

# Surface Marking and Radiological Anatomy of Thorax

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## Introduction

Surface marking refers to the projection of internal anatomical structures onto the external surface of the body. Understanding these lines and points helps correlate **clinical signs**, **radiological images**, and **procedural landmarks** during examination or surgery

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## Surface Marking

### Surface Marking of Parietal Pleura

- **Cervical Pleura:**

Represented by a curved line forming a dome over the **medial one-third of the clavicle**, rising about **2.5 cm above it** on both sides.

- **Anterior Margin (Costomediastinal Reflection):**

- **Right side:** From the **sternoclavicular joint**, it descends to the **midpoint of the sternal angle**, then continues vertically to the **xiphisternal joint**, slightly to the right of the **xiphicostal angle**.
- **Left side:** Similar course until the **fourth costal cartilage**, then curves laterally and downward along the **sternal margin** to the **sixth costal cartilage**

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- **Inferior Margin (Costodiaphragmatic Reflection):**

The line passes laterally across:

- **8th rib** at the **midclavicular line**,
- **10th rib** at the **midaxillary line**,
- **12th rib** at the **lateral border of the sacrospinalis muscle**,  
and ends **2 cm lateral to the T12 spine**.

Clinically, the pleura extends below the costal margin at the **xiphicostal** and **costovertebral angles**, making these regions prone to pleural injury during **renal surgery**

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- **Posterior Margin:**

Extends from a point **2 cm lateral to the T12 spine** to **2 cm lateral to the C7 spine**, where the costal pleura becomes mediastinal pleura.

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## Surface Marking of Lungs

- **Apex:**

Lies **2.5 cm above the medial one-third of the clavicle**, following the dome of the cervical pleura.

- **Anterior Border:**

- **Right lung:** Follows the same path as the right pleural reflection from the **sternoclavicular joint** to the **xiphisternal joint**.
- **Left lung:** Similar until the **fourth costal cartilage**, then curves laterally for **3.5 cm** from the sternal margin, forming the **cardiac notch**, before curving back to the

## sixth costal cartilage

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- **Inferior Border:**

Crosses the:

- **6th rib** at the **midclavicular line**,
- **8th rib** at the **midaxillary line**,
- **10th rib** posteriorly at the **lateral border of the erector spinae**.

- **Posterior Border:**

Extends from the **apex (2.5 cm above clavicle)** down to **T10 vertebra** in the mid-scapular line, slightly below the posterior pleural line.

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## Clinical Importance

- Knowledge of these markings helps in procedures like **pleural aspiration** (done in the 8th–9th intercostal space, posterior axillary line).
- The **pleural recesses** (costodiaphragmatic and costomediastinal) are key sites for **fluid accumulation** in pleural effusion.
- Accurate surface marking prevents **lung or pleura injury** during interventions such as **thoracentesis** and **biopsies**.

## Surface Marking and Radiological Anatomy of Thorax

### Borders of the Heart, Arteries, Veins, and Trachea

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## Borders of the Heart

- The **heart** lies obliquely in the thoracic cavity, with two-thirds to the **left of the midline** and one-third to the **right**.
- The **surface marking** is obtained by joining points over the thoracic wall corresponding to the heart's margins and chambers.

### 1. Right Border:

- Formed mainly by the **right atrium**.
- Extends from the **right 3rd costal cartilage (1 cm from the right margin of sternum)** to the **right 6th costal cartilage** near the **sternal margin**.

### 2. Inferior Border:

- Formed chiefly by the **right ventricle**, with a small contribution from the **left ventricle**.
- Draw a line from the **right 6th costal cartilage** (sternal margin) to the **left 5th intercostal space, 9 cm from the midline**, corresponding to the **apex beat**.

### 3. Left Border:

- Formed mainly by the **left ventricle**.
- Extends from the **apex** to the **left 2nd costal cartilage, 1.5 cm from the sternal margin**.

### 4. Upper Border:

- Formed by the **right and left atrial appendages** and the **ascending aorta**.

- Draw a line from the **left 2nd costal cartilage (1.5 cm from sternum)** to the **right 3rd costal cartilage (1 cm from sternum)**.

#### Clinical Note:

- The area between the **4th and 6th costal cartilages** on the left sternal margin represents the **area of cardiac dullness** on percussion.
  - The **apex beat** is normally felt in the **left 5th intercostal space, 9 cm from the midline**, just medial to the midclavicular line.
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### Arteries

#### 1. Ascending Aorta:

- Begins behind the **left 3rd costal cartilage**, slightly left of the sternum.
- Ascends upward to reach the **level of the sternal angle (T4/T5)**.

#### 2. Arch of Aorta:

- From the **sternal angle**, curves **posteriorly and to the left**, reaching the **left 2nd costal cartilage**.
- It then descends behind the left bronchus to continue as the **descending thoracic aorta** at the level of **T4 vertebra**.
- The arch gives off **three main branches** (from right to left):
  - **Brachiocephalic trunk**
  - **Left common carotid artery**

- **Left subclavian artery**

### **3. Pulmonary Trunk:**

- Begins at the **upper border of the left 3rd costal cartilage**, runs upward and backward.
- Divides into **right and left pulmonary arteries** at the level of the **sternal angle**.
- Lies anterior to the **ascending aorta** in its initial part.

### **4. Descending Thoracic Aorta:**

- Lies to the **left of the vertebral column**, continuing from the **arch of aorta** at **T4**, and descends to the **aortic opening of the diaphragm at T12**.
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## **Veins**

### **1. Superior Vena Cava (SVC):**

- Formed by the union of the **right and left brachiocephalic veins** behind the **first right costal cartilage**.
- Descends vertically along the **right border of the sternum**.
- Enters the **right atrium** at the **level of the 3rd costal cartilage**.

### **2. Inferior Vena Cava (IVC):**

- Enters the thorax through the **central tendon of the diaphragm** at the **T8 vertebral level**.
- Opens into the **lower part of the right atrium** behind the **right 6th costal cartilage**.

### 3. Pulmonary Veins:

- Each lung gives two veins — **superior and inferior**.
- They open into the **left atrium** — superior veins lie anterior and inferior veins lie posterior.

### Clinical Correlation:

- Enlargement of the **SVC** or **azygos vein** may cause visible **venous engorgement** over the chest wall.
  - The **SVC syndrome** occurs due to compression by mediastinal tumors or enlarged lymph nodes, leading to venous congestion of the head, neck, and upper limbs.
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### Trachea

- The **trachea** is represented on the surface by a **midline structure** in the neck and upper thorax.
- Begins at the **lower border of the cricoid cartilage (C6)** and descends to the **sternal angle (T4/T5)**, where it divides into **right and left main bronchi**.
- It lies **anterior to the oesophagus** and is **slightly tilted to the right**.

### Surface Marking:

- In the **neck**, it lies in the midline from **C6 to the suprasternal notch**.
- In the **thorax**, it continues downward behind the **manubrium sterni**, ending at the **sternal angle**, where the **carina** corresponds to the site of bifurcation.

### Clinical Relevance:

- The **trachea** may deviate to one side in **pneumothorax**, **pleural effusion**, or **collapse of lung**.
- **Tracheostomy** is usually done between the **2nd and 4th tracheal rings**.
- The **carina** is the most sensitive area for the **cough reflex**.

## Surface Marking and Radiological Anatomy of Thorax

### Right Bronchus, Left Bronchus, Oesophagus, and Thoracic Duct

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#### Right Bronchus

- The **right principal bronchus** begins at the **lower end of the trachea** at the level of the **sternal angle (T4/T5)**.
- It passes **downward, backward, and laterally** to enter the **right lung hilum** opposite the **T5 vertebra**.
- The right bronchus is **shorter (2.5 cm)**, **wider**, and **more vertical** than the left, making it a common site for **inhaled foreign bodies**.
- On surface projection, it runs behind the **sternal end of the 3rd right costal cartilage** to the **root of the right lung**.

#### Clinical Relevance:

- **Foreign bodies, aspirated food particles, or vomitus** often lodge in the right bronchus due to its vertical course.
- **Bronchoscopic view** shows the **right upper lobe bronchus** arising **before the carina** — a feature known as the **eparterial bronchus**.



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## Left Bronchus

- The **left principal bronchus** also begins at the **sternal angle** and runs **downward, backward, and laterally** beneath the **arch of aorta**, entering the **left lung** opposite the **T6 vertebra**.
- It is **longer (5 cm)**, **narrower**, and **more horizontal** than the right bronchus.
- On the body surface, it corresponds roughly to a line drawn **from the sternal angle to the root of the left lung** (near the **4th costal cartilage**).

### Clinical Relevance:

- Because the left bronchus passes **under the arch of aorta** and **in front of the oesophagus and descending aorta**, it is often compressed in **aortic aneurysm** or **enlarged lymph nodes**.
- The left bronchus has **no eparterial branch**; all its lobar bronchi arise **below the pulmonary artery** (hence, **hyarterial**).

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## Oesophagus

- The **oesophagus** begins at the **lower border of the cricoid cartilage (C6)**, runs downward through the **superior and posterior mediastina**, and passes through the **diaphragm at T10**, ending in the **stomach at T11**.
- On the body surface, it lies **behind the trachea in the midline**, curving slightly to the **left** as it descends.
- The lower end lies a little to the left of the **midline**, behind the **7th costal cartilage** near the **xiphisternal joint**.

### Constrictions (clinically important for endoscopy):

1. At **C6** – at the cricoid cartilage.
2. At **T4/T5** – where crossed by the aortic arch and left main bronchus.
3. At **T10** – where it passes through the diaphragm.

### Clinical Relevance:

- **Barium swallow radiographs** show these constrictions as natural narrowings.
  - **Left atrial enlargement** may produce a **posterior indentation** on the oesophagus.
  - In **portal hypertension**, veins at the lower end of the oesophagus form **varices**, which may rupture and cause **haematemesis**.
  - **Tracheoesophageal fistula** may occur congenitally, causing **coughing during feeding** in infants.
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### Thoracic Duct

- The **thoracic duct** begins in the abdomen at the **cisterna chyli** (around the **lower border of T12**) and enters the thorax through the **aortic opening of the diaphragm**.
- It ascends between the **aorta (on the left)** and **azygos vein (on the right)**, **behind the oesophagus** in the posterior mediastinum.
- At the **T5 vertebral level**, it crosses from the right to the left side and ascends in the **superior mediastinum** along the **left side of the oesophagus**.
- In the neck, it arches laterally and downward to open into the **left venous angle** — the junction of the **left subclavian** and **left internal jugular veins**.

### Surface Projection:

- A line drawn from the **aortic opening (T12)** upward along the **vertebral column**, crossing to the left at **T5**, and ending at the **left supraclavicular region** (2 cm above the clavicle) represents its surface marking.

### Clinical Relevance:

- **Chylothorax** — rupture of the thoracic duct leads to accumulation of **lymph (chyle)** in the pleural cavity.
- **Obstruction** by tumors or fibrosis causes **lymphatic congestion** of the lower limbs and left upper limb.
- The duct must be preserved during **neck dissections** and **mediastinal surgeries** to prevent **chyle leak**.

### Radiological Anatomy (Thorax)

When you look at a standard **posteroanterior (PA) chest X-ray**, you must read it in an organized way. These are the key structures you're expected to identify and comment on.

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#### 1. Soft Tissues

- **Nipples** may be seen as round shadows overlying the lung fields in both sexes.
- In females, the **breast shadows** overlap the lower zones of the lungs.
  - The amount of overlap depends on breast size and how pendulous they are.

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Why it matters:

- Nipple shadows can mimic lung nodules if you don't recognize them.
  - Breast tissue can partially obscure lower lung fields.
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## 2. Bones

- **Vertebral bodies** are faintly seen.
- **Posterior parts of the ribs** are more clearly seen than anterior parts, because they are more calcified.
- Ribs become **wider and thinner** as they pass forward.
- **Costotransverse joints** are visible.
- **Costal cartilages** are normally not seen unless calcified in older age.
- Medial border of the **scapula** may project over the lung field if the patient hasn't protracted the shoulders.

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Why it matters:

- Always check for fractures, lytic lesions, or rib destruction.
  - Misplaced scapula can look like a lung opacity.
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## 3. Trachea

- Seen as a vertical **air-filled lucent column** in the midline of the neck and upper thorax.

- Lies in front of the upper thoracic vertebrae.

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Clinical note:

- **Shift of trachea** suggests volume loss (pull) or mass/effusion (push).
    - Pulmonary collapse pulls trachea toward that side.
    - Tension pneumothorax pushes trachea away.
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## 4. Diaphragm

- Seen as two **dome-shaped opaque curvatures**.
- The **right dome** is normally slightly **higher than the left** (because of the liver).
- The sharp angles between diaphragm and chest wall are the **costophrenic angles** (right and left).
  - Blunting of a costophrenic angle suggests **pleural effusion**.
- Under the **left** diaphragm you may see **gas in the stomach fundus**;
- Under the **right** dome is the **smooth soft-tissue density of the liver**.

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## 5. Lungs

- Lung fields appear **radiolucent (dark)** because they are air-filled.

- The **hila/root of each lung** forms a denser shadow due to:
  - Main bronchi
  - Pulmonary arteries and veins
  - Bronchial vessels
  - Hilar lymph nodes
- As you go peripherally, branching vascular markings taper and fade.
- The smaller bronchi are usually not seen clearly on normal X-ray.

For description, each lung can be divided into 3 vertical zones on PA film:

- **Upper zone:** From apex down to the level of the 2nd costal cartilage.
- **Middle zone:** 2nd to 4th costal cartilage (includes the hilum).
- **Lower zone:** 4th costal cartilage down to the diaphragm.

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Why this matters:

- You never say "there's an opacity in the right lung."  
You say "there's a rounded opacity in the right mid zone, medial aspect," etc. This is how cases are presented.

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## 6. Mediastinum / Cardiomedastinal Shadow

The mediastinum on X-ray is not one single organ. The “mediastinal shadow” is produced by the **heart plus great vessels plus superimposed soft tissues**.

- The **transverse diameter of the heart** is normally **about half the transverse diameter of the thoracic cage** on PA film.
- During deep inspiration, the heart appears slightly elongated and more tubular, because it descends.

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Borders of the mediastinum on PA film:

- **Right mediastinal border** (from top to bottom) is formed by:

- Right brachiocephalic vein
- Superior vena cava
- Right atrium
- Inferior vena cava (at the lower end)

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- **Left mediastinal border** (from top to bottom) is formed by:

- Arch of aorta (seen as the classic “aortic knuckle”)
- Left margin of the pulmonary trunk
- Left atrial appendage (left auricle)
- Left ventricle, which forms most of the lower left heart border

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- **Inferior mediastinal border** merges with:

- Diaphragm
- Liver shadow on the right

Why it matters:

- If the **aortic knuckle** is widened ? think aortic aneurysm.
  - If the **pulmonary trunk segment** is prominent ? think pulmonary hypertension.
  - If the **right atrial border** is bulging ? think right atrial enlargement.
  - If the **left ventricular border** is displaced laterally and inferiorly ? think left ventricular enlargement.
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## 7. How to systematically read a chest X-ray in exam:

- Soft tissues (breast, nipple shadows, neck)
- Bones (ribs, clavicles, vertebrae, scapula)
- Trachea and mediastinum (position and width)
- Diaphragm and costophrenic angles
- Lung fields (symmetry, opacities, lucencies, vascularity)
- Gastric air bubble (left subdiaphragmatic)

This sequence is often expected in viva.

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## Numericals / Quick Reference Values



These numbers are extremely commonly asked.

- **Anteroposterior diameter of the thoracic inlet:** ~5 cm

- **Transverse diameter of the thoracic inlet:** ~10 cm

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- **Level of suprasternal (jugular) notch:** opposite the body of **T2 vertebra**
- **Level of sternal angle (manubriosternal joint):** at the **intervertebral disc between T4 and T5**

- Also the level where:

- Arch of aorta begins and ends
- Trachea bifurcates
- Azygos vein drains into SVC
- 2nd costal cartilage articulates with sternum

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- **Level of xiphisternal joint:** opposite **T9 vertebra**

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- **Subcostal angle:** Between the right and left 7th costal cartilages at their sternal attachments (essential landmark for upper abdominal exam).

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- **Vertebra prominens:** Spinous process of **C7** (palpable at base of neck).

- **Scapular surface landmarks:**

- Superior angle of scapula ? level of **T2 spine**
- Root (medial end) of spine of scapula ? level of **T3 spine**
- Inferior angle of scapula ? level of **T7 spine**  
These are used to judge rib levels on the back.

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- **Length of oesophagus: ~25 cm total**

- Cervical part: ~4 cm
- Thoracic part: ~20 cm
- Abdominal part: ~1.25 cm
- Begins at **C6**
- Ends at stomach at **T11**

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- **Trachea:**

- Begins at **C6**
- Length: ~10–15 cm
- Bifurcation: upper border of **T5** vertebra (? sternal angle in living adult)

- **Principal bronchi lengths:**

- Right principal bronchus: ~2.5 cm

- Left principal bronchus: ~5 cm

This explains why inhaled foreign bodies prefer the right side.

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These radiological checkpoints and numeric levels are exactly what examiners love:

- "At what vertebral level does the trachea bifurcate?"
- "What forms the right and left borders of the mediastinal shadow?"
- "Why is the right hemidiaphragm higher than the left?"
- "Which bronchus is more vertical and why is that clinically important?"

Memorizing these lets you answer fast and confidently in both theory and viva.