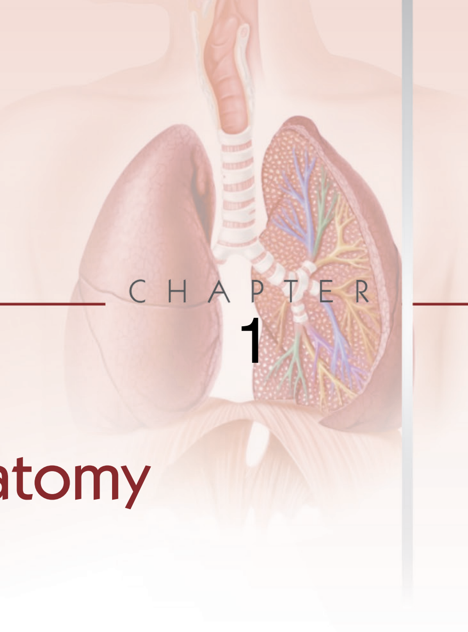
CHAPTER 1



Respiratory Anatomy

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Competencies

AN 24.2 Identify side, external features and relations of structures which form root of lung and bronchial tree and their clinical correlate.

AN 24.3 Describe a bronchopulmonary segment with its clinical anatomy.

ANATOMY AND CLINICAL CORRELATION

Root of Lung

The root of the lung otherwise called as the hilum, is a critical anatomical structure which serves as the point of entry and exit for various vital structures associated with the lungs. It is significance is not only for its anatomical features but also for its clinical implications in respiratory medicine and cardiothoracic surgery. It is pertinent to understand the anatomy, external features and relationships of the structures forming the root of the lung and the bronchial tree for diagnosing and managing various pulmonary diseases **(Fig. 1.1)**.

Anatomical overview: The root of the lung is located on the medial aspect of each lung, at the level of the 5th to 7th thoracic vertebrae. It is collection of structures that enter and exit the lung at the hilum, located on the medial surface of each lung **(Fig. 1.2)**. The main components are as follows:

a. **Bronchi:** Primary, secondary and tertiary bronchi
b. **Pulmonary arteries:** Right and left pulmonary arteries
c. **Pulmonary veins:** Superior and inferior pulmonary veins
d. **Bronchial arteries and veins:** Supply blood to the lung tissue
e. **Nerves:** Autonomic nervous supply to the lung
f. **Lymphatics:** Lymphatic vessels draining the lung

External features: The lung roots are characterised by specific features that aid in their identification and clinical relevance:

a. **Hilum:** It is a wedge-shaped area where structures enter and exit the lung.
b. **Fissures:** The presence of fissures in the lung lobes (e.g. oblique and horizontal fissures) influences the orientation of the bronchial tree.
c. **Pulmonary ligament:** A double fold of pleura that extends from the hilum to the diaphragm, allowing movement during respiration.

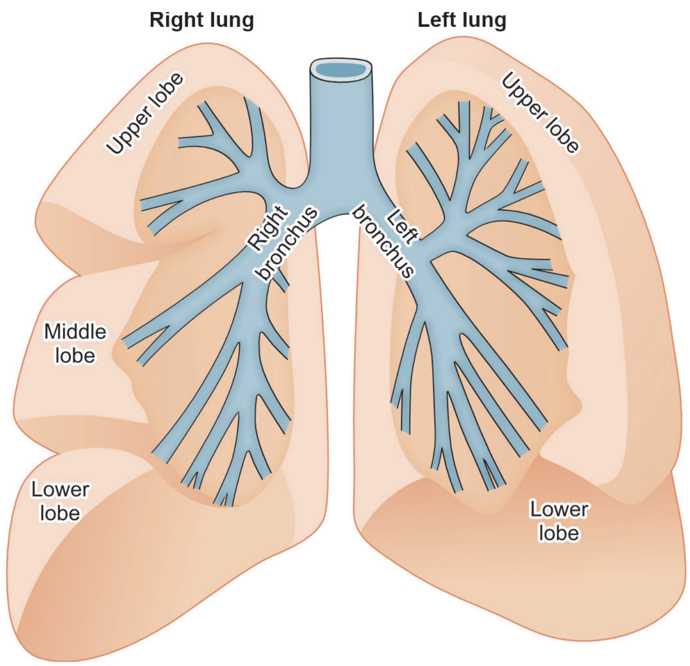

Fig. 1.1: Root of lung

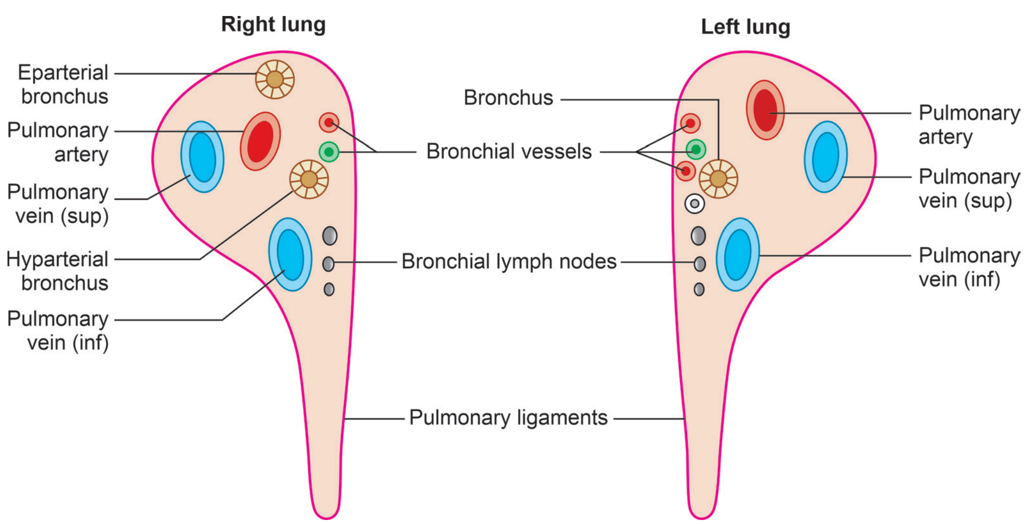

Fig. 1.2: Cut section of root of lung

Side differences: The anatomy of the lung roots exhibits some side differences between the right and left side.

a. **Right side:** The right main bronchus is wider, shorter and more vertical as compared to the left. Thus making it more prone to aspiration of foreign objects. The right pulmonary artery runs horizontally and is positioned more anteriorly as compared to the left pulmonary artery.

b. **Left side:** The left main bronchus is longer, narrower and more horizontal, creating a greater angle with the trachea. The left pulmonary artery is positioned superior to the left main bronchus.

Structures Forming the Root of the Lung (Table 1.1)

Table 1.1: Structures constituting the root of the lung

Structure	Right lung	Left lung
Main bronchus	Right main bronchus (shorter, wider, more vertical)	Left main bronchus (longer, narrower, more oblique)
Pulmonary artery	Lies anterior to the bronchus	Lies superior to the bronchus
Pulmonary veins	Two veins (superior and inferior) lie anterior and inferior to the artery and bronchus	Two veins (superior and inferior) lie anterior and inferior to the artery and bronchus
Bronchial arteries	Arise from the descending aorta, run posterior to the main bronchus	Arise from the descending aorta, run posterior to the main bronchus
Lymphatics	Tracheobronchial lymph nodes are located at the root	Tracheobronchial lymph nodes are located at the root
Nerves	Pulmonary plexus formed by vagus and sympathetic nerves	Pulmonary plexus formed by vagus and sympathetic nerves

Main Bronchi

Right main bronchus: It is wider and shorter (approximately 2–3 cm) and divides into three secondary bronchi (upper, middle, lower) to supply the three lobes of the right lung.

Left main bronchus: It is longer (approximately 5 cm) and more angled and divides into two secondary bronchi (upper and lower) to supply the two lobes of the left lung.

Clinical correlation: The anatomical orientation of the bronchi has implications in procedures like bronchoscopy and in the aspiration of foreign bodies, particularly in the right main bronchus.

Pulmonary Arteries

Right pulmonary artery: Emerges from the pulmonary trunk and travels horizontally, positioned anterior to the right main bronchus.

Left pulmonary artery: It also arises from the pulmonary trunk but travels horizontally and is positioned superior to the left main bronchus.

Clinical correlation: Understanding the location of the pulmonary arteries is essential during surgeries involving the lungs and in diagnosing pulmonary embolism, which can lead to sudden pulmonary artery obstruction.

Pulmonary Veins

Right pulmonary veins: Two veins (superior and inferior) drain blood from the right lung back to the left atrium of the heart. The right superior pulmonary vein lies anterior to the right main bronchus, while the inferior vein runs below the bronchi.

Left pulmonary veins: Two veins (superior and inferior) drain blood from the left lung to the left atrium. The left superior pulmonary vein runs anteriorly to the left main bronchus.

Clinical correlation: The anatomical position of the pulmonary veins is significant in surgical interventions, such as lobectomies and in managing pulmonary hemorrhage.

Bronchial Arteries and Veins

Bronchial arteries: Usually, two left bronchial arteries arise from the aorta and one right bronchial artery arises from the right third intercostal artery.

Bronchial veins: Drain into the azygos system and the pulmonary veins, providing a connection between systemic and pulmonary circulation.

Clinical correlation: Damage to bronchial arteries can lead to ischemia of lung tissue, which may complicate conditions like chronic obstructive pulmonary disease (COPD).

Nerves

The lungs are innervated by the pulmonary plexus, which consists of sympathetic and parasympathetic fibres.

Sympathetic fibres arise from the thoracic sympathetic chain and causes bronchodilation and vasoconstriction.

Parasympathetic fibres (vagal) cause bronchoconstriction and vasodilation.

Clinical correlation: Understanding the nerve supply is crucial in procedures like thoracotomy and in managing conditions like asthma, which involves dysregulation of autonomic control.

Lymphatics

Lymphatic drainage from the lungs is carried out by lymphatic vessels that converge into regional lymph nodes (hilar, tracheobronchial and mediastinal nodes).

Clinical correlation: Knowledge of lymphatic drainage patterns is vital in cancer staging and management, especially in cases of lung cancer metastasis.

Relations of Structures at the Root of the Lung (Table 1.2)

Table 1.2: Anatomical relations of lung root structures

Structure	Anterior relation	Posterior relation	Superior relation	Inferior relation
Right lung root	Phrenic nerve, pericardium	Vagus nerve, esophagus	Azygos vein	Pulmonary veins
Left lung root	Phrenic nerve, pericardium	Vagus nerve, descending aorta	Arch of aorta	Pulmonary veins

Right Lung Relations (Fig. 1.3)

a. **Anterior relations:**
   Right pulmonary artery: Anterior to the right main bronchus.
   Right pulmonary veins: Anterior to both the artery and bronchus.

b. **Posterior relations:**
   Esophagus: Posteriorly located, particularly at the carina region.
   Thoracic aorta: Located more medially, especially in the upper part.

c. **Medial relations:** Structures include the right atrium and part of the right ventricle.

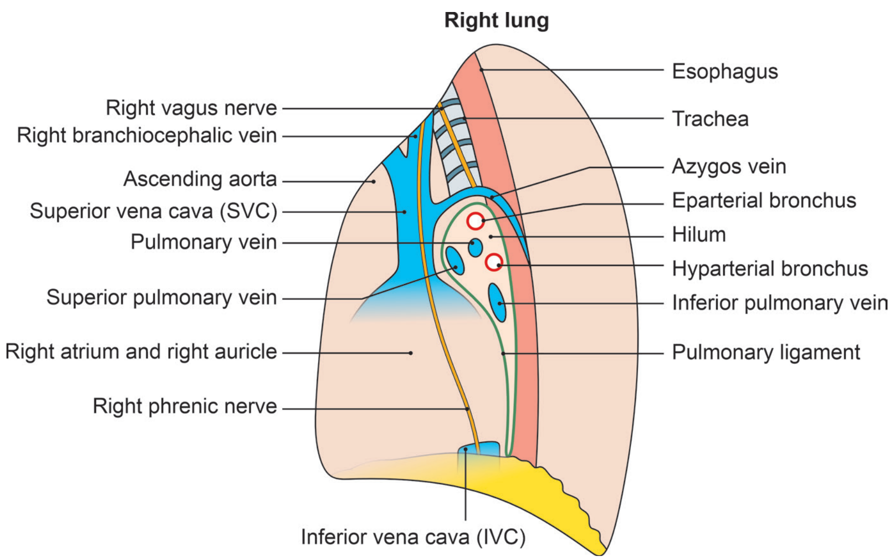

Fig. 1.3: Right lung relations

Left Lung Relations (Fig. 1.4)

a. **Anterior relations:**

Left pulmonary artery: Located above the left main bronchus.

Left pulmonary veins: Positioned anteriorly and inferiorly.

b. **Posterior relations:** The esophagus runs posteriorly, which can be clinically significant in cases of esophageal tumours causing compression of the lung structures. The thoracic aorta is located medially.

c. **Medial relations:** Structures include the left atrium and a part of the left ventricle.

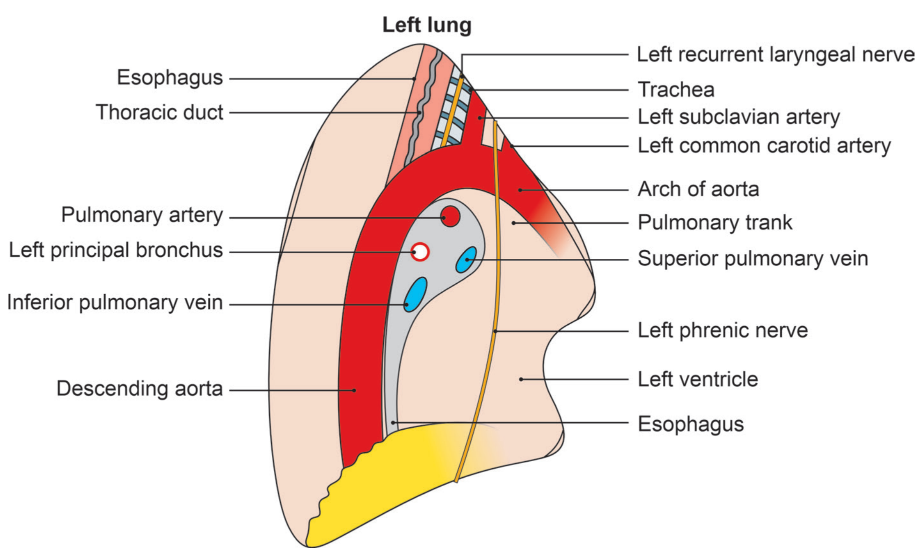

Fig. 1.4: Left lung relations

Clinical Correlates

Pulmonary conditions

Lung cancer: Tumours located near the hilum can compress or invade the structures within the root of the lung. This can lead to symptoms such as hemoptysis (coughing up blood), dyspnea (shortness of breath) and chest pain. The anatomical relationships of the hilum and surrounding structures are important for staging lung cancer. Lymphatic drainage patterns help in understanding metastasis and planning surgical interventions.

Bronchogenic carcinoma: This type of lung cancer often arises from the large bronchi at the hilum, leading to obstruction and collapse of the distal lung (atelectasis).

Lymphadenopathy: Enlarged lymph nodes at the hilum (hilar lymphadenopathy) are commonly seen in conditions like sarcoidosis, lymphoma or metastatic cancer. This can compress the bronchi or blood vessels, causing respiratory symptoms.

Vascular conditions

Pulmonary embolism: A blood clot in the pulmonary artery can lodge near the root of the lung, obstructing blood flow and leading to chest pain, shortness of breath and potentially life-threatening complications.

Pulmonary hypertension: This condition involves increased pressure in the pulmonary arteries, which may cause the pulmonary artery at the root of the lung to dilate. This can be observed on imaging studies.

Infections

Pneumonia: Inflammation and infection in the lung parenchyma can lead to pleuritic pain, fever and cough. Understanding the anatomy of the bronchial tree is crucial for effective management, including targeted antibiotic therapy. Infections involving the lung parenchyma near the hilum can lead to consolidation seen on chest X-rays or CT scans, often accompanied by cough, fever and difficulty breathing.

Tuberculosis: The root of the lung is a common site for tuberculosis infection, particularly in the lymph nodes, leading to hilar lymphadenopathy.

Trauma

Blunt or penetrating trauma: Injuries to the chest can affect the root of the lung, potentially leading to pneumothorax (air in the pleural cavity), hemothorax (blood in the pleural cavity) or injury to the major vessels and bronchi.

Surgical interventions

Lobectomy and pneumonectomy: During lung surgeries, knowledge of the relationships between the pulmonary arteries, veins and bronchi is crucial for avoiding complications. The approach may vary based on the side and structural relations of the lung.

Bronchoscopy: Understanding the bronchial tree anatomy is essential for navigating the airways during diagnostic and therapeutic procedures.

Radiological importance

Chest X-rays and CT scans: Accurate interpretation of imaging studies depends on an understanding of the normal anatomy of the lung root and bronchial tree. Pathologies can often distort these structures, aiding in diagnosis.

Interventional procedures

Thoracentesis: In cases of pleural effusion, understanding the anatomy of the pleura and lung root is essential for safe fluid drainage.

Endobronchial ultrasound: A minimally invasive technique for diagnosing lung cancer and lymphadenopathy requires knowledge of the relationships of structures in the hilum.

Bronchopulmonary Segment

A bronchopulmonary segment is a vital anatomical and functional unit of the lungs, each supplied by its own segmental (tertiary) bronchus and a corresponding branch of the pulmonary artery. These segments are separated from each other by connective tissue septa and have their air and blood supply, making them somewhat independent. Each segment serves a specific role in respiratory physiology, contributing to gas exchange and overall pulmonary health.

Anatomy of the Bronchopulmonary Segment (Figs 1.5 to 1.10)

Each segment consists of pulmonary parenchyma, bronchi, blood vessels, lymphatics and nerves.

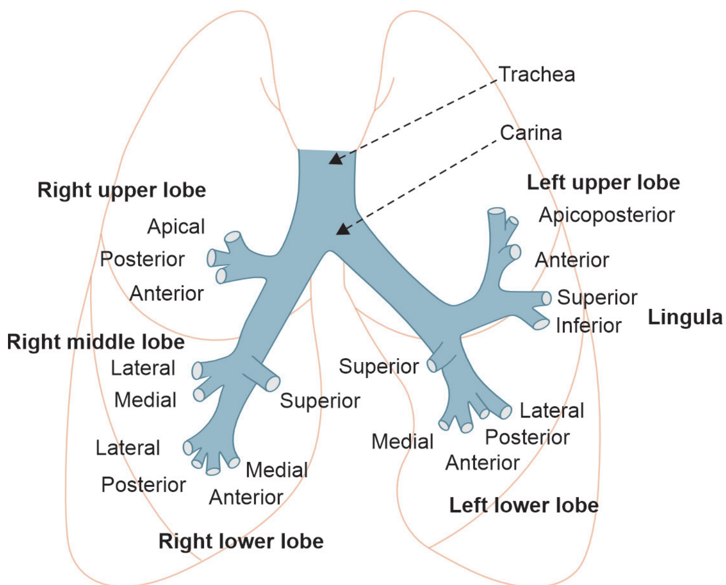

Fig. 1.5: Spatial locations of bronchopulmonary segments

Secondary (lobar) bronchi
- Within lung primary bronchi branch into secondary (lobar) bronchi
  - 3 in right lung
  - 2 in left lung

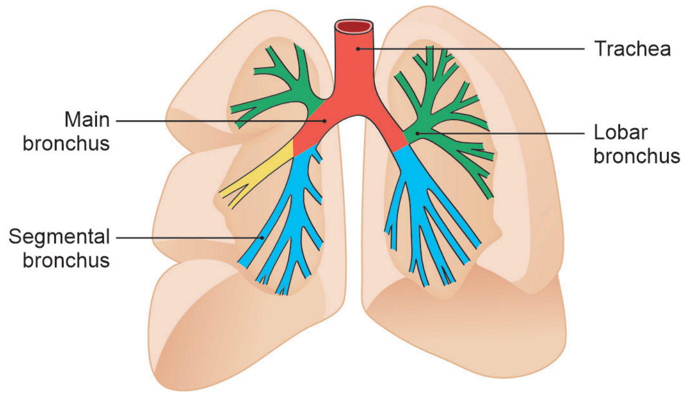

Fig. 1.6: Lobar bronchi of lungs

- **Right**
  - Wider, shorter and more vertical
  - Before entering the lung
    - Gives superior lobar bronchus
  - On entering the lung
    - Divides into
      - Middle lobar bronchus
      - Inferior lobar bronchus
- **Left**
  - Narrower, longer and more horizontal
  - On entering the lung
    - Divides into
      - Superior lobar bronchus
      - Inferior lobar bronchus

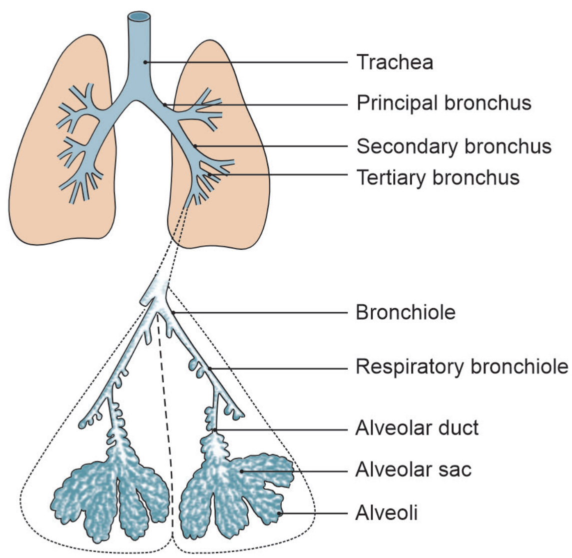

Fig. 1.7: Principal bronchi of lungs

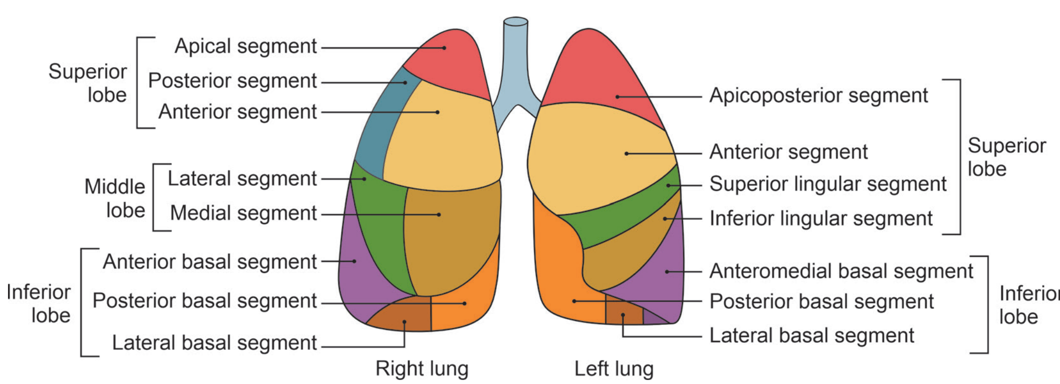

Fig. 1.8: Lung segments

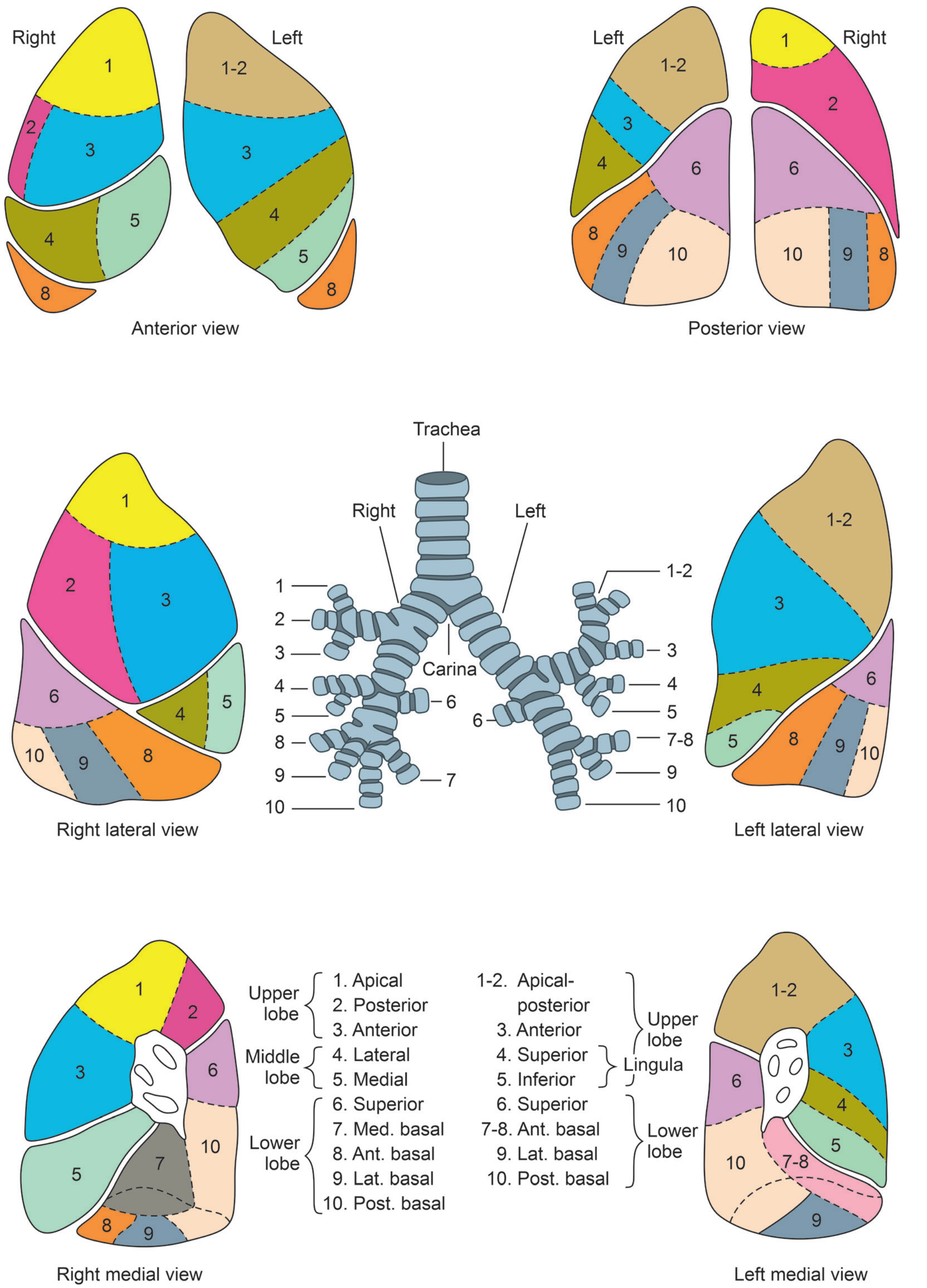

Fig. 1.9: Components of a bronchopulmonary segment

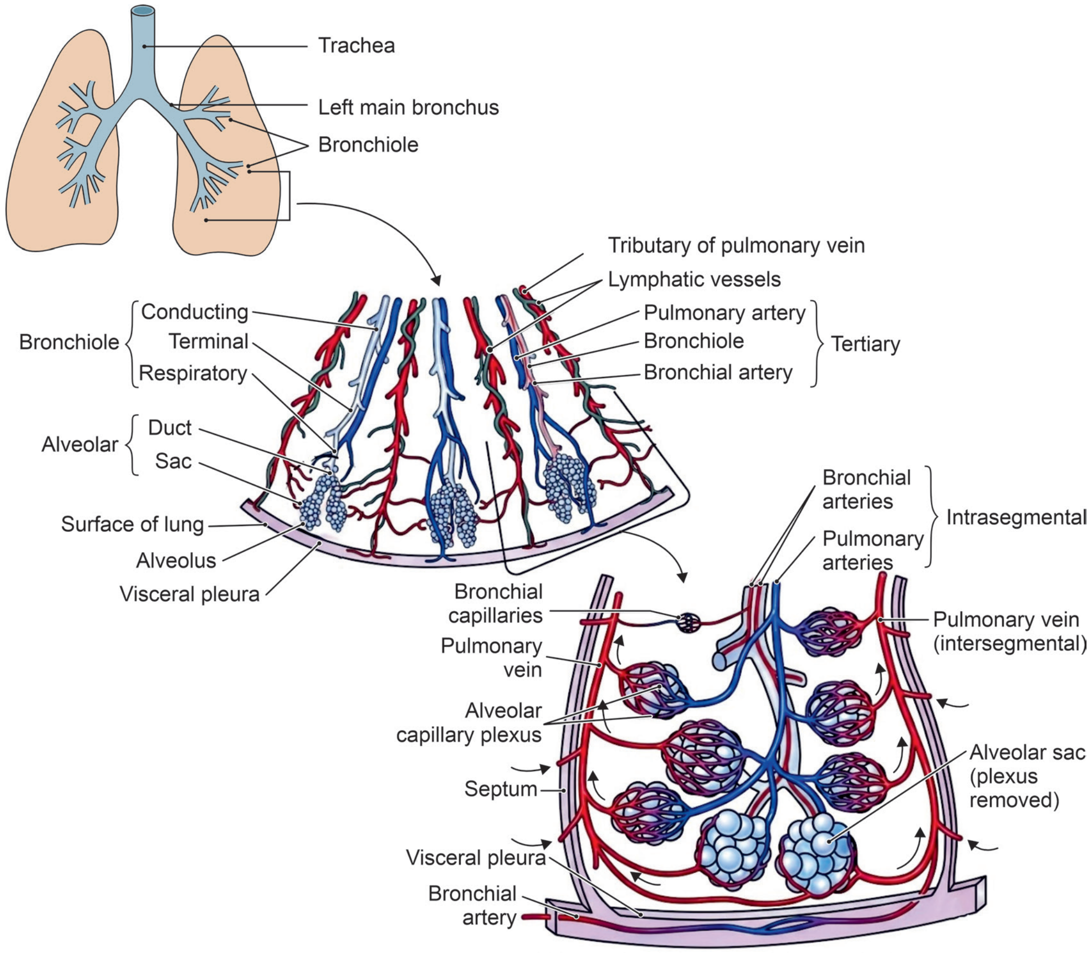

Fig. 1.10: Bronchopulmonary segment structure

Division of the lungs: The lungs are divided into lobes, which are further subdivided into bronchopulmonary segments **(Tables 1.3 and 1.4).**

Table 1.3: Right lung bronchopulmonary segments

Lobe	Segments (name and location)
Upper lobe	1. Apical (superior)
	2. Posterior
	3. Anterior
Middle lobe	4. Lateral
	5. Medial
Lower lobe	6. Superior
	7. Medial basal
	8. Anterior basal
	9. Lateral basal
	10. Posterior basal

Table 1.4: Left lung bronchopulmonary segments

Lobe	Segments (name and location)
Upper lobe	1. Apical-posterior (often combined)
	2. Anterior
Lingula	3. Superior lingular
	4. Inferior lingular
Lower lobe	5. Superior
	6. Medial basal (may be absent)
	7. Anterior basal
	8. Lateral basal
	9. Posterior basal

Each bronchopulmonary segment comprises several components **(Table 1.5)**:

Segmental bronchus: Each segment is supplied by a specific tertiary (segmental) bronchus, which branches off from the secondary (lobar) bronchus. The segmental bronchi divide into smaller bronchioles, leading to alveolar ducts and eventually to alveoli, where gas exchange occurs.

Pulmonary arteries: Each bronchopulmonary segment receives blood from a segmental branch of the pulmonary artery. These arteries carry deoxygenated blood from the right ventricle of the heart to the lungs for oxygenation.

Pulmonary veins: The oxygenated blood from each segment is drained by the pulmonary veins, which return the blood to the left atrium of the heart.

Bronchial arteries: In addition to the pulmonary arteries, bronchial arteries (typically arising from the aorta) supply oxygenated blood to the lung tissue, including the bronchopulmonary segments.

Lymphatics: Each segment has its own lymphatic drainage, which helps to remove excess fluid and pathogens. Lymphatic vessels drain into regional lymph nodes.

Nerves: The autonomic nervous system innervates the bronchopulmonary segments, influencing bronchoconstriction and bronchodilation. The sympathetic fibres come from the thoracic sympathetic chain, while parasympathetic fibres arise from the vagus nerve.

Geometric arrangement: The bronchopulmonary segments are arranged in a pyramidal configuration, with the base of the pyramid facing the surface of the lung and the apex pointing toward the hilum. This arrangement allows for efficient gas exchange and optimal lung function.

Table 1.5: Comparison of bronchopulmonary segments in right and left lung

Feature	Right lung	Left lung
Total segments	10	8–10
Upper lobe segments	3	3 (including lingula)
Middle lobe segments	2	Not present
Lower lobe segments	5	4–5
Clinical relevance	Segmental resections, bronchoscopy and infection spread	Same as the right lung

Functions of Bronchopulmonary Segments

- **Gas exchange:** The primary function of bronchopulmonary segments is to facilitate gas exchange. Each segment contains numerous alveoli, where oxygen and carbon dioxide are exchanged between the air and the bloodstream. The independent nature of segments allows for localised ventilation and perfusion.
- **Autonomy and segmentation:** The autonomy of bronchopulmonary segments means that disease or surgical intervention can affect one segment without impacting the others. This is crucial for managing conditions such as lung cancer, infections and other pulmonary diseases.
- **Involvement in respiratory physiology:** The bronchopulmonary segments play an essential role in the overall function of the respiratory system:
  - *Ventilation:* Each segment can be ventilated independently, allowing for optimal airflow distribution during breathing.
  - *Perfusion:* Blood flow to each segment is regulated through the segmental branches of the pulmonary arteries, which can adjust according to the metabolic demands of the lung tissue.
- **Immunological function:** Lymphatic drainage from each segment helps to maintain immune surveillance and response to infections or inflammation.

Clinical Significance (Fig. 1.11)

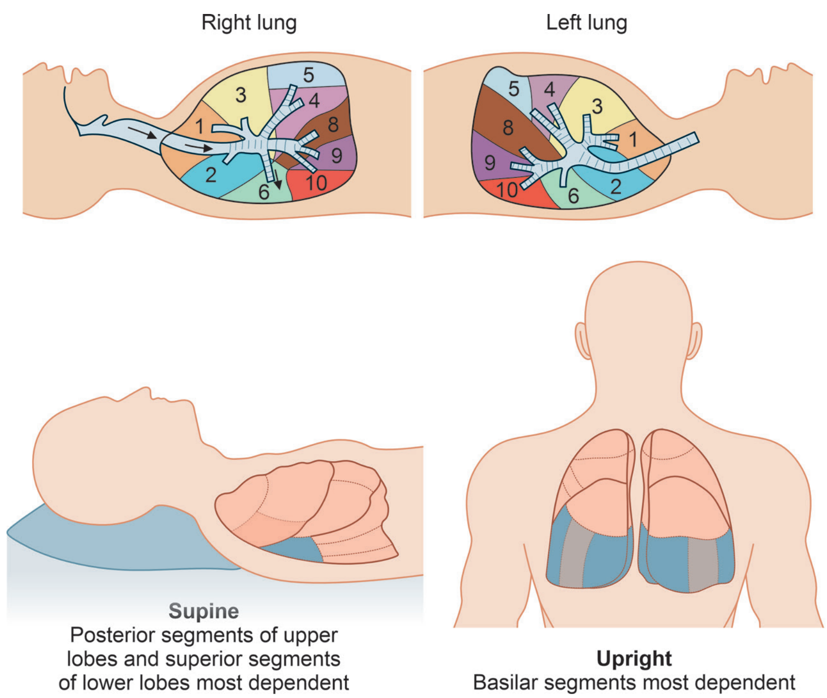

Fig. 1.11: Clinical relevance of bronchopulmonary segments

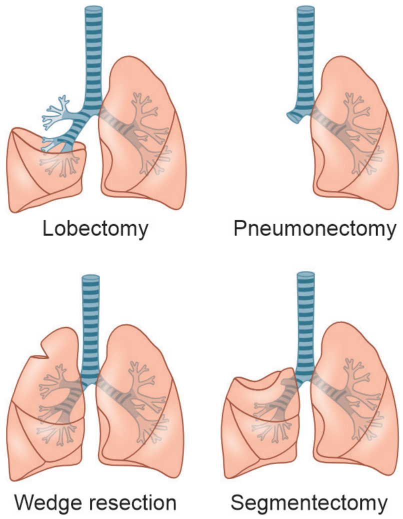

Fig. 1.12: Various surgical interventions in lung

Surgical interventions: The bronchopulmonary segments are crucial in surgical procedures involving the lungs. Understanding the anatomy of these segments helps surgeons to perform segmentectomies (removal of a bronchopulmonary segment) or lobectomies (removal of a lobe) with minimal impact on surrounding lung tissue **(Fig. 1.12)**.

Segmentectomy: In cases of localised lung tumours or infections, segmentectomy allows for the removal of the affected segment while preserving lung function. This approach is often used for early-stage lung cancer.

Lobectomy: For larger tumours or more extensive disease, lobectomy may be required. Knowledge of the bronchopulmonary segments aids in surgical planning and execution.

Disease localisation: Various pulmonary diseases can localise to specific bronchopulmonary segments, making it essential for diagnosis and treatment:

- **Pneumonia:** Infections can occur in specific segments, leading to segmental pneumonia. Identifying the affected segment is crucial for targeted antibiotic therapy.
- **Tuberculosis:** Pulmonary tuberculosis often affects specific segments, particularly the apical segments of the upper lobes. Radiological imaging can help localise the disease for treatment.
- **Lung cancer:** Tumours can arise within specific segments and understanding the bronchopulmonary segment anatomy aids in staging and treatment planning. Lymphatic drainage patterns are also important for assessing metastasis.

Radiological assessment: Knowledge of bronchopulmonary segments is vital for interpreting chest X-rays and CT scans. Radiologists use segmental anatomy to identify abnormalities, such as:

- **Consolidation:** Segmental consolidation can indicate pneumonia or other infections.

- **Mass lesions:** Tumours can often be localised to specific segments, which is important for diagnosis and management.
- **Emphysema:** Changes in lung architecture can be assessed by evaluating the integrity of bronchopulmonary segments.

Pulmonary conditions: Understanding the anatomy and function of bronchopulmonary segments is important in managing various pulmonary conditions:

- **Asthma:** The bronchi and bronchioles within each segment can become inflamed, leading to obstructed airflow. Treatments often target specific segments based on the pattern of the disease.
- **Chronic obstructive pulmonary disease (COPD):** In COPD, certain segments may become more affected than others, influencing treatment strategies.
- **Bronchiectasis:** This condition, characterised by abnormal dilation of the bronchi, can be localised to specific segments, impacting clinical management and outcomes.

Endobronchial procedures: The understanding of bronchopulmonary segments is also essential for various endobronchial procedures:

- **Bronchoscopy:** During bronchoscopy, physicians can navigate to specific segments to collect samples or perform interventions. Knowing the segmental anatomy facilitates targeted procedures.
- **Endobronchial ultrasound (EBUS):** This technique is used for diagnosing lung cancer and assessing lymph nodes. Understanding segmental anatomy aids in guiding biopsies.

CLINICAL FEATURES AND MANAGEMENT PRINCIPLES

Competency

SU 26.3 Describe the clinical features of mediastinal diseases and the principles of management.

Mediastinal diseases encompass a broad spectrum of medical and surgical conditions that affect the mediastinum, the central compartment of the thoracic cavity. This area contains vital structures such as the heart, great vessels, trachea, esophagus, lymph nodes, thymus and a part of the nervous system. Clinical manifestations of mediastinal diseases vary widely depending on the specific pathology, the structures involved and the size and location of the lesions.

Anatomy of the Mediastinal Structures (Fig. 1.13)

The mediastinum is a central region in the thorax that is bounded:

- **Superiorly:** By the thoracic inlet (the opening at the top of the thoracic cavity)
- **Inferiorly:** By the diaphragm, which separates the thoracic cavity from the abdominal cavity
- **Anteriorly:** By the sternum
- **Posteriorly:** By the vertebral column (thoracic spine)
- **Laterally:** By the pleurae of the lungs

It contains several vital structures, including the heart, great vessels, trachea, esophagus and lymphatic tissues, which makes its anatomy complex and essential for understanding mediastinal diseases **(Fig. 1.14)**.

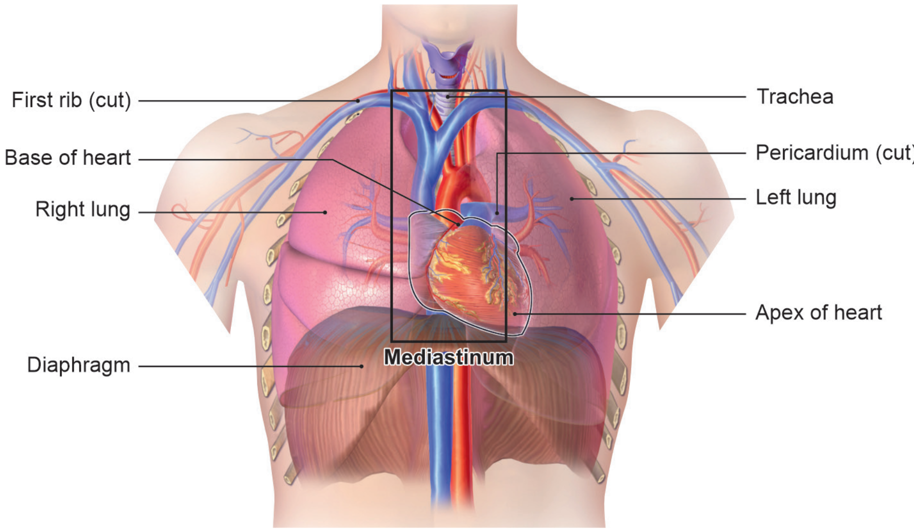

Fig. 1.13: Mediastinum

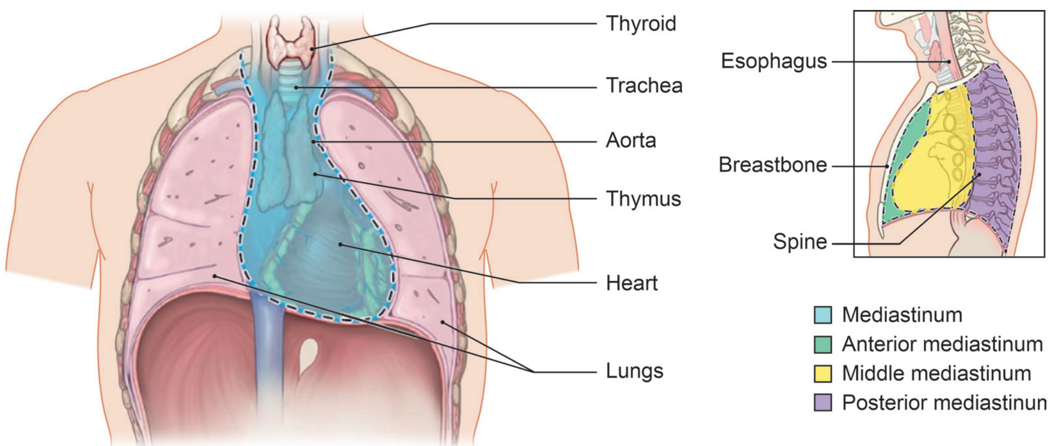

Fig. 1.14: Mediastinum divisions and structures

The mediastinum can be divided into three compartments based on their anatomic boundaries:

- **Anterior mediastinum:** It lies between the sternum and the pericardium.
- **Middle mediastinum:** It contains the heart, great vessels and trachea.
- **Posterior mediastinum:** It lies between the pericardium and the vertebral column.

Each of these compartments contains distinct structures and is associated with different types of diseases, making an understanding of their anatomy crucial for clinical practice.

Anterior Mediastinum

The anterior mediastinum is the most anterior or superficial compartment and lies between the sternum and the anterior aspect of the pericardium. It is also referred to as the prevascular space. The contents of this compartment is primarily loose connective tissue, fat, lymph nodes and the thymus gland.

- **Thymus:** The thymus is a lymphoid organ that plays a critical role in immune development, especially during childhood. Thymomas and thymic hyperplasia are common pathologies associated with this structure.
- **Lymph nodes:** Lymph nodes in this region can become enlarged due to infections (tuberculosis) or malignancies like lymphoma.
- **Arterial supply:** Blood supply to this region mainly comes from branches of the internal thoracic arteries.
- **Venous drainage:** Venous return from this area is directed into the brachiocephalic veins and subsequently into the superior vena cava.

Clinical significance

Masses in the anterior mediastinum, such as thymomas, lymphomas and germ cell tumours, often present with nonspecific symptoms like cough or chest pain but can lead to more serious issues like superior vena cava syndrome.

Middle Mediastinum

The middle mediastinum is the largest among all three compartments and contains:

- **Heart and pericardium:** The heart occupies most of the middle mediastinum. It is enclosed by the pericardial sac, which protects and anchors it within the thorax.
- **Great vessels:** These include the ascending aorta, pulmonary trunk and superior vena cava. The pulmonary arteries and veins are also located here, facilitating blood flow to and from the heart and lungs.
- **Trachea and main bronchi:** The trachea passes through the superior portion of the middle mediastinum and bifurcates into the right and left main bronchi at the level of the carina (thoracic 4th vertebra).
- **Lymph nodes:** Lymph nodes in this region can become involved in infections or malignancies, especially lung cancer and lymphoma.

Clinical significance

- Diseases affecting the heart, such as pericarditis or pericardial effusion, can present with chest pain and shortness of breath.
- Tracheal compression from tumours or masses can result in respiratory symptoms like stridor or wheezing.

Posterior Mediastinum

The posterior mediastinum is the most posterior compartment and lies between the pericardium and the vertebral column. It contains the esophagus, descending thoracic aorta, thoracic duct, azygos and hemiazygos veins and sympathetic chains.

- **Esophagus:** The esophagus travels through the posterior mediastinum, connecting the pharynx to the stomach.
- **Aorta:** The descending thoracic aorta travels through the posterior mediastinum, giving off several branches that supply the intercostal spaces and other thoracic structures.
- **Thoracic duct:** This is the main lymphatic duct that drains lymph from the body below the diaphragm and the left side of the thorax and upper limb into the venous system.

Clinical significance

- Esophageal diseases, such as esophageal cancer or achalasia, often present with dysphagia (difficulty swallowing).
- Aortic aneurysms or dissections can cause life-threatening symptoms like severe chest pain, hypotension or shock.

Mediastinal Compartments in Relation to Specific Pathologies (Fig. 1.15)

- **Anterior mediastinum:** Common diseases include thymomas, lymphomas and germ cell tumours.
- **Middle mediastinum:** Tumours of the heart, pericardial cysts and lymphadenopathy from infectious or neoplastic processes.
- **Posterior mediastinum:** Neurogenic tumours, esophageal diseases and vascular abnormalities like aortic aneurysms.

Clinical aspects of mediastinal diseases: Mediastinal diseases encompass a wide range of pathologies, including congenital anomalies, infections, neoplasms and

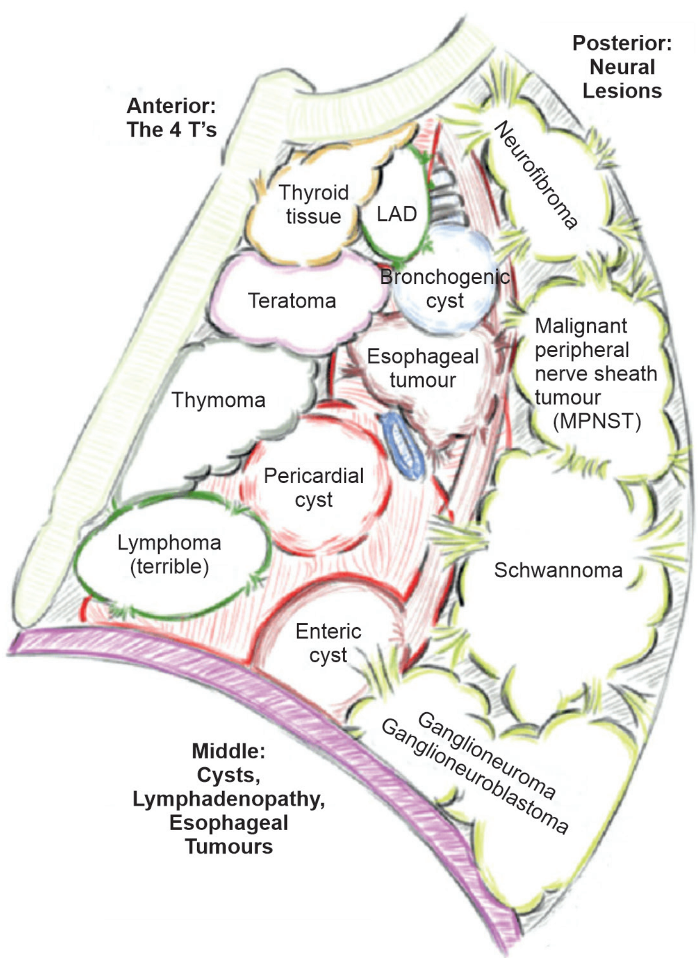

Fig. 1.15: Mediastinal compartments in relation to specific pathologies

inflammatory conditions. These diseases can arise from any of the structures within the mediastinum and their clinical presentation can vary widely based on the location and size of the lesion.

- **Congenital diseases:** These include conditions like bronchogenic cysts and neurogenic tumours, malformations, etc. which are often asymptomatic but may cause symptoms if they enlarge or become infected.
- **Infectious diseases:** Acute mediastinitis, often a complication of esophageal rupture or post-surgical infection, is a serious condition that requires immediate attention.
- **Neoplasms:** Tumours can arise from any of the tissues within the mediastinum, with thymomas, lymphomas and germ cell tumours being among the most common.

Clinical features based on the affected mediastinal region: The clinical features of mediastinal diseases depend largely on the specific region of the mediastinum that is affected.

- **Anterior mediastinal masses:** These often present with symptoms of mass effect, such as chest pain, cough or dyspnea, due to compression of the trachea or heart. In cases of superior vena cava syndrome, patients may experience facial swelling, distended neck veins and cyanosis.
- **Middle mediastinal pathologies:** Diseases in this region often involve the heart or great vessels, leading to symptoms like chest pain, palpitations or heart failure. Tumours in the middle mediastinum can also compress the trachea or main bronchi, causing respiratory distress.
- **Posterior mediastinal disorders:** These may involve the esophagus or aorta, leading to dysphagia, retrosternal pain or severe chest pain if there is an aortic dissection.

Detailed Discussion of Specific Mediastinal Diseases (Table 1.6)

- **Thymoma and thymic hyperplasia:** Thymomas are the most common anterior mediastinal tumours in adults. They can be associated with myasthenia gravis and other autoimmune conditions. Surgical resection is often required.
- **Lymphoma:** Both Hodgkin's and non-Hodgkin's lymphomas can present as mediastinal masses. Symptoms include fever, night sweats, weight loss and lymphadenopathy.
- **Germ cell tumours:** These are often found in the anterior mediastinum and may secrete hormones like β-hCG or AFP, leading to clinical syndromes such as gynecomastia or virilization.

Table 1.6: Mediastinal compartments and associated conditions

Compartment	Borders	Normal structures	Masses
Anterior	• Anterior: Sternum • Posterior: Pericardium, ascending aorta, brachiocephalic vessels	• Lymph nodes • Connective tissue • Thymus (remnant in adults)	• Thymoma • Germ cell neoplasm • Lymphoma • Thyroid enlargement (intrathoracic goiter) • Other tumours

(Contd.)

Table 1.6: Mediastinal compartments and associated conditions (Contd.)

Compartment	Borders	Normal structures	Masses
Middle	• Anterior: Anterior pericardium, ascending aorta, brachiocephalic vessels • Posterior: Posterior pericardium	• Pericardium • Heart • Vessels: Ascending aorta, venae cavae, main pulmonary arteries • Trachea • Lymph nodes • Nerves: Phrenic, upper vagus	• Carcinoma • Lymphoma • Pericardial cyst • Bronchogenic cyst • Benign lymph node enlargement (granulomatous disease)
Posterior	• Anterior: Posterior pericardium • Posterior: Posterior chest wall	• Esophagus • Descending aorta • Vertebral column • Nerves: Sympathetic chain, lower vagus • Lymph nodes • Connective tissue	• Neurogenic tumour • Diaphragmatic hernia

Diagnostic Approach to Mediastinal Diseases

1. **History and physical examination:** The diagnostic approach to mediastinal diseases begins with a thorough history and physical examination. Key symptoms to elicit include:
   - *Respiratory symptoms:* Cough, dyspnea or stridor may indicate tracheal compression.
   - *Cardiovascular symptoms:* Chest pain or palpitations may suggest cardiac involvement.
   - *Dysphagia:* Difficulty swallowing may indicate esophageal compression.
   - *Constitutional symptoms:* Fever, weight loss and night sweats are common in malignancies.
2. **Imaging studies:** Imaging plays a central role in the diagnosis of mediastinal diseases.
   - *Chest X-ray:* Often the first imaging modality used, chest X-rays can show the presence of a mediastinal mass, widening of the mediastinum or tracheal deviation.
   - *CT and MRI:* Cross-sectional imaging, especially CT scans, provides detailed information about the size, location and composition of mediastinal masses. MRI is particularly useful for evaluating neurogenic tumours in the posterior mediastinum.
   - *PET scans:* These are used primarily for staging malignancies, such as lymphoma, by identifying areas of increased metabolic activity.
3. **Laboratory tests and biomarkers:** Laboratory tests can provide important clues to the underlying diagnosis.
   - *Tumour markers:* Germ cell tumours often produce specific markers, such as α-fetoprotein (AFP) and β-hCG, which can help confirm the diagnosis.
   - *Autoimmune markers:* In patients with suspected thymoma and associated myasthenia gravis, testing for acetylcholine receptor antibodies is useful.
4. **Invasive diagnostic techniques:**
   - *Mediastinoscopy:* This surgical procedure allows for direct visualisation and biopsy of mediastinal lymph nodes or masses.

- *Fine-needle aspiration:* Often performed under CT guidance, this procedure allows for minimally invasive sampling of mediastinal masses.
- *Video-assisted thoracoscopic surgery (VATS):* VATS allows for the removal or biopsy of mediastinal masses using a minimally invasive approach.

Principles of Management in Mediastinal Diseases

1. **Medical management:**
   - *Pharmacologic treatment:* Mediastinal infections like acute mediastinitis require broad-spectrum antibiotics and, in some cases, antifungal or antiviral medications. Anti-tubercular treatment in lymph node TB as well.
   - *Chemotherapy:* Malignant mediastinal tumours, such as lymphomas and germ cell tumours, often require systemic chemotherapy. Lymphomas are highly chemosensitive, with combination regimens like CHOP or ABVD being commonly used.
   - *Immunosuppressive therapy:* Thymic hyperplasia or thymomas associated with myasthenia gravis may require immunosuppressive drugs-like corticosteroids, azathioprine or mycophenolate.
2. **Surgical management:** Surgery is a cornerstone of treatment for many mediastinal diseases, particularly tumours.
   - *Thymectomy:* Surgical removal of the thymus is indicated for thymomas and is often performed in patients with myasthenia gravis.
   - *Resection of mediastinal tumours:* Tumours in the anterior or posterior mediastinum may require complete surgical excision. Minimally invasive techniques, such as VATS, are increasingly used for small, well-circumscribed tumours.
   - *Drainage of mediastinal infections:* In cases of mediastinitis, surgical drainage and debridement of infected tissue are necessary to prevent the spread of infection and sepsis.
3. **Radiation therapy:** Radiation therapy is commonly used in the treatment of malignant mediastinal tumours, either as primary therapy or as an adjunct to surgery and chemotherapy.
   - *Thymomas:* Radiation therapy is often used after incomplete surgical resection of thymomas or in cases of invasive disease.
   - *Lymphoma:* Mediastinal involvement in Hodgkin's lymphoma often requires radiation as part of combined-modality treatment.
4. **Management of specific conditions:**
   - *Thymomas:* The primary treatment for thymomas is surgical resection. In cases of advanced disease, radiation or chemotherapy may be required.
   - *Lymphomas:* Chemotherapy is the mainstay of treatment for mediastinal lymphomas, with radiation therapy used in some cases.
   - *Germ cell tumours:* These tumours often respond well to platinum-based chemotherapy. Surgical resection may be necessary for residual masses after chemotherapy.
   - *Neurogenic tumours:* Surgical excision is the treatment of choice for neurogenic tumours in the posterior mediastinum, especially if they are symptomatic or malignant.

Prognosis and Outcomes in Mediastinal Diseases

1. **Factors influencing prognosis:**
   - *Tumour type:* Benign tumours, such as benign thymomas or bronchogenic cysts, have an excellent prognosis with surgical resection. Malignant tumours, like invasive thymomas or mediastinal lymphomas, have a more guarded prognosis.
   - *Stage of disease:* Early-stage tumours that are confined to the mediastinum and have not spread to surrounding tissues or distant organs have a better prognosis than advanced-stage tumours.
   - *Response to treatment:* Tumours that are highly responsive to chemotherapy or radiation, such as lymphoma or germ cell tumours, tend to have a better prognosis than tumours that are resistant to these treatments.
2. **Survival rates and prognostic indicators:**
   - *Thymomas:* Survival rates for thymomas are generally favourable, with 5 year survival rates ranging from 80 to 95% for early-stage disease. Advanced-stage disease has a worse prognosis, with 5 year survival rates of 30 to 50%.
   - *Lymphomas:* Mediastinal lymphomas, particularly Hodgkin's lymphoma, have excellent survival rates with appropriate treatment. The 5 year survival rate for patients with mediastinal Hodgkin's lymphoma is approximately 85 to 90%.
   - *Germ cell tumours:* Mediastinal germ cell tumours have a good prognosis when treated with combination chemotherapy. The 5 year survival rate for patients with mediastinal germ cell tumours is approximately 70 to 90%, depending on the histology of the tumour and the stage at diagnosis.
3. **Complications of mediastinal diseases:**
   - *Recurrence:* Tumours like thymomas and germ cell tumours may recur after treatment, especially if they were not completely resected or treated with radiation or chemotherapy.
   - *Long-term effects of treatment:* Surgery, radiation and chemotherapy can lead to long-term complications, such as fibrosis, scarring or secondary malignancies. Patients who receive radiation therapy to the mediastinum are at risk for developing radiation-induced lung disease or cardiovascular complications.

The diagnosis of mediastinal diseases requires a thorough clinical evaluation, including a detailed history, physical examination and appropriate imaging studies. Laboratory tests, including tumour markers and autoimmune markers, may provide additional diagnostic information. Invasive techniques, such as mediastinoscopy and biopsy, are often necessary to obtain tissue for histologic diagnosis. Management of mediastinal diseases depends on the underlying cause and may include medical, surgical or radiation therapy. The prognosis for patients with mediastinal diseases varies based on the type of disease, its stage at diagnosis and the patient's response to treatment.

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