the side of the obstruction. The best description for the lung changes that result from this obstruction is:
a- Absorptive atelectasis
b- Compression atelectasis
c- Contraction atelectasis
d- Patchy atelectasis
e- Hyaline membrane disease
Answer: A

2- Histologic sections of lung tissue from an individual with adult respiratory distress syndrome (ARDS) are most likely to reveal:
a- Angio invasive infiltrates of pleomorphic lymphoid cells
b- Deposits of needle-like crystals from the membranes of eosinophils
c- Infiltrating groups of malignant cells having intercellular bridges
d- Irregular membranes composed of edema, fibrin, and dead cells lining alveoli
e- Plexiform lesions within pulmonary arterioles
Answer: D

We can see in ARDs hyaline cartilage,fibrin rich edema fluid,necrotic cells

3- Which one of the following is a correct association concerning the pathogenesis of smoking- induced emphysema?
a- Destruction of distal acinus = centrilobular emphysema
b- Destruction of distal acinus = paraseptal emphysema
c- Destruction of entire acinus = panlobular emphysema
d- Destruction of proximal acinus = centrilobular emphysema
e- Destruction of proximal acinus = paraseptal emphysema
Answer: D

4)Regarding atelectasis:
A. In resorption atelectasis, the mediastinum shifts toward the atelectatic lung.
B. Accumulation of mucus in bronchi is the most common cause of atelectasis in kids.
C. Air in the parietal cavity causes contraction atelectasis.
D. All forms of atelectasis are reversible and curable.
Answer: A

5) Regarding ARDS, which of the following is correct?
A. It is the milder form of acute lung injury.
B. The most common cause is pancreatitis
C. It is characterized by the presence of hyaline membrane in the organizing stage.
D. Sepsis is indicative for poor prognosis
E. It is related to cardiac causes

Answer: D

6)which of the following is true regarding ARDS?
Poor prognosis in case of bacteraemia

7)which of the following is true about atelectasis?
Chronic bronchitis cause resorption atelectasis

8.wrong about atelectasis:
air in Pneumothorax (compression atelectasis) is irreversible.

9.most common cause of ARDS:
Sepsis.

10.70 year old in ICU complaining shortness of breath, it was shown fibrin-rich membrane:
ARDS.

11.wrong about emphysema:
Inflammation with associated fibrosis.

12.true about COPD:
Inflammation is involved in the pathogenesis of both emphysema and chronic bronchitis.

13.airway obstruction in chronic bronchitis is due to:

Bronchiolitis.

14) Not correct about Chronic bronchitis:
bacterial infection has a role

15) According to pathogenesis of emphysema occurs because:
protease - anti protease imbalance

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