MEDICAL EDUCATION RESOURCE

Surface Marking and Radiological Anatomy of Thorax

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.

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.

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

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.

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**.

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.

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

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**.

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, **hyparterial**).

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.

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 / Cardiomediastinal 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.

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).

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- **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)

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- **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.