RADY 416 PRESENTATION: AIR LEAK IN THORACIC CAVITY

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CAUSES:

- Pneumothorax
- Pneumomediastinum
- Pneumopericardium
- Pulmonary interstitial Emphysema
- Subcutaneous Emphysema
AIR LEAK IN THORACIC CAVITY

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Pneumothorax
(Air trapped between parietal and visceral pleura)

Air enters the pleural cavity from

Outside (Pleural Tear)  Lung (Parenchymal Damage)

Tension Pneumothorax  Open Pneumothorax  Closed Pneumothorax
(Pleural tear acts as ball valve)  (Pleural tear is sealed)
Pathophysiology of Pneumothorax
Classification of Pneumothorax Based on Origin

Simple Pneumothorax (Open and Closed)
- Mediastinum remains central
- Clinical condition stable
- Can wait for CXR to confirm diagnosis

Tension Pneumothorax
- Progressive build up of air causes mediastinum shift away from side of pneumothorax
- Clinical condition unstable
- Do **not** wait for CXR to confirm diagnosis
Image: CXR PA view showing Simple Pneumothorax in Right Lower Lung

Image: CXR PA view showing Tension Pneumothorax in Left Lung
Etiological Classification of Pneumothorax

Spontaneous

Primary
Secondary

Trauma

Iatrogenic

1. Intubation
2. Tracheostomy
3. Biopsy - Lung and Breast
4. Positive Pressure Ventilation
5. CVP Line
6. Thoracentesis

Non-Iatrogenic

1. Blunt (rib fracture)
2. Peneterating (gun shot/stab)
Primary Spontaneous Pneumothorax

- It occurs in young healthy individuals without underlying lung disease
- Due to rupture of subpleural apical bleb

PREDISPOSING FACTORS:
- Smoking
- Tall, thin male

RECURRENCE:
- 50% on the same side
- 15% on opposite side
Images: CXR PA view showing left lung primary spontaneous pneumothorax following rupture of apical subpleural bleb
Subpleural Bleb

- Air pocket within visceral pleura
- Most common location is apical, usually <1cm

Image: Sagittal and Axial view of lung showing multiple Subpleural Blebs
Secondary Spontaneous Pneumothorax

- It occurs due to pre-existing lung diseases
- Recurrence rate higher than Primary Pneumothorax

CAUSES:
- Pulmonary fibrosis
- Bronchial Asthma
- Cystic Lung Disease
- Cavitary Lung Disease
- Metastasis close to lung edge
Where does air accumulate?

- In erect position, air is seen in apicolateral pleural space
- In supine position, air is seen in anteromedial pleural space
CXR Features of Pneumothorax

Area of hyperlucency

1. No lung markings lateral to line
2. Visceral pleural line parallel to chest wall
Expiration films are more sensitive

**Reason:** Lung volume reduces in Expiration but size of a Pneumothorax will remain the same. Hence, a small Pneumothorax not visible on Inspiratory films may be seen in Expiratory films.

- Rotation may obscure pneumothorax or mimic mediastinal shift

- Lateral decubitus views helpful in difficult cases

**Reason:** Since air rises high, Lateral decubitus view with affected side up and Xray beam directed parallel may show small Pneumothorax not visible in erect view (especially useful in Infants)
DEEP SULCUS SIGN

- Indirect Indicator of Pneumothorax in supine CXR
- Air collects anterolaterally producing abnormally deep costophrenic angle
DOUBLE DIAPHRAGM SIGN

- Indirect Indicator of Pneumothorax in supine CXR
- In supine position, air outlines the anterior portions of hemidiaphragm
- Hence, both the diaphragmatic domes and anterior portions of the diaphragm are visualized
Remember! Visceral pleural line may be confused for:

**SKIN FOLD**

- Extends beyond the chest wall
- Lung markings extend beyond it
- Does not follow expected course of visceral pleural

Lung markings present beyond it

Extend beyond chest wall

PLEURAL LINE
- Thin
- Sharp

SKIN FOLD
- Broad
- Ill-Defined

Image Courtesy: Differentiating Pneumothorax from the Common Radiographic Skinfold Artifact M. Obadah Kattea and Omar Lababede.
Remember! Visceral pleural line may be confused for:

**SCAPULAR EDGE**

- In erect films, patient positioned in a way that the medial edge of scapula lies outside the rib cage.

- However, in supine films, medial edge may superimpose on the upper lung field, mimicking visceral pleural line.

Differential DDx for absent lung markings

- Large emphysema-tous bullae
- Large lung cysts
- Pulmonary embolism

**REMEMBER!**
ONLY PNEUMOTHORAX HAS A WHITE LINE PARALLEL TO THE CHEST WALL
Image 6: CXR PA View and CT scan lung showing large emphysematous bullae with absent lung markings in them but absent visceral pleural line.
The pleural line caused by pneumothorax is usually bowed at its center towards lateral chest wall but the inner margins of bulla or cyst is generally concave rather than convex.

Pneumothorax with pleural adhesion may simulate bulla or lung cyst.

Differentiate via comparison with previous chest radiography, lateral decubitus or CT scan.
Emphysematous Bulla vs Loculated Pneumothorax

Inner margins concave

Pleural line bowed towards chest wall
Lung markings visible beyond pleural line if pleural adhesions present, mimicking appearance of Emphysematous Bulla
Catamenial Pneumothorax

- Pneumothorax occurring along with menstrual cycle (72 hours before or after)
- Recurrent
- Mostly (90-95%) affects Right hemithorax

THEORIES:
- In metastatic model, abnormal migration of endometrial tissue outside the uterus (Endometriosis)
- In hormonal model, PGF2 cause constriction of bronchioles f/b alveolar rupture
- In anatomical mode, absence of cervical mucus plug cause air to pass through fenestration in diaphragm from genital tract to lungs
- Spontaneous rupture of blebs under hormonal influence during menstruation
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**Pneumomediastinum**

(Air trapped in mediastinal cavity)

**CAUSES:**
- Rupture of alveolar wall  
  Air tracks along bronchovascular bundles to enter mediastinum
- Rupture of air containing viscus in mediastinum
  - Distal Esophagus (esp. posterolateral wall)  
    Boerhaave Syndrome
  - Tracheobronchial Tree  
    Iatrogenic/Non-iatrogenic Trauma
Chest X-ray findings in Pneumomediastinum

- Linear streaky lucency associated with White line paralleling left heart border
- Air outlining major aortic and pulmonary artery branches
  - “Ring around Artery”
  - “Tubular Artery Sign”
- Air outlines central portion of diaphragm below heart forming unbroken superior surface
  - “Continuous Diaphragm Sign”
- Linear streaks of air parallel to spine extending into neck and surrounding esophagus and Trachea
CONTINUOUS DIAPHRAGM SIGN
SPINNAKER SAIL SIGN (ANGEL WING SIGN)

Seen on neonatal PA view CXR when thymic lobes are displaced laterally by air (Very typical sign in neonate)

Image Courtesy: Prof Frank Gaillard et al.
https://radiopaedia.org/articles/spinnaker-sign-mediastinum
**TUBULAR ARTERY SIGN**
Air around aortic artery and branches

**RING AROUND ARTERY**
Air around Pulmonary artery and branches

Image Courtesy: Pneumomediastinum Dr Francis Fortin and Dr Martin Gorrochategui et al
https://radiopaedia.org/articles/pneumomediastinum
It is seen as a V-shaped air collection. One limb of the V is produced by mediastinal gas outlining the left lower lateral mediastinal border. The other limb is produced by gas between the parietal pleura and medial left hemidiaphragm.

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Pneumopericardium

(Air trapped in Pericardial Cavity)

CAUSES:

• Usually by direct penetrating trauma (iatrogenic or non-iatrogenic)

• More common in pediatric population (Hyaline Membrane Disease)

• Very rare for pleural air to enter pericardium except those who have pericardial defects such as surgical window incised in pericardium
The heart being partially or completely surrounded by air, with the pericardium sharply outlined by air density on either side.
Air in the pericardial sac should not rise above the anatomic limits of the pericardial reflection on the proximal great vascular pedicle.

Radiographs obtained with the patient in the decubitus position, air in the pericardial sac will shift immediately, while air in the mediastinum will not shift in a short interval between films.
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Air trapped in the connective tissue of peribronchovascular sheaths and interlobular septa (Interstitium)

Intraalveolar Rupture  Air dissects along Extra-alveolar perivascular sheaths
More in Age<40 years because of loose connective tissue

**CAUSES:**
1. Asthma
2. Barotrauma
3. Assisted Ventilation
Chest X-ray findings in Pulmonary Interstitial Emphysema

- Cystic or linear radiolucencies in the interstitium radiating from the hilum
- The affected segment is often hyperinflated and static in volume on multiple radiographs
- The heart tends to get smaller as intrathoracic pressure increases
Pulmonary Interstitial Emphysema

Image Courtesy: Pulmonary Interstitial Emphysema Dr. Vincent Tatco and Rishi Aggarwal et al (https://radiopaedia.org/articles/pulmonary-interstitial-emphysema)
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Subcutaneous Emphysema
(Air trapped in soft tissues and musculature along the fascial planes)
X-ray findings in Thoracic Subcutaneous Emphysema

Striated lucencies in the soft tissues outlining muscle fibers giving comb-like appearance

Subcutaneous Emphysema affecting the anterior chest wall, outline the pectoralis major muscle, giving rise to the ginkgo leaf sign\(^2\)
Subcutaneous Emphysema

Image Courtesy: Extensive subcutaneous emphysema: iatrogenic
Case contributed by Dr Sajoscha Sorrentino. https://radiopaedia.org/cases/extensive-subcutaneous-emphysema-iatrogenic

References

1. National Organization for rare diseases (NORD)


3. [https://radiopaedia.org/articles](https://radiopaedia.org/articles)


7. Image Courtesy: Medpix and Yale Image Finder