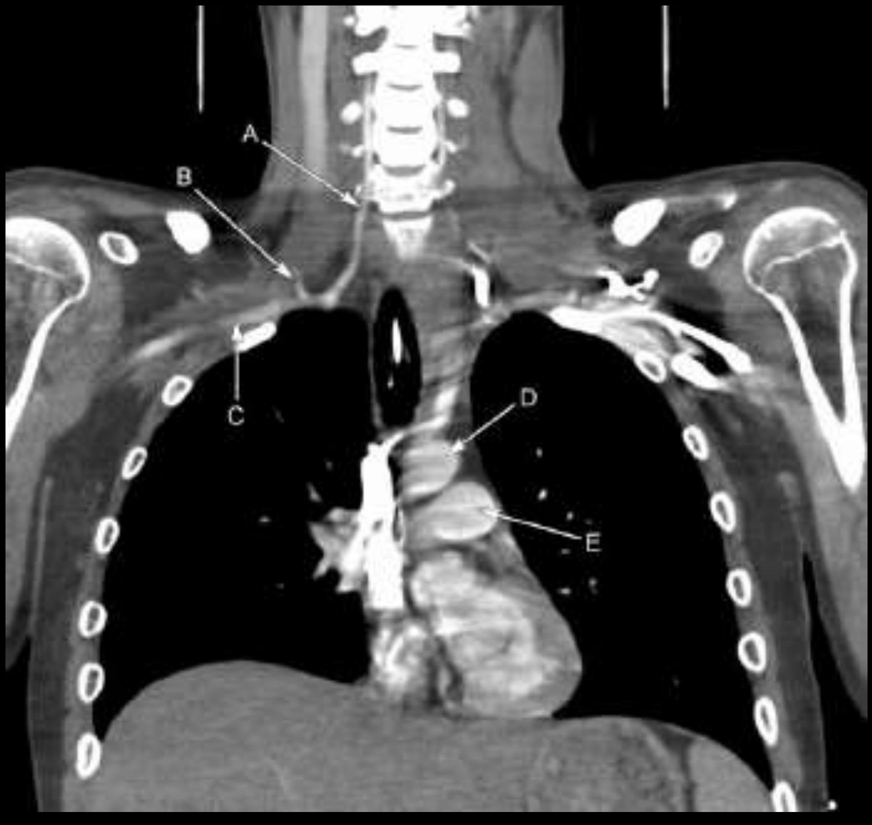
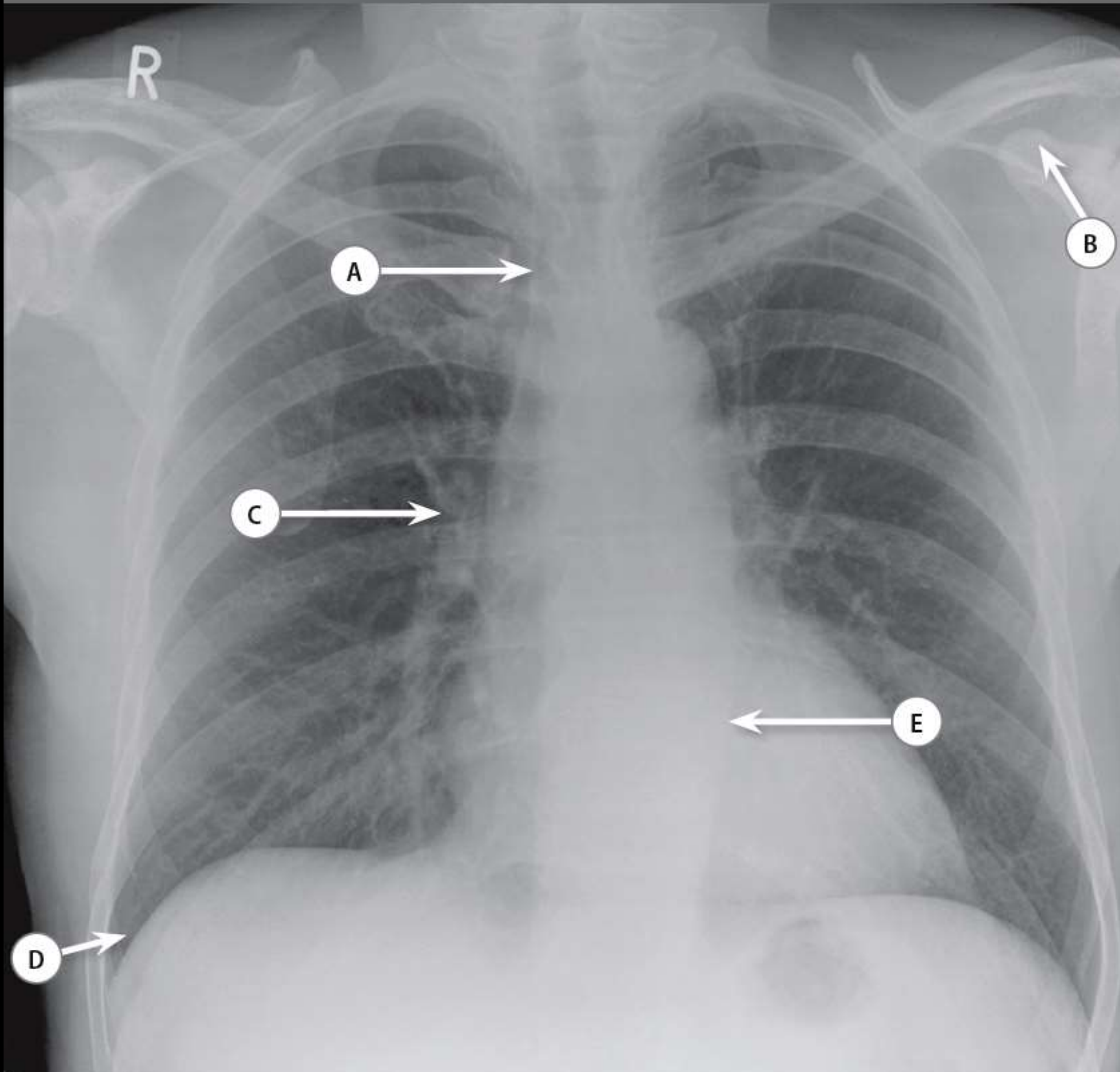
THORAX



CONTENTS

PLAIN FILM

Case 2.21



Case 2.21

A Paratracheal stripe

B Left coracoid process

C Right hilar point

D Right costophrenic angle

E Descending thoracic aorta

Chest radiograph.

The paratracheal stripe is normally less than 3–4 mm wide and formed by the pleura in contact with the right lateral wall of the trachea. The pleura is in contact with the

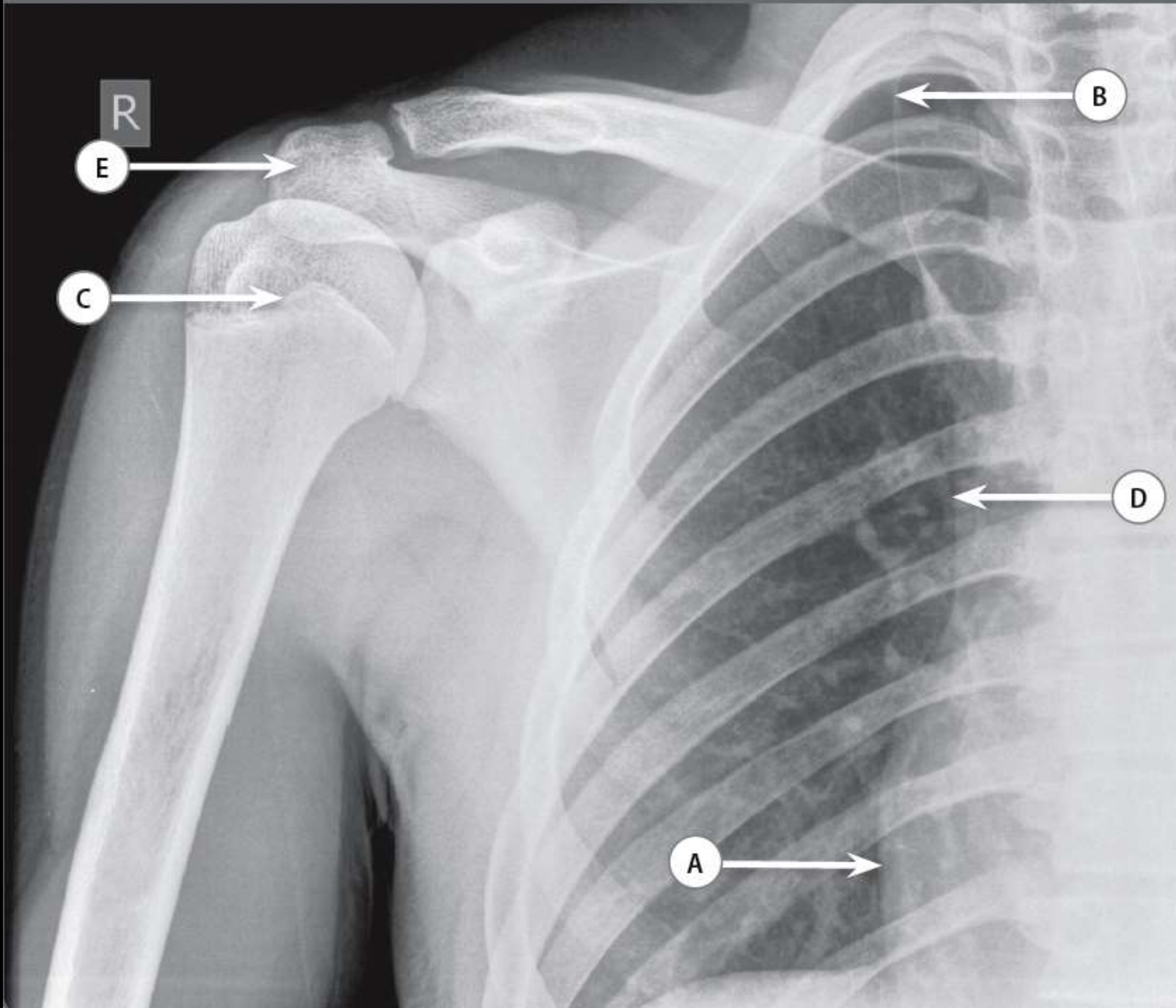
trachea from the clavicles down to the azygous vein at the right tracheobronchial angle. The left lateral wall of the trachea is not normally distinguishable from the mediastinum.

The left coracoid process projects anteriorly from the upper border of the neck of the scapula.

Most lung markings are due to vessels. The hilar point is where the superior pulmonary vein crosses the descending pulmonary artery. The right is 1 cm lower than the left, and is projected over the 6th posterior interspace. The angle between the vessels at the hilar point (hilar angle) is normally 120°.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 90.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 120.
Weber E, Netter FH, Vilensky JA, Carmichael SW. Netter's Concise Radiologic Anatomy. Philadelphia: Saunders/Elsevier, 2009: 183.

Case 2.24



Case 2.24

A Right atrial border

B Azygos fissure

C Anatomical neck of right humerus

D Superior vena cava

E Acromion of right scapula

Shoulder radiograph.

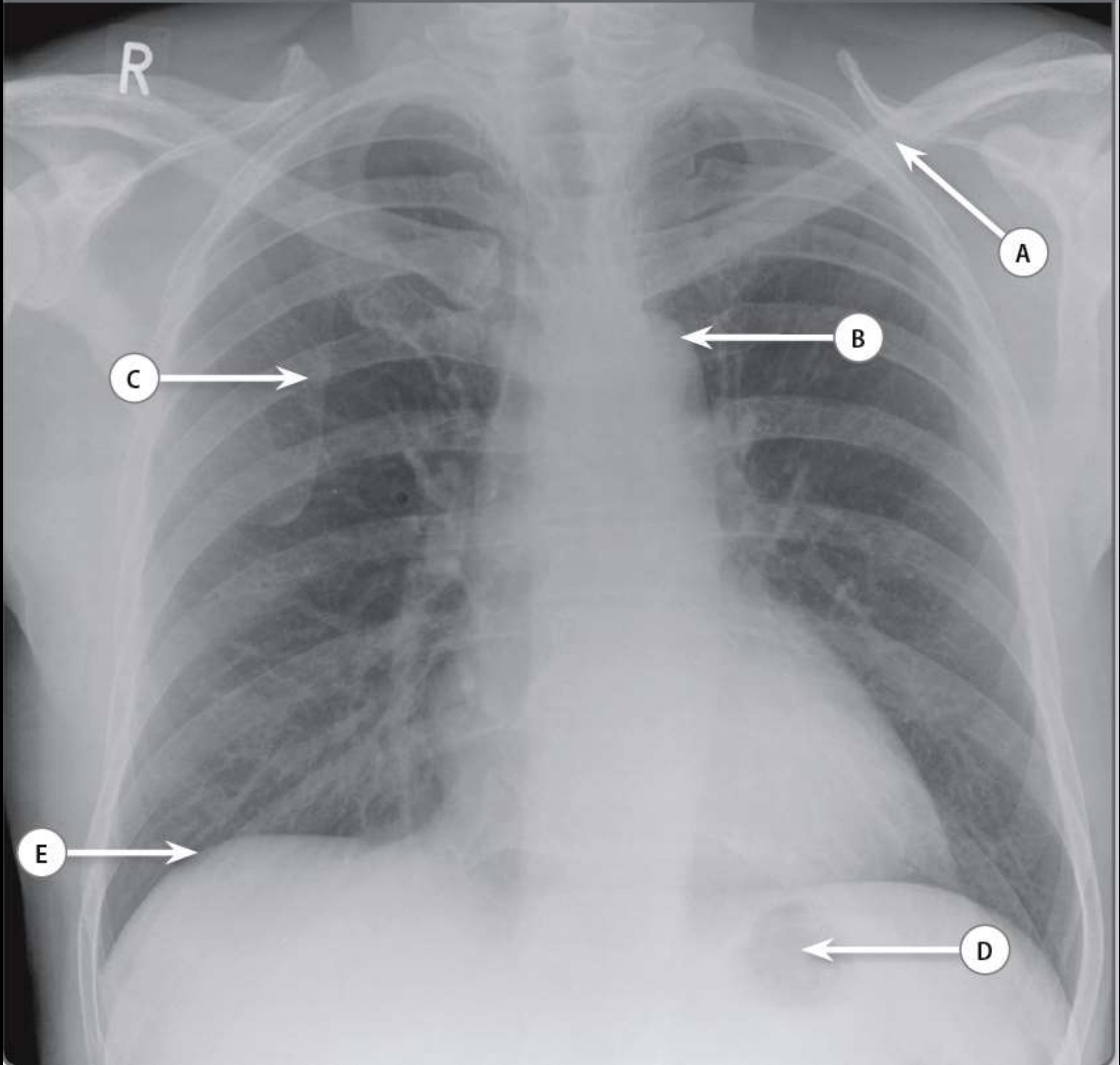
The azygos fissure is a normal variant. The azygos vein travels through the right apical lobe, where it has four pleural layers: two parietal and two visceral.

The anatomical neck of the humerus separates the greater and lesser tuberosities. The surgical neck is the narrow area of shaft just inferior to the tuberosities and anatomical neck. The surgical neck is fractured more frequently than the anatomical neck, and the axillary nerve is at risk here.

The acromion articulates with the clavicle at the acromioclavicular joint to help provide stability to the shoulder joint.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 125–126.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 114.

Case 2.25



Case 2.25

A Middle third of left clavicle

B Aortic arch

C Right posterior 6th rib/right blade of scapula

D Stomach bubble/gas within the gastric fundus

E Right hemidiaphragm

Chest radiograph.

The clavicle articulates with the acromion process of the scapula laterally, and the manubrium medially. It can be divided into the proximal, middle and distal thirds, to describe the location of pathology.

The aortic arch, or aortic knuckle, is seen forming the left upper mediastinal contour and continues as the descending thoracic aorta which can be seen behind the cardiac shadow. The descending aorta is found in the posterior mediastinum.

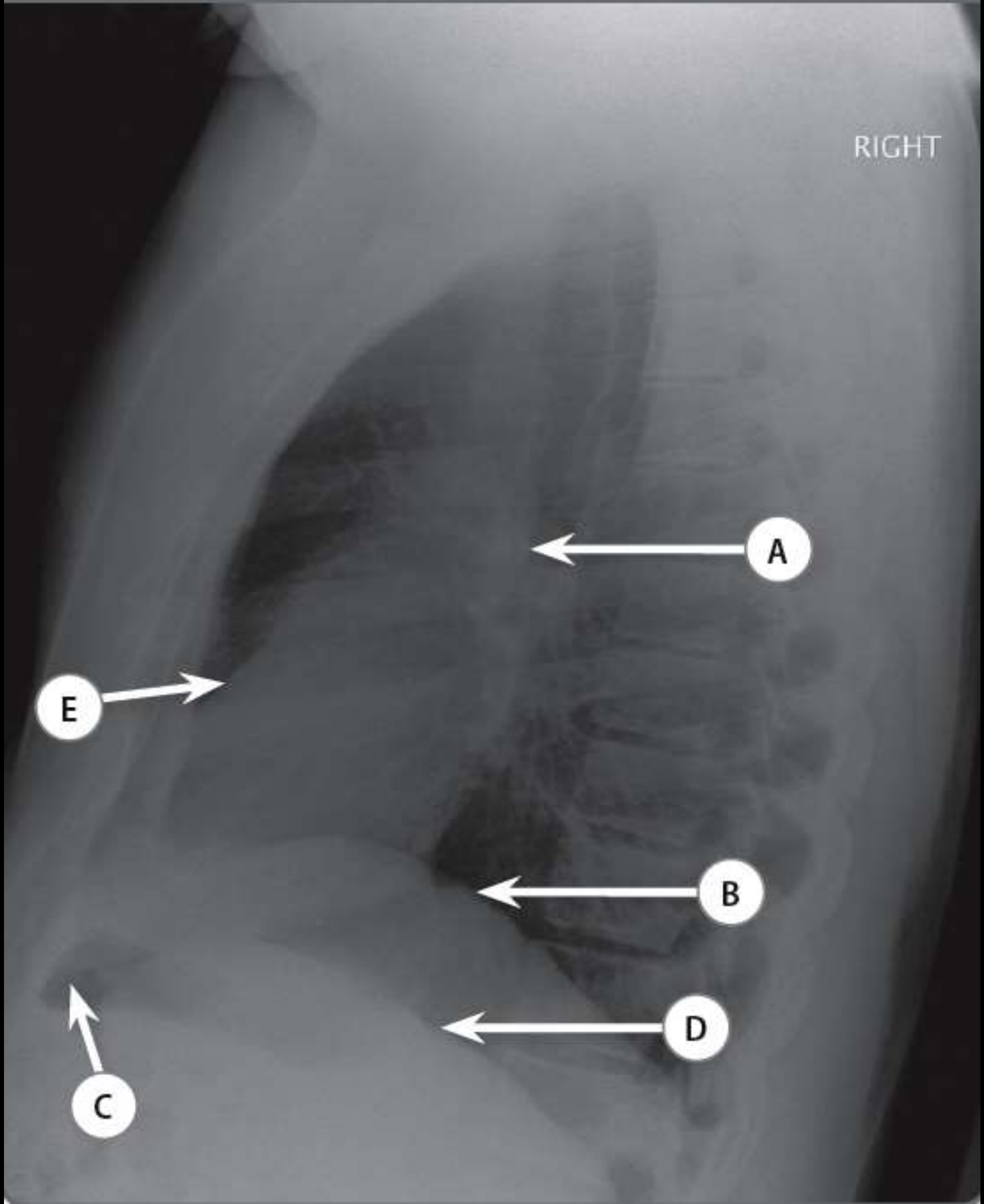
A right-sided aortic arch, or double aortic arch, is sometimes seen as a normal variant. These particular anomalies can create complete vascular rings, and may cause compressive symptoms affecting the trachea and oesophagus.

The scapular blade is often seen overlying a chest radiograph, which can help to determine whether the image was acquired anteroposterior (AP) or posteroanterior (PA). If the scapula is overlying the lung, it means the arms have not been abducted and the radiograph is most likely to have been taken AP; the positioning for an erect PA chest radiograph involves lifting the arms over the cassette, with the backs of the hands placed on the hips and the shoulders rolled forwards. This moves the scapulae anteriorly and laterally, so they do not obscure the lungs. In this position, the X-rays travel from posterior to anterior, with the heart close to the film, thus reducing magnification of the heart.

In an erect chest radiograph gas is often seen in the gastric fundus. It is sometimes possible to identify gastric rugae outlined by air on a chest radiograph. Remember that if the film is taken supine, the gas will move anteriorly and so will be seen in a different position.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 90.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 120.

Case 2.26



Case 2.26

A Right main pulmonary artery

B Right hemidiaphragm

C Stomach bubble

D Left hemidiaphragm

E Right ventricle

Plain lateral chest radiograph.

The right diaphragm is usually higher than the left, and you can see the heart through it, i.e. the heart therefore cannot be in contact with it. The inferior vena cava may be seen to pass through the right diaphragm.

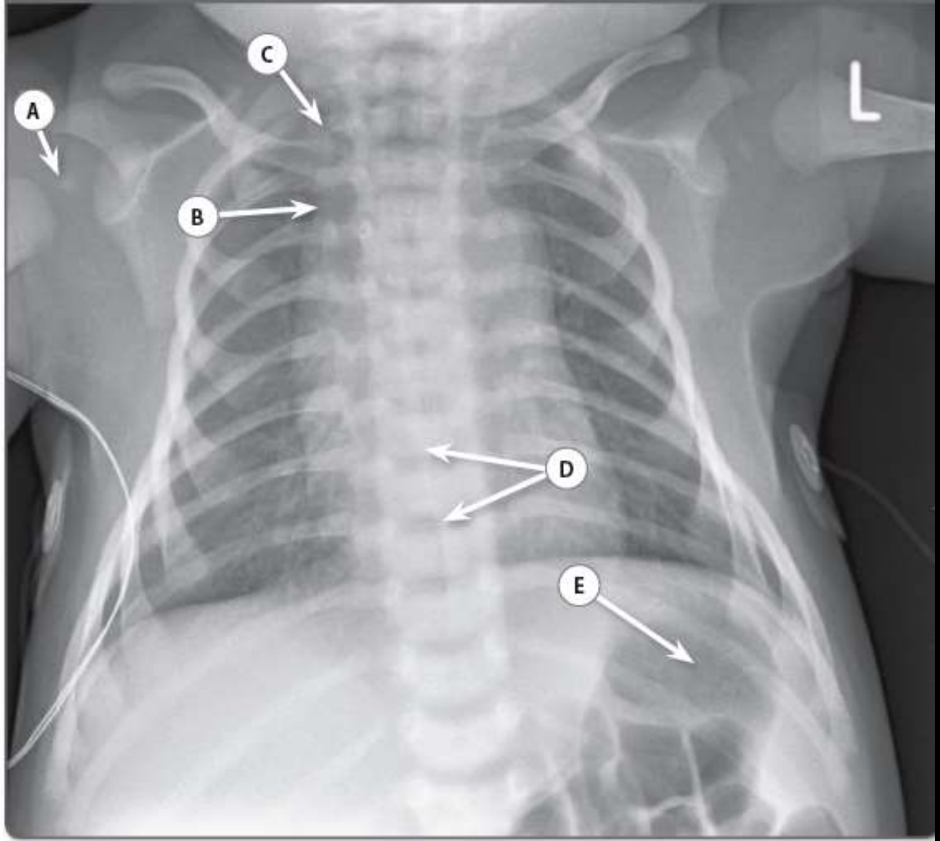
Aerated lung is adjacent to the right hemidiaphragm and therefore its contour is visible from its posterior to anterior aspects.

The left diaphragm is usually lower than the right and the heart is in contact with it, i.e. the heart is sitting on the left diaphragm and the gastric bubble can be seen to lie below it.

The right ventricle is the most anterior chamber of the heart. It is crescent shaped, and has a thinner wall than the larger, more muscular left ventricle. The left ventricle is so large that it bulges into the right ventricle, giving it its crescent shape. Inflow is from the right atrium via the tricuspid valve (three leaflets). Outflow is into the pulmonary artery via the pulmonary valve.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 91.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 121.
Weber E, Netter FH, Vilensky JA, Carmichael SW. Netter's Concise Radiologic Anatomy. Philadelphia: Saunders/Elsevier, 2009: 203.

Case 3.4



Case 3.4

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the anterior mediastinal structure labelled B.	
C	Name the structure labelled C.	
D	What does the line labelled D correspond to?	
E	Name the structure labelled E.	

Case 3.4

A Ossification centre of right humeral head

B Thymus

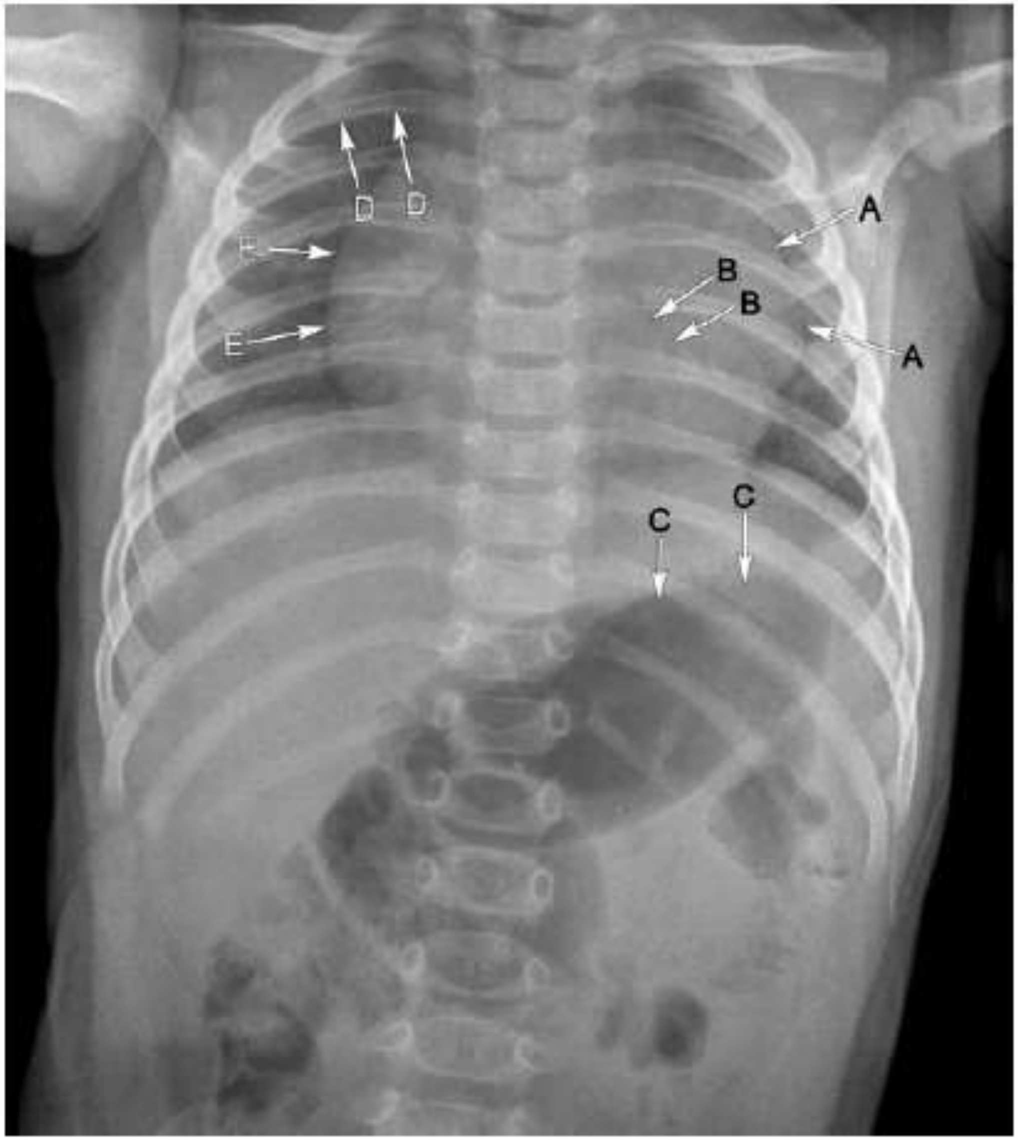
C Right transverse process of T2

D Azygo-oesophageal recess

E Gastric fundus

A number of anatomical lines, stripes and other interfaces are evident on chest radiographs, deviation of which can be a subtle sign of pathology. The azygo-oesophageal recess is visualised as a result of the different densities of the mediastinum and the posteromedial aspect of the right lower lobe. The recess lies anterior to the vertebral column and posterior or lateral to the oesophagus. Its superior extent is the anterior turn of the azygos vein, with the inferior extent being the aortic hiatus. Pathologies which alter the normal contour of the recess include hiatus hernias, oesophageal tumours and lymph node enlargement.

Question 1.6



Name the structures labelled **A** to **E**.

1.6 AP X-ray of the neonatal chest

A Thymus.
B Left lower lobe bronchus.
C Stomach.
D Posterior right third rib.
E Thymus.

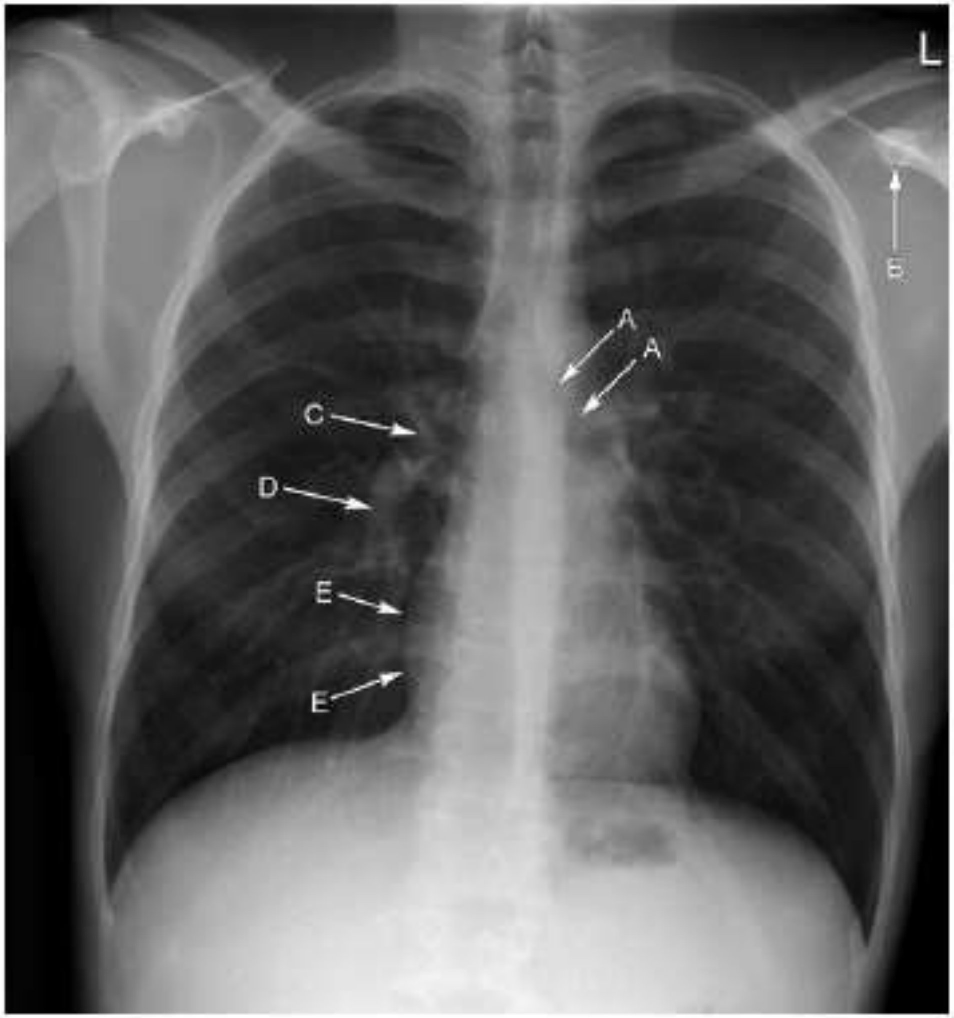
The neonatal chest X-ray (CXR) is performed as a supine antero-posterior radiograph that exaggerates the heart size and mediastinal width. The normal evolution of the CXR appearances from neonates to adults should be understood in order to recognize pathology when present. For instance, it is normal to see the thymus gland on neonatal CXR but in adults this should not be visualized.

The thymus is a specialized organ for the production of T-lymphocytes of the immune system. It is located in the anterior superior mediastinum and is most prominent in the neonatal period. As the child grows, it becomes much less prominent on CXR and after about eight years old it is not readily identifiable.

Aids to recognition of the thymus gland include:

- Its characteristic 'sail' shape.
- Location in the anterior mediastinum should not obscure the heart borders.
- Scalloping of the border of the thymus by the anterior ribs.
- A normal thymus will not displace the trachea: if this is identified, another pathology must be suspected.

Question 2.6



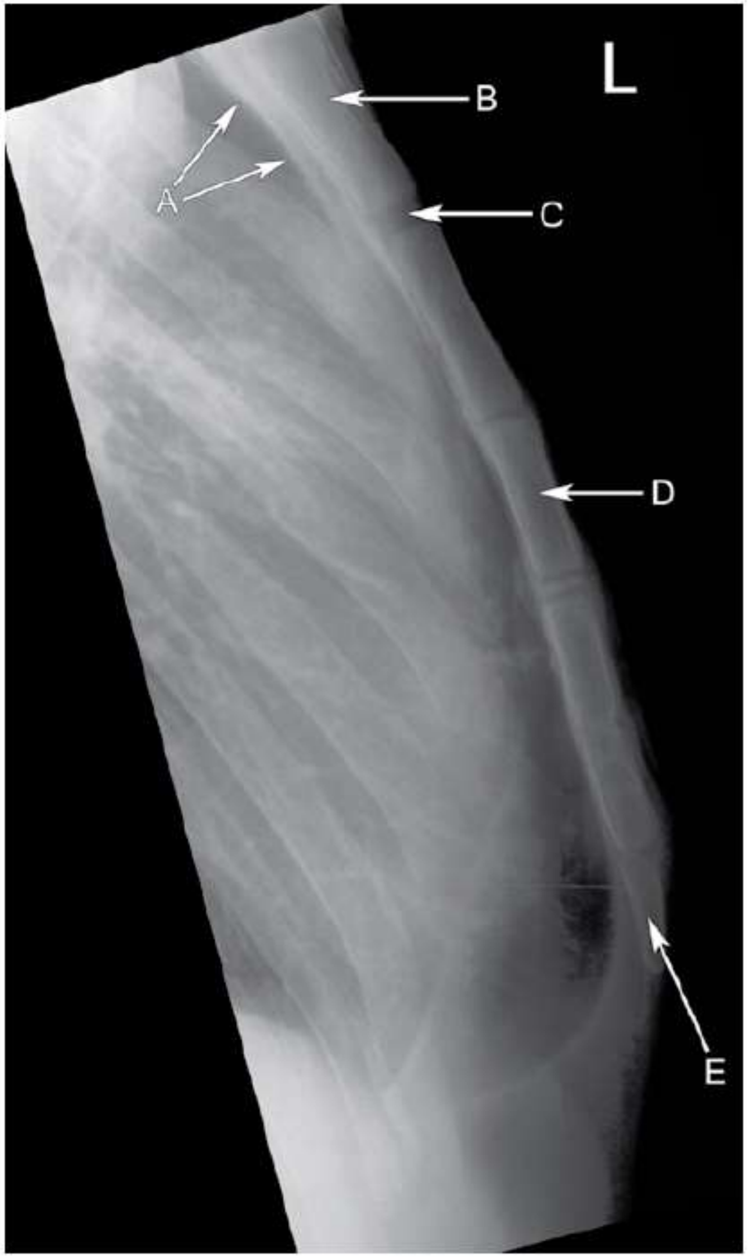
Name the structures labelled **A** to **D**.
E Which cardiac chamber makes up this part of the cardiac silhouette?

2.6 PA X-ray of the chest

A Left main bronchus.
B Left coracoid process.
C Right hilum or hilar point.
D Right interlobar pulmonary artery.
E Right atrium.

The pulmonary arteries, veins and bronchi make up the hila. The hilar point is formed by the descending upper lobe veins superiorly as they cross behind the interlobar pulmonary artery inferiorly. The angle between the vessels is known as the hilar angle and normally measures 120°. The right hilar point is normally located 1 cm lower than the left hilar point and should never be located higher than the left. The left heart border consists of the left atrium superiorly and left ventricle inferiorly. The right heart border consists of the right atrium alone.

Question 3.8



Name the structures labelled **A** to **E**.

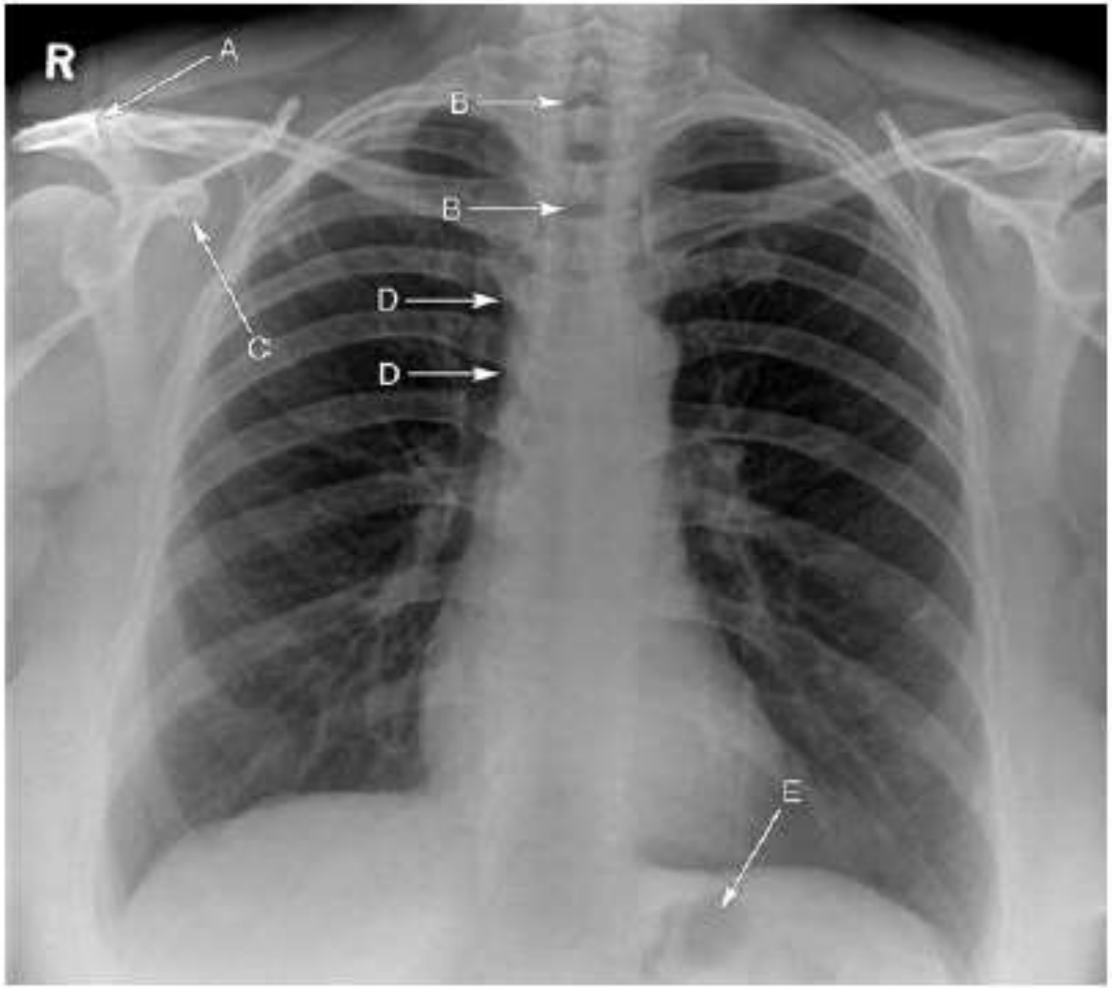
3.8 Lateral X-ray of a paediatric sternum

A Parietal pleura.
B Manubrium.
C Manubriosternal joint (angle of Louis).
D Body of sternum.
E Xiphoid process.

The sternum is located in the centre of the thorax and is composed of three parts. The superior part is called the manubrium, the middle is called the body and the inferior part is the xiphoid process. The sternal angle (also called the angle of Louis or the manubriosternal joint) is the angle formed at the junction of the manubrium and the body of the sternum. The angle of Louis lies at the level of the T4/5 and is an important anatomical landmark of the thorax. The mediastinal structures that lie on a horizontal plane with the angle of Louis include:

- The bifurcation of the trachea.
- The start and end of the aortic arch.
- The entry of the azygos vein as it arches over the right main bronchus to enter the trachea.

Question 7.10



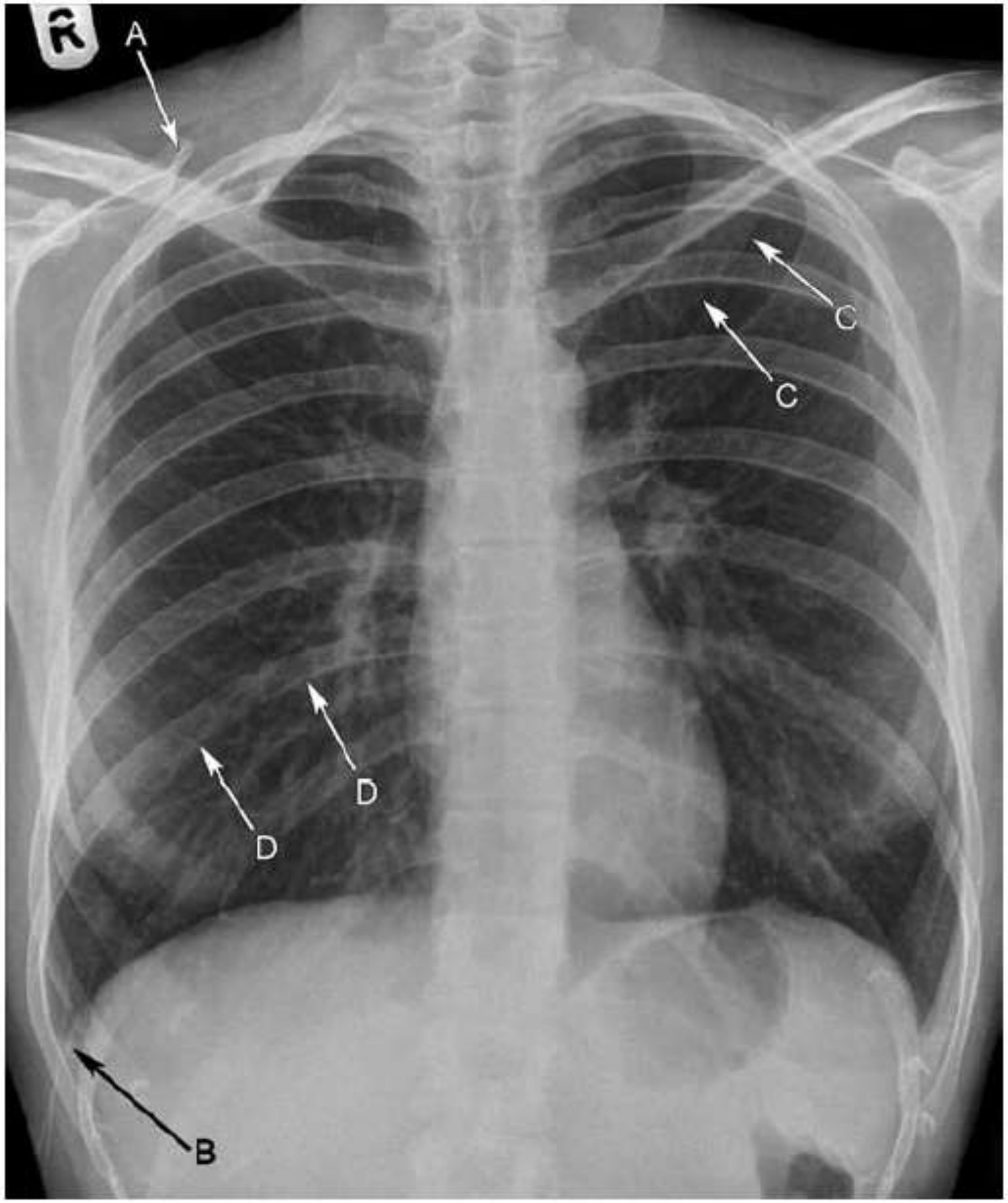
Name the structures labelled **A** to **E**.

7.10 X-ray of the chest

A Right acromioclavicular joint.
B Trachea.
C Right coracoid process.
D Superior vena cava.
E Stomach.

The acromioclavicular joint (AC joint) is a synovial joint connecting the scapula to the clavicle. It is stabilized by the superior and inferior acromioclavicular ligaments, and is a common site of sporting injuries. The normal acromioclavicular joint space is less than 5 mm. There is a further connection between the scapula and clavicle via the coracoclavicular ligament (which connects the coracoid process to the clavicle). The normal coracoclavicular distance is less than 12 mm. When assessing chest X-rays it is important also to inspect the shoulder joints, as it not uncommon to pick up unexpected pathology.

Question 8.9



Name the structures labelled **A** to **D**.

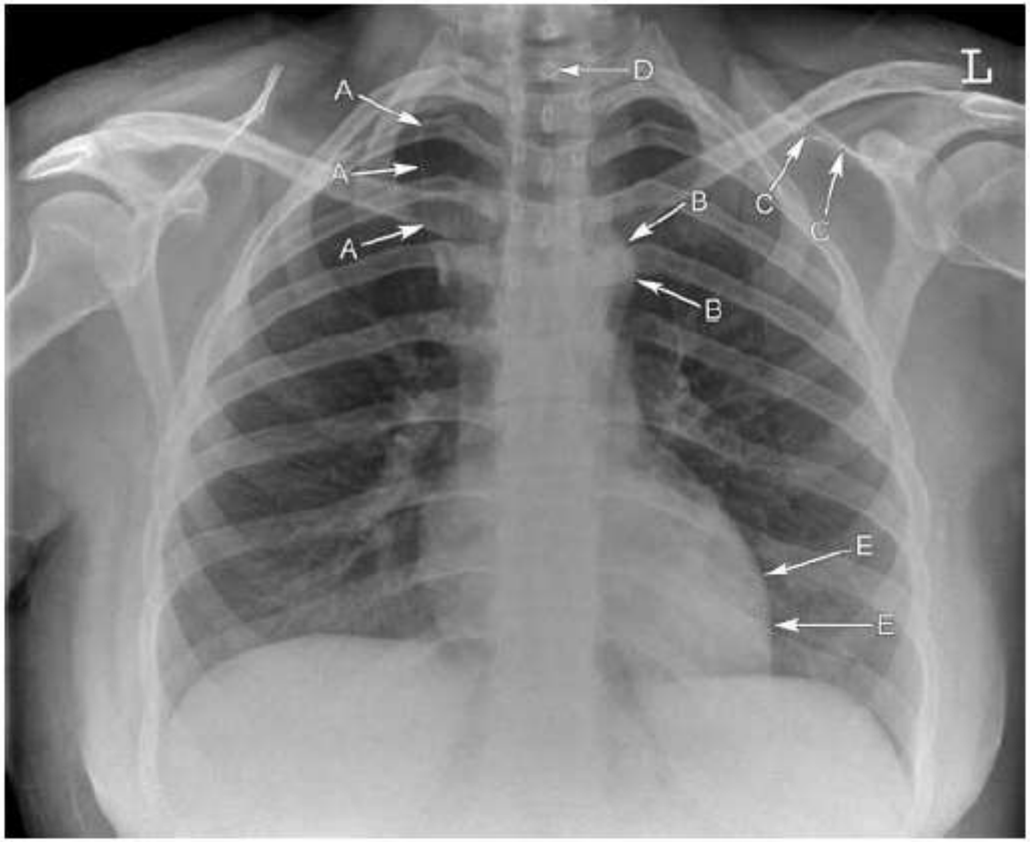
E What normal variant is present?

8.9 PA X-ray of the chest

A Superior angle of right scapula.
B Right costophrenic angle.
C Left anterior first rib.
D Right posterior ninth rib.
E Right cervical rib.

A cervical rib is an additional rib arising from the seventh cervical vertebra and is found in approximately 1 in 500 people. It is generally unilateral. Cervical ribs can be problematic and lead to thoracic outlet syndrome from compression of the brachial plexus or subclavian artery. These structures become trapped between the cervical rib and the scalene muscles. Symptoms include arm weakness and paraesthesia.

Question 8.12



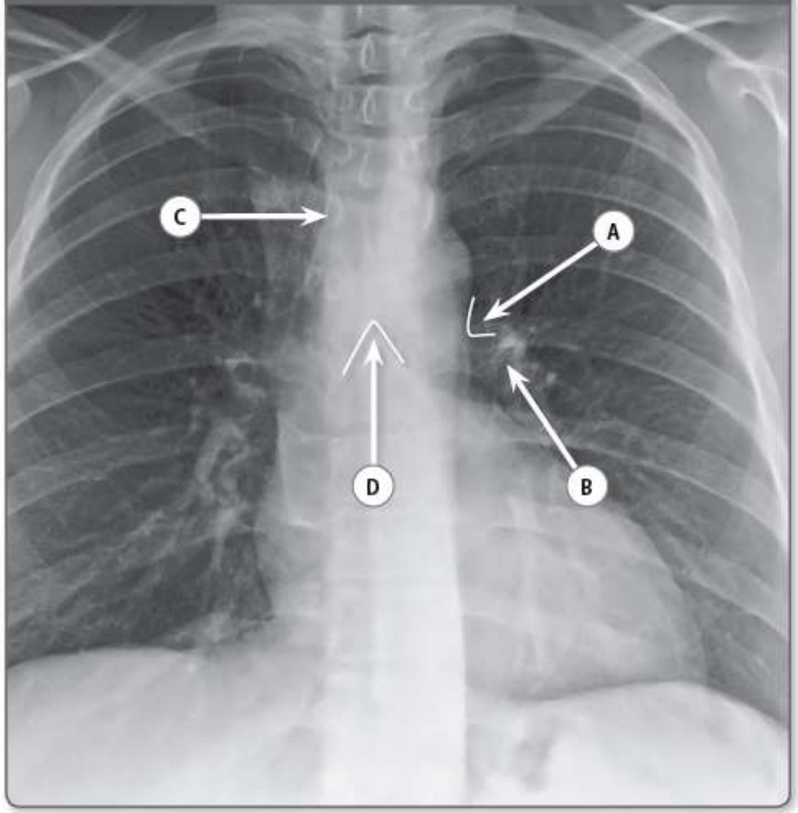
Name the structures labelled A to E.

8.12 PA X-ray of the chest

A Azygos fissure.
B Aortic knuckle or arch.
C Spine of the left scapula.
D Spinous process of T2.
E Left ventricle.

The azygos fissure is a normal variant seen in 1–2% of individuals. It is formed when the azygos vein fails to migrate over the apex of the lung during foetal development. The azygos vein instead courses through the lung, bringing a layer of parietal and visceral pleura with it. The azygos fissure therefore consists of four layers of pleura (two parietal layers and two visceral layers). These wrap around the vein and are said to give a 'tadpole' appearance on the plain chest radiograph.

Case 2.1



Case 2.1

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the vascular structure labelled B.	
C	Name the structure labelled C.	
D	Name the outlined structure labelled D.	
E	Which anatomical variant is present on this image?	

Case 2.1

A Aorto-pulmonary angle or aorto-pulmonary window

B Left lower lobe pulmonary artery

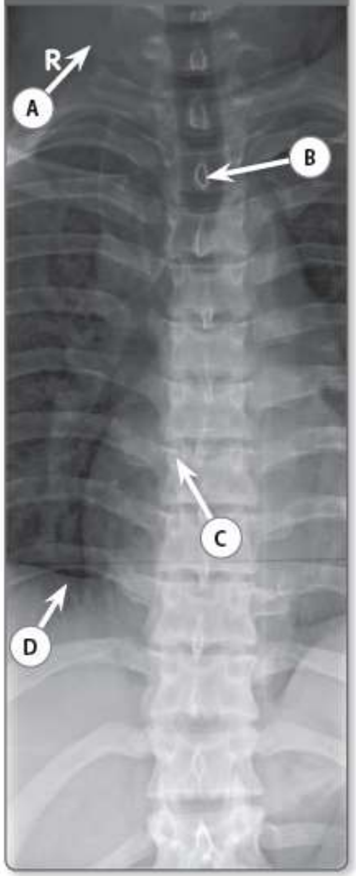
C Right pedicle of T5

D Carina

E Azygos lobe/fissure

The aorto-pulmonary angle is an important anatomical landmark formed by the lateral edge of the aorta and the upper margin of the left pulmonary artery. This angle can be obliterated in cases of mediastinal lymph node enlargement. The ligamentum arteriosum and the left recurrent laryngeal nerve are two important structures located here.

Case 4.12



Case 4.12

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Which anatomical variant is present on this image?	

Case 4.12

A Right transverse process of C7

B Spinous process of T2

C Right pedicle of T7

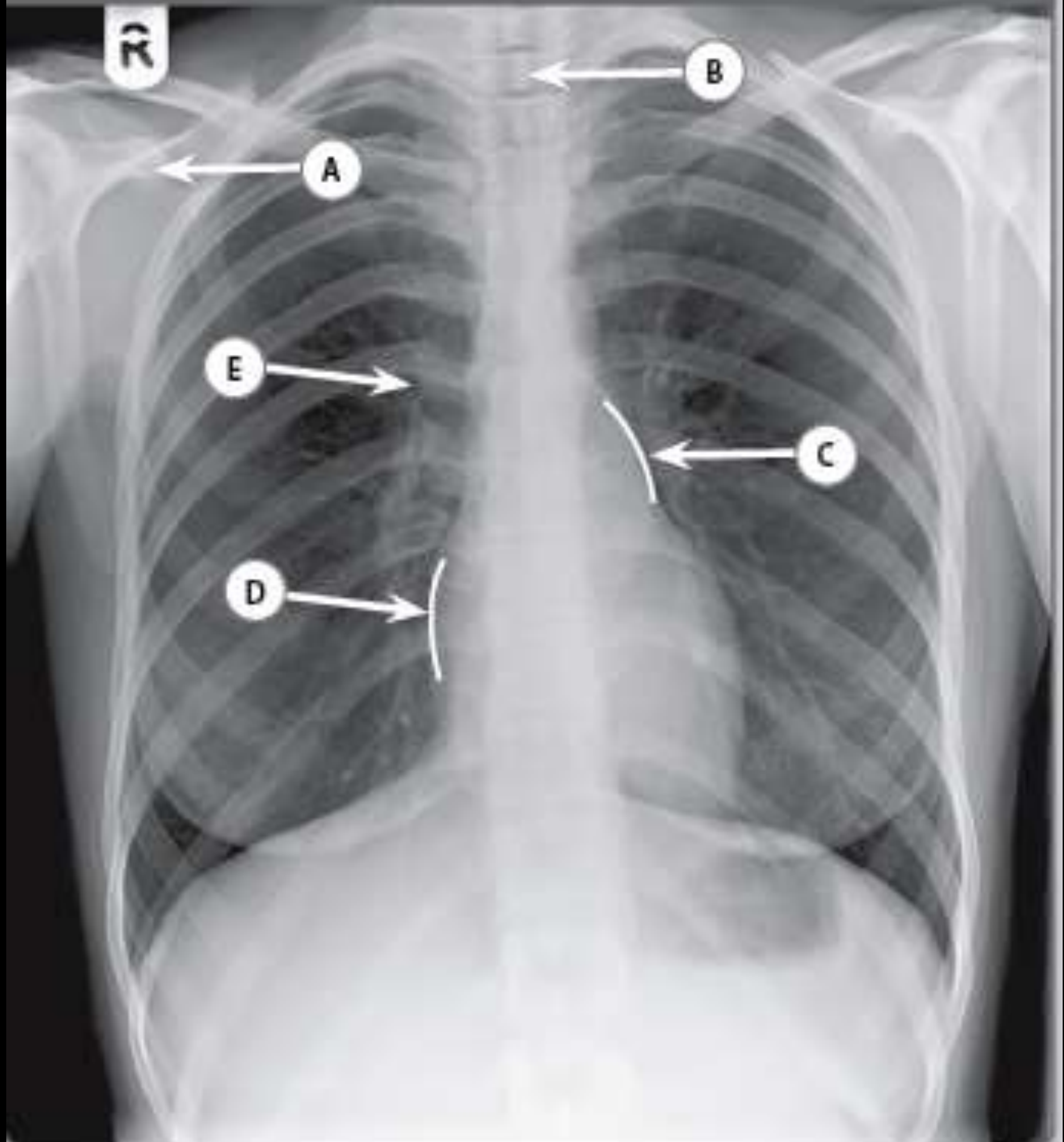
D Right hemidiaphragm

E Azygos fissure

The azygos fissure is the most common accessory fissure visible on chest radiography (seen in approximately 1–2%). The azygos vein runs in the most medial aspect of the fissure, surrounded by both parietal and visceral pleura.

A vertebra seen on an anteroposterior radiograph can be thought of as an owl: the spinous process corresponding to the beak, the pedicles representing eyes. The 'winking owl' sign is an important indication of pedicular destruction.

Case 5.5



Case 5.5

A Coracoid process of the right scapula

B Spinous process of T2

C Left atrial appendage

D Lateral border of the right atrium

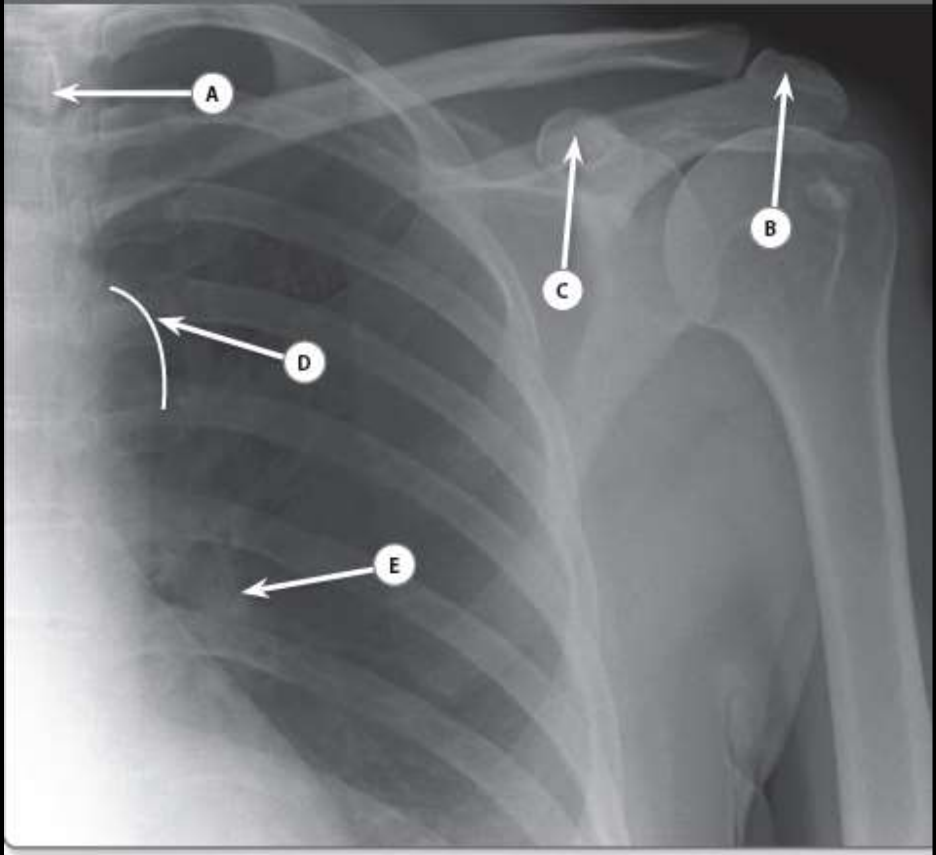
E Right upper lobe segmental bronchus (end on)

In the cardiac silhouette, it is important to know the borders of the heart and the chambers which form them. The lower right heart border is formed by the right atrium and the upper right silhouette created by the superior vena cava.

The bulge of the left atrial appendage contributes to the left heart border superiorly, with the inferior left heart border formed by the left ventricle.

The right ventricle forms most of the inferior border of the heart.

Case 6.1



Case 6.1

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the vascular structure labelled E.	

Case 6.1

A Spinous process of T2

B Left acromion process

C Left coracoid process

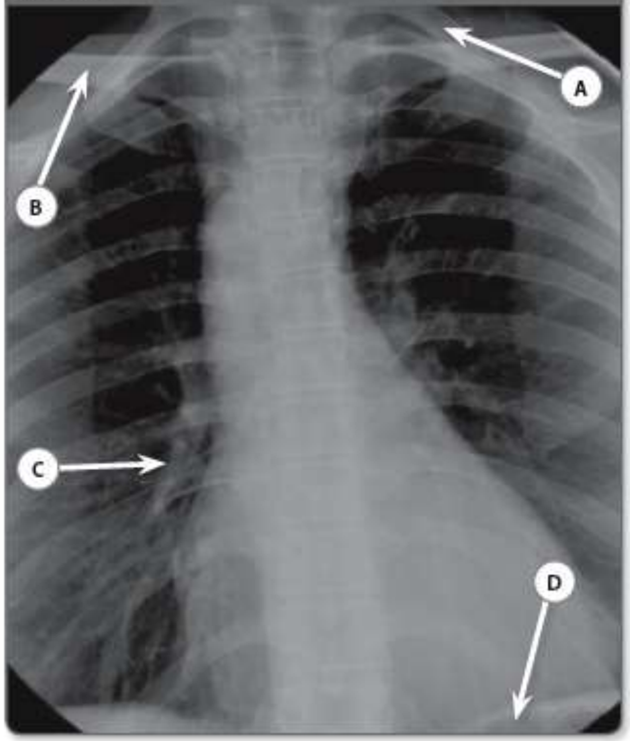
D Arch of aorta (aortic knuckle)

E Left lower lobe pulmonary artery

The three ligaments that attach to the coracoid process are:

1. Coracoclavicular ligament
2. Coracoacromial ligament
3. Coracohumeral ligament.

Case 8.3



Case 8.3

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	In which structure does the gas labelled D lie?	
E	Which anatomical variant is present on this image?	

Case 8.3

A Left first rib

B Right clavicle

C Right lower lobe pulmonary artery

D Gastric fundus

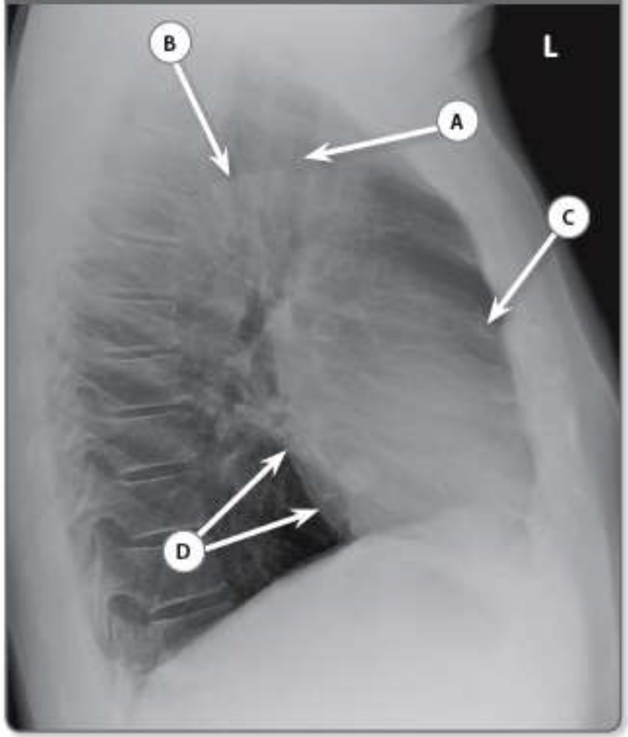
E Right aortic arch

The asymptomatic adult variant of a right aortic arch is usually associated with an aberrant left subclavian artery. This can cause a posterior indentation of the oesophagus on a barium swallow.

This can be identified on a chest radiograph using the following clues:

1. Ensure the radiograph is appropriately orientated (side marker)
2. Appreciate the lack of a left sided arch above the left pulmonary artery
3. Ensure that the heart is normally sited, i.e. there is no dextrocardia.

Case 10.17



Case 10.17

QUESTION		WRITE YOUR ANSWER HERE
A	Name the radiolucent structure labelled A.	
B	Name the structure labelled B.	
C	Which chamber of the heart lies anteriorly (C)?	
D	Which chamber of the heart lies posteriorly (D)?	
E	At what level does the trachea usually divide?	

Case 10.17

A Trachea

B Aortic arch

C Right ventricle

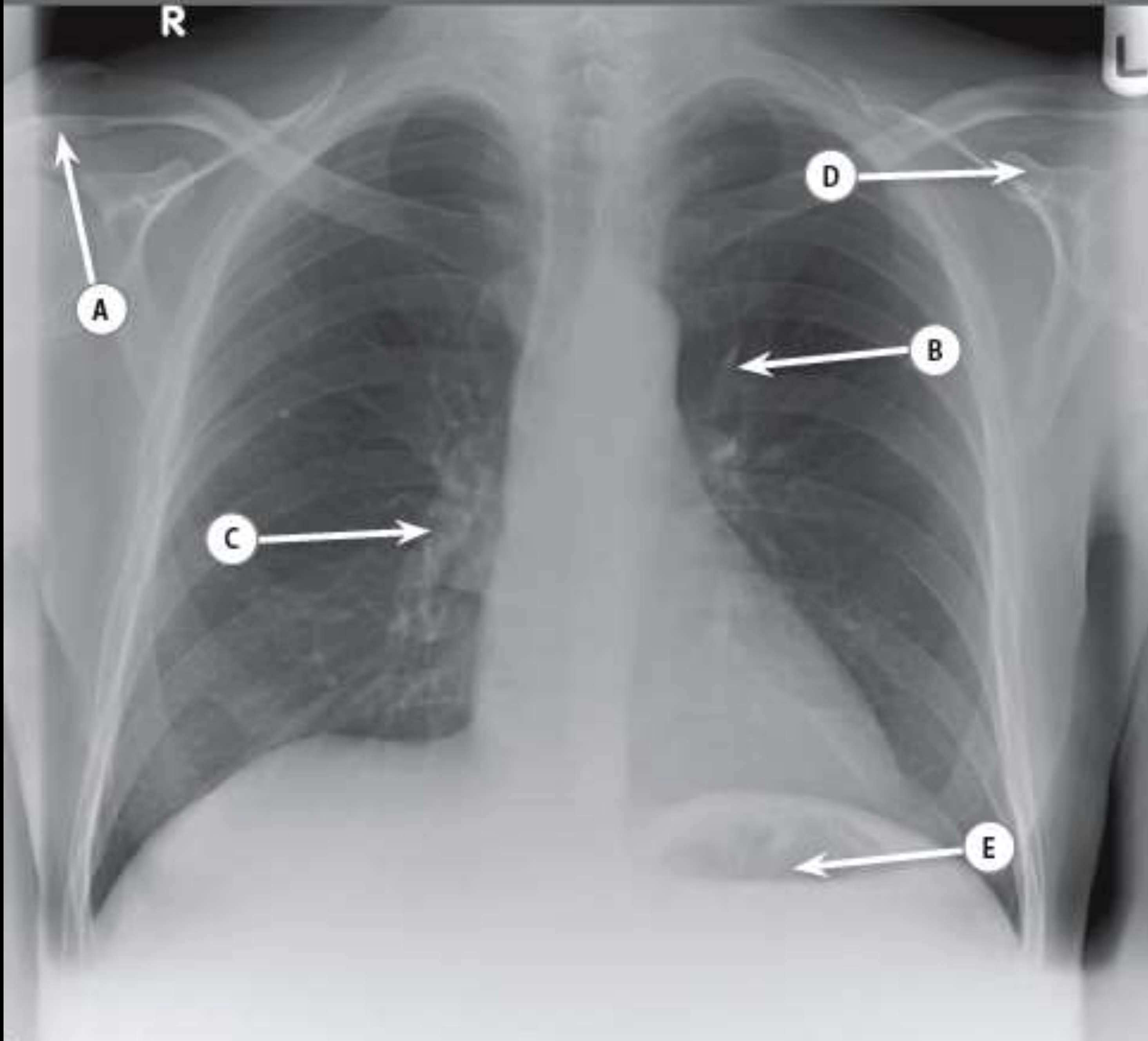
D Left atrium

E T4

If not specified, most lateral radiographs will be performed in the left lateral position. There are three important 'retro' spaces:

1. Retrosternal – the heart is usually in contact with the lower third of the sternum. In emphysema, this space may be widened. It may be obliterated in right ventricular hypertrophy.
2. Retrotracheal – posterior to the trachea, anterior to the spine and superior to the aortic arch. Mediastinal adenopathy can opacify this space.
3. Retrocardiac – usually lucent, although basal consolidation or a pleural effusion may obliterate this space.

Case 11.14



Case 11.14

A Right acromioclavicular joint

B Left upper lobe pulmonary vein

C Right lower lobe pulmonary artery

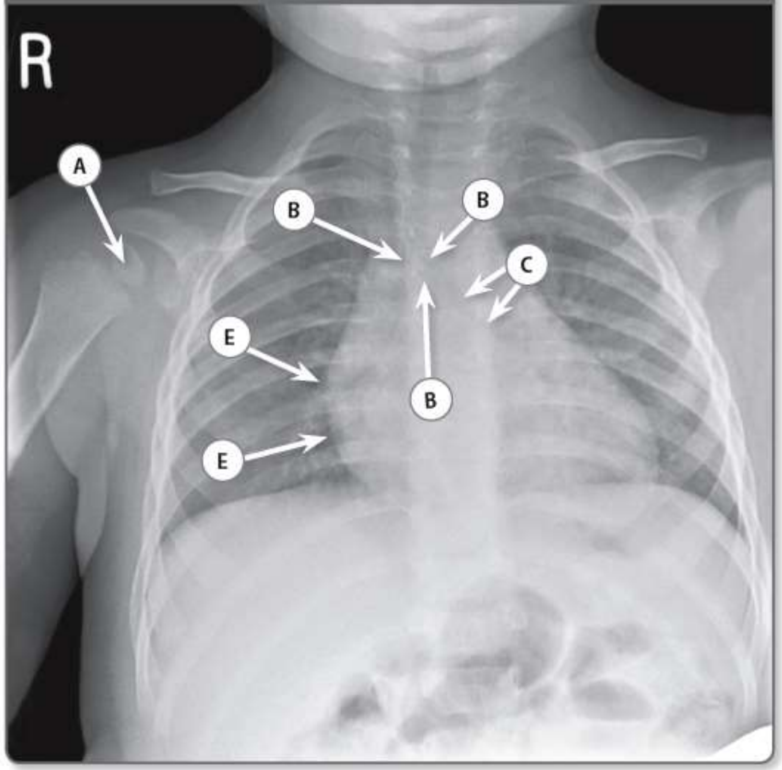
D Left coracoid process of scapula

E Gastric fundus

The hila are composed of major bronchi, blood vessels and lymphatics. The hila may be seen at the same level but commonly, the left is higher than the right because of the position of the left main bronchus, over which the left upper lobe pulmonary artery courses.

The hilar points are the angles formed by the descending upper lobe veins and descending pulmonary arteries. Not every normal patient has a very clear hilar point on both sides, but if present, they can be useful indicators of disease processes.

Case 13.15



Case 13.15

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the part of the airways tract labelled B.	
C	Name the part of the airways tract labelled C.	
D	Name the most posterior cardiac chamber.	
E	Name the cardiac chamber that forms the right heart border.	

Case 13.15

A Epiphysis of right humeral head

B Carina

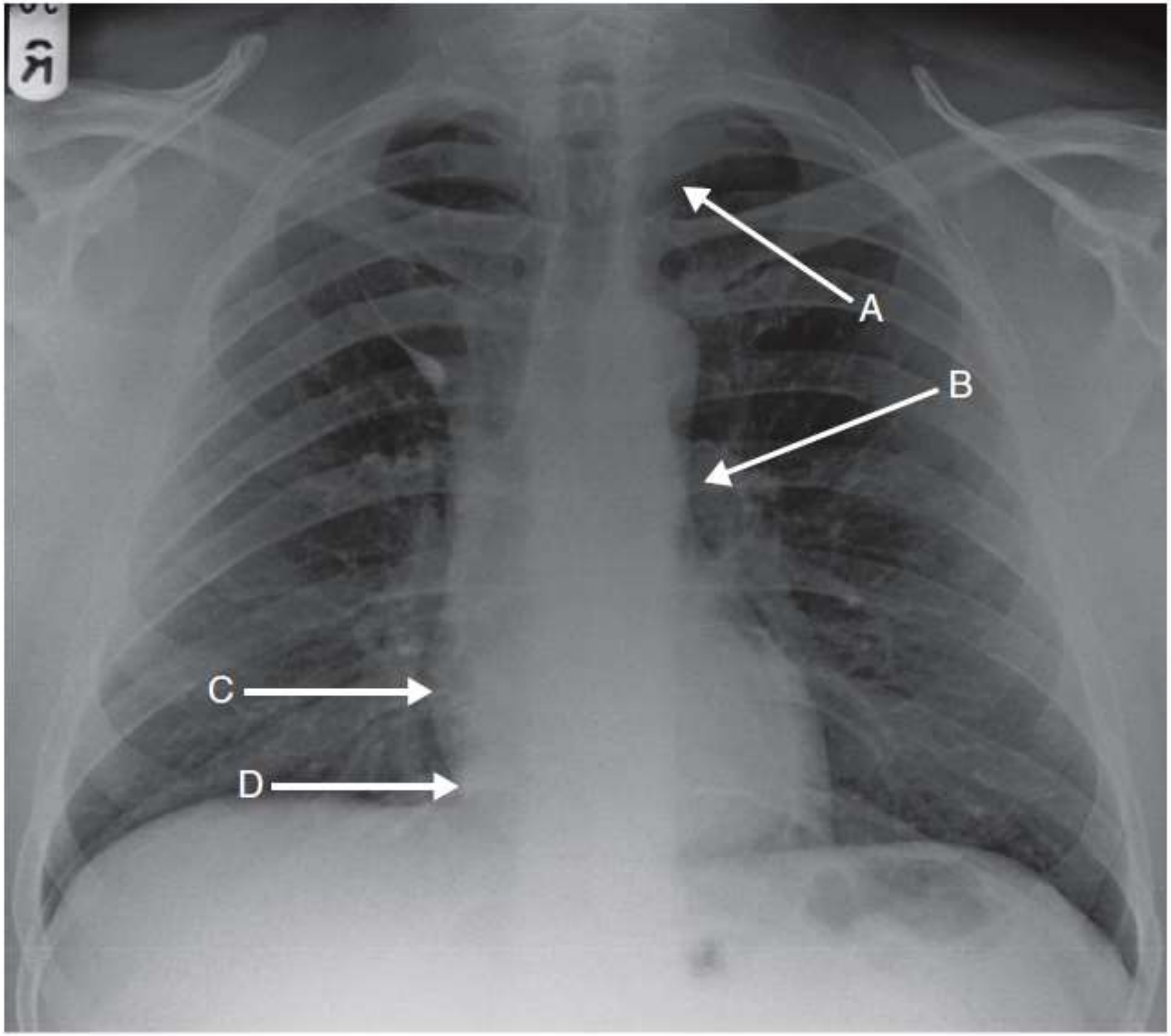
C Left main bronchus

D Left atrium

E Right atrium

The carina is the point at which the trachea bifurcates into the left and right main bronchi. The left atrium lies below the carina, and as such, splaying of the carina is seen in the event of left atrial enlargement (e.g. in mitral valve disease). The right atrium forms the lower part of the right heart border and is typically obscured in cases of right middle lobe collapse or consolidation. The left ventricle forms the lower part of the left heart border. The right ventricle sits anteriorly and does not contribute to the heart borders as seen on a frontal radiograph.

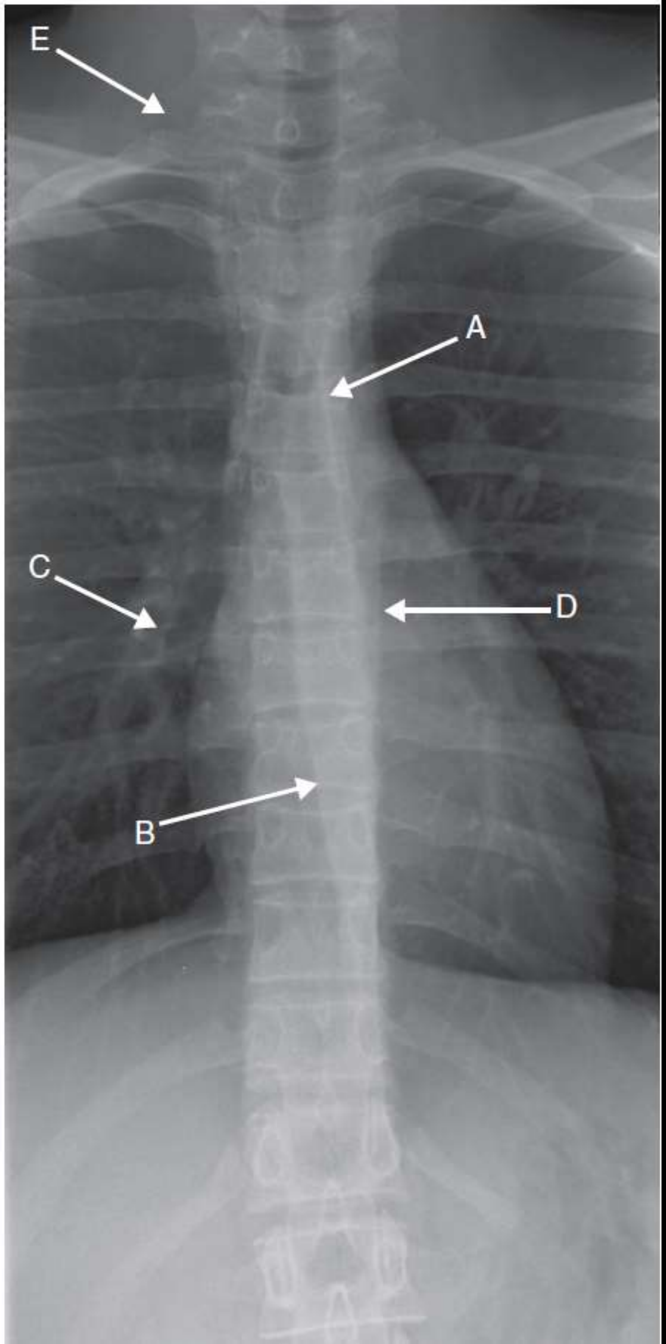
Case 1.1



1.1 Postero-anterior (PA) chest radiograph

(a) Left brachiocephalic vein. The left brachiocephalic vein forms a silhouette with the adjacent lung. This interface 'fades' above the clavicles as it becomes more anteriorly placed and 'merges' with the anterior chest wall.
(b) Pulmonary trunk.
(c) Right atrium (right heart border).
(d) Right cardiophrenic recess.
(e) Azygos fissure. The azygos fissure is seen in 0.5% of chest radiographs. It is formed by the caudal invagination of the azygos vein through the apex of the right upper lobe. It begins as a line in the upper portion and extends in an arc caudally toward the 'teardrop' density that is the azygos vein. The azygos vein is outside the parietal pleura – the line is therefore composed of two visceral and two parietal pleural layers. The so-called azygos 'lobe' is the segment of lung between the fissure and the trachea. It is not a true separate 'lobe' as the total bronchial anatomy in the right upper lobe has not been altered even though there may be minor variations in the bronchial supply to this segment of upper lobe.

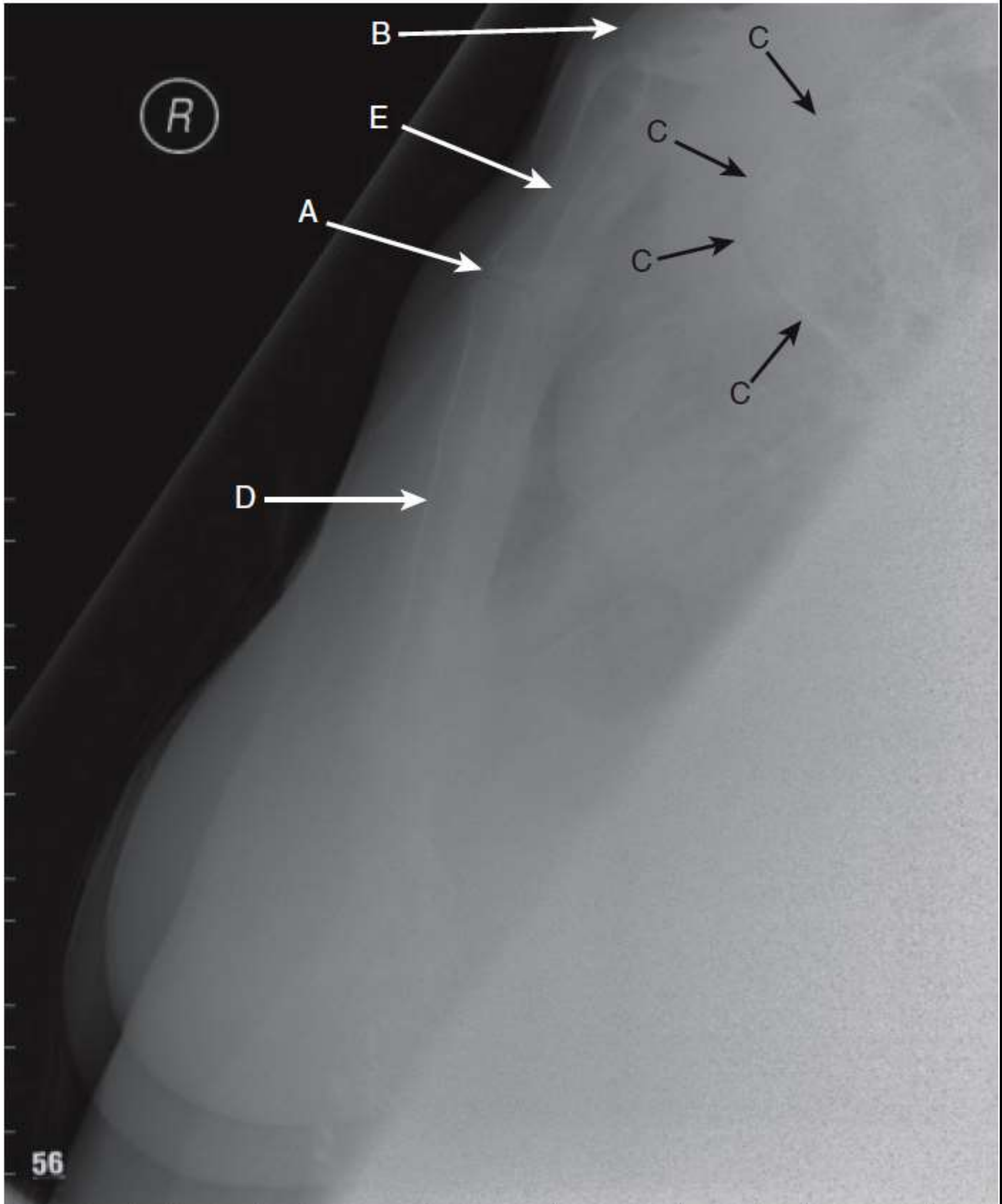
Case 1.13



1.13 PA chest radiograph centred over mediastinum

(a) Anterior junction line. This is formed by the interface of the anterior lungs as they meet in the midline. This line will only be seen on the frontal projection if there is sufficient penetration of the beam, which should be tangential to the interface. The line runs below the aortic arch and to the left in a caudal direction.
(b) Azygo-oesophageal line. This is formed by the interface between the right lung and the azygos vein and oesophagus. The cranial end of the line terminates at the point where the azygos vein drains into the superior vena cava. Any bulge of this line is indirect evidence of a possible oesophageal or posterior/middle mediastinal mass lesion and before the advent of cross-sectional imaging, this was sometimes the only plain radiograph sign of such pathology.
(c) Right interlobar pulmonary artery.
(d) Descending thoracic aorta.
(e) Right transverse process of the C7 vertebra. The transverse process of a cervical vertebra points downwards unlike that of a thoracic vertebra, which points upwards. This is a useful fact to remember when determining whether an atypical rib is a cervical or hypoplastic first rib. In the case of a cervical rib, the rib articulates with a transverse process that is pointing downwards.

Case 1.15



1.15 Lateral radiograph of the sternum

(a) Manubrio-sternal joint (sternal angle). The manubrio-sternal joint is a secondary cartilaginous joint and may be involved with generalized seronegative arthropathies.

Anatomically, it normally lies at the level of the T4–T5 intervertebral disc and the aortic arch.

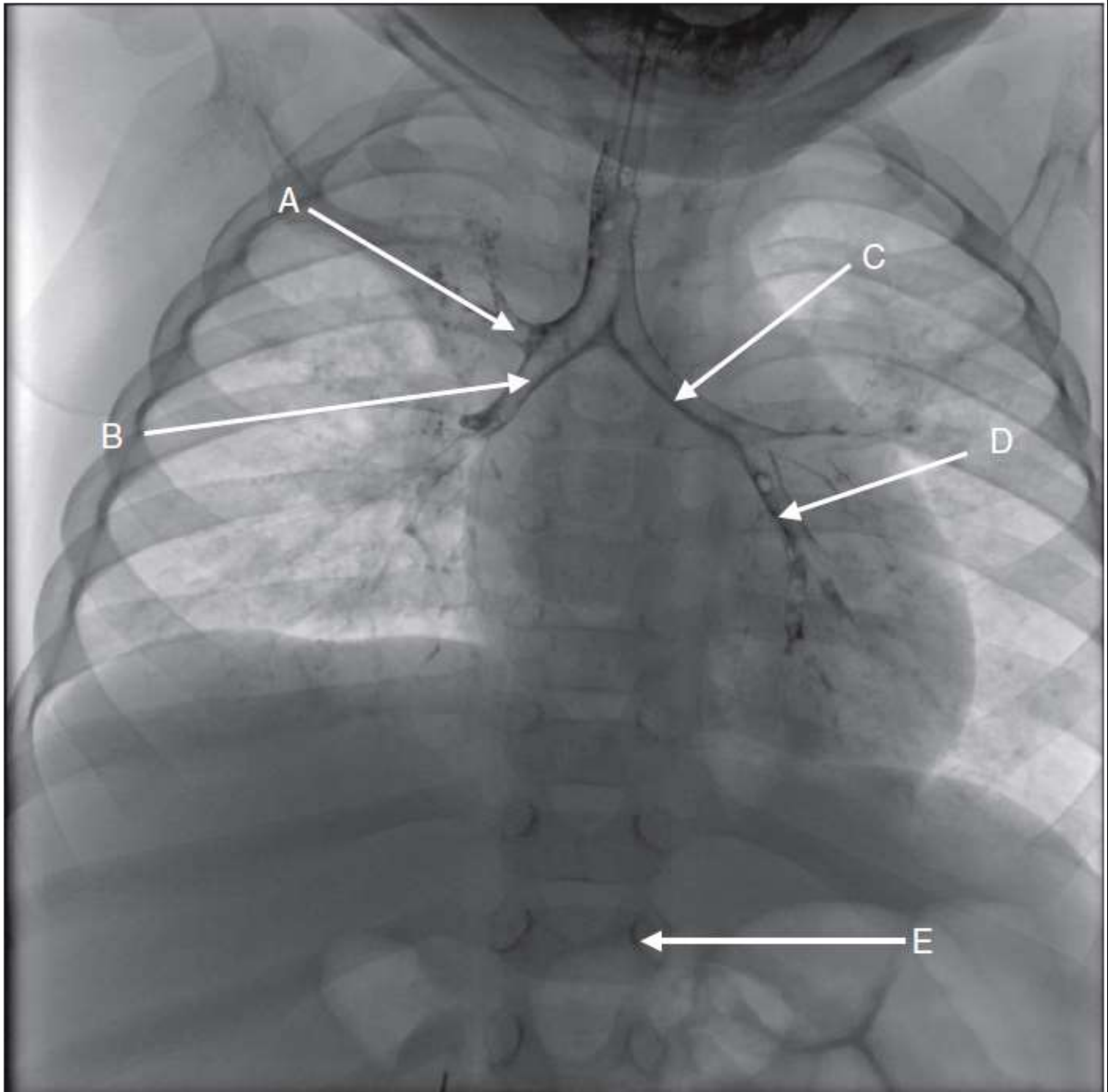
(b) Medial clavicle.

(c) Head of humerus.

(d) Body of sternum.

(e) Manubrium.

Case 2.4



2.4 Paediatric bronchogram

(a) Right upper lobe bronchus.
(b) Bronchus intermedius.
(c) Left main bronchus.
(d) Left lower lobe bronchus.
(e) Left T11 pedicle.

Bronchograms are performed in an intubated but spontaneously breathing patient to assess the patency of the large respiratory airways throughout the respiratory cycle.

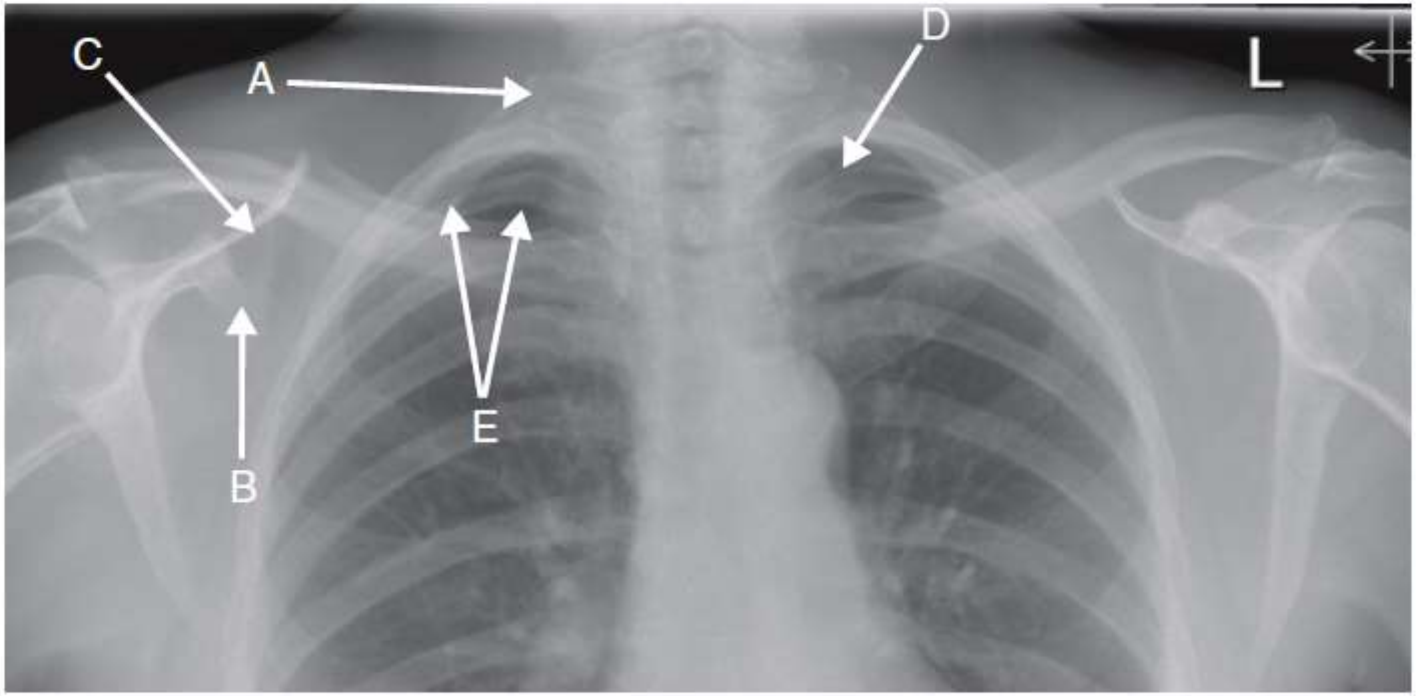
In cases of bronchomalacia the airway will collapse during expiration resulting in airtrapping.

External compression of the airways or displacement related to congenital cardiac and large vessels anomalies can also be apparent.

The trachea splits into the right and left main bronchi at the carina forming a ridge between the openings of the bronchi. The right main bronchus has a shorter and more vertical course than the left; it also has a larger calibre. The right main bronchus then splits into the right upper lobe bronchus and the bronchus intermedius. The right upper lobe is divided into three segments, the apical, posterior and anterior. The bronchus intermedius divides into the short right middle lobe bronchus that supplies the two segments of the right middle lobe: the lateral and medial segments. The right lower lobe bronchus has five segmental branches: the apical, medial, anterior, lateral and posterior segments. The left main bronchus has a horizontal and long course. It divides into the left upper lobe and left lower lobe bronchi. The upper lobe bronchus supplies five segments: the apical, posterior, anterior and the two lingular segments, the superior and inferior. The left lower lobe bronchus supplies the apical, medial, anterior, lateral and posterior segments.

There are several common large airway congenital anomalies, the commonest being the pig bronchus with the right upper lobe bronchus arising directly from the trachea. They are rarely of clinical relevance unless cardiothoracic surgery is required. The pig bronchus can result in a persistently collapsed right upper lobe of the lung when the patient is intubated. This is because the tip of the endotracheal tube can be distal to the origin of the upper lobe bronchus and so can occlude it despite the tip of the endotracheal tube being in an apparent satisfactory position on plain radiographs.

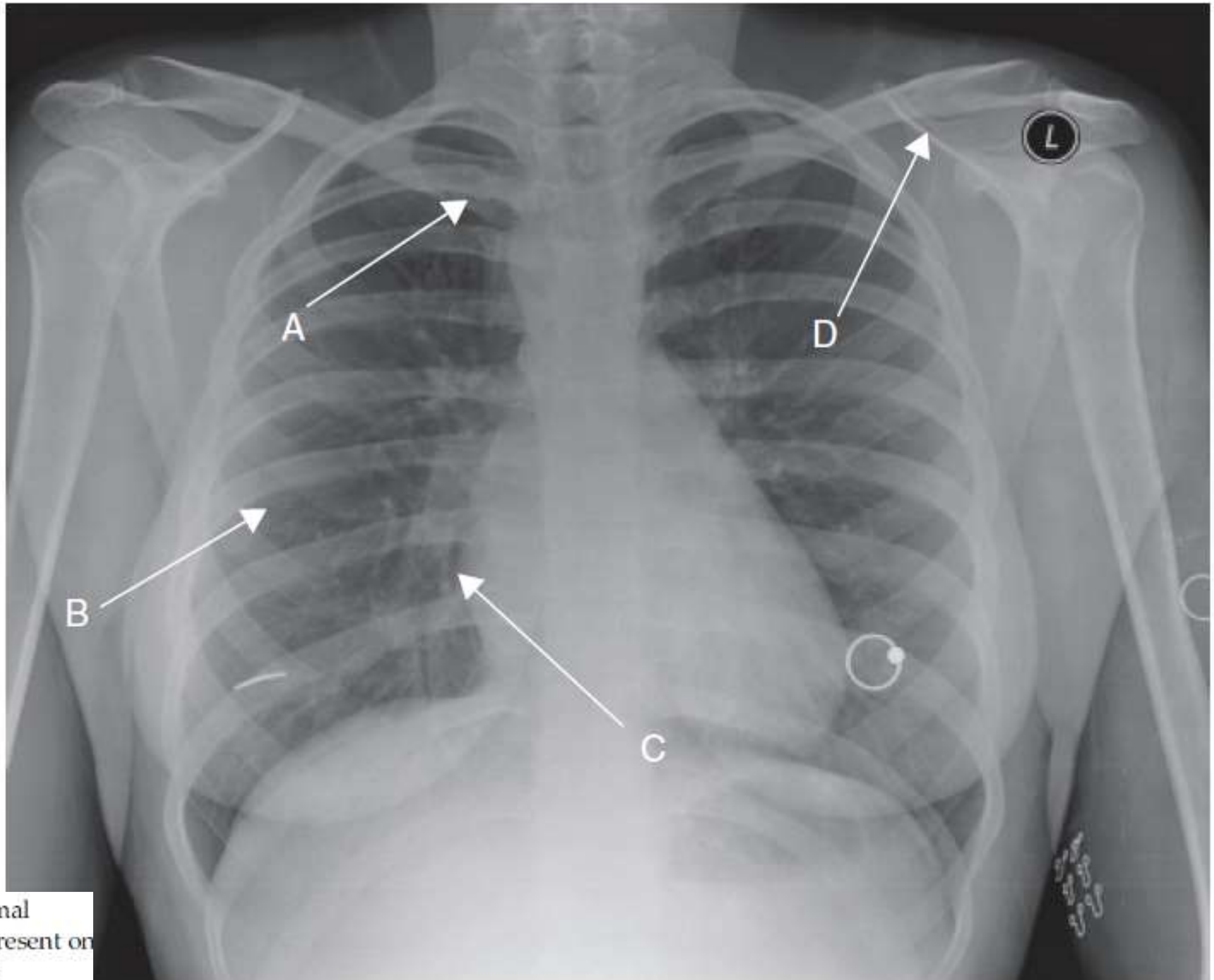
Case 2.14



2.14 PA radiograph centred over the upper chest

(a) Right first costo-transverse joint.
(b) Coracoid process of right scapula.
(c) Spine of right scapula.
(d) Tubercle of left third rib.
(e) Companion shadow of right clavicle. The companion shadow is formed by the skin and subcutaneous tissue that lies superficial to the clavicle. As the x-ray beam tangentially hits the interface between the skin and the air in the supraclavicular fossa, it produces the so-called companion shadow.

Case 3.15

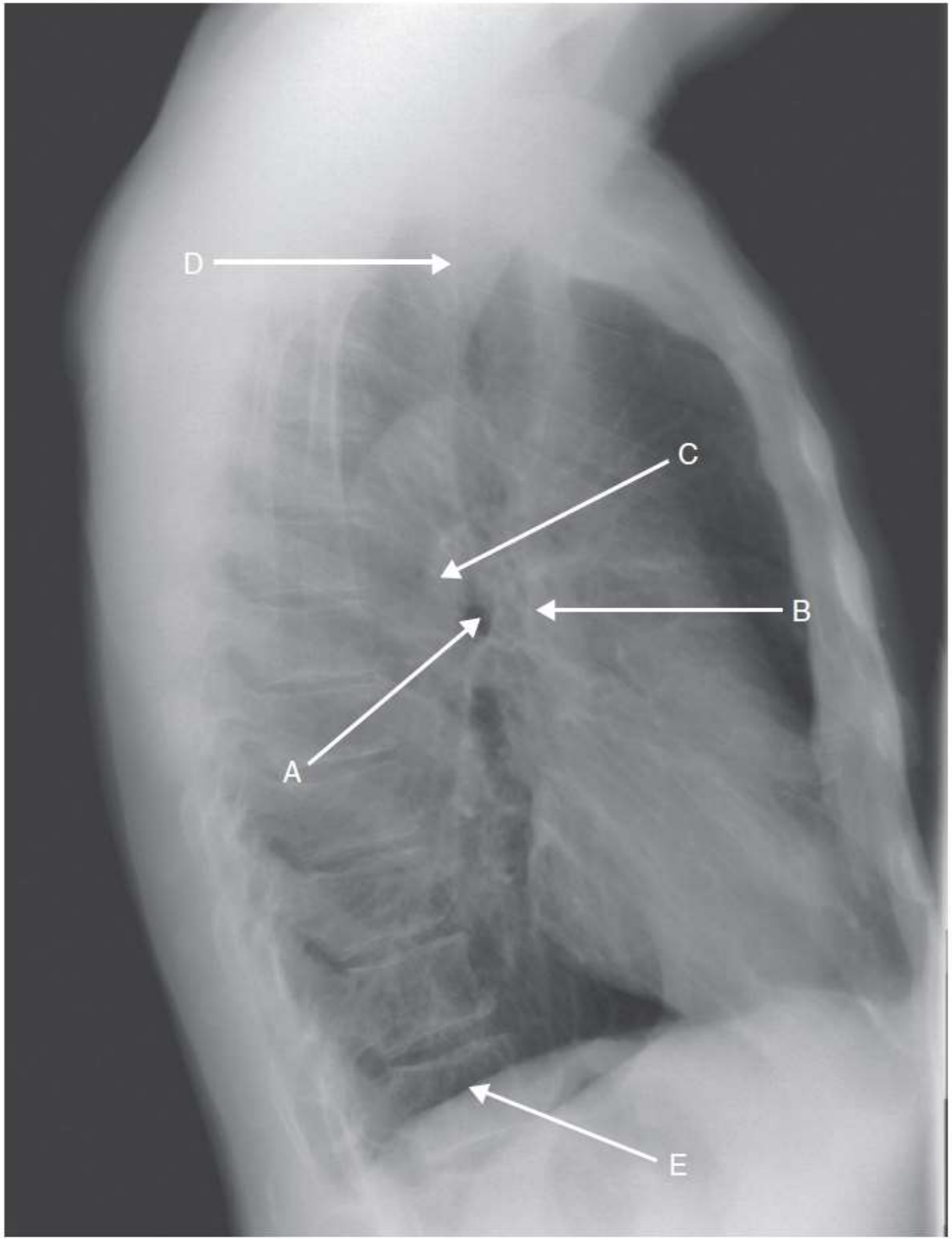


(e) Which normal variant is present on this image?

3.15 PA chest radiograph

(a) Rhomboid fossa.
(b) Medial border of the right scapula.
(c) Right atrium.
(d) Spine of left scapula.
(e) Right-sided aortic arch. A right-sided aortic arch results from persistence of the right fourth branchial arch. It is more commonly seen in conjunction with an aberrant left subclavian artery. When right aortic arch is present with mirror image branching pattern (left brachiocephalic trunk, right common carotid and subclavian arteries) it is almost always associated with congenital heart disease, especially the cyanotic type.

Case 4.16



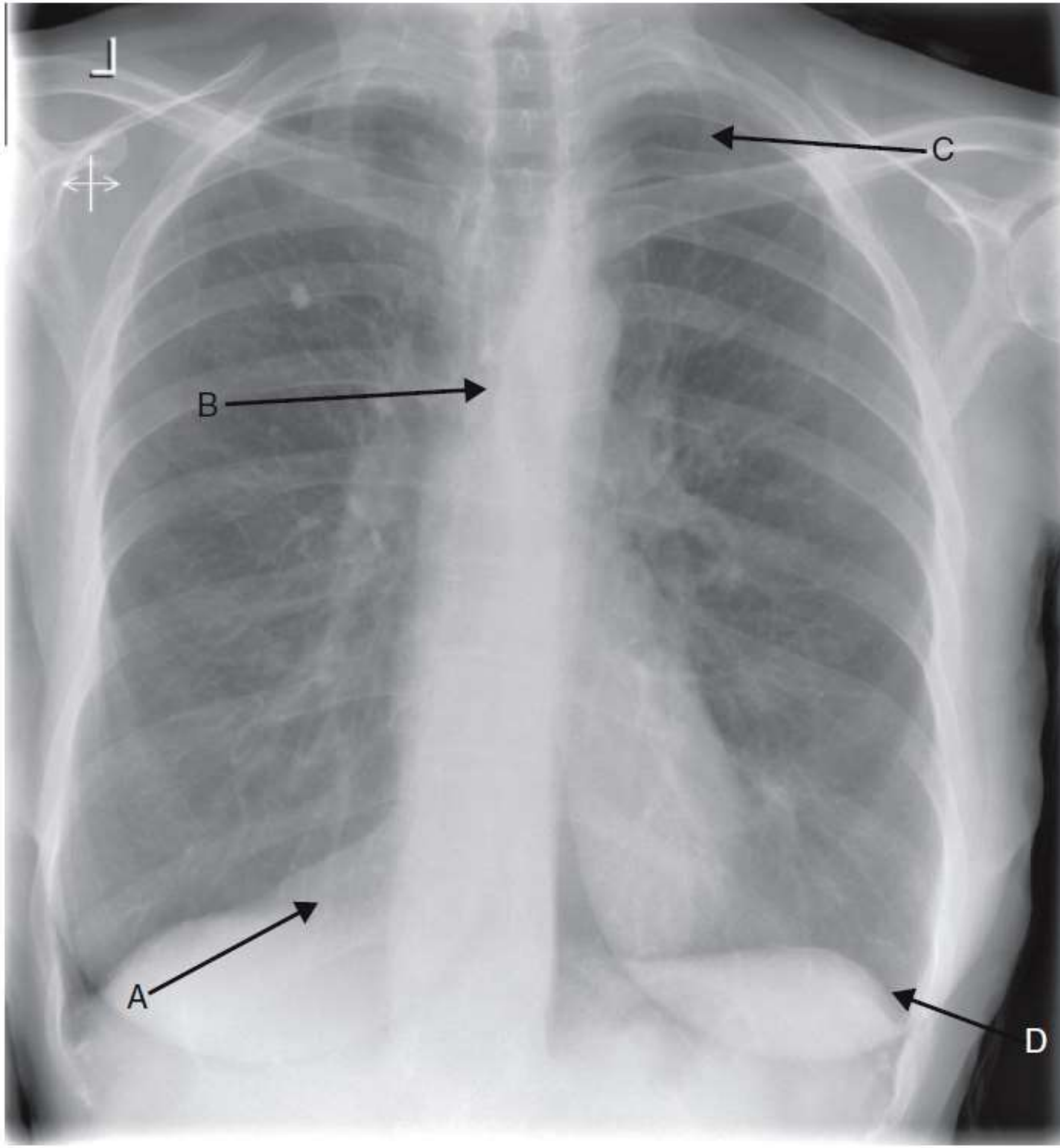
4.16 Lateral chest radiograph

(a) Left main bronchus.
(b) Right pulmonary artery.

(c) Left pulmonary artery. The left pulmonary artery is *posterior* to the right pulmonary artery on the lateral projection and lies superior to the relatively horizontally orientated left main bronchus, which appears as an oval lucency (A).
(d) Posterior tracheal stripe. The posterior tracheal stripe should be no greater than 2.5 mm in thickness when the posterior tracheal wall coming into contact with the upper lobe forms the stripe. The posterior tracheal stripe will be up to 5.5 mm thickness if there is apposition of the anterior oesophageal wall and the posterior trachea.

Raider's (retrotracheal) triangle is bounded by the thoracic inlet superiorly, aortic arch inferiorly, the spine posteriorly and the posterior tracheal stripe anteriorly.
(e) Left hemidiaphragm. Determining the side of the hemidiaphragm on the lateral film is reasonably straightforward. The diaphragm that is 'lost' under the cardiac silhouette is the left hemidiaphragm because it has the same radiographic density as the heart. If the gastric bubble is above one hemidiaphragm and below another, then it is below the left hemidiaphragm (if the gastric bubble is below both hemidiaphragms, this method cannot be used to determine the side).

Case 4.20



(e)	Which normal variant is present on this image?

4.20 PA chest radiograph

Please note the side marker!

(a) Left pericardial fat pad. This is of no clinical bearing but can sometimes be confused for a mediastinal mass because of its shape. The density of a fat pad is less than that produced by soft tissue mass lesions.
(b) Left main bronchus.
(c) Right first rib.
(d) Right costophrenic angle.
(e) Situs inversus. The radiograph has been presented the wrong way round but the side marker is present on the film.

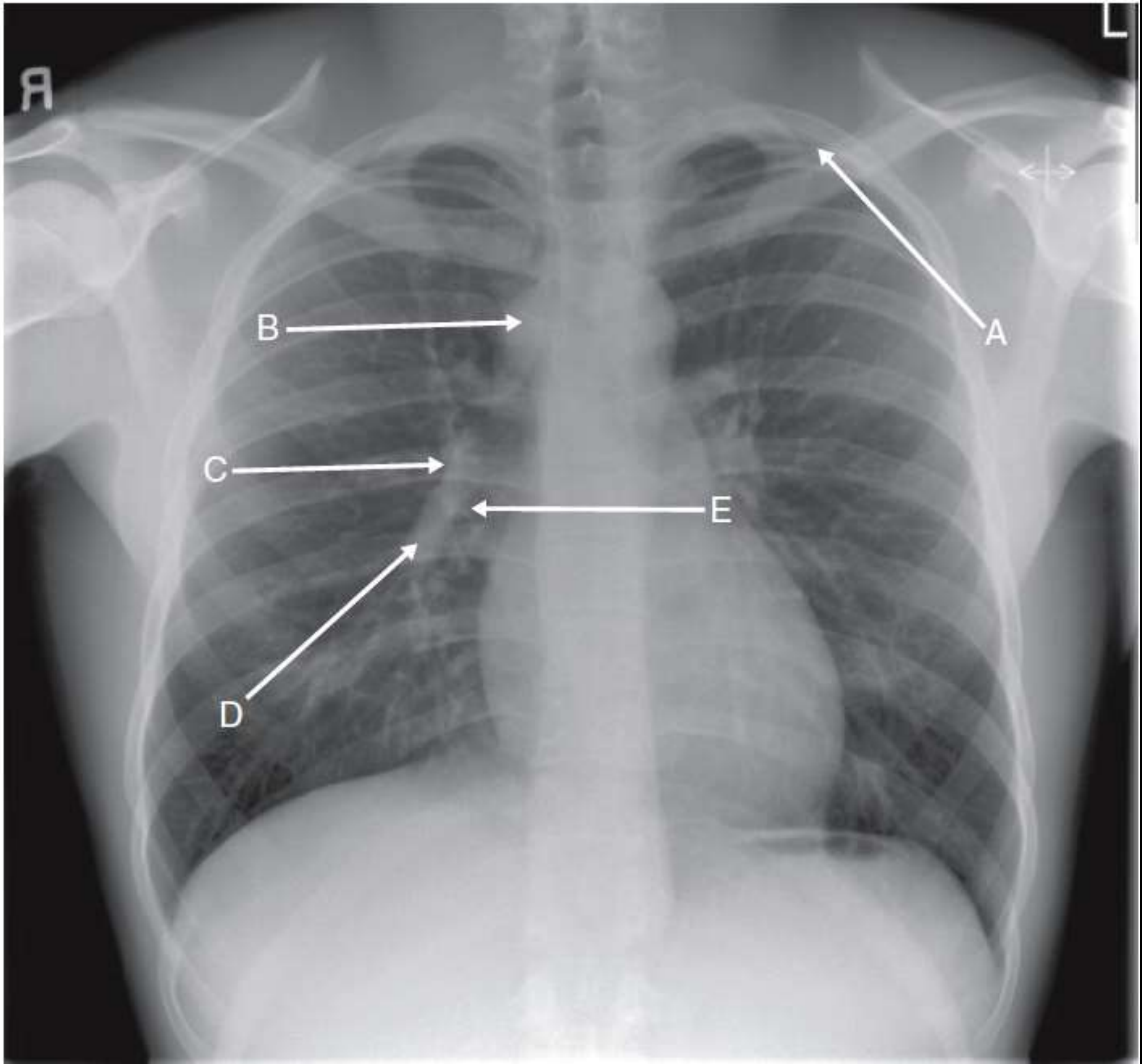
Situs inversus implies the position of the heart is mirrored as is that of the abdominal viscera. Normal position is referred to as situs solitus.

If solely the position of the heart is altered, with the apex towards the right, then this is referred to as dextrocardia.

Kartagener's syndrome is a not infrequent association with situs inversus, affecting 20% of patients. It is a disease affecting mucociliary function and therefore patients often present with sinusitis and bronchiectasis.

Situs inversus also has bearing on patients presenting with trauma or abdominal pain and it needs to be considered, for instance, the spleen will be on the right and the appendix on the left.

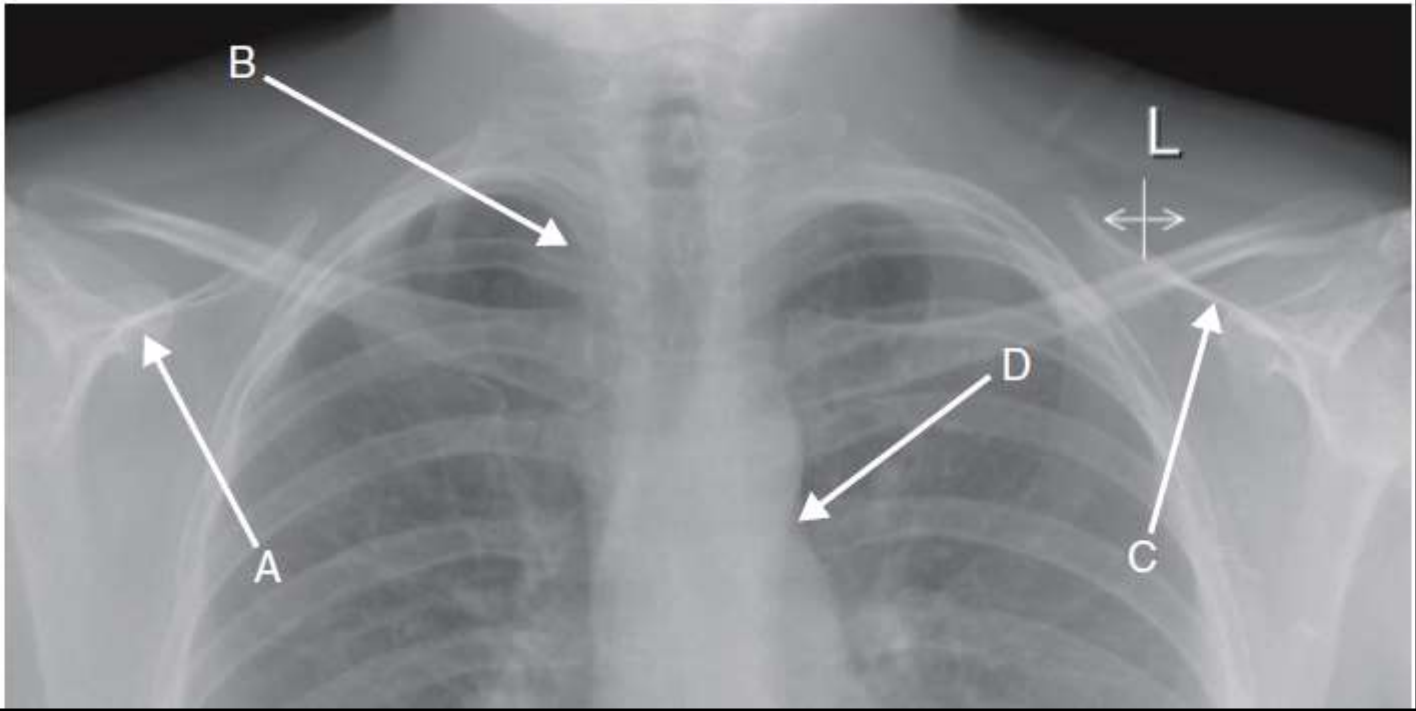
Case 7.12



7.12 PA chest radiograph

(a) Companion shadow of left clavicle.
(b) Azygos vein.
(c) Right hilar point.
(d) Right interlobar pulmonary artery.
(e) Bronchus intermedius. The pulmonary arteries are always located alongside bronchi. In the case of bronchus intermedius, it lies adjacent to the interlobar artery.

Case 7.15

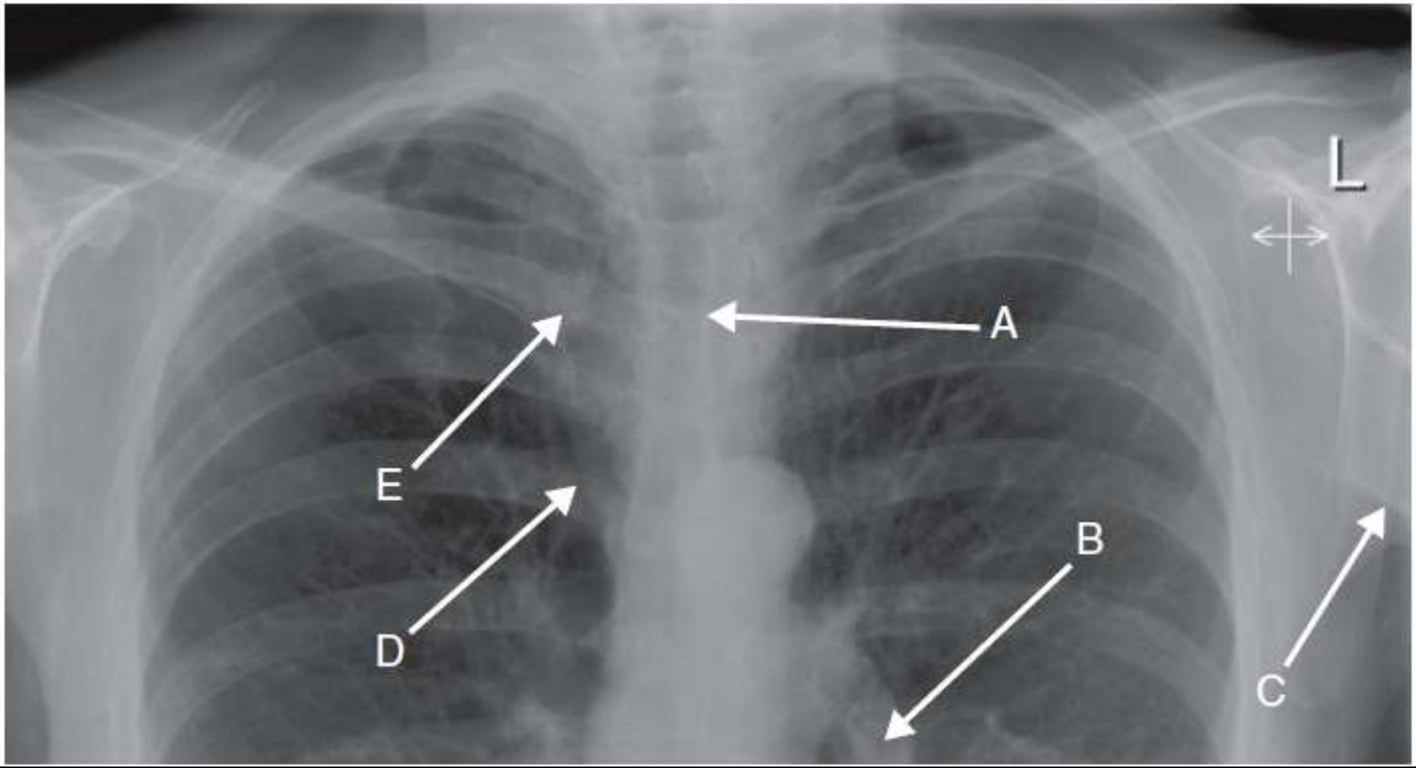


(e)	Which normal variant is present on this image?

7.15 PA chest radiograph

(a) Coracoid process of the right scapula.
(b) Right transverse process of T3.
(c) Spine of left scapula.
(d) Aorto-pulmonary window.
(e) Right cervical rib. A cervical rib articulates with a transverse process which is orientated in a downwards direction unlike thoracic ribs, which articulate with an upwardly orientated transverse process. They may cause vascular and neural compression leading to symptoms in the upper limb.

Case 8.5



8.5 PA chest radiograph centred over the upper mediastinum

(a) Posterior junction line. The posterior junction line is seen in about 30% of PA chest radiographs and is formed when the x-ray beam is tangential to the apposition of the postero-medial portion of both upper lobes posteriorly. On the PA radiograph it runs from above the clavicles to the arch of the aorta and is projected through the trachea. The line comprises four layers – two parietal and two visceral pleural layers. The line may become a stripe if there is a significant amount of mediastinal fat in between the two lungs.

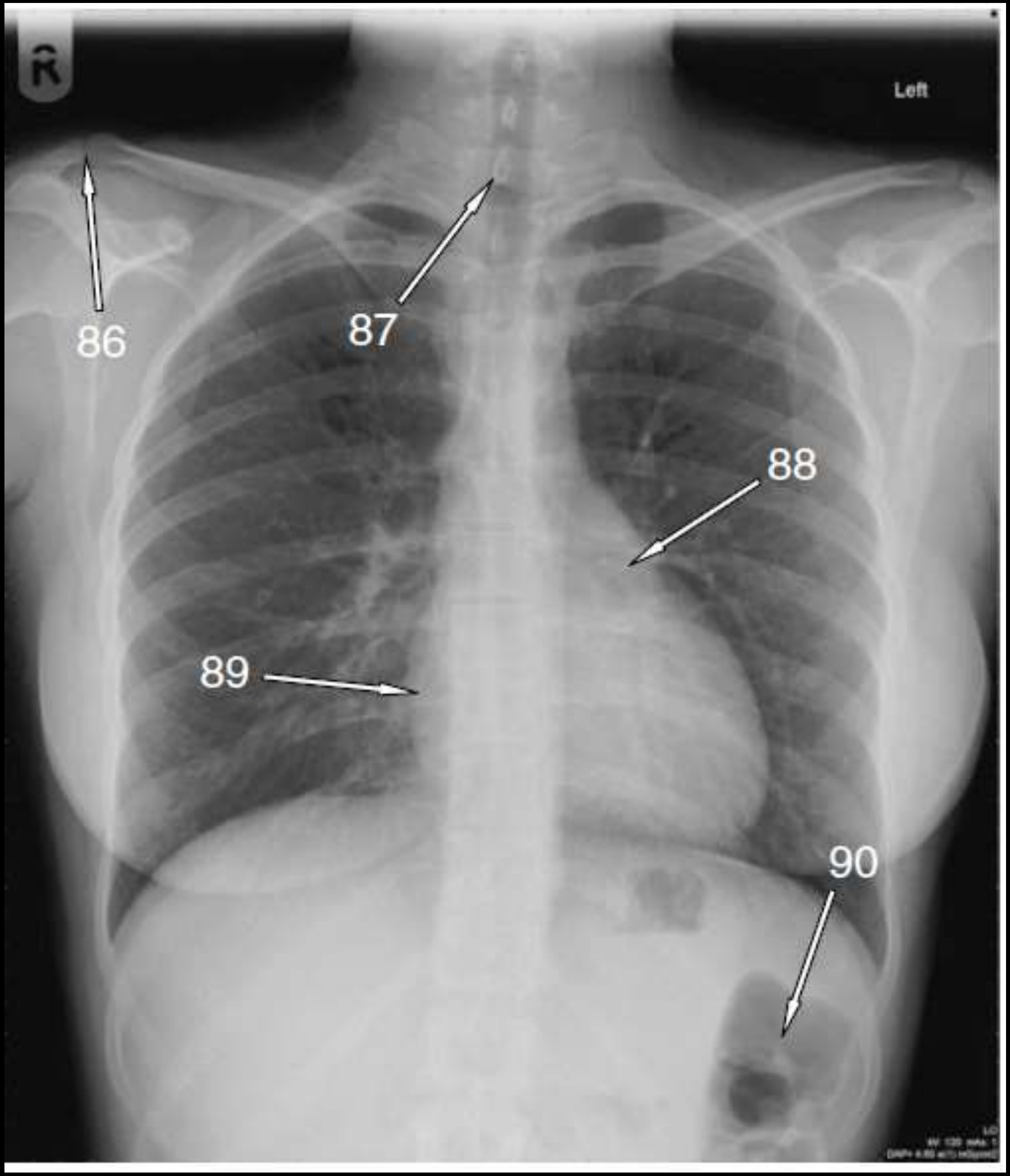
Abnormal bulging of this line suggests mass lesions of the oesophagus, lymphadenopathy or neurogenic masses.

(b) Left main pulmonary artery. The left main pulmonary artery is more cranial in position than the right main pulmonary artery since it is superior to the left main bronchus just prior to its bifurcation.

(c) Left axillary fold.

(d) Right lateral border of the sternum.

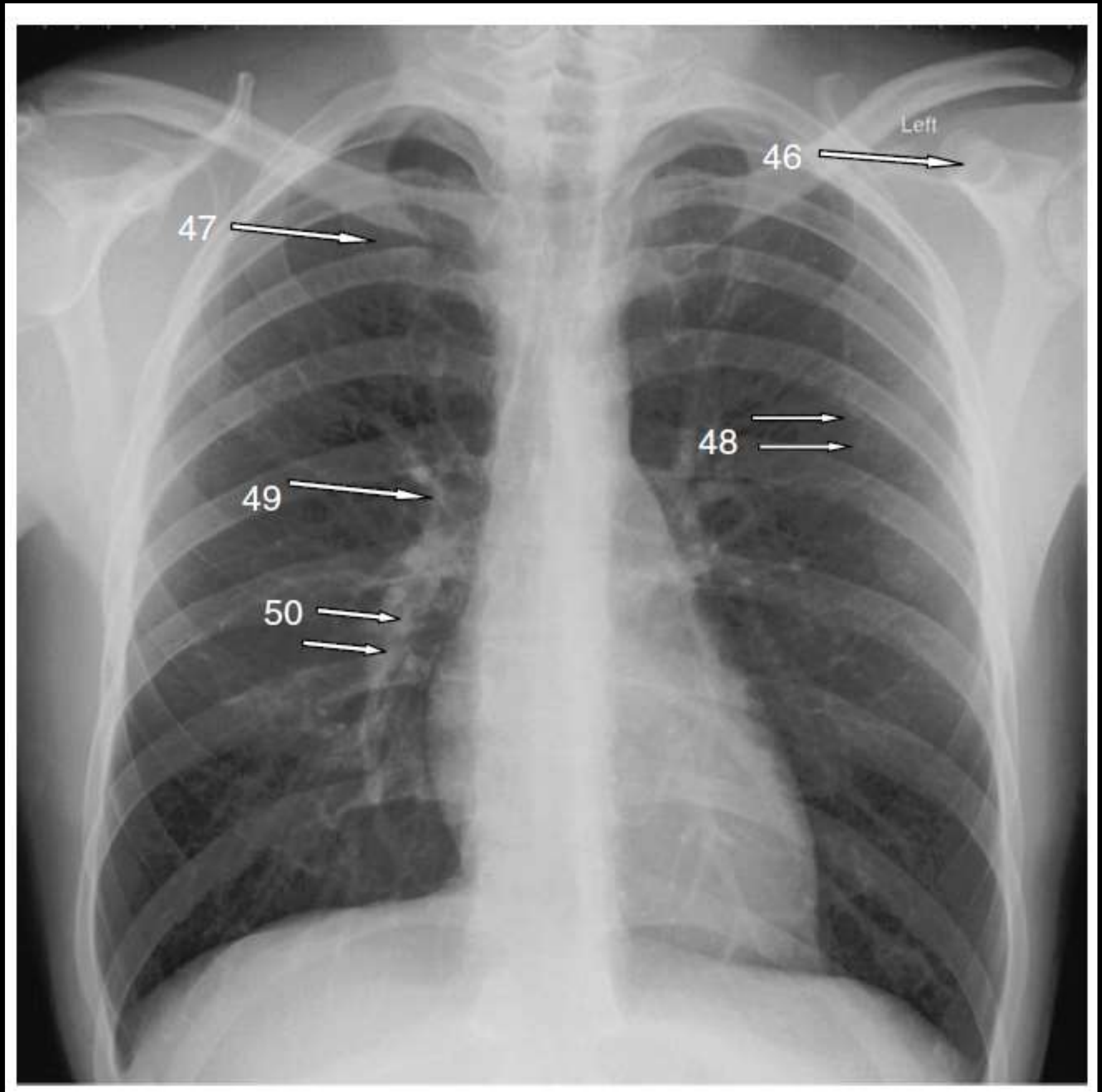
(e) Right sternoclavicular joint. The sternoclavicular joint is a synovial joint separated by a flat articular disc. There are four strong ligaments (anterior and posterior sternoclavicular, interclavicular and costoclavicular) and a strong fibrous capsule. As a result trauma to the joint rarely causes disruption but instead is associated with clavicular fracture.


R
Left
86
87
88
89
90

Chest Radiograph

86. Right acromioclavicular joint
87. Spinous process T1 vertebra
88. Left atrium (left atrial appendage)
89. Right atrium
90. Gas in colon/splenic flexure

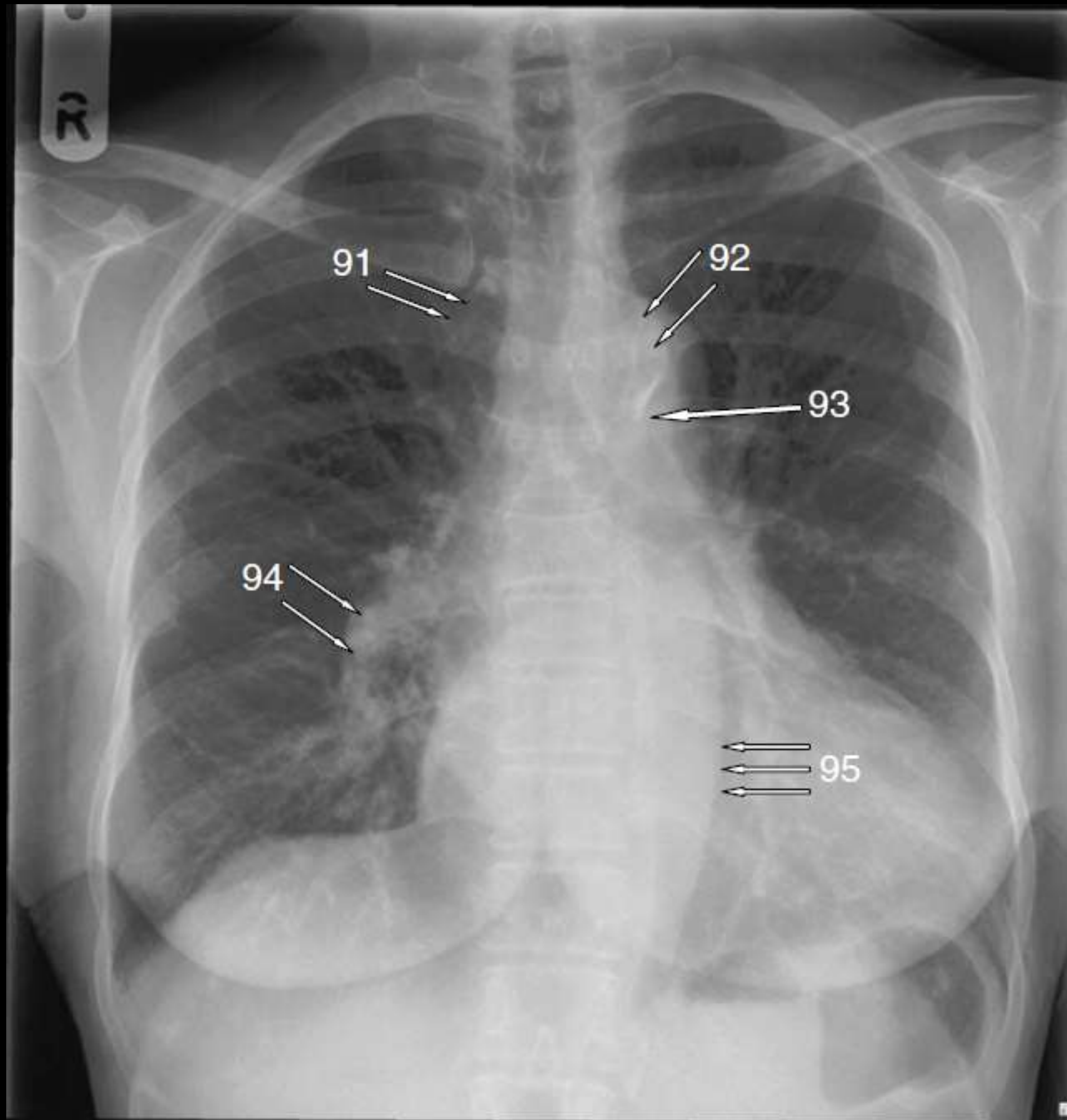
This is gas in the colon; the gastric air bubble is seen superiorly.


Left
46
47
48
49
50

Chest Radiograph

46. Left coracoid process
47. Right 1st rib (anterior)
48. Medial border of left scapula
49. Right hilar point
50. Interlobar artery (right lower lobe artery)

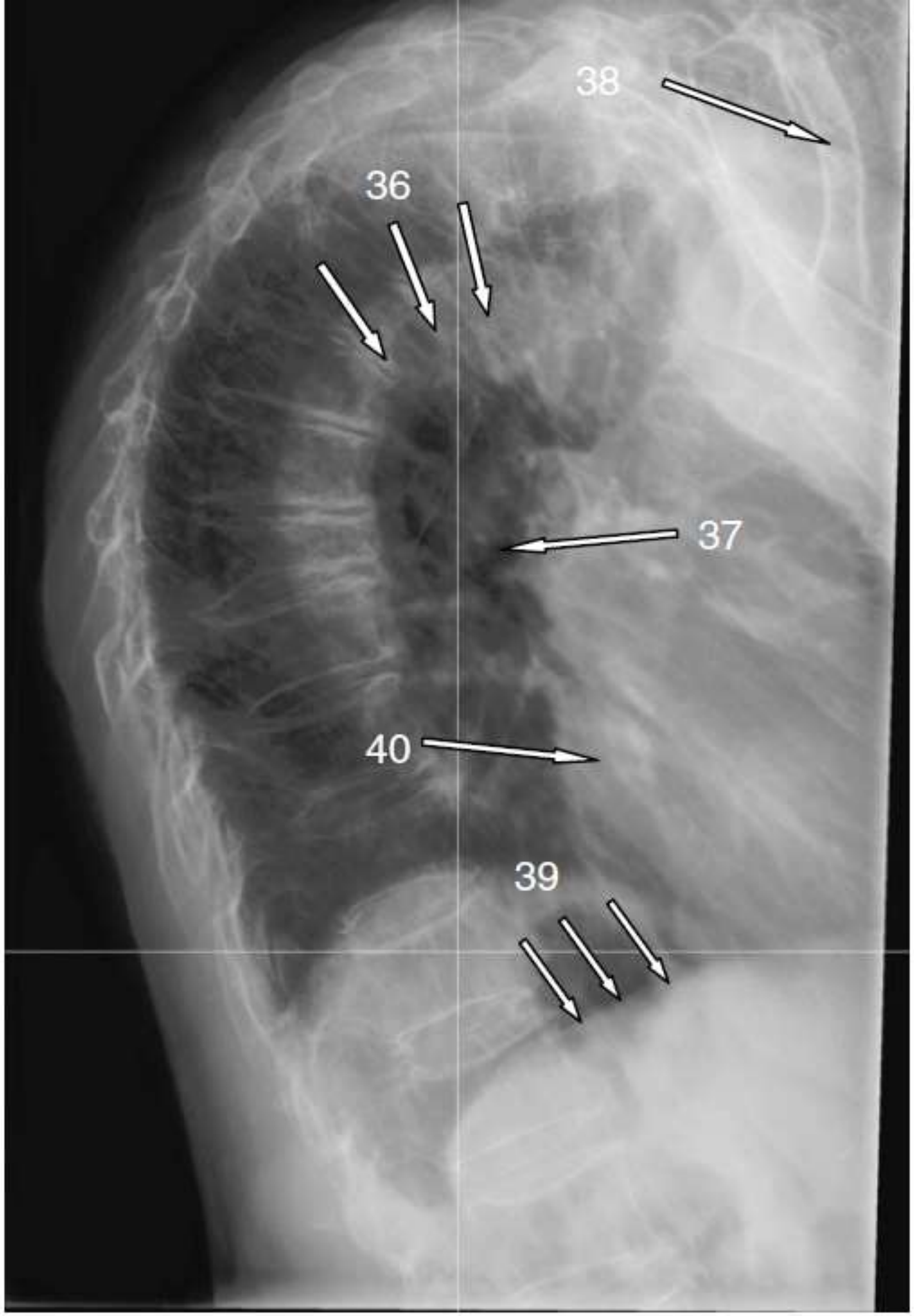
The hilar points are the angles formed by the descending upper lobe veins, as they cross behind the lower lobe arteries.



R
91
92
93
94
95

Chest Radiograph

91. Manubrium
92. Aortic knuckle
93. Aortopulmonary window
94. Interlobar artery
95. Descending thoracic aorta


38
36
37
40
39

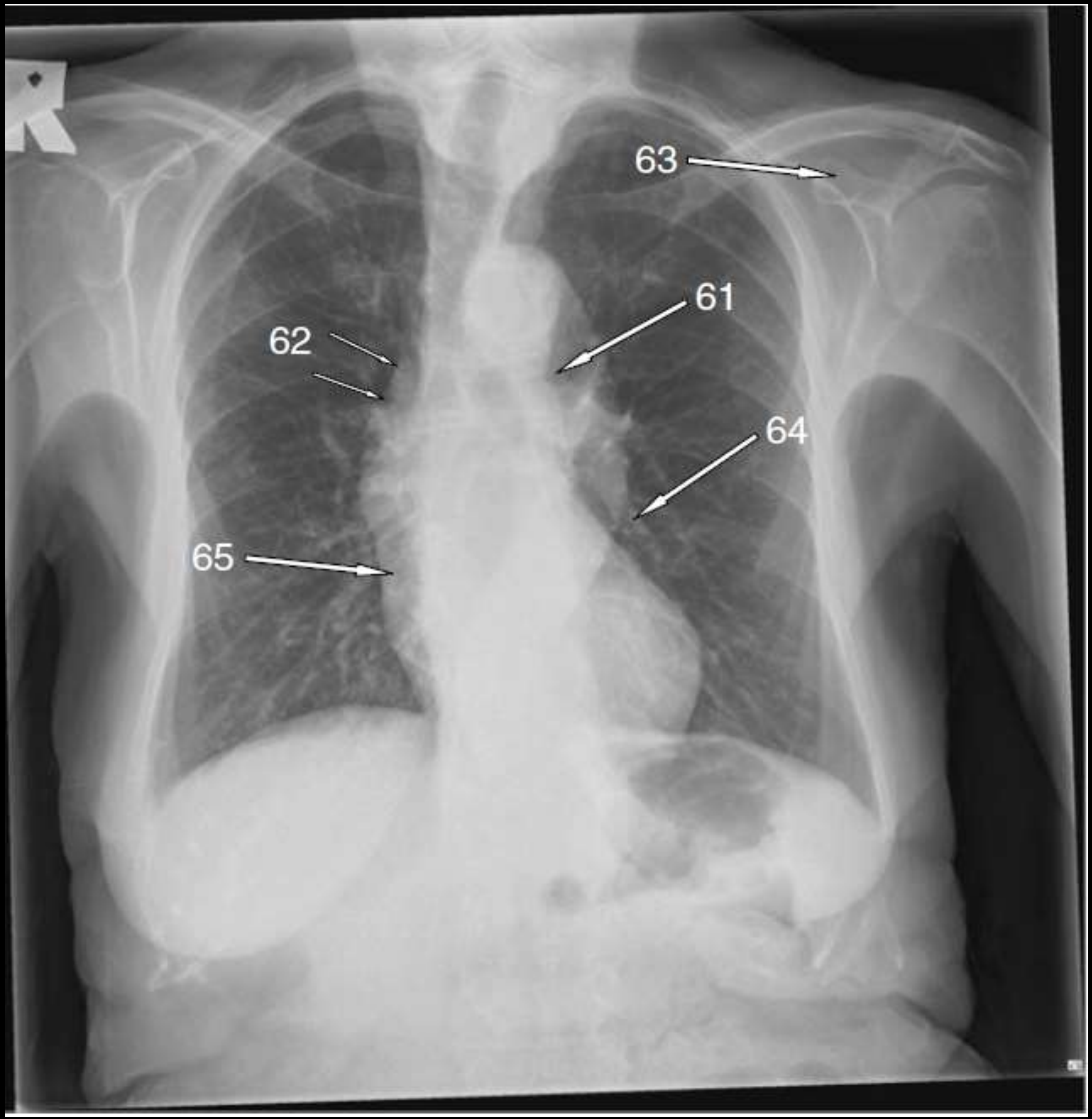
Chest Radiograph

36. Arch of aorta
37. Left main bronchus
38. Clavicle
39. Right dome of diaphragm
40. Left atrium

Lateral chest x-ray demonstrating kyphosis. Remember that the left main bronchus, being more horizontal, is seen as a circular structure. The left pulmonary artery is comma-shaped as it arches over the left main bronchus.

The following points help identify the domes of the diaphragm:

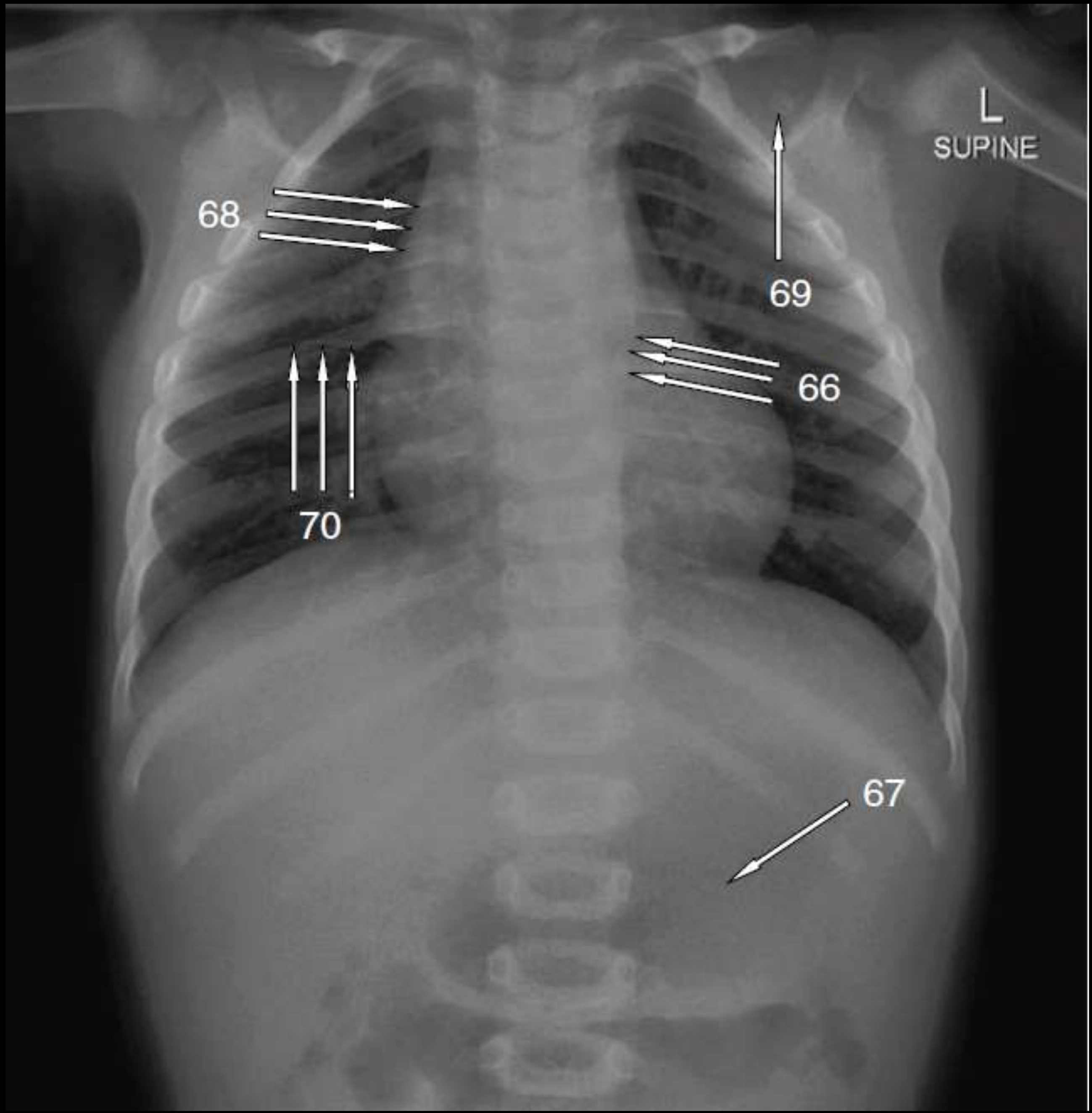
- Air within the gastric fundus lies under the left dome.
- The heart shadow obscures part of the left dome.
- The inferior vena cava may be seen traversing the right dome.



R
63
61
62
64
65

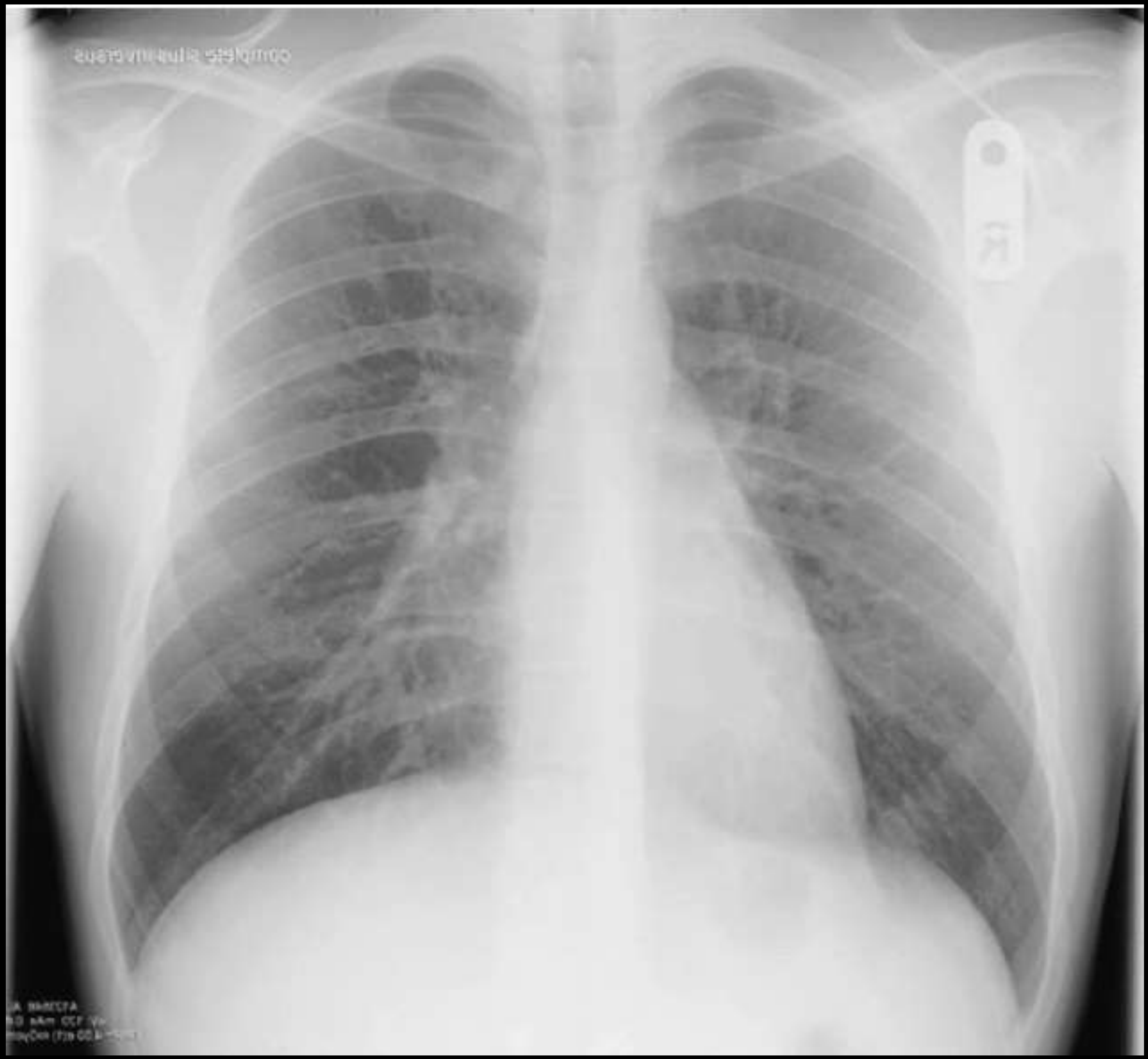
Chest Radiograph

61. Aortopulmonary window
62. SVC
63. Left coracoid process
64. Left inferior pulmonary artery
65. Right atrium


L
SUPINE
68
69
66
70
67

66. Descending thoracic aorta
67. Stomach gas shadow
68. Lateral border right lobe of thymus
69. Ossification centre of left coracoid process of the scapula
70. Right horizontal (minor) fissure

The thymus is very variable in size and shape. It may be triangular when it abuts the horizontal fissure and often has a wavy outline. It never compresses or deviates other mediastinal structures, such as the trachea.



Name the normal variant

(**Continued**): **Chest Radiograph**

Situs inversus (same patient's CXR)
Thoracic situs refers to the position of the tracheobronchial tree. In situs inversus the right main bronchus is longer than the left main bronchus, the left upper lobe bronchus is superior to the left pulmonary artery, and the right upper lobe bronchus is inferior to the right pulmonary artery. It is associated with dextrocardia, as in this example. The stomach bubble can be seen below the right hemidiaphragm.

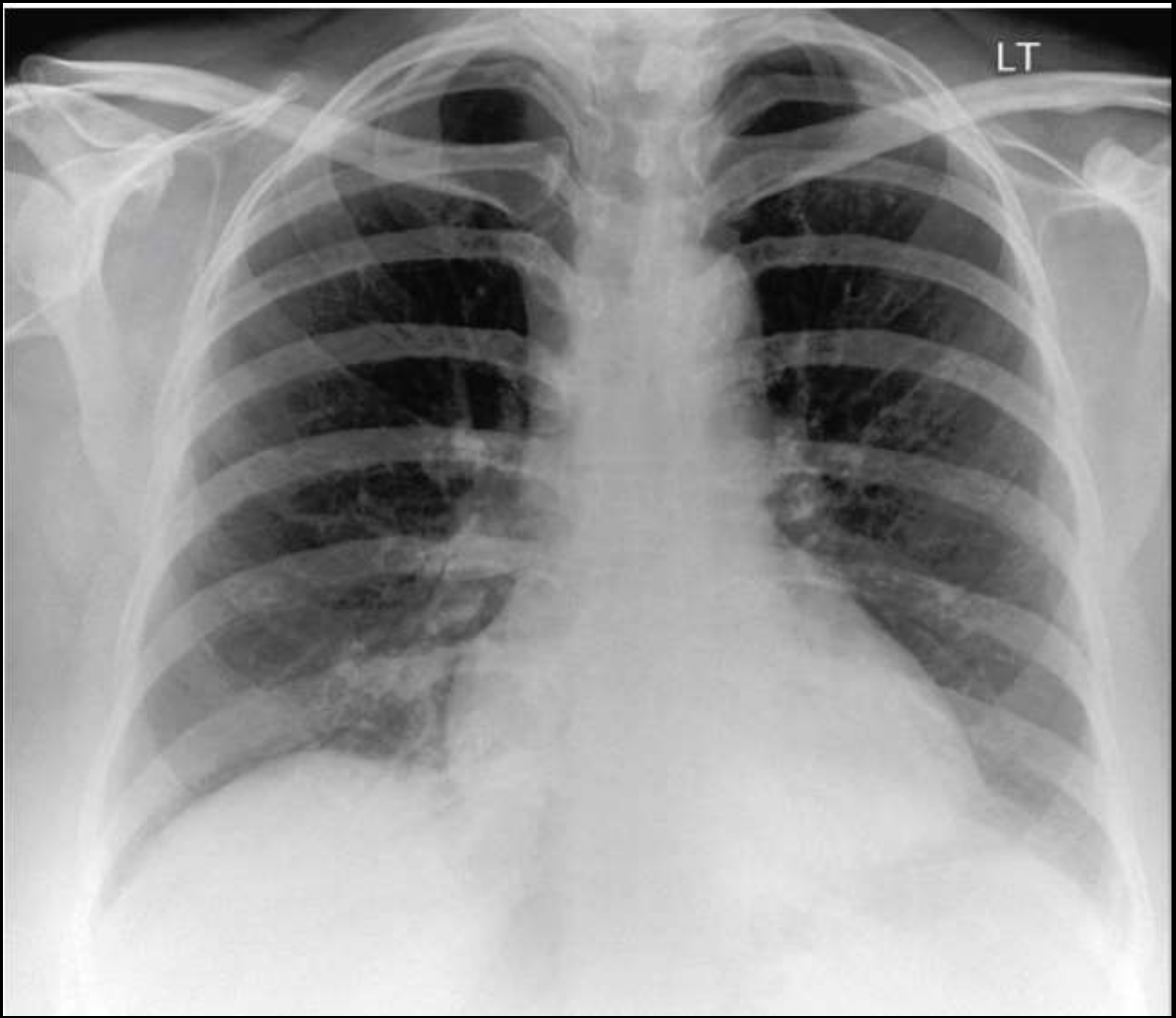
Beware of the side marker – in this example the image has been deliberately shown to make you look at the side marker and spot the abnormality.

Name the normal variant

Chest Radiograph

Azygous fissure

The azygous fissure is seen due to the azygous vein passing through the apical portion of the right upper lobe. The fissure contains four layers of pleura (two parietal and two visceral) which is why the fissure is more prominent than the reminder of the fissures. It is present in 1 % of postmortem specimens but only seen on 0.4 % CXR.

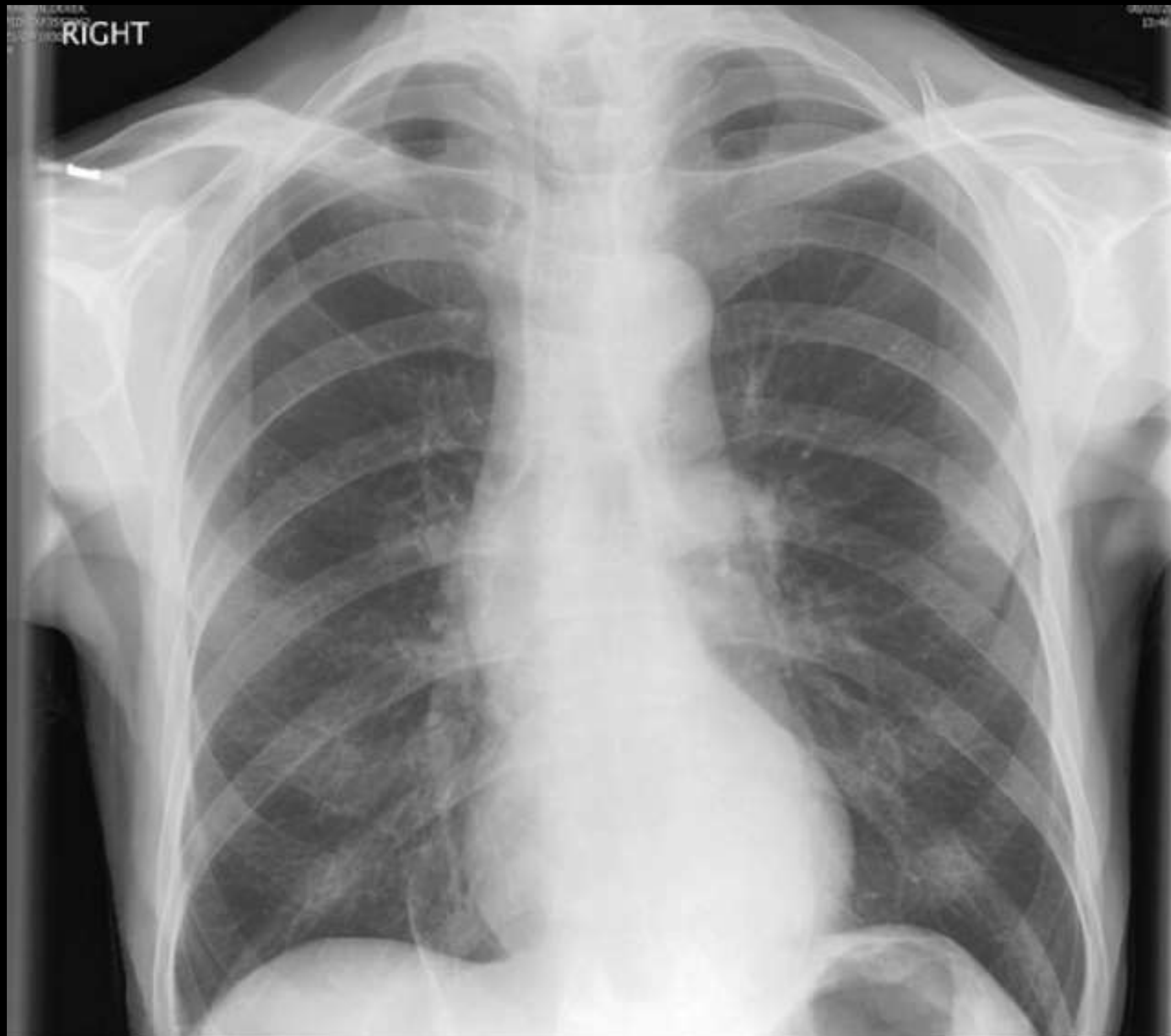


Name the normal variant

Chest Radiograph

Left cervical rib

A cervical rib is a normal variant but can cause clinical symptoms. Patients may present with tingling and numbness of the hand. A cervical rib is a bony or fibrous band between C7 and the first rib. They are seen in 1–2 % people. Fifty percent are bilateral, but they are often asymmetrical.

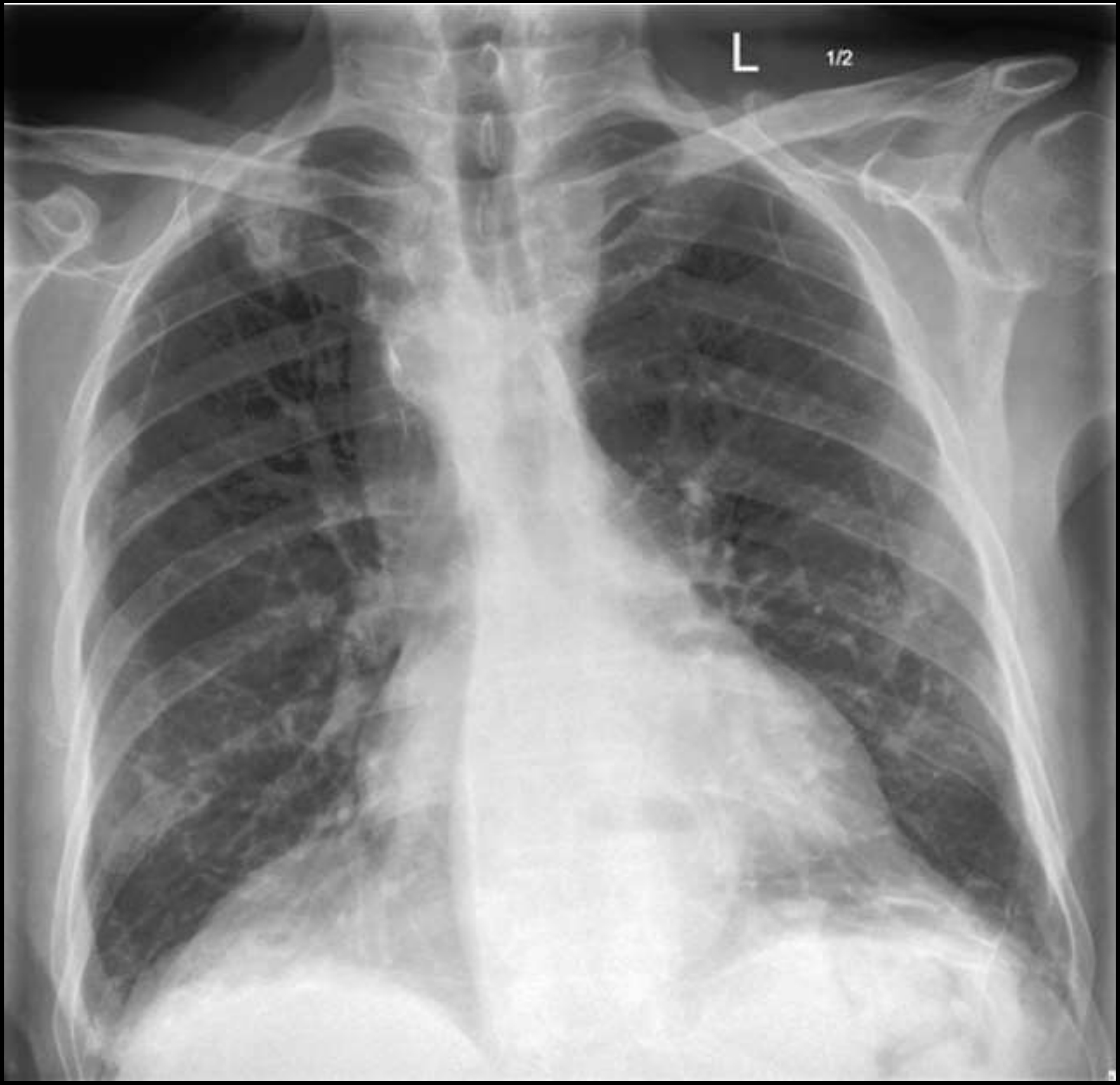


Name the normal variant

Chest Radiograph

Inferior accessory fissure

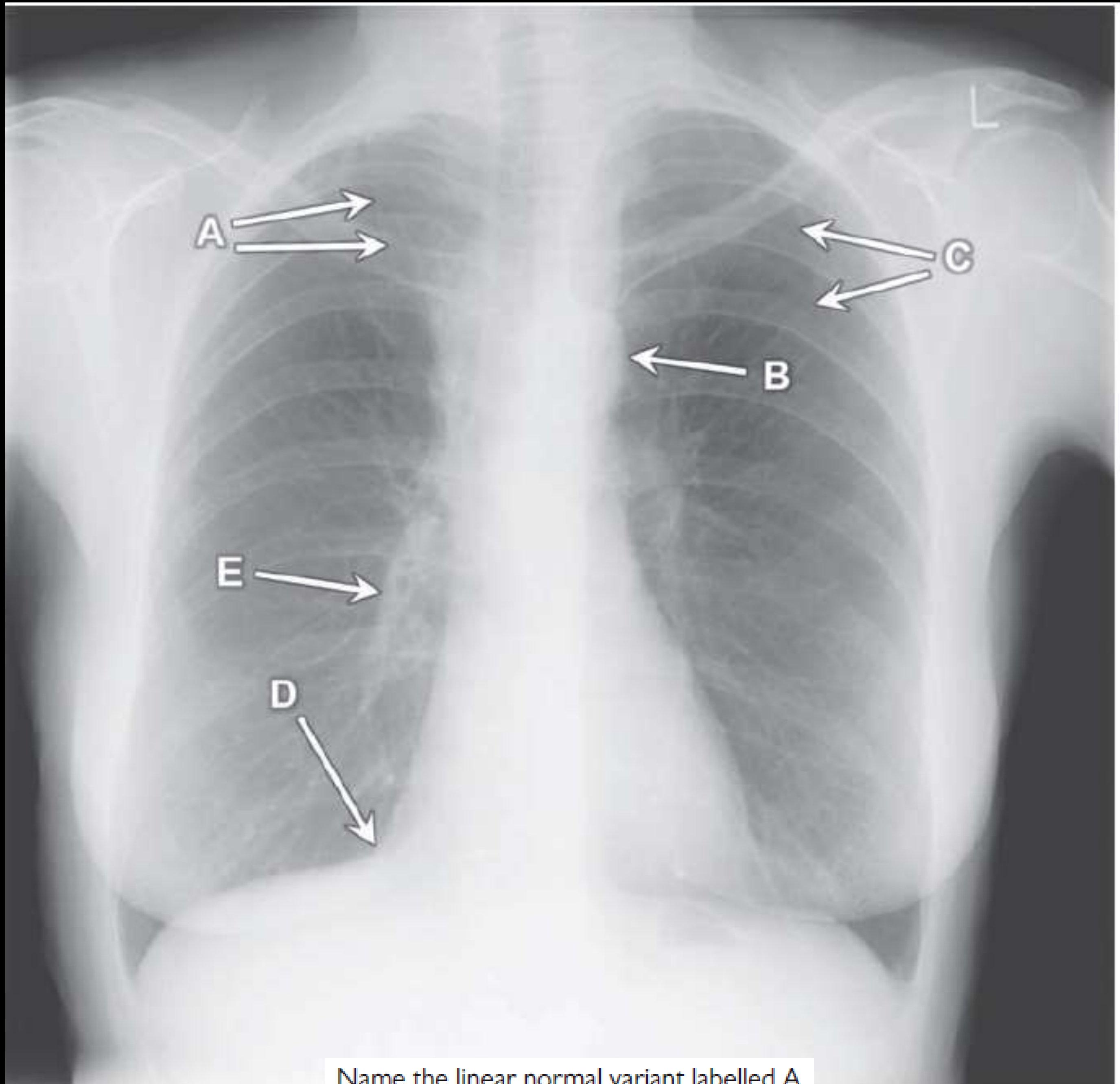
Inferior accessory fissure is seen in 8 % CXR and 20 % HRCT. It separates the medial basal segment from the other right lower lobe segments. It is also known as Twinings' line. It is found on 30–50 % postmortem specimens.



Name the normal variant

Chest Radiograph

Right-sided aortic arch
Seen in 1–2 % of people due to persistence of the right aortic arch and right descending aorta and regression of the left aortic arch. The arch courses to the right of the trachea and oesophagus, over the right main bronchus. It crosses over the lower thoracic spine and passes through the left hemidiaphragm. It is often associated with other vascular and cardiac anomalies.



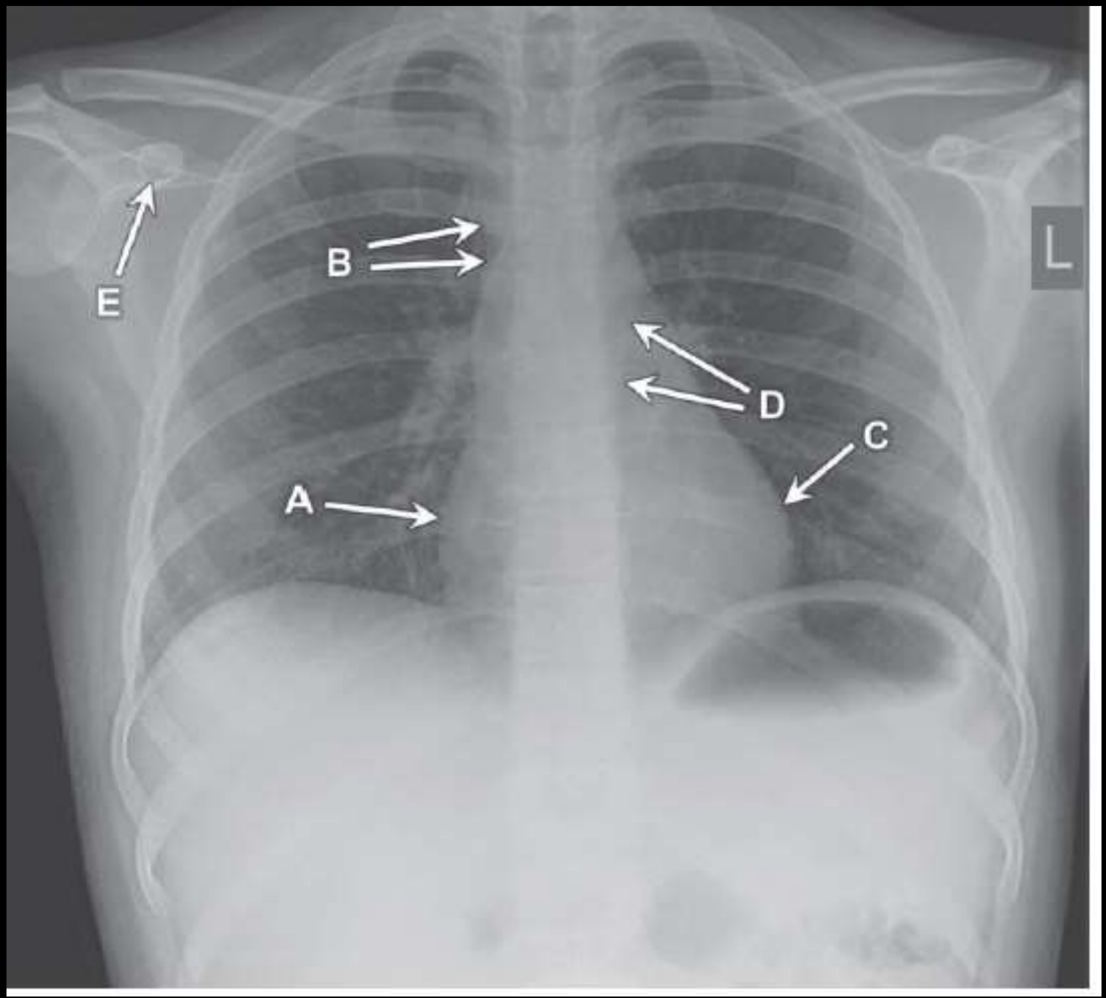
Name the linear normal variant labelled A.

Case 6

Plain radiograph. AP chest.

1. Azygos fissure
2. Aortic arch
3. Medial border of the left scapula
4. Right cardiophrenic angle
5. Interlobar artery

The azygos fissure is seen in about 1% of the population. The azygos vein sits at the caudal aspect of the fissure.

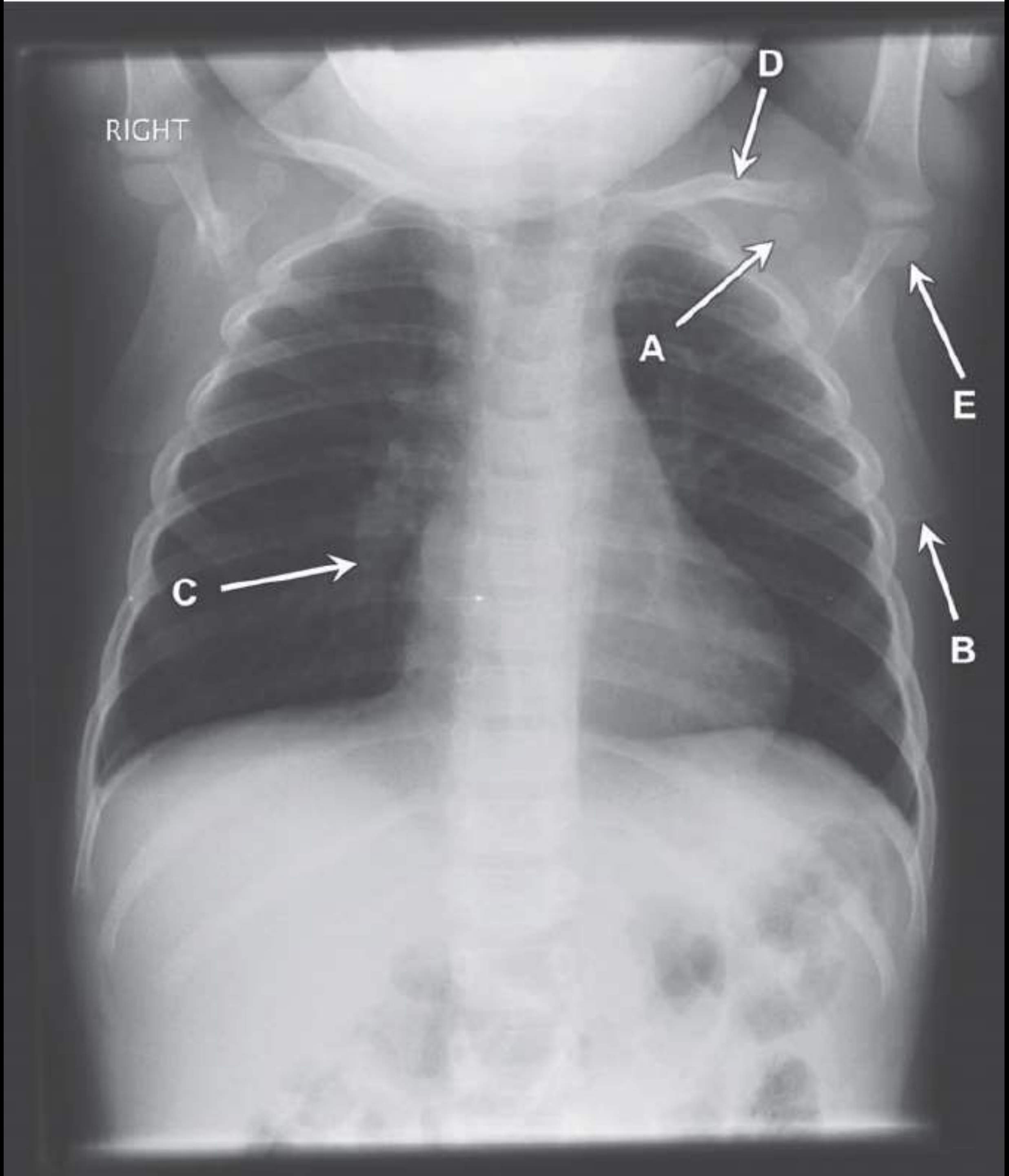


Name the muscle that connects the structure labelled E and the thoracic cage.

Case 1

PA chest radiograph.

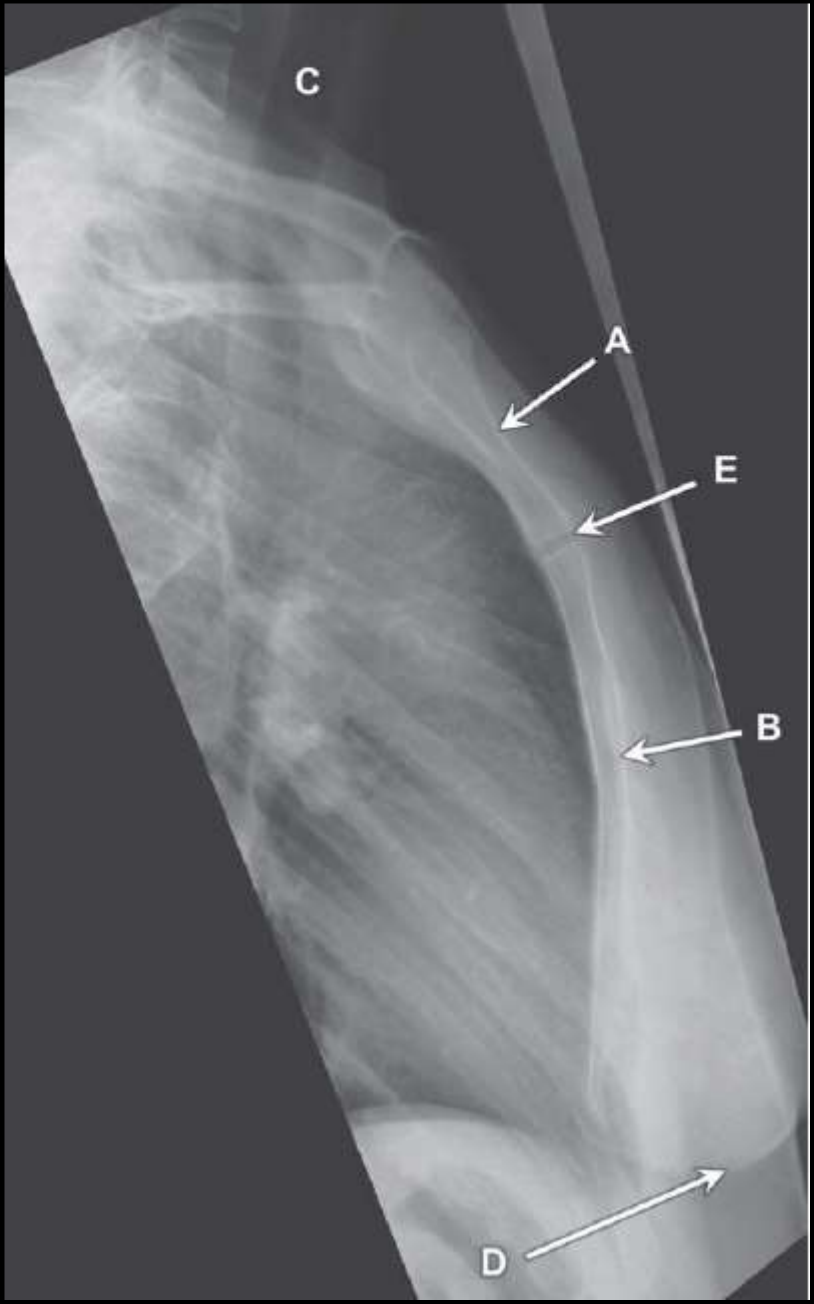
1. Right atrium
2. Superior vena cava
3. Left ventricle
4. Descending thoracic aorta
5. Right pectoralis minor


RIGHT
D
A
E
C
B

Case 18

PA chest radiograph, child.

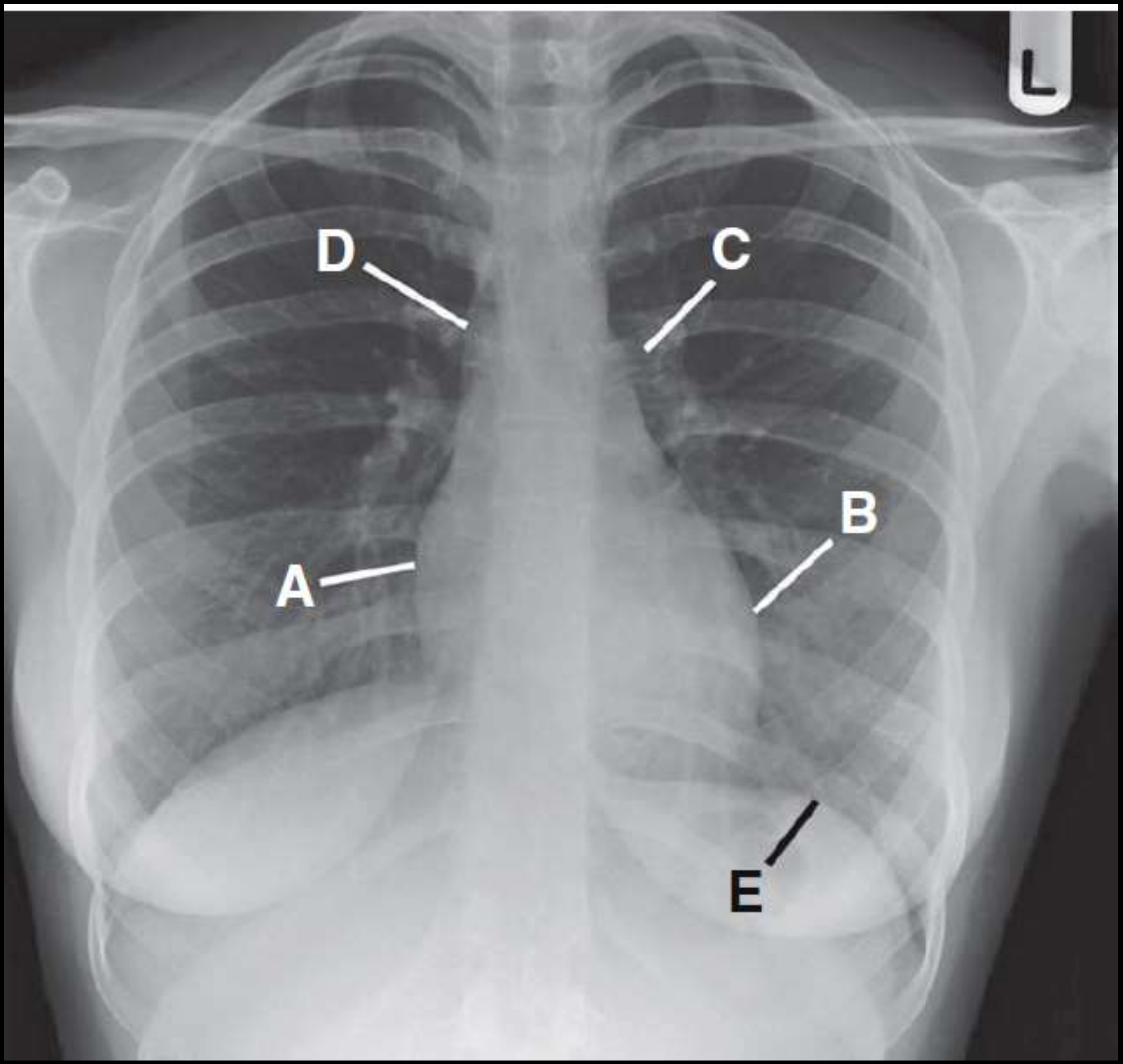
1. Ossification centre of the coracoid process of the left scapula
2. Tip of the left scapula
3. Right lower lobe pulmonary artery
4. Left clavicle
5. Proximal epiphysis of the left humerus


C
A
E
B
D

Case 18

Plain radiograph. Lateral sternum.

1. Manubrium of sternum
2. Body of sternum
3. Trachea
4. Breast
5. Manubriosternal joint


L
D
C
B
A
E

Q1 Answers

a Right atrium
b Left ventricle
c Left pulmonary artery
d Superior vena cava (SVC)
e Left hemi-diaphragm

Chest radiograph, PA projection

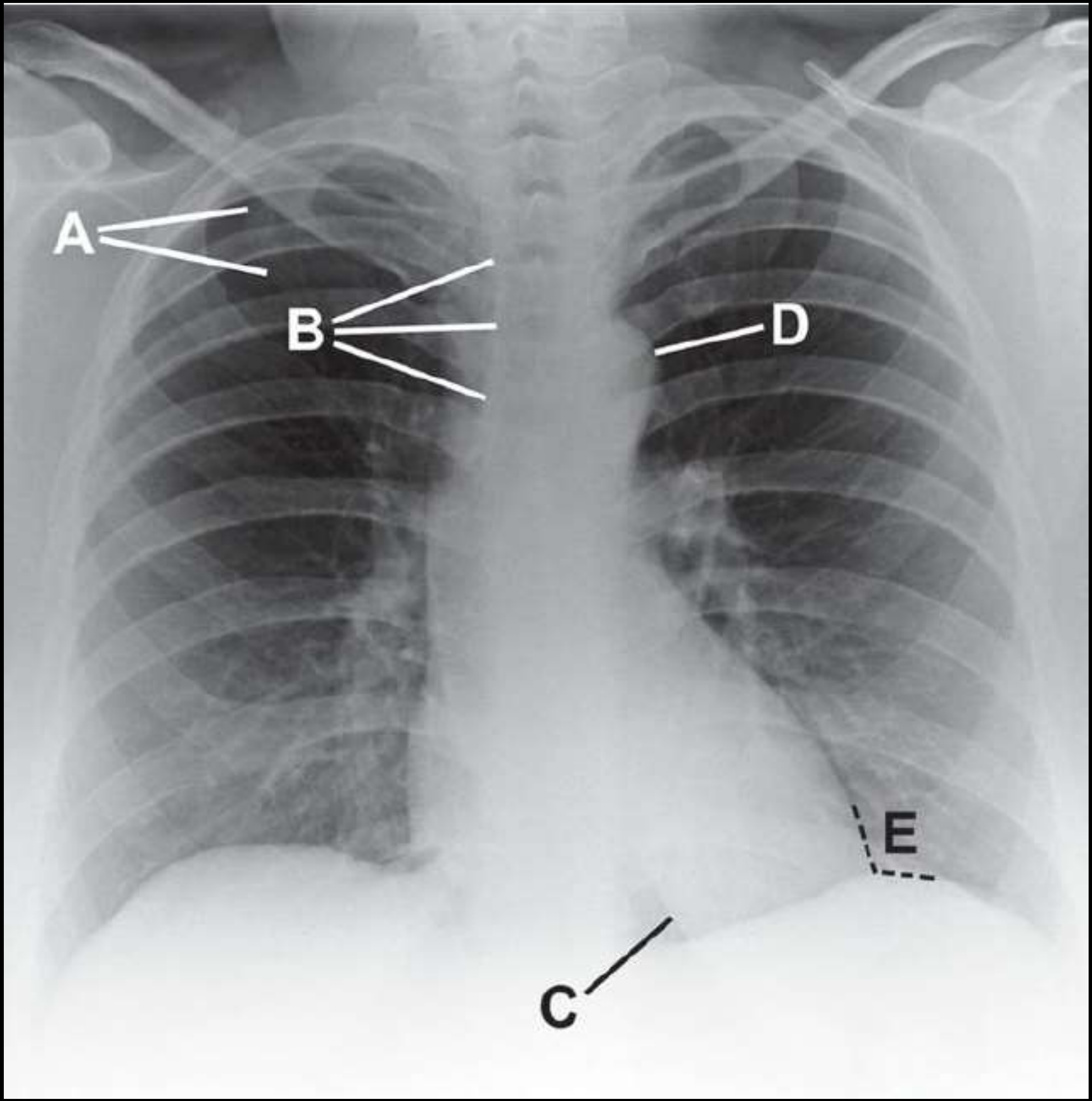
Cardiac and mediastinal silhouettes seen on the chest radiograph depend on there being contrast between the cardiac edge and adjacent aerated lung. Pathology within the chest can alter the appearance of one or more of these edges in a way that can enable accurate anatomical localization of the problem – the 'silhouette sign'.

The majority of the right cardiac border is made up of the right atrium with a small section of IVC inferiorly and the right hilum of the lung and SVC superiorly. From superior to inferior, the left mediastinal silhouette is formed by the left subclavian artery, distal aortic arch (aortic knuckle), pulmonary trunk and the hilum of the left lung. The left cardiac border is composed mostly of left ventricle, with the auricle of the left atrium forming the uppermost part of this border.

The left pulmonary artery spirals over the top of the left bronchus such that its branches come to lie posterior to the bronchi. The right pulmonary artery, longer than the left, passes anterior to the carina and at the lung root lies anterior to the bronchus. The right pulmonary artery gives off its branch to the upper lobe then enters the hilum where its branches also spiral over the bronchi to come to lie posterior to them.

Viewed from the front, the diaphragm curves up into the right and left domes. The highest point of the right dome is at the 6th intercostal space anteriorly (ranging from the 4th to the 7th). The left dome is usually 2cm lower than the right, although this may not be the case in all subjects. The level of the dome of the diaphragm can move about 4cm in deep respiration, but again there is a wide range of normal.

Felson B, Felson H. Localization of Intrathoracic Lesions by means of the Postero-anterior Roentgenogram: The Silhouette Sign. *Radiology* 1950; 55:363–374.


A
B
D
E
C

Q2 Answers

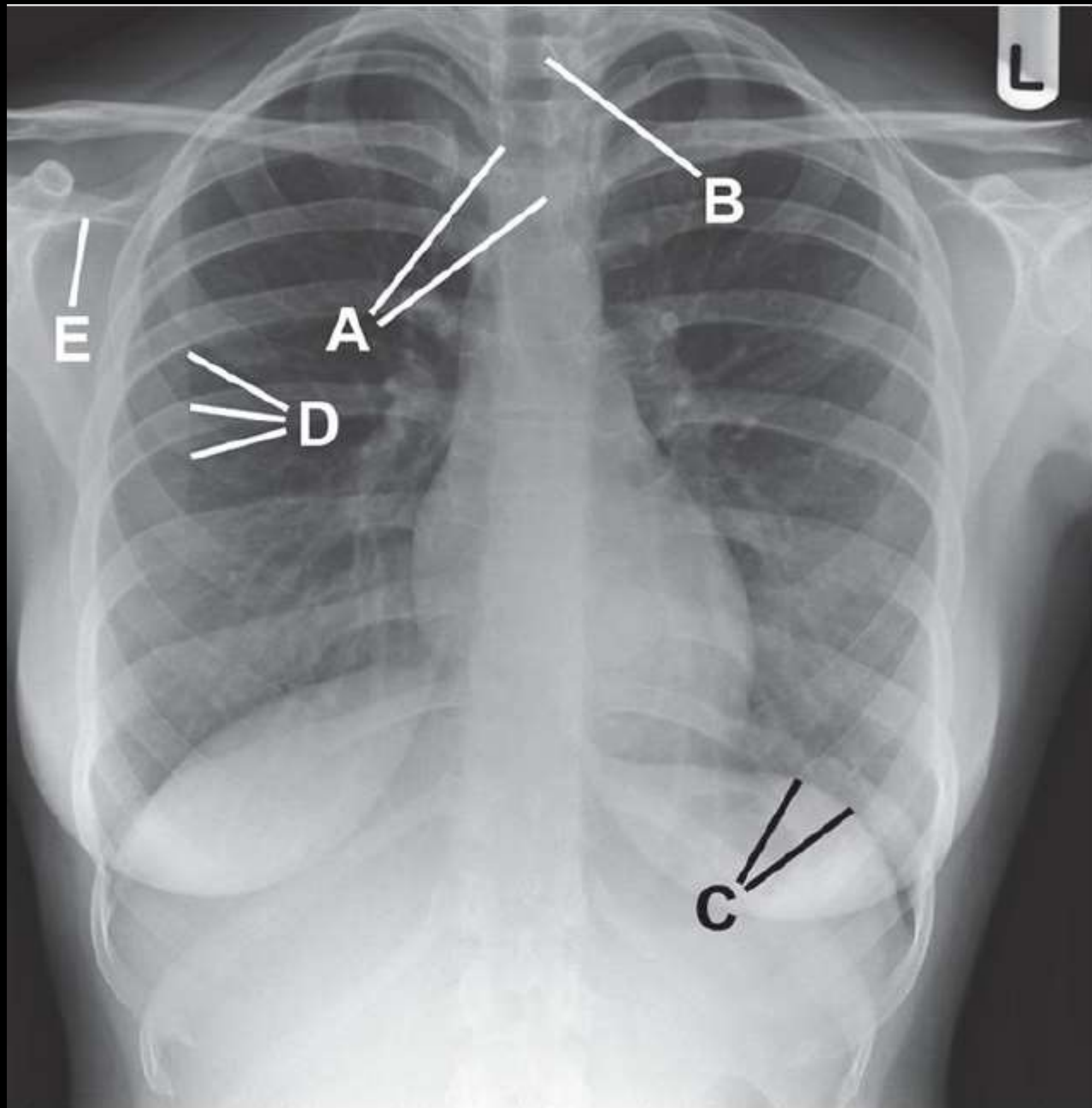
a Right 1st rib
b Paratracheal stripe
c Medial border of the left breast
d Aortic arch
e Left cardiophrenic angle

Chest radiograph, PA projection

The structures which create the mediastinal contour on a frontal radiograph are in part dependant on the age of the patient. The thymus is prominent in the superior mediastinum in paediatric patients and usually atrophies during childhood. The dense curved line on the right mediastinal border is formed by the ascending aorta, which lies relatively anterior in the chest. The distal aortic arch usually lies in the left posterior chest and is seen as the aortic knuckle.

The right paratracheal stripe is normally visible because the right upper pulmonary lobe lies immediately adjacent to the lateral tracheal wall. The opaque stripe is formed by the visceral and parietal pleura and some mediastinal fat. Normally the width should not exceed 3mm.

Breast shadows can produce lines which are projected over the chest.


L
B
A
E
D
C

Q3 Answers

a Trachea
b Spinous process
c Left phrenic nerve
d Medial border of right scapula
e Spine of right scapula

Chest radiograph, PA projection

The upper margin of the trachea as seen on a chest radiograph is approximately at the level of C6. It terminates at the carina, the position of which can vary depending on whether the radiograph is taken in inspiration (T4) or expiration (T6). The arch of the aorta and left-sided vessels lie along its left border and the pleura lies along the right (which forms the paratracheal stripe).

Vertebral spinous processes are viewed en face in this image.

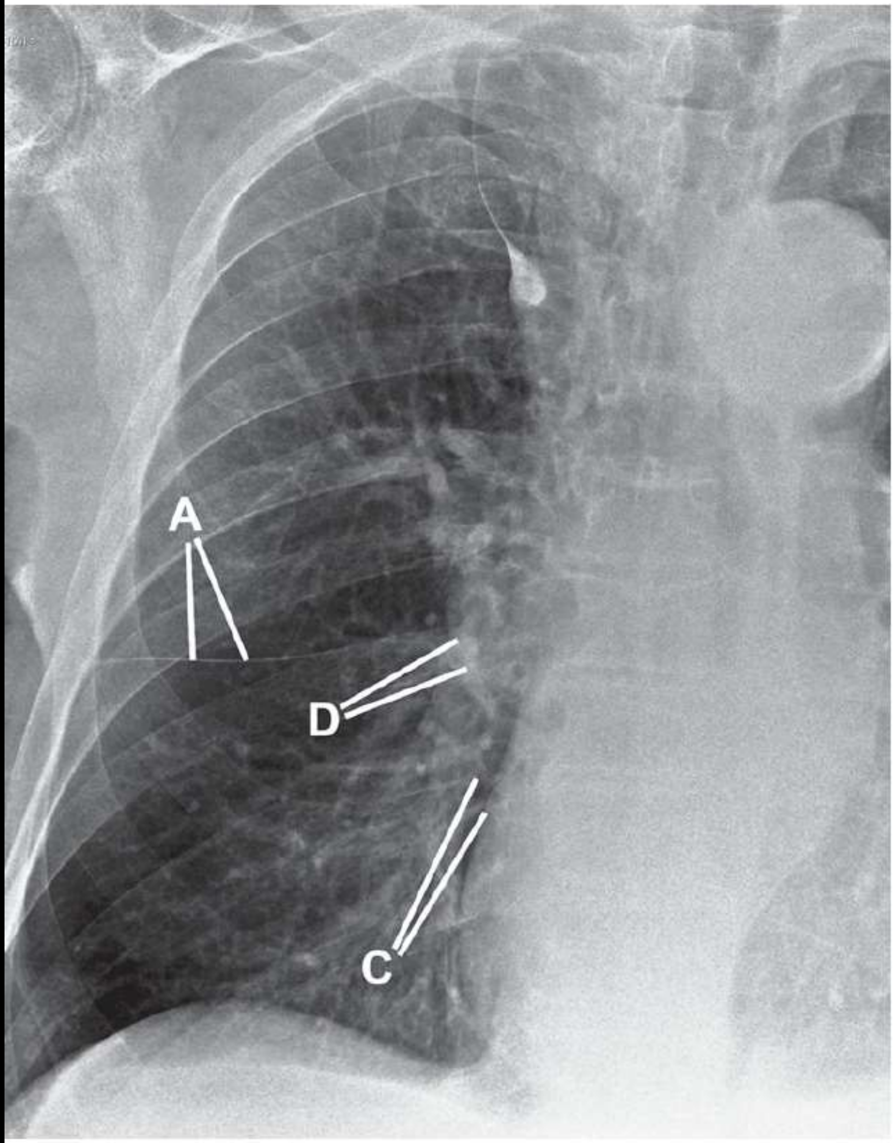
Hemi-diaphragms are mainly innervated by the left and right phrenic nerves, which arise from spinal nerve roots C3–5 and supply all motor and most sensory innervation (sensory innervation of the peripheral diaphragm is partly through intercostal nerves). Phrenic neuropraxia or neuropathy results in the ipsilateral hemidiaphragmatic dome lying in a more cranial position than usual due to muscle relaxation. This can be idiopathic or as a result of mediastinal disease.

Scapular position in the frontal radiograph can vary. Asking the patient to put their hands on hips or overhead causes supero-lateral rotation of the scapula and therefore lessens the degree of overlay seen on the radiograph.

Naveed N. Good positioning is key to PA chest x-ray exams. 2001 www.auntminnies.com

Q4

a Name the structure labelled A
b Name the structures located superior and inferior to the structure labelled A
c Name the airway labelled C
d Name the structure labelled D
e Name the anatomical variant demonstrated in this image



Q4 Answers

a Horizontal (minor) fissure
b Anterior segment of upper lobe (superior) and the middle lobe (inferior)
c Bronchus intermedius
d Anterior segmental pulmonary artery
e Azygos fissure

Chest radiograph, AP projection

On a frontal radiograph, the visible line of the minor fissure consists of two layers of adjacent visceral pleura; the top layer from the anterior segment of the right upper lobe with pleura from the right middle lobe as the lower layer. On a frontal radiograph it runs transversely from the interlobar artery at the hilum, usually within 1cm of the hilar point, to the lateral aspect of the 6th rib.

Accessory fissures are occasionally present and the most common of these is the azygos fissure. As a result of incomplete migration of the embryological azygos vein through the right upper lobe, there remains a fissure of invaginated parietal and visceral pleura with the azygos vein lying at the base. This is seen on frontal radiograph as a curvilinear line running from the mediastinum through the right upper zone with a rounded opacity at its lower end. The section of right upper lobe between the fissure and mediastinum is termed the azygos lobe, however it is not an independent segment as it derives arterial and bronchial supply from the apical or posterior segment of the right upper lobe. A triangular area that marks the uppermost margin of the fissure is known as the trigone parietale. Stibbe (1919) classified the azygos lobe into being one of three types depending on the position of the trigone on the pulmonary apex. In type A, the trigone is located on the lateral aspect of the pulmonary apex; in type B, the trigone is situated in the midpoint of the cupula of the apex and in type C, the trigone is located on the medial aspect of the apex. Opacification of the normal azygos lobe has been described, especially in type B and C configurations.

On a frontal radiograph it is common to see one or both of the anterior segmental bronchi and arteries as rounded structures which are viewed 'end-on'. They should measure approximately 4–5mm diameter with the bronchus usually lying more laterally.

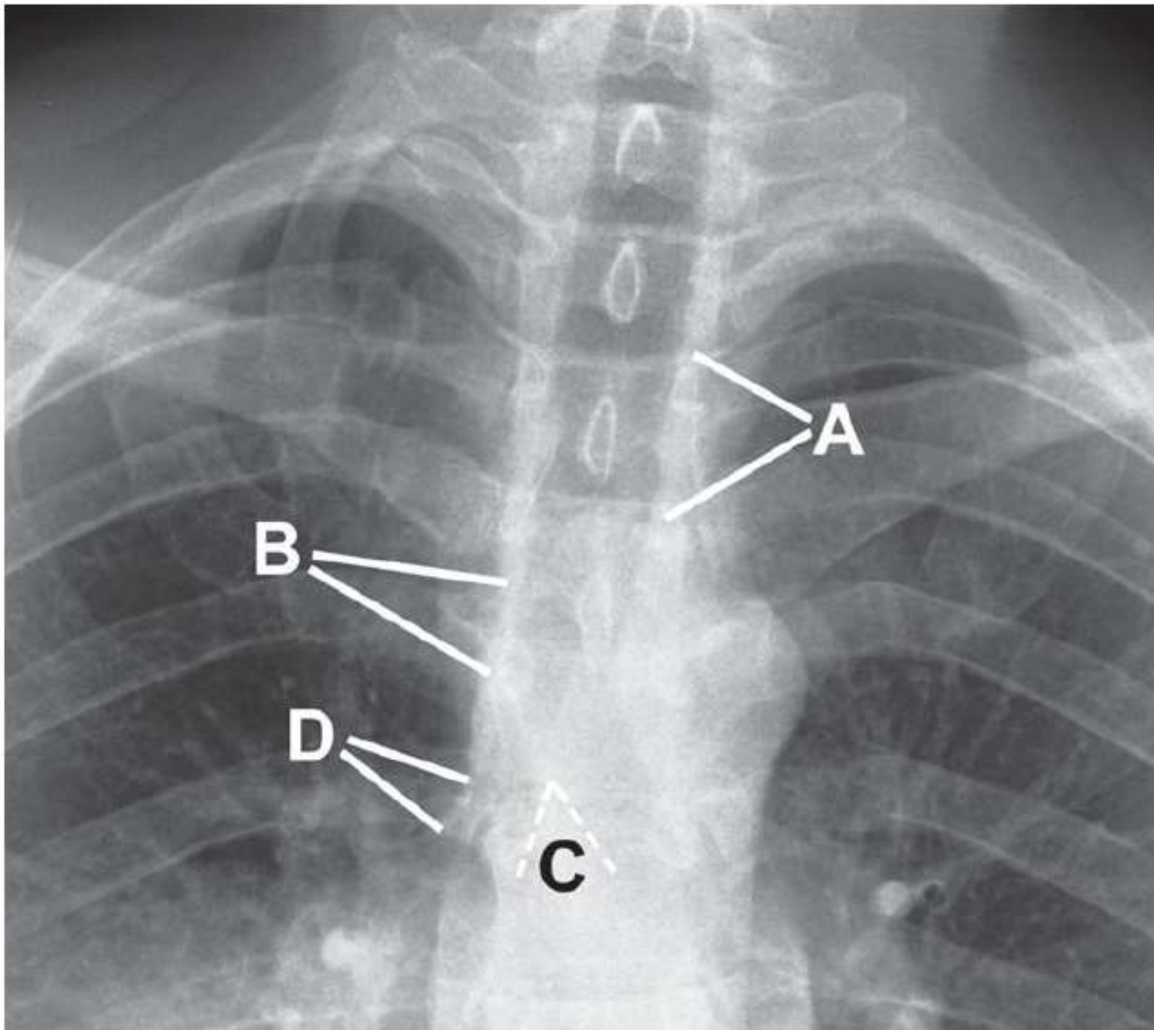
Stibbe EP. The Accessory Pulmonary Lobe of the Vena Azygos. *Journal of Anatomy* 1919; 53:305–314.

Caceres J. The Azygos Lobe: Normal Variants That May Simulate Disease. *European Journal of Radiology* 1998; 27:15–20.

Caceres J, Mata JM, Alegret X, Palmer J, Franquet T. Increased Density of the Azygos Lobe on Frontal Chest Radiographs Simulating Disease: CT Findings in Seven Patients. *Am J Roentgenol* 1993; 160:245–248.

Q5

a Name the lymph node station indicated by label A
b Name the lymph node station indicated by label B
c Name the lymph node station outlined and indicated by label C
d Name the lymph node station indicated by label D
e Name the anatomical variant demonstrated on this image



Q5 Answers

a Left upper paratracheal nodes (2L)
b Right lower paratracheal nodes (4R)
c Sub-carinal nodes (7)
d Right tracheobronchial nodes (10R)
e Right cervical rib

Chest radiograph, PA projection, zoomed up view

Lymph nodes are located throughout the mediastinum and there is wide variation amongst normal individuals in their number and distribution. The descriptive nomenclature used does not correspond with the anatomical divisions of the mediastinum but is based on lymph node maps which have been variously defined by Naruke (1967) and Mountain (1996). A revised internationally standardized mapping criteria compiled by Rusch (2009) has been adopted by the American Joint Committee on Cancer (AJCC) and the Union Internationale Contre le Cancer (UICC).

The location of nodes are divided into numbered 'stations' with the suffix 'L' or 'R' to define laterality where needed. The boundaries of the stations are not symmetrical, reflecting differences in lymphatic drainage between the left and right lungs. There are 14 numbered stations in total.

In practical terms, when describing lymph nodes in the context of lung cancer staging there are three groups: ipsilateral hilar and/or tracheobronchial nodes (stations 10–14); ipsilateral mediastinal or sub carinal nodes (stations 1–9); and contralateral hilar or mediastinal, scalene or supraclavicular nodes. Involvement of these nodes defines N1, N2 and N3 disease respectively.

A cervical rib is the product of excessive elongation of the costal element of the seventh cervical vertebra. It may be an osseous or fibrous structure which extends to the first rib. These can cause compression of the subclavian artery and T1 nerve root at the thoracic outlet.

Naruke T. The spread of lung cancer and its relevance to surgery. *Nippon Kyobu Geka Gakkai Zasshi* 1967; 68:1607–1621.

Mountain CF, Dresler CM. Regional lymph node classification for lung cancer staging. *Chest* 1997; 111:1718–1723.

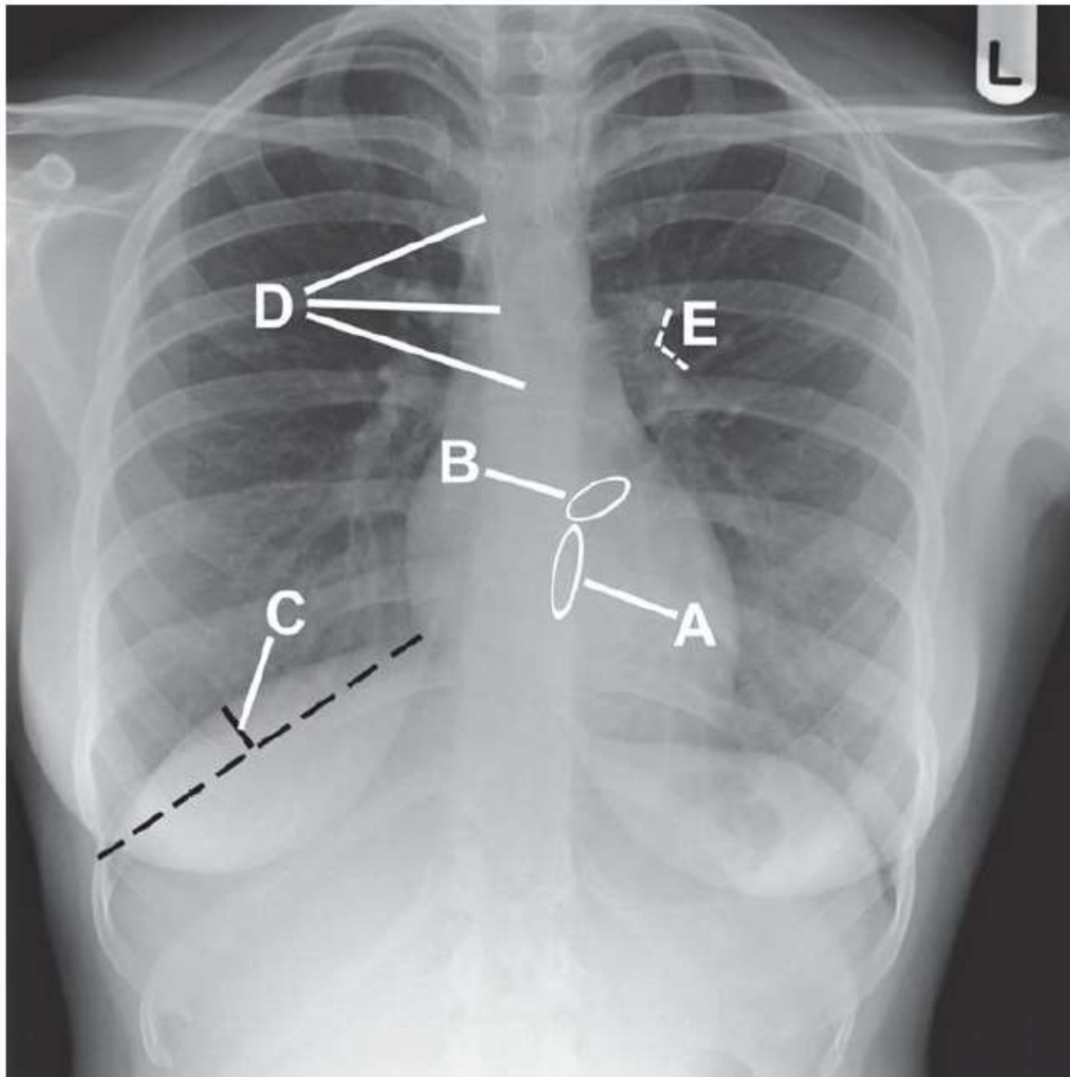
Rusch VW, Asamura H, Watanabe H *et al.* The IASLC Lung Cancer Staging Project: A Proposal for a New International Lymph Node Map in the Forthcoming Seventh Edition of the TNM Classification for Lung Cancer. *Journal of Thoracic Oncology* 2009; 4:568–577.

Sobin LH, Gospodarowicz MK, Wittekind C. *TNM Classification of Malignant Tumours*, Wiley-Blackwell, Chichester, 2009.

Edge SB, Byrd DR, Compton CC, Fritz AG. *AJCC Cancer Staging Manual*, 7th Ed, Springer, New York, 2010.

Q6

a Name the structure that lies in position A
b Name the structure that lies in position B
c Define the normal measurement of line C
d Name the structure labelled D
e Name the normal constituents of the structure outlined and labelled E



Q6 Answers

a Mitral valve
b Aortic valve
c >2.5cm
d Azygo-oesophageal stripe
e Superior pulmonary vein and lower lobe pulmonary artery (Hilar point)

Chest radiograph, PA projection

The cardiac valves are not usually visible on plain radiographs; however associated calcification or prosthetic implants can be seen. All four valves lie along a line from 3rd left to 6th right costal cartilages (or from the mid left atrium to the right cardiophrenic angle on chest x-ray (CXR)). In the frontal projection the mitral and aortic valves are positioned centrally. The mitral annulus is larger and usually orientated in a more vertical direction. The aortic valve is smaller and lies orientated at around 45 degrees to vertical. The lowest point of the aortic valve lies very close to the anterior annulus of the mitral valve and this is where the two are in fibrous anatomical continuity.

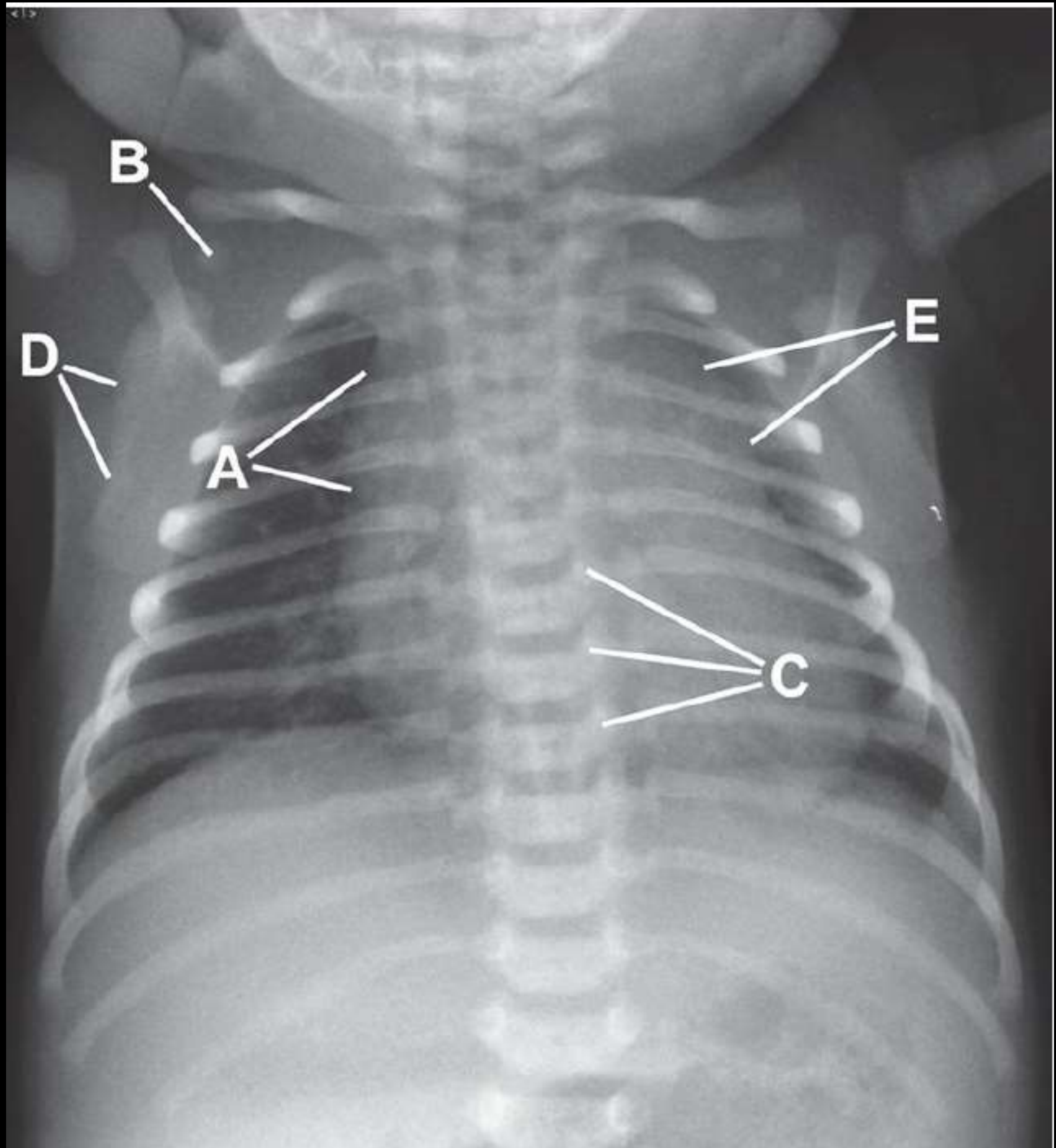
The diaphragmatic height can be calculated by drawing a line from the costophrenic angle to the cardiophrenic angle. Perpendicular measurement to the diaphragmatic dome should be >2.5cm, a height less than this suggests diaphragmatic flattening, possibly as a result of pulmonary hyperexpansion.

For descriptive purposes, when referring to pleural reflections around the mediastinum a 'line' typically measures <1mm in width, an example being the opposed layers of pleura of the fissures. A 'stripe' is typically >1mm wide and occurs when a mediastinal structure has gas on both sides (as in this case). An 'edge' is used to describe when structures of two different densities come into contact with each other.

The azygo-oesophageal stripe is formed where the azygos vein runs in close approximation to the right postero-lateral oesophageal margin. Following the course of the azygos vein, it is seen superiorly to veer towards the right. The right lung abuts the two structures at the azygo-oesophageal recess and, together with gas in the oesophageal lumen, forms this visible stripe.

The hilar point is formed where the superior pulmonary vein crosses the descending pulmonary artery. They should form an angle of approximately 120 degrees with the right hilar point projected over the 6th intercostal space and lying 1cm lower than the left.

Sussmann AR, Ko JP. Understanding chest radiographic anatomy with MDCT reformations. *Clinical Radiology* 2010; 65:155–166.



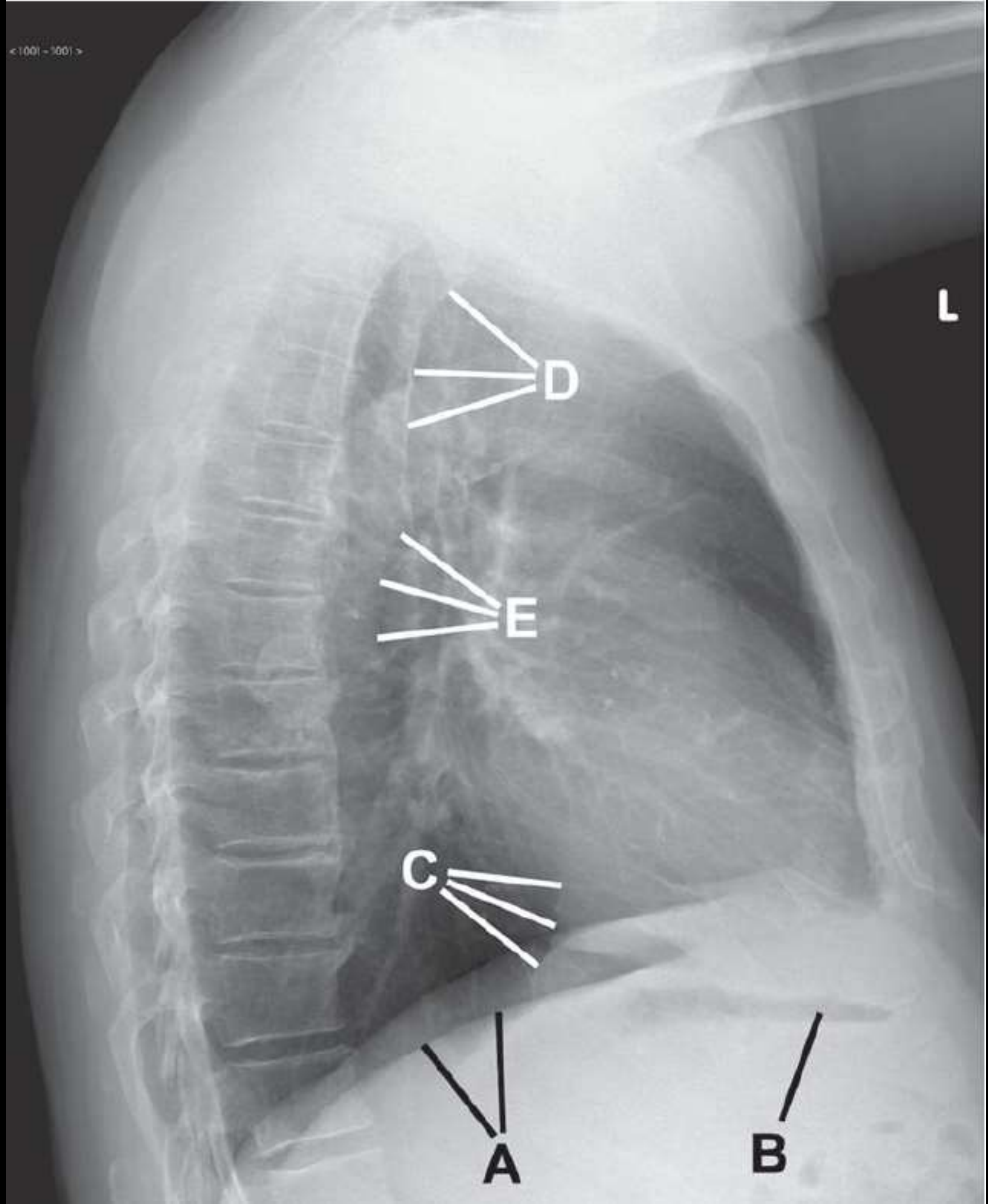
B
D
A
E
C

Q7 Answers

- **a** Right lobe of thymus
- **b** Secondary ossification centre of the coracoid process
- **c** Pedicles of the vertebrae
- **d** Lateral border of the scapula
- **e** Left lobe of thymus

Chest radiograph in a neonate, AP projection

The major intra-thoracic anatomy of the newborn is largely similar to that of an adult with the notable exception of the thymus gland. The thymus is a lymphoid organ which is located within the anterior mediastinum; its relative volume is far greater in infants than in adults. On a frontal radiograph the thymus commonly creates an opacity extending from the mediastinum into one or both lung fields; however the classic description of a triangular 'sail' sign is not always seen. The normal thymus is not usually visible on a frontal radiograph beyond the age of five years.



L
D
E
C
A
B

Q8 Answers

a Left hemi-diaphragm
b Gas bubble in gastric fundus
c IVC
d Scapular spine
e Descending aorta

Right lateral chest radiograph

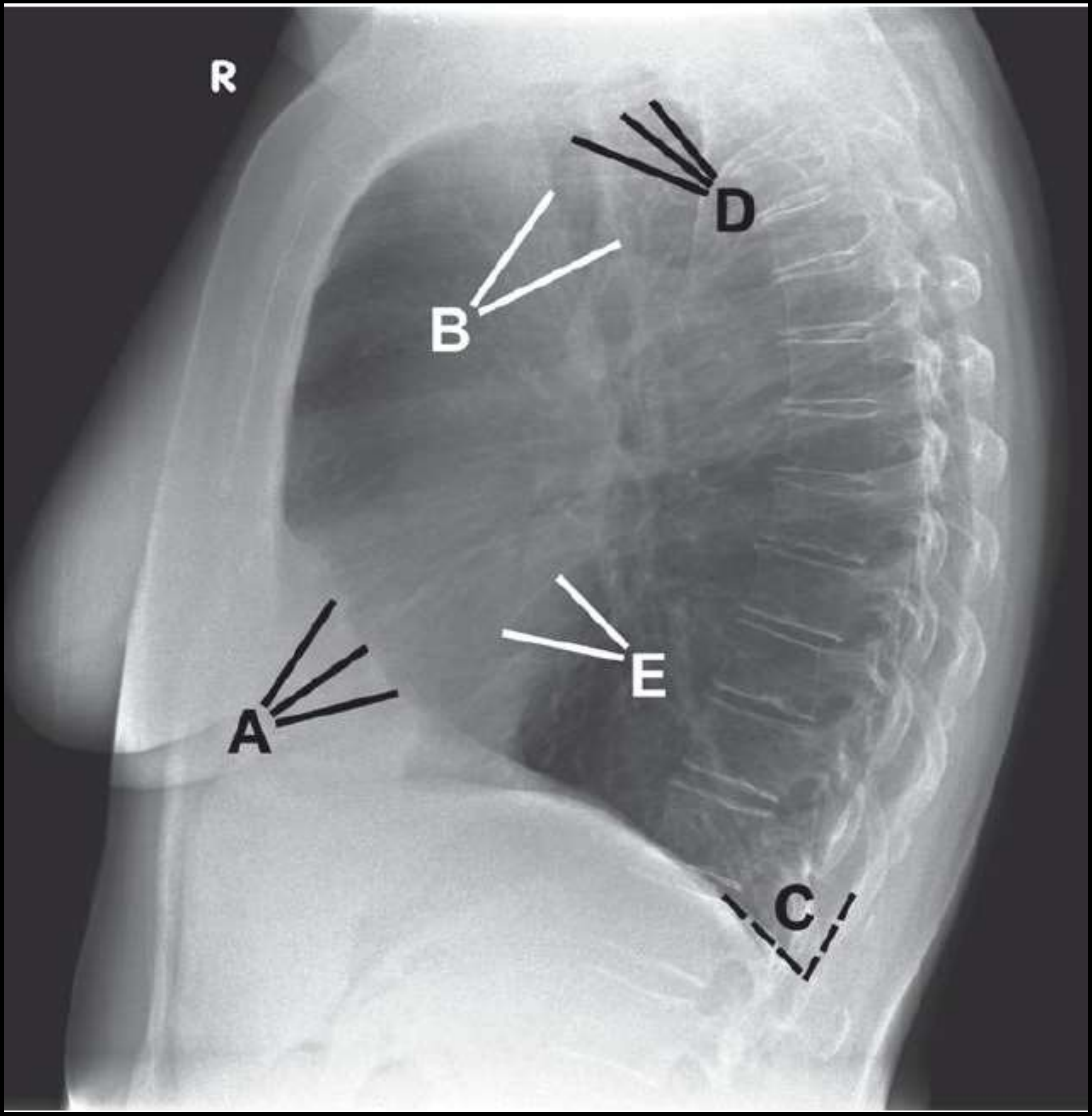
The dome of the left hemi-diaphragm is typically at a level inferior to that of the right and does not extend to the anterior chest wall due to the position of the heart. Along with the presence or absence of the gastric air bubble, these are features that can allow differentiation between the two hemi-diaphragms on a lateral chest radiograph.

The aortic arch can be seen in profile as it courses towards the back of the chest, becoming the descending aorta at around the level of the fourth thoracic vertebra. The superior and inferior vena cava both terminate at the right atrium and therefore lie towards the front of the chest (within the 'middle' mediastinum), with the IVC penetrating the right hemi-diaphragm at the level of T8 vertebral body.

To minimize composite bone overlap from the humerus, patients are asked to lift their arms out of the line of projection. This usually results in the scapula rotating externally and therefore entering into the field of view.

Padley S, MacDonald LS. *Grainger & Allison's Diagnostic Radiology*, Ch 12 – The Normal Chest, 5th Ed, Churchill Livingstone Elsevier, Edinburgh, 2008.

Ahmad N. Mastering AP and lateral positioning for chest x-ray. 2001 www.auntminnie.com


R
D
B
E
A
C

Q9 Answers

a Cardiac incisura (cardiac fat pad)
b Trachea
c Costophrenic recess (or sulcus)
d Left subclavian artery
e Oblique (major) fissure of left lung

Left lateral chest radiograph

The anterior aspect of the left lung base may come to lie in contact with the apex of the heart or more commonly with the epicardial fat pad. The latter of these will displace the lung from the antero-medial chest wall and can be mistaken for a mass lesion. The size and morphology of this fat pad can be variable, with rounded, angular and straight configurations described.

The costophrenic recess (or costophrenic sulcus) forms the inferior margin of the pleural cavity on both sides. Depth and location of the recess is dependant on, among other things, patient size, age and respiratory health. The lateral recess is seen readily on frontal radiographs, whereas the posterior aspect is best visualized using a lateral projection. On the right side, the posterior recess has been shown to be, on average, 3cm lower than the lateral costophrenic recess with its inferior aspect at the level of the L1 vertebral body.

Both the left subclavian and right brachiocephalic arteries travel postero-superiorly in the upper thorax and can be seen as they cross the air-filled trachea. The margin of the left subclavian artery can be seen to follow a gentle curve across the posterior aspect of the trachea. In contrast, the brachiocephalic artery has a slightly convex appearance in most people. The silhouette of both vessels should have only slightly curved margins and any striking linear convexity within this region could be the result of an underlying mass lesion.

Oh JK, Ahm MJ, Kim HL, Park SH, Shin E. Retrodiaphragmatic portion of the lung: how deep is the posterior costophrenic sulcus on posteroanterior chest radiography? *Clinical Radiology* 2009; 64:786–791.

Sussmann AR, Ko JP. Understanding chest radiographic anatomy with MDCT reformations. *Clinical Radiology* 2010; 65:155–166.

Q10

a Name the structure labelled A
b Name the joint space labelled B
c Name the joint positioned lateral to B
d Name the structure labelled D
e Name the structure labelled E

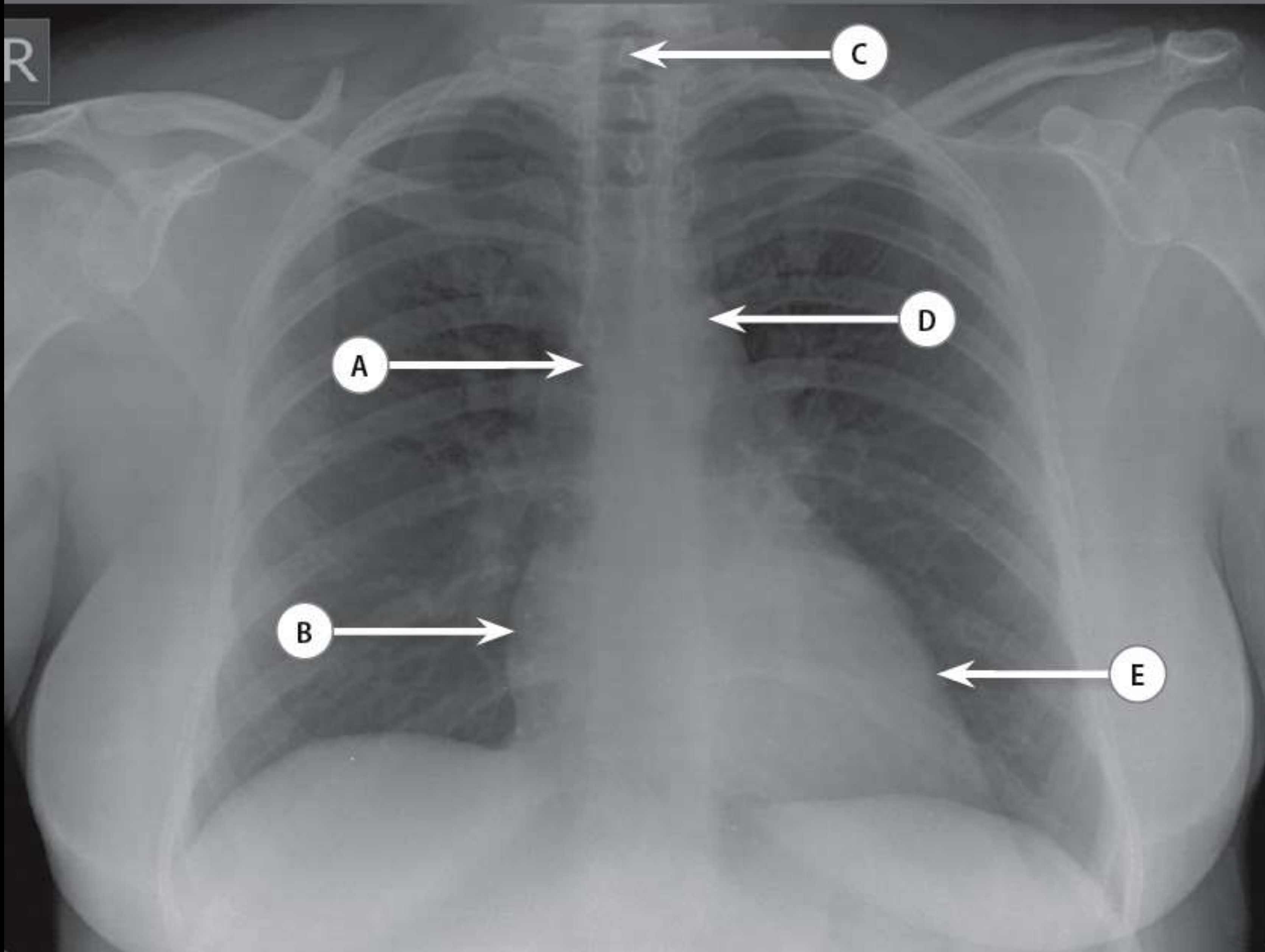
Q10 Answers

a Clavicle
b Manubriosternal joint
c 2nd sternocostal joint
d Manubrium
e Body of the sternum

Radiograph of the sternum, lateral view

The sternum is an anterior midline structure which gives structural support to the anterior thoracic wall. The upper bone is the manubrium. This has lateral articulations with the first costal cartilage by means of a primary cartilaginous joint. The manubriosternal joint is a symphysis where the manubrium articulates with the body of the sternum. This joint is slightly angulated (angle of Louis) and indicates the level of the 2nd sternocostal joint. Posteriorly the manubriosternal joint is at the level of the disc between vertebrae T4 and T5. Above this level is the superior mediastinum and below it the inferior mediastinum. The body of the sternum articulates with the costal cartilages of the 3rd–7th ribs by means of single synovial joints. At the inferior aspect of the sternum is the xiphisternal joint which is a symphysis between the body of the sternum and xiphoid process. The manubriosternal and xiphisternal joints frequently calcify in later life.

Case 2.1



Case 2.1

A Right main bronchus

B Right atrial border

C Spinous process T1

D Aortic arch

E Left ventricle border

Plain frontal chest radiograph.

The bifurcation of the trachea lies at the level of the sternal angle (T5 level; T4 on inspiration, T6 on expiration). The trachea begins at C6 level at the lower border of the cricoid cartilage. The trachea is lined by ciliated columnar epithelium, is approximately 15 cm long, 2 cm in diameter, and made of 15–20 incomplete rings of cartilage which are completed posteriorly by the trachealis muscle.

The right atrium forms the right heart border and the superior and inferior vena cavae drain into its superior and inferior parts respectively.

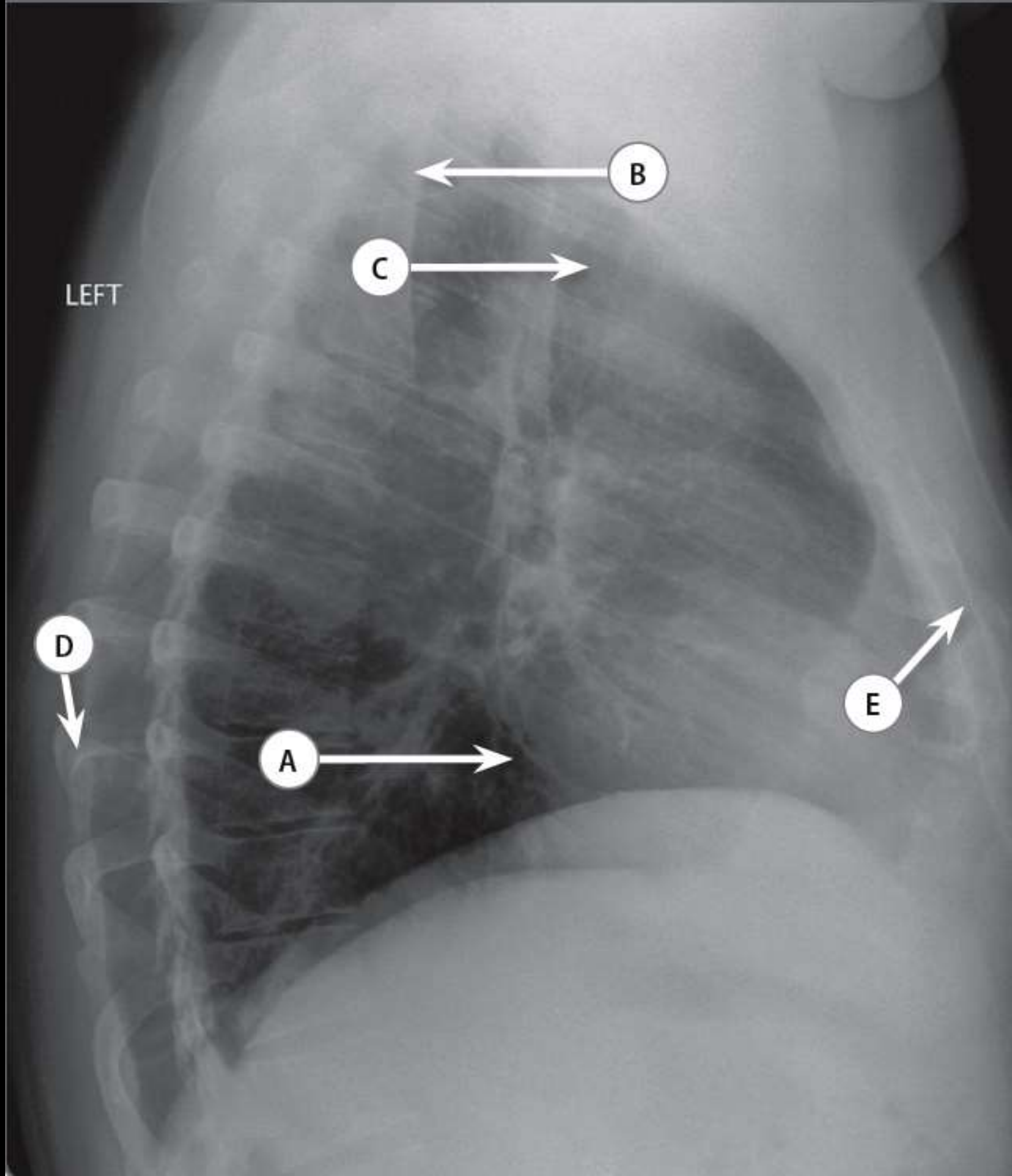
You can identify structure C as the spinous process of T1, as the first ribs originate from this vertebra.

The aortic arch passes posteriorly from right to left to lie just left of T4. It is anterior to the trachea and arches over the left main bronchus and pulmonary artery. The left upper lobe lies anterior and to the left of the aortic arch. On the right are trachea, oesophagus, thoracic duct and body of T4 from front to back. The ligamentum arteriosum is the fibrous remnant of the ductus arteriosus which is connected to its inferior aspect. The aortic isthmus is the junction of the descending aorta with the arch. This is liable to injury in blunt trauma as it is fixed.

The left ventricle forms the left heart border.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 90.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 120.
Weber E, Netter FH, Vilensky JA, Carmichael SW. Netter's Concise Radiologic Anatomy. Philadelphia: Saunders/Elsevier, 2009: 183.

Case 2.27



Case 2.27

A Left atrial border

B Left scapula

C Trachea

D Right 8th rib

E Body of sternum

Plain lateral chest radiograph.

The left atrium forms the left posterior heart border. The left ventricle can be identified as the most posterior and inferior of the cardiac chambers.

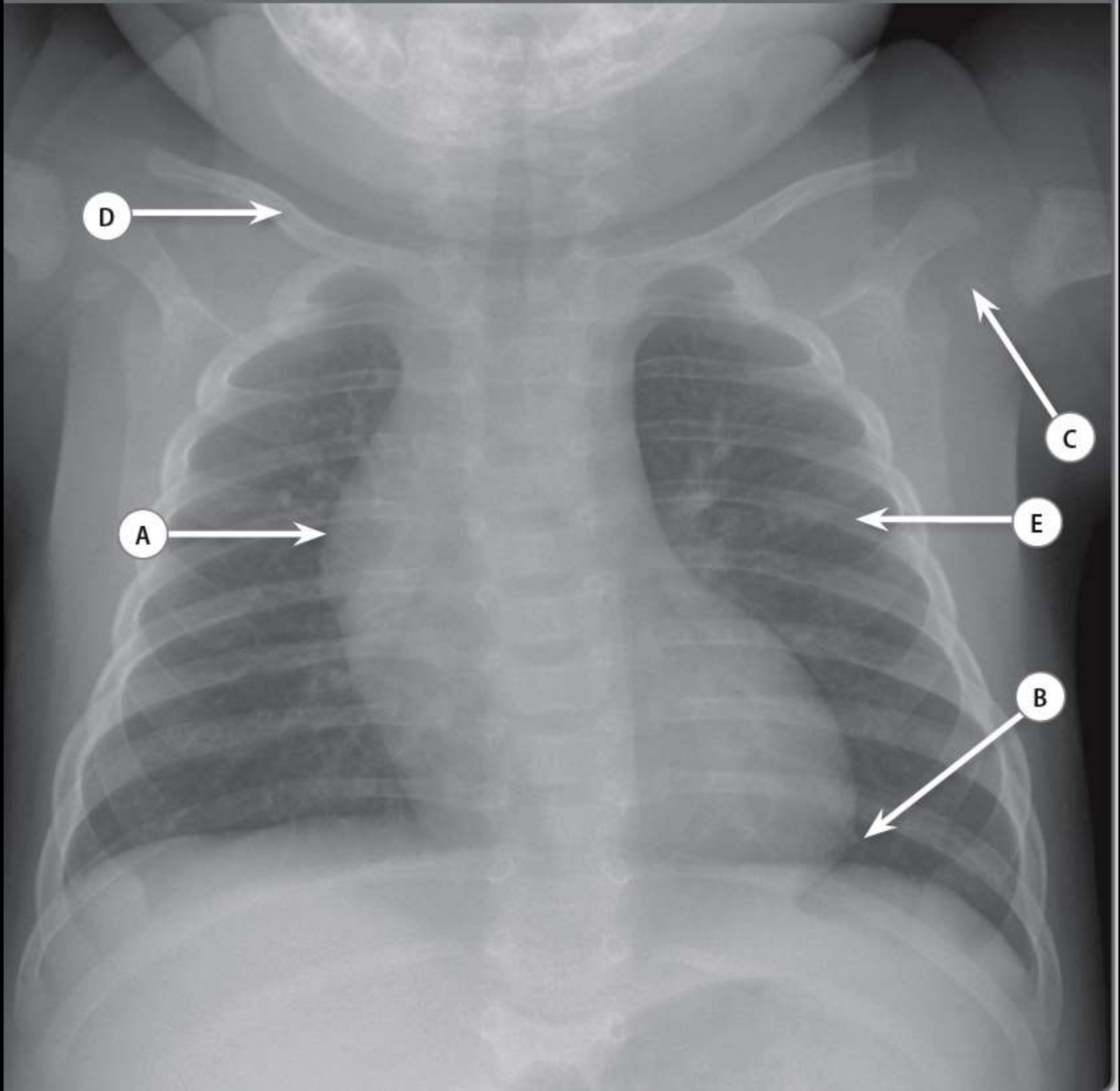
The lower trachea is supplied by branches of the bronchial artery. The upper trachea is supplied by the inferior thyroid artery. The arch of the aorta may be seen to indent the left side of the trachea just above the carina.

The sternum consists of three fused bones: manubrium, body of sternum and xiphoid process. Superiorly, the junction of the manubrium with the body of sternum is called the 'Angle of Louis'. This is at the level of T4/T5, where the 2nd rib articulates. This is the same level as the aortic arch and the carina.

In order to ascertain which rib is labelled, one can use the 'big rib sign'. On a well positioned left lateral chest radiograph, the left ribs are in contact with the film. The right ribs are farther from the film than the left, and are therefore magnified and look bigger.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 91.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 121.
Kurihara Y, Yakushiji YK, Matsumoto J et al. The ribs: anatomic and radiologic considerations. Radiographics 1999; 19:105–119.

Case 2.32



Case 2.32

A Thymus

B Left cardiophrenic angle

C Ossification centre of left humeral head

D Right clavicle

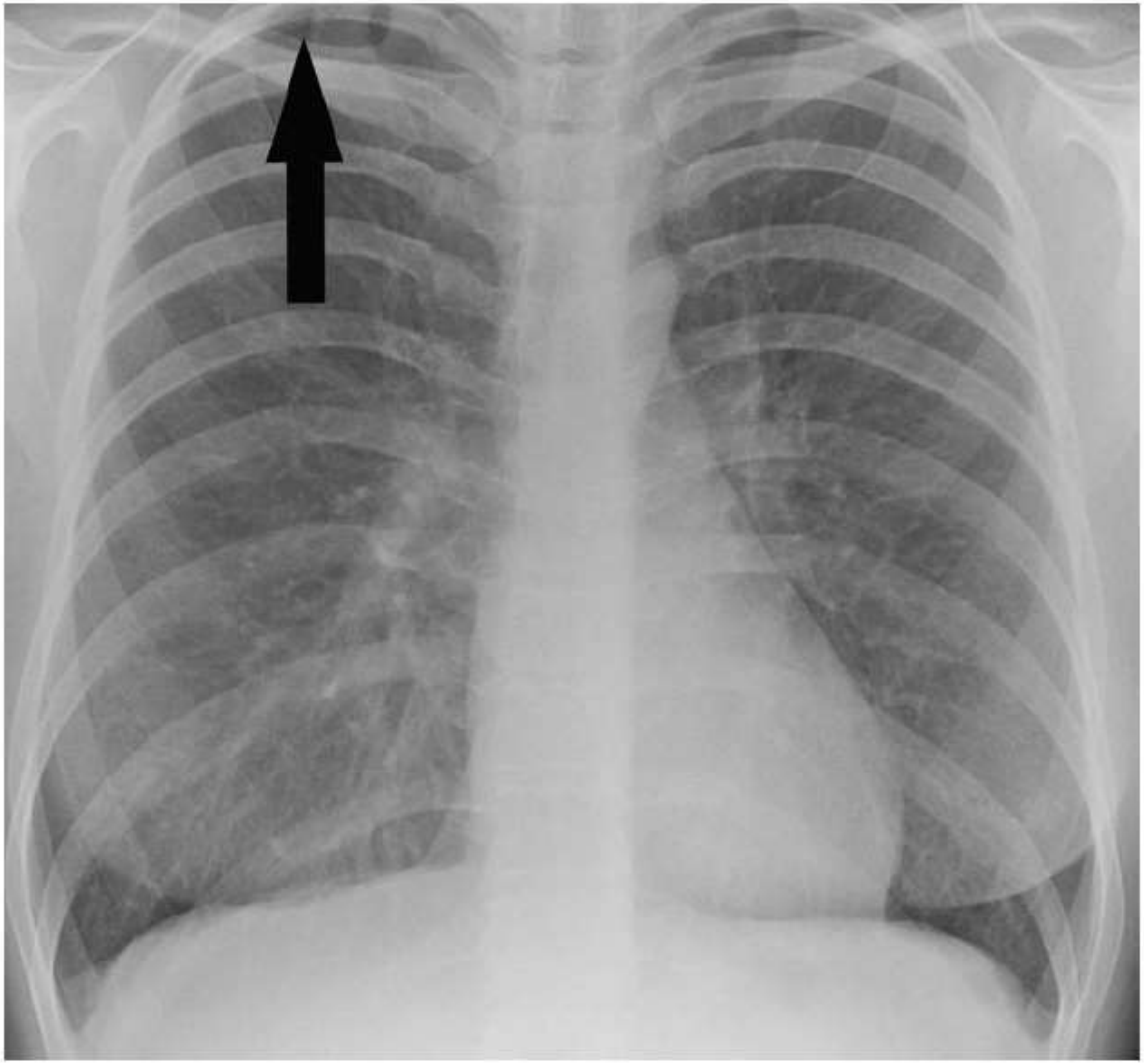
E Left posterior 5th rib

Frontal chest radiograph.

The thymus is a soft structure of the lymphatic system which sits in the anterior mediastinum. It has left and right lobes. It is hugely variable in size and shape, and because of its soft density, the lateral edges may appear 'wavy' as they conform to the overlying ribs and intercostal spaces. Lung markings may be seen through it, and a normal thymus should never deviate other structures. The thymus normal involutes by around age 8, but may be seen as a small remnant of anterior mediastinal soft tissue on CT in adults.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 147–148.

Question 6:



Question 6: PA chest radiograph

Answer: Companion shadow beside the right clavicle

- The companion shadow is the skin and subcutaneous fat that are seen as a thin soft tissue stripe along the upper edge of the clavicle. It should not be mistaken for an abnormality.
- Similar companion shadows can be formed by the ribs and scapulae. They are not always seen on a radiograph.

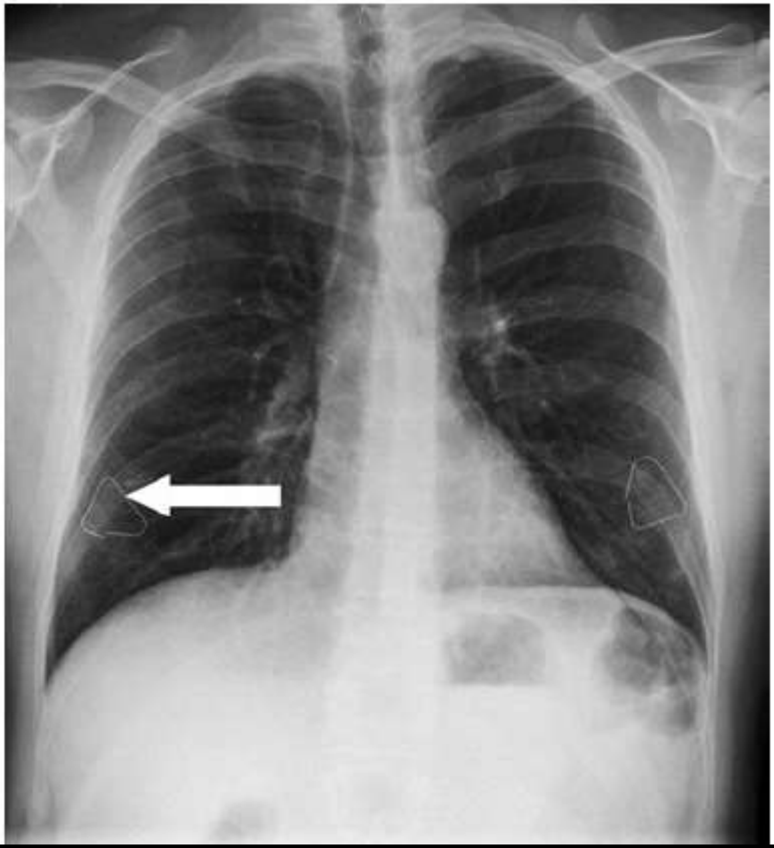
- **Question 9:**

Question 9: PA chest radiograph

Answer: Left first rib

- The first rib is the flattest and most curved rib.
- The first rib arises from the upward sloping transverse process of the first thoracic vertebra; this distinguishes it from a cervical rib, which arises from the downward sloping transverse process of the seventh cervical vertebra.

Question 14:

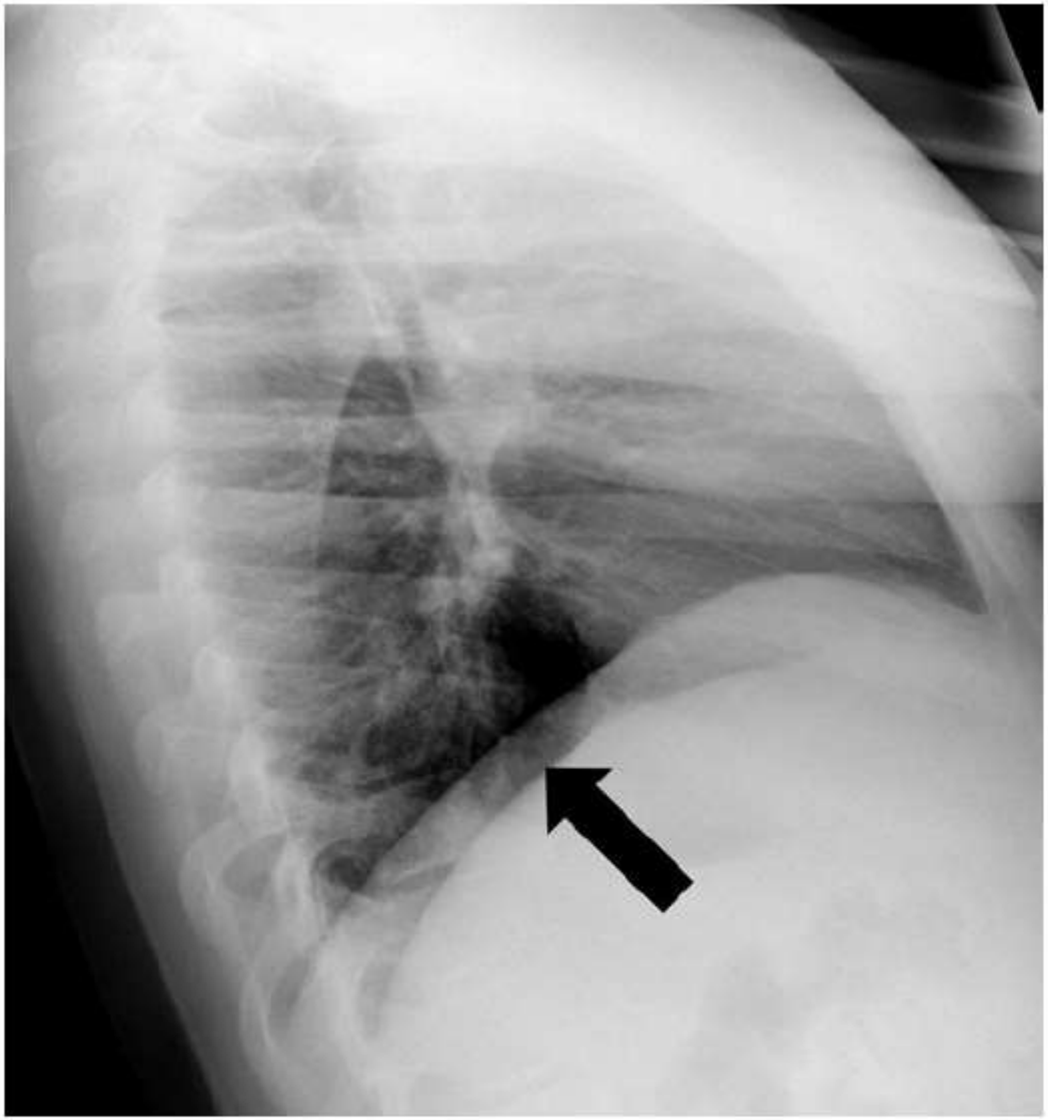


Question 14: PA chest radiograph

Answer: Right nipple marker

- A nipple marker is a high-density object (usually a metallic triangle or marker) that is placed over the nipple to help differentiate nipple shadows that appear as soft tissue densities from a true parenchymal nodule in erect chest radiographs.
- Nipple shadows, if present, have a characteristic location at the level of the fifth or the sixth anterior rib and often have a well-defined lateral margin; their location can vary with breast size.

Question 18:

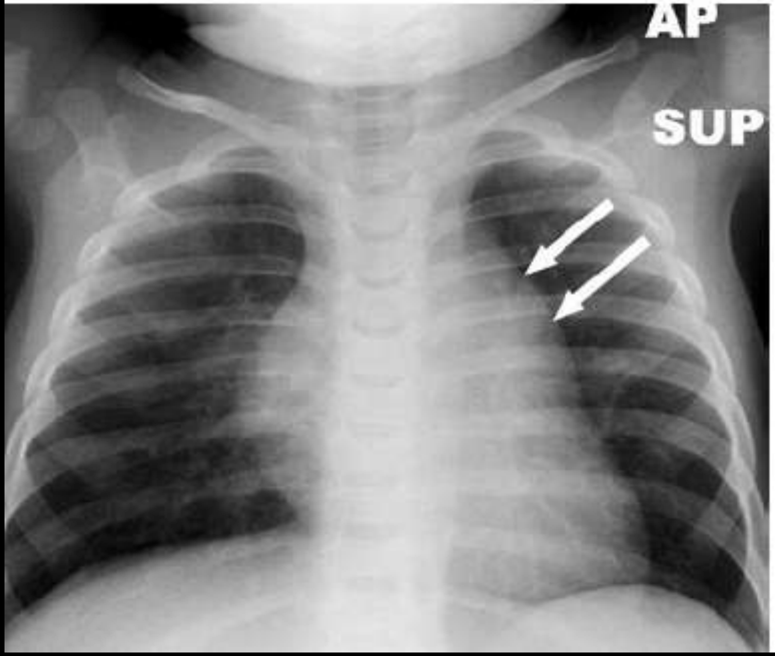


Question 18: Lateral chest radiograph

Answer: Left hemidiaphragm

- The diaphragm is a 2-3 mm thick highly convex muscle that forms the floor of the thoracic cage. It consists of a dome-shaped central tendon surrounded by sheets of striated muscle that attach to three groups of muscles or 'slips': the costal, sternal, and lumbar slips.
- It is easy to distinguish the left hemidiaphragm from the right on a lateral chest radiograph.
- The right hemidiaphragm can be seen in its entirety from the costophrenic recess posteriorly to the anterior aspect of the thorax. It is also usually higher than the left hemidiaphragm.
- Conversely, only part of the left hemidiaphragm is visible on a lateral radiograph. The outline of the left hemidiaphragm extends from the costophrenic recess to the back of the cardiac shadow.

- **Question 21:**

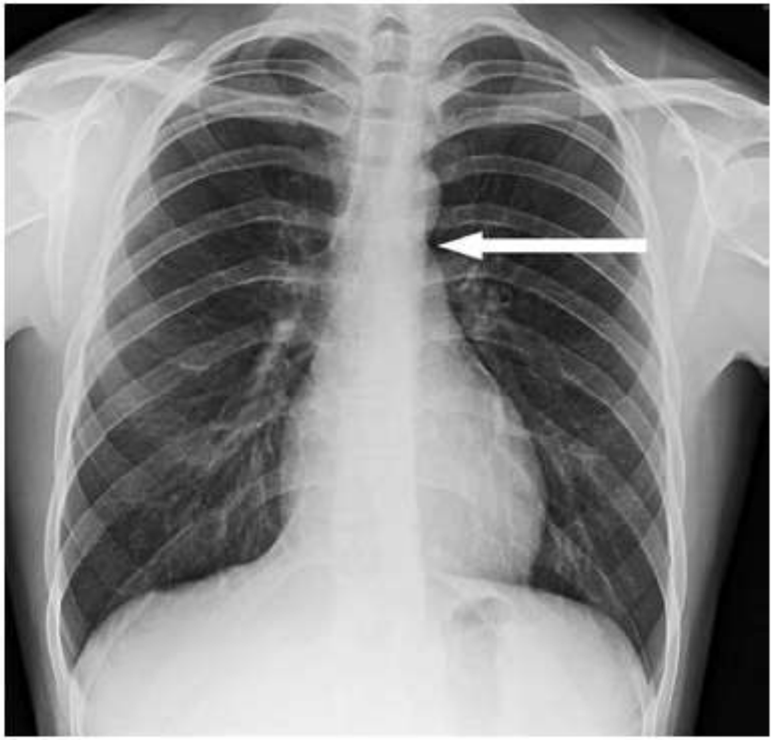


Question 21: PA chest radiograph

Answer: Thymus

- The thymus is an anterior mediastinal structure situated anterior to the aorta and right ventricular outflow tract.
- It varies in size but, as a general rule, it is largest in children and adolescents where it is commonly bi-lobed or triangular in shape.
- This is one of the frequently occurring questions in the examination. Make sure to familiarise yourself with the variable appearances of the thymus in children.

- **Question 24:**

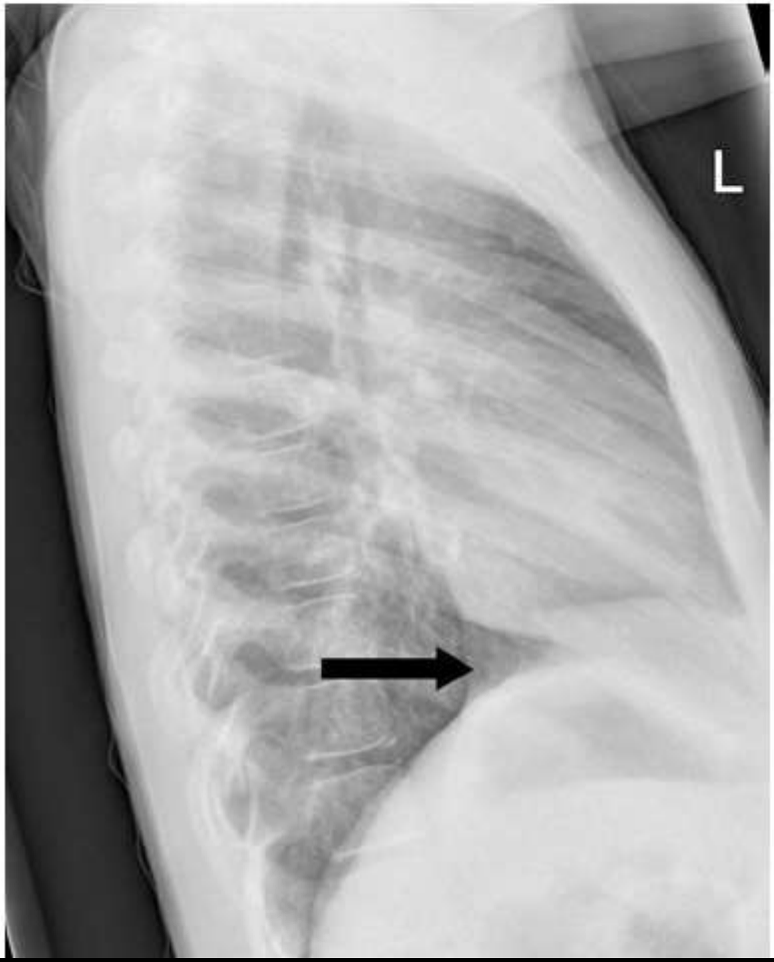


Question 24: PA chest radiograph

Answer: Aortopulmonary window

- An aortopulmonary window is a radiological mediastinal space seen on frontal chest X-rays. It is a concave space that is bounded by the aortic arch superiorly and the left pulmonary artery inferiorly.
- It contains the ligamentum arteriosum, the left recurrent laryngeal nerve, lymph nodes, and fatty tissue.
- It is a common site for tumours and lymphadenopathy, in which case the concavity will be lost.

Question 28:

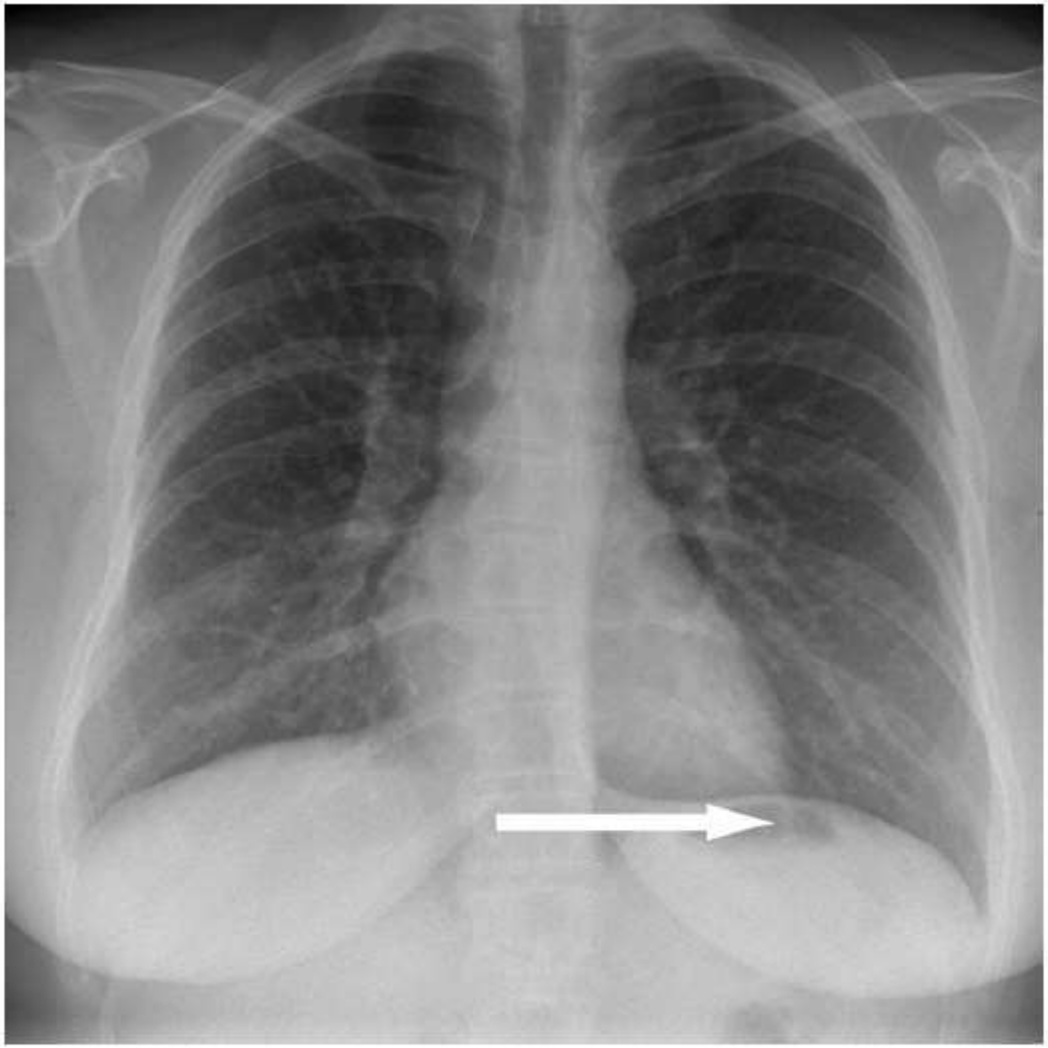


Question 28: Lateral chest radiograph

Answer: Inferior vena cava

- The thoracic inferior vena cava (IVC) is an extremely short segment.
- On a lateral radiograph, the thoracic IVC occupies the posteroinferior corner of the posterior cardiac silhouette.
- The IVC can be difficult to delineate on a frontal chest radiograph. However, it forms part of the cardiomediastinal silhouette where it occupies the right cardiophrenic angle.

Question 32:



Question 32: PA chest radiograph

Answer: Stomach bubble

- The stomach bubble is air in the fundus of the stomach.
- The bubble of air will be seen below the left hemidiaphragm if the patient is erect.
- It is useful to recognise this because, if the bubble is on the right, it provides a clue that the patient has situs inversus.

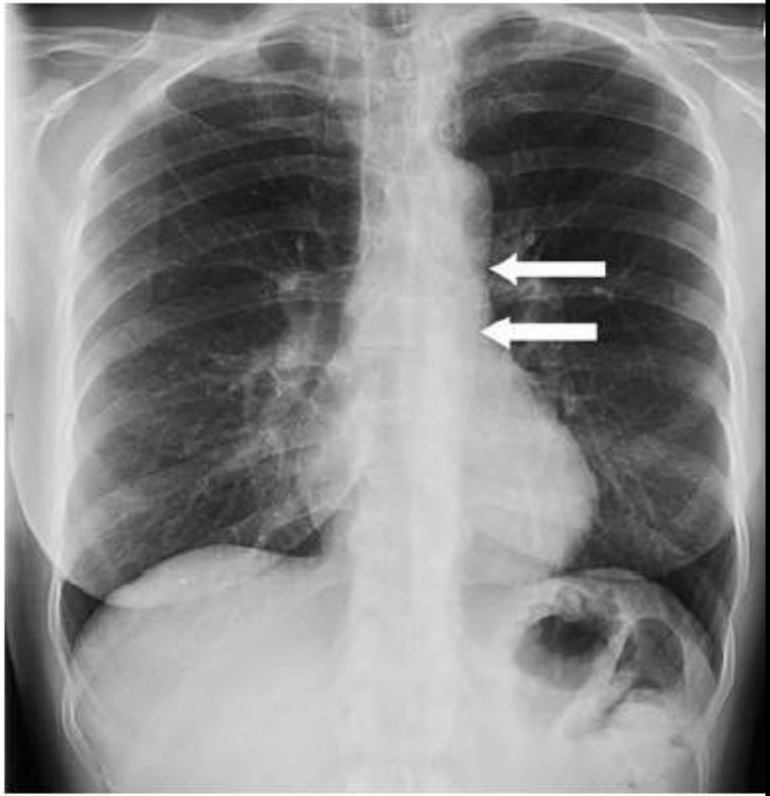
- **Question 34:**

Question 34: PA chest radiograph

Answer: Right hilar point

- The hilar point is the crossing point between the lower lobe pulmonary artery and the upper lobe pulmonary vein. The right hilar point lies at the level of the right 6th rib in the mid-axillary line.
- The left hilum is approximately 1 cm higher than the right. This is because the main pulmonary artery on the right passes anterior to the right main bronchus, whereas the left main pulmonary artery passes posteriorly and hooks over the left main bronchus.
- The hilar points are at the same level in approximately 5% of normal chest X-rays.
- The hilar angle is the angle between the two vessels and is normally 120°.

Question 39:

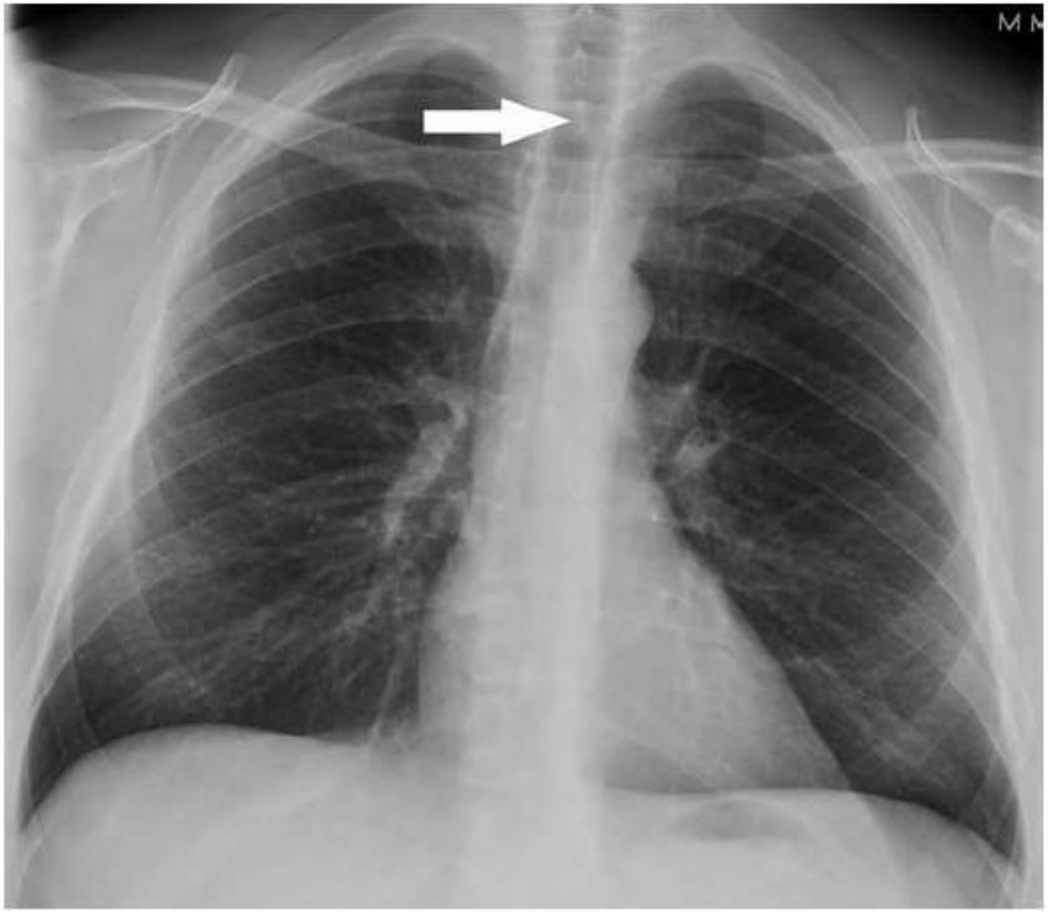


Question 39: PA chest radiograph

Answer: Descending aorta

- The descending thoracic aorta is identifiable on the frontal and lateral projections of the chest radiograph.
- On the frontal projection, the lateral border of the descending aorta is seen behind the heart and lateral to the vertebral bodies.
- On the lateral projection, the descending aorta is seen less clearly overlying the thoracic spine.

- **Question 43:**



Question 43: PA chest radiograph

Answer: T3 spinous process

- The spinous process is a bony prominence that is the midline coalescence of the two laminae.
- It is directed posteriorly and inferiorly at all levels and acts as an attachment for muscles and ligaments.
- The vertical distance between the spinous processes should be uniform. An abnormally increased or decreased distance is suspicious for a fracture or dislocation of the facet joints.

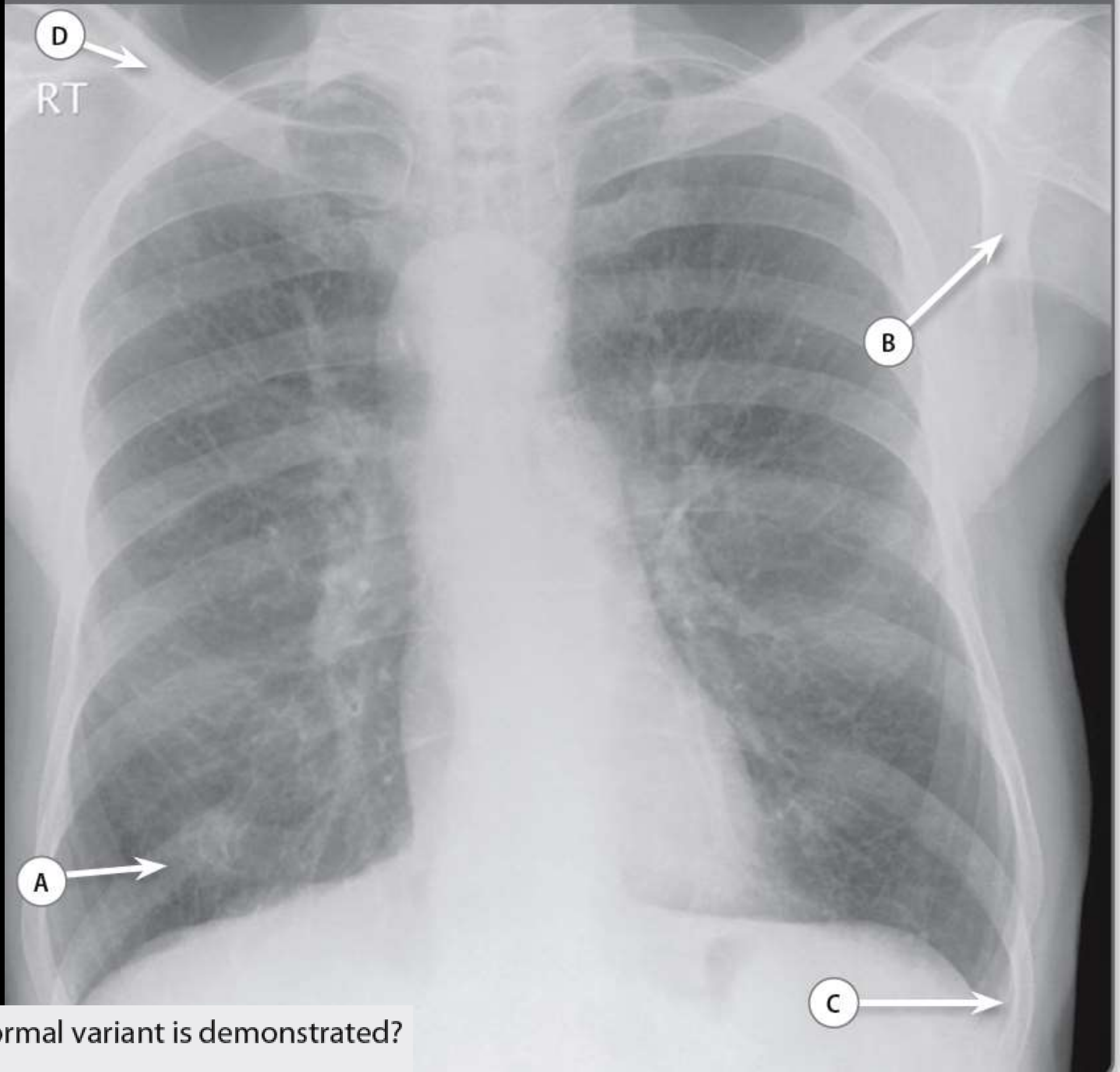
- **Question 48:**

Question 48: PA chest radiograph

Answer: Right cervical rib

- A cervical rib is an extra rib that arises from the transverse process of C7.
- It can be a bony or fibrous band.
- It occurs in 1 to 2% of the population. Cervical ribs are bilateral in 50% of cases.
- To distinguish this from a normal first rib, look at the transverse process from which it arises. A normal first thoracic rib will arise from an upward-sloping transverse process because the transverse processes of the thoracic vertebrae are always orientated in a superior direction. Conversely, the transverse processes of the cervical vertebrae are downward-sloping.

Case 5.1



Which normal variant is demonstrated?

Case 5.1

A Right 10th rib

B Left scapula

C Left costophrenic angle

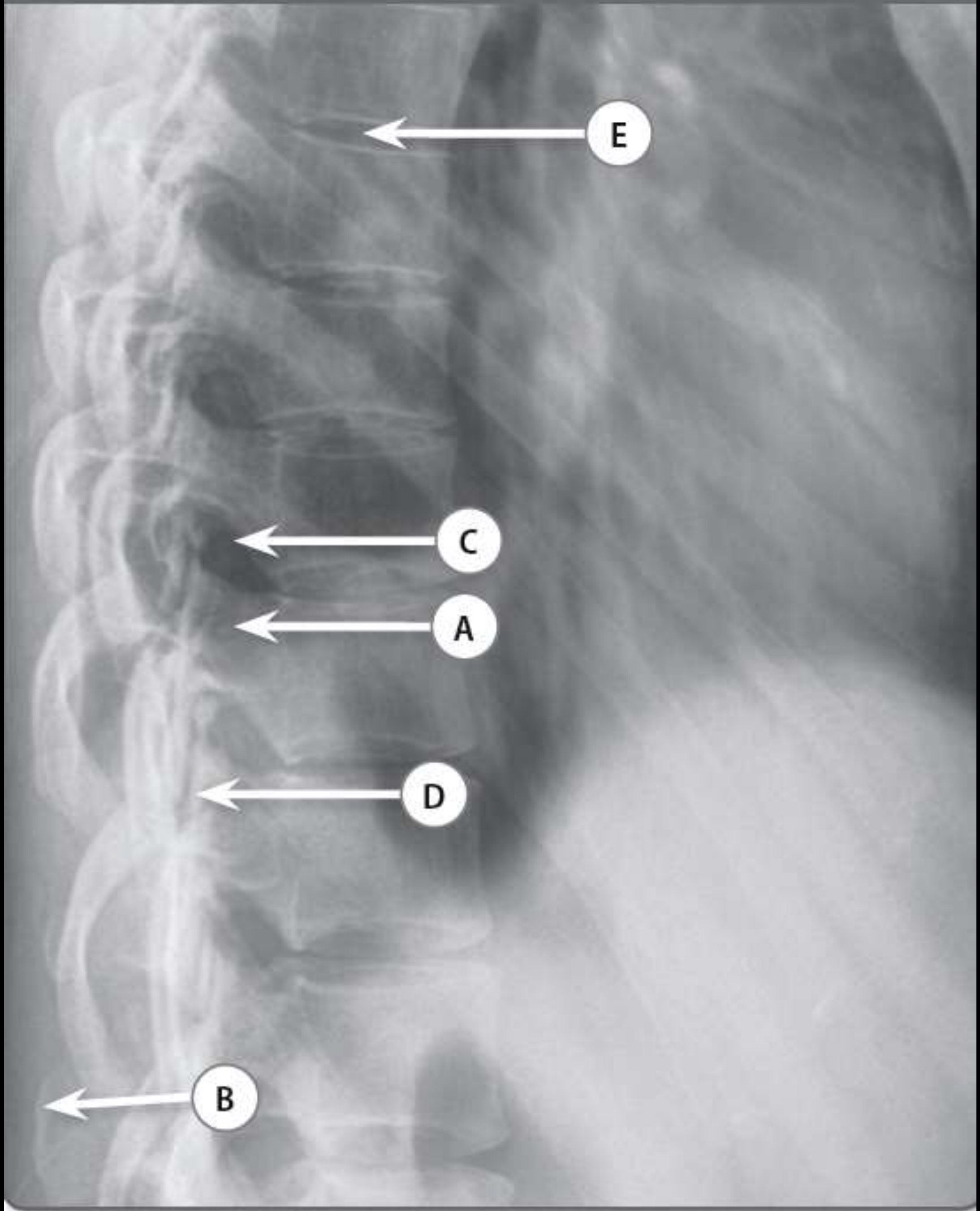
D Right clavicle

E Name the normal variant: right aortic arch

Frontal radiograph of the chest.

For further discussion see Chapter 2, Cases 2.26–2.32.

Case 5.8



Case 5.8

A Pedicle

B Spinous process

C Inferior vertebral notch

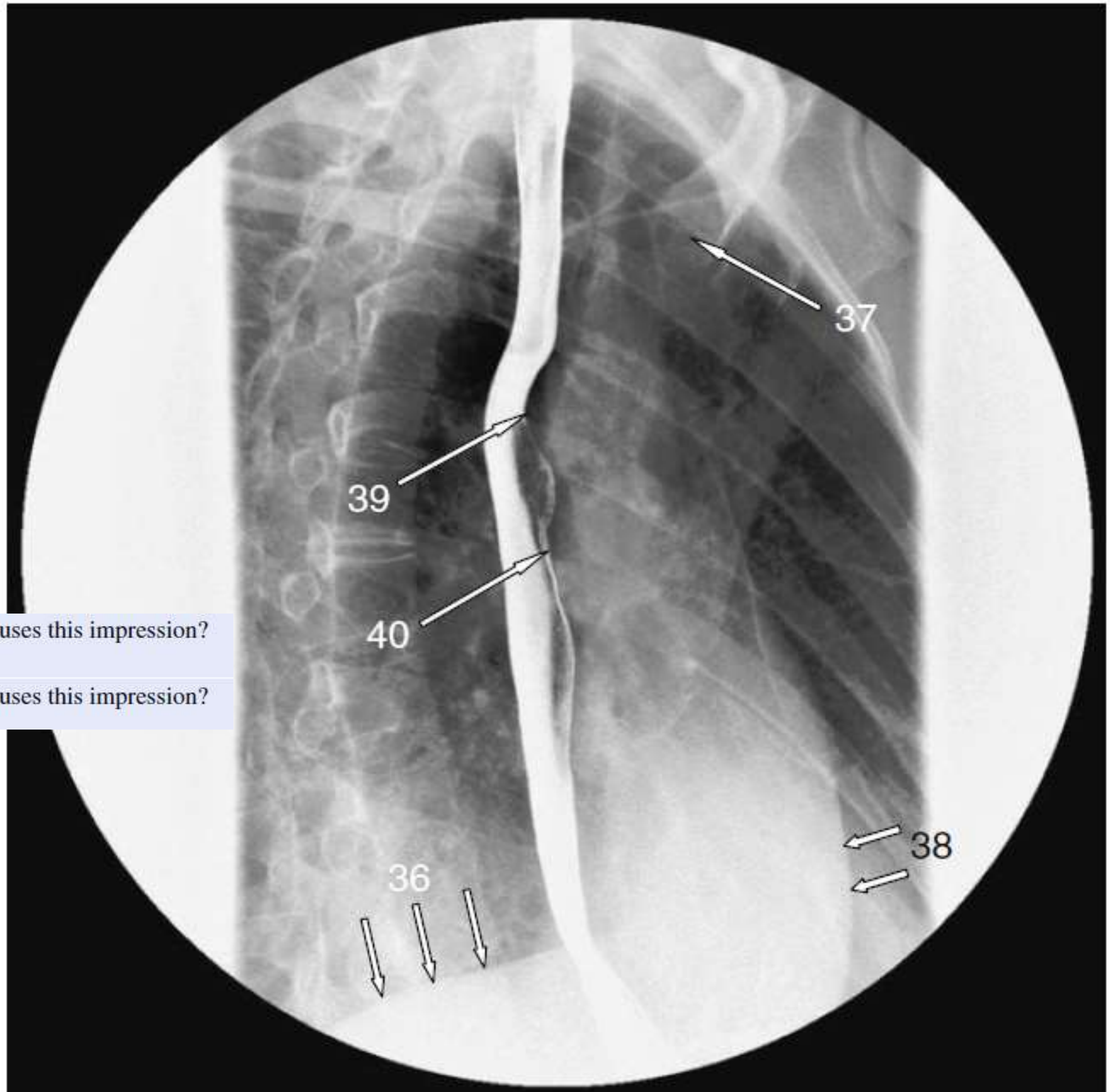
D Facet joint

E Intervertebral disc

Lateral radiograph of the thoracic spine.

For further discussion see Chapter 4, Cases 4.19–4.31.

FLUORO



39.	What structure causes this impression?
40.	What structure causes this impression?

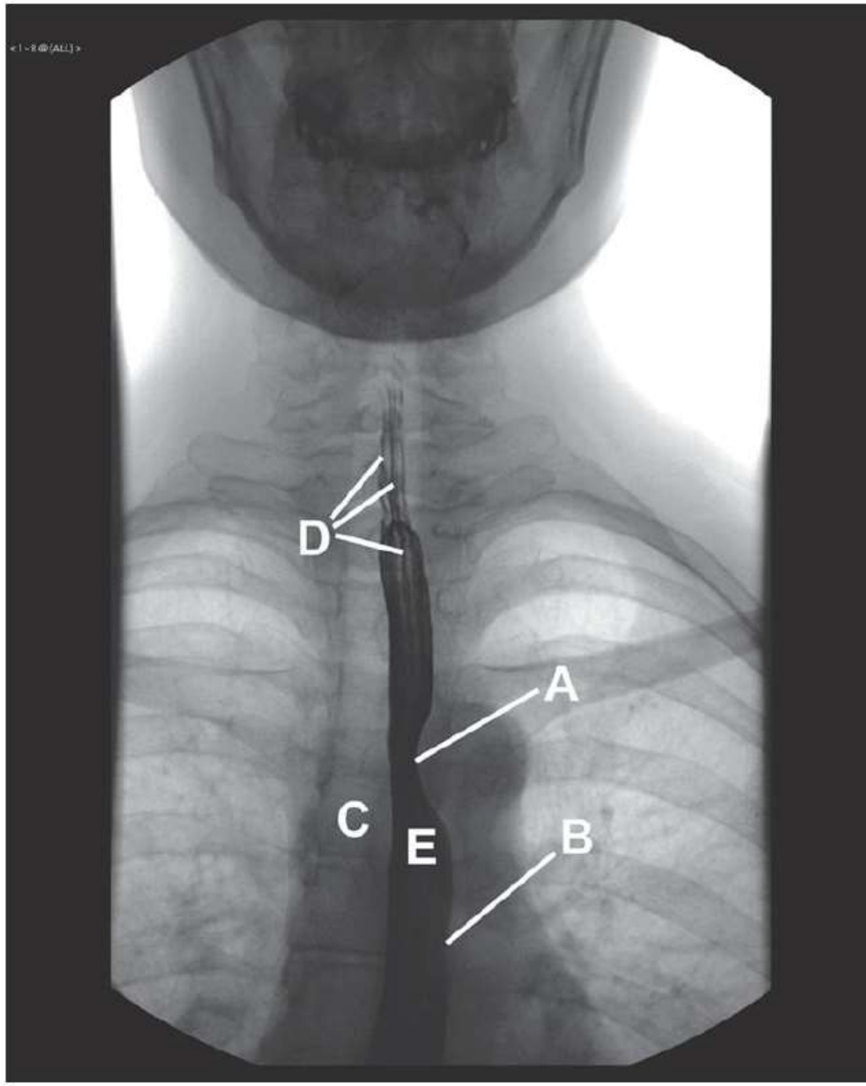
Barium Swallow

36. Right hemidiaphragm
37. Left medial head of clavicle
38. Anterior border of heart (right ventricle)
39. Arch of aorta
40. Left main bronchus

This barium swallow image is taken in the right anterior oblique position. Three major impressions in the oesophagus are seen anteriorly. These are made by the aortic arch, the left main bronchus and the left atrium from above down.

Q14

a Name the structure that creates the impression labelled A
b Name the structure that creates the impression labelled B
c Name the structure crossing the midline (right to left) posteriorly to the oesophagus at the level labelled C
d Name the linear structures labelled D
e Name the nodal group into which lymph from the oesophagus drains at position E



Q14 Answers

a Arch of the aorta
b Left main bronchus
c Thoracic duct
d Longitudinal mucosal folds of the oesophagus
e Posterior mediastinal nodes

Barium swallow examination, frontal view

Within the chest, normal impressions seen in the left wall of the oesophagus are (from superior to inferior) the aortic arch, left main bronchus and left atrium. A circumferential impression can often be seen at the level of the diaphragmatic hiatus. Aberrant vessels are a recognized cause of posterior impression (aberrant right subclavian artery) and anterior impression (aberrant left pulmonary artery).

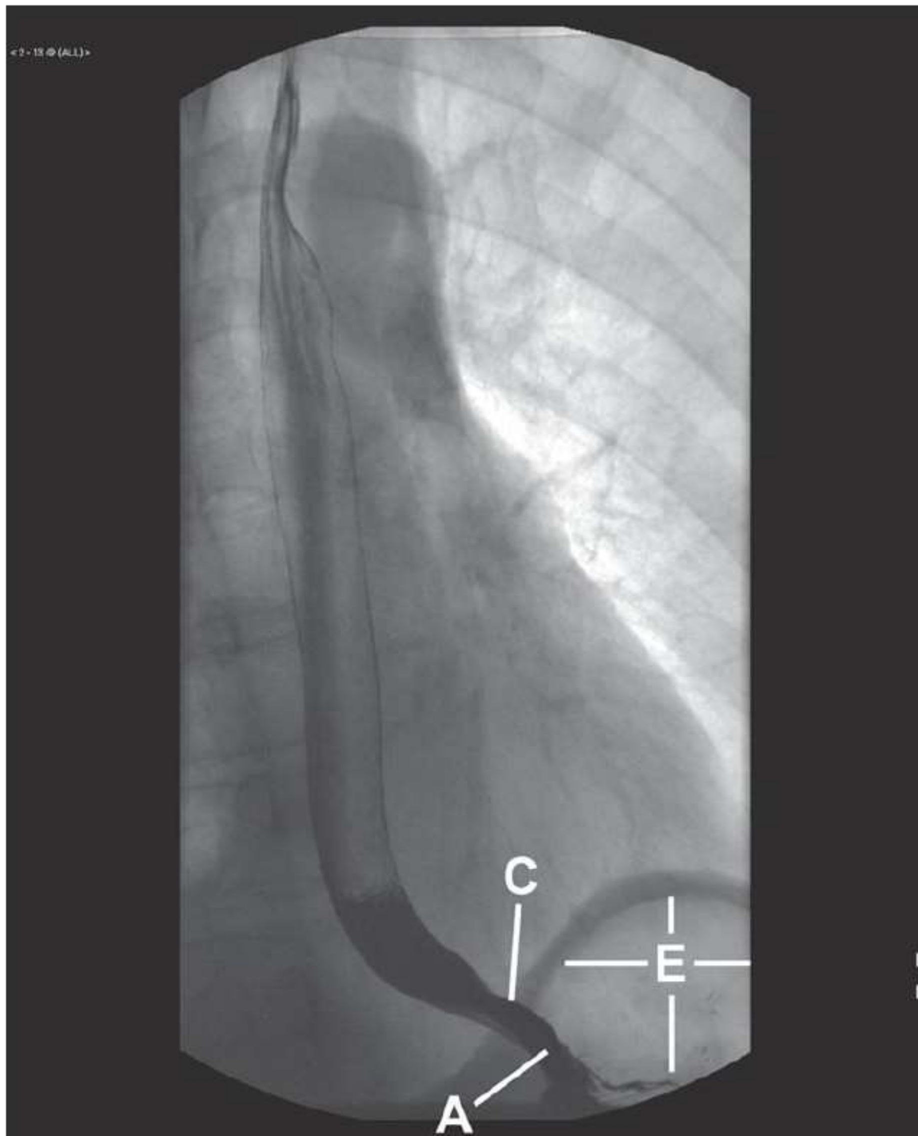
The thoracic duct lies right and posterior to the lower thoracic oesophagus. It crosses the midline at the level of T5/6 then ascends along the left lateral aspect of the oesophagus behind the aorta and left subclavian artery. Drainage into the venous circulation occurs near the junction of the left internal jugular and subclavian veins.

Fine longitudinal folds are the typical mucosal appearance of the thoracic oesophagus.

Lymph from the upper oesophagus drains to the deep cervical nodes, the middle oesophagus drains to the posterior mediastinal nodes and the lower oesophagus to the para-aortic group of the coeliac nodes.

Q15

a Name the structure labelled A
b Name the parent artery whose branches supply the structure labelled A
c Name the vertebral level at the point labelled C
d Name the nerve(s) which crosses the diaphragm at the point labelled C
e Name the structure labelled E



Q15 Answers

a Gastro-oesophageal junction
b Left gastric artery
c T10
d Left and right vagus nerves/vagal trunks (CN X)
e Air bubble in the gastric fundus

Double-contrast barium swallow, right anterior oblique (RAO) projection

The oesophagus courses forward and left in the lower chest where it passes in front of the aorta before crossing through the diaphragm hiatus at the level of T10. The hiatus is approximately 3cm left of the midline and the oesophageal wall often shows an indentation at this level. Crossing with the oesophagus through the diaphragm are the vagus nerves (CN X), branches of the left gastric vessels and lymphatics.

The oesophageal mucosa contains fine longitudinal folds measuring approximately 3mm thick whilst the gastric mucosal folds are seen to be thicker. The site of transition marks the gastro-oesophageal junction.

Arterial supply of the oesophagus can be divided into upper, middle and lower thirds. Branches of the inferior thyroid artery supply the upper; branches of the descending thoracic aorta supply the middle; and branches of the left gastric artery supply the lower third.

ANGIO

Question 2.7

Name the structures labelled **A** to **E**.

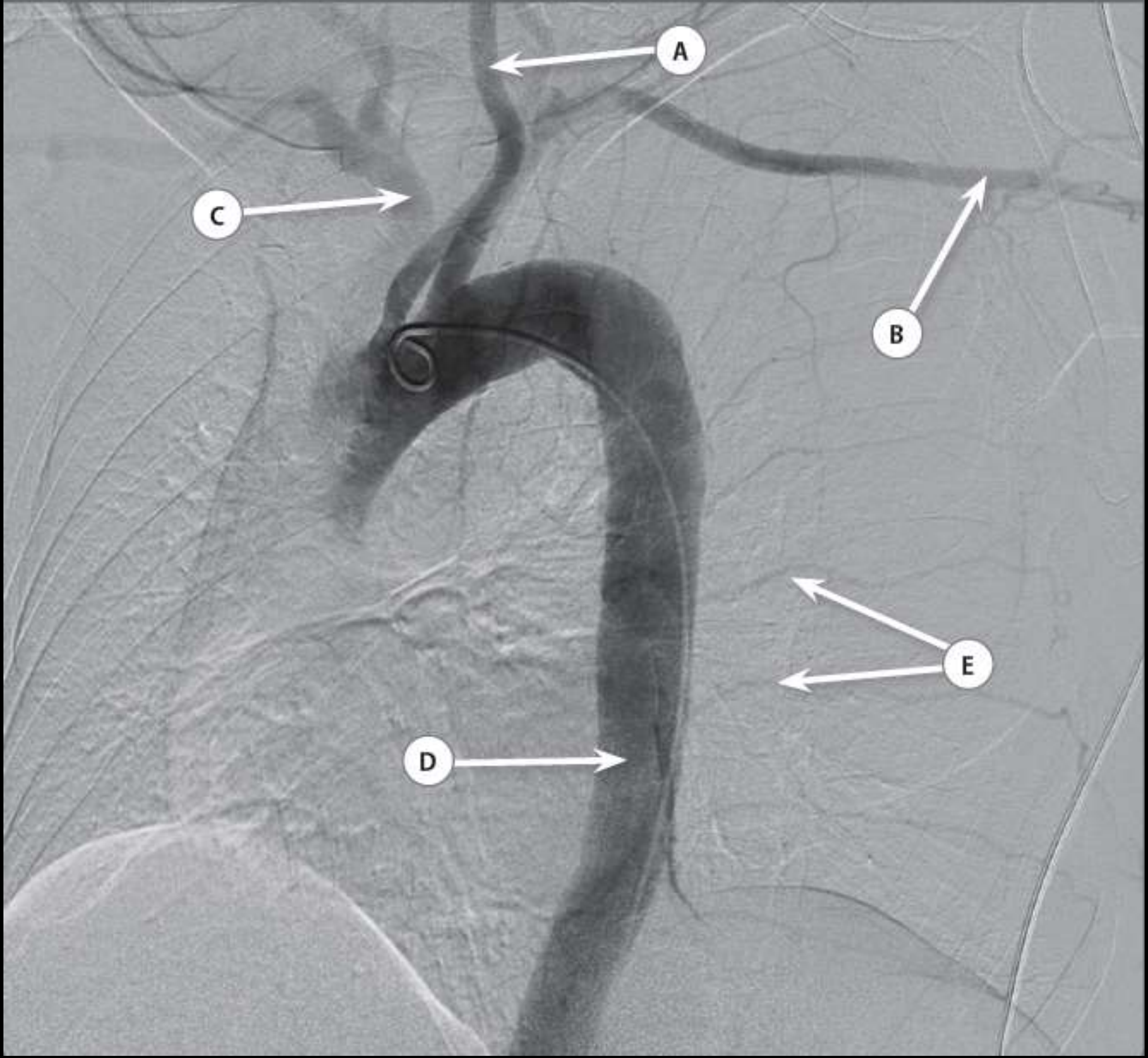
2.7 Coronal CT of the chest with IV contrast

A Right vertebral artery.
B Right thyrocervical trunk.
C Right subclavian artery.
D Aortic arch.
E Pulmonary trunk.

The arch of the aorta commences at T4/5, which is also the level of the third costal cartilage. It reaches the T3/4 level at its apex and ends at the T4 level. It runs posteriorly from right to left, passing anterior to the trachea and over the left main bronchus and left main pulmonary artery. There are three main branches of the aortic arch. From right to left these are the brachiocephalic, left common carotid and left subclavian arteries. The right subclavian artery arises from the brachiocephalic artery.

The subclavian artery is divided into three parts as defined by the scalenus anterior. The first part is from the vessel's origin to the medial border of the scalenus anterior. The second part lies posterior to the scalenus anterior and the third part is from the lateral border of the scalenus anterior to the inferior border of the first rib (where the artery becomes the axillary artery). The first branch of the first part of the subclavian artery is the vertebral artery, which ascends to the brain through the foramen transversarium of the cervical vertebrae. The second branch of the first part of the subclavian artery is the thyrocervical trunk.

Case 11.11



Case 11.11

A Left common carotid artery

B Left axillary artery

C Brachiocephalic trunk/innominate artery

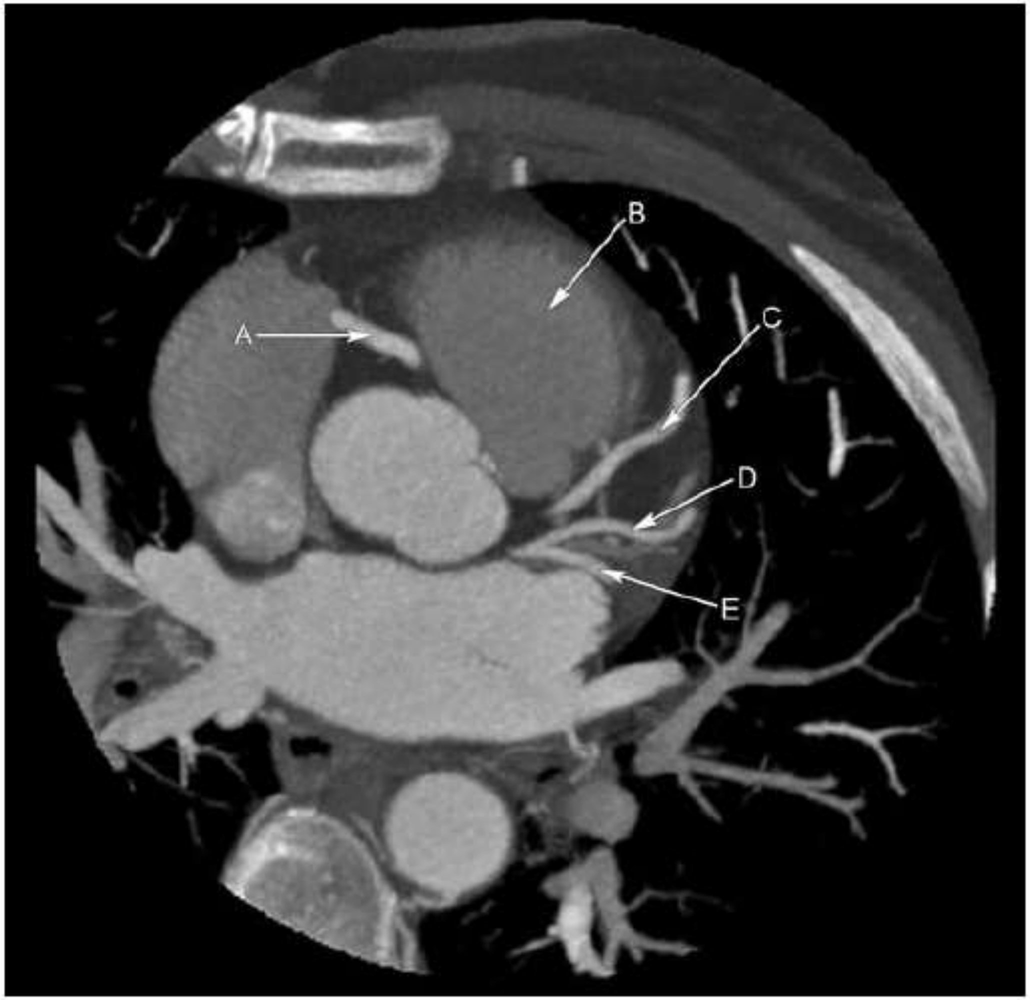
D Descending thoracic aorta

E Left Intercostal vessels

The intercostal arterial branches are evident on this example. There are a total of eleven posterior intercostal arteries on each side. The upper two arise from the superior intercostal artery, which is a branch of the costocervical trunk of the subclavian artery. The lower nine paired branches arise from the thoracic aorta and travel along the inferior border of the corresponding rib. Each artery travels in a neurovascular bundle along with a posterior intercostal vein and intercostal nerve.

The artery is sandwiched between the vein (which lies above) and the nerve (below). Hence, the mnemonic **VAN** can be used to recall the order of the **V**ein, **A**rtery and **N**erve.

Question 3.6



Name the structures labelled **A** to **E**.

3.6 Axial CTA of the heart

A Right coronary artery.
B Right ventricle.
C Left anterior descending artery.
D Left obtuse marginal artery (M1).
E Left circumflex artery.

There are two main coronary arteries and both arise from the aortic root above the aortic valve. About 4% of people have a third main artery, called the posterior coronary artery.

The right coronary artery originates from the anterior coronary sinus, above the right cusp of the aortic valve. It passes to the right of and posterior to the pulmonary artery. It can be seen emerging from under the right atrial appendage and then coursing along the anterior atrioventricular groove. It first gives rise to a conus branch in 50% of cases and then a sinoatrial branch in 55% of cases (this arises from the left circumflex in the other 45%).

The left coronary artery arises from the left posterior aortic sinus, above the left cusp of the aortic valve. After approximately 5–10 mm, it bifurcates into the left anterior descending artery (which runs down the anterior intraventricular groove to the apex) and the left circumflex artery (which runs in the left posterior atrioventricular groove). The major branches of the left circumflex artery are the obtuse marginal arteries, which are numbered sequentially from proximal to distal. In approximately 15% of cases the left coronary artery trifurcates giving rise to a third branch known as the ramus intermedius artery.

Question 7.7

Name the structures labelled **A** to **E**.

7.7 Axial cardiac CT with IV contrast

A Right superior pulmonary vein.
B Superior vena cava.
C Ascending aorta.
D Right main pulmonary artery.
E Left main pulmonary artery.

The pulmonary veins carry oxygenated blood from the lungs to the left atrium of the heart. They are notable in containing no valves. There are four main pulmonary veins – left superior, left inferior, right superior and right inferior. At the root of the lung the superior pulmonary vein lies anteroinferior to the pulmonary artery. The bronchus lies behind the pulmonary artery, as can be seen on this image.

The ascending aorta arises from the left ventricle at the level of the third costal cartilage just to the left of the sternum. At the highest point of its arch it reaches the level of the anterior margin of the second costal cartilage. In cases of chest paint or trauma it is important to assess the ascending aorta carefully for evidence of dissection.

Question 7.8

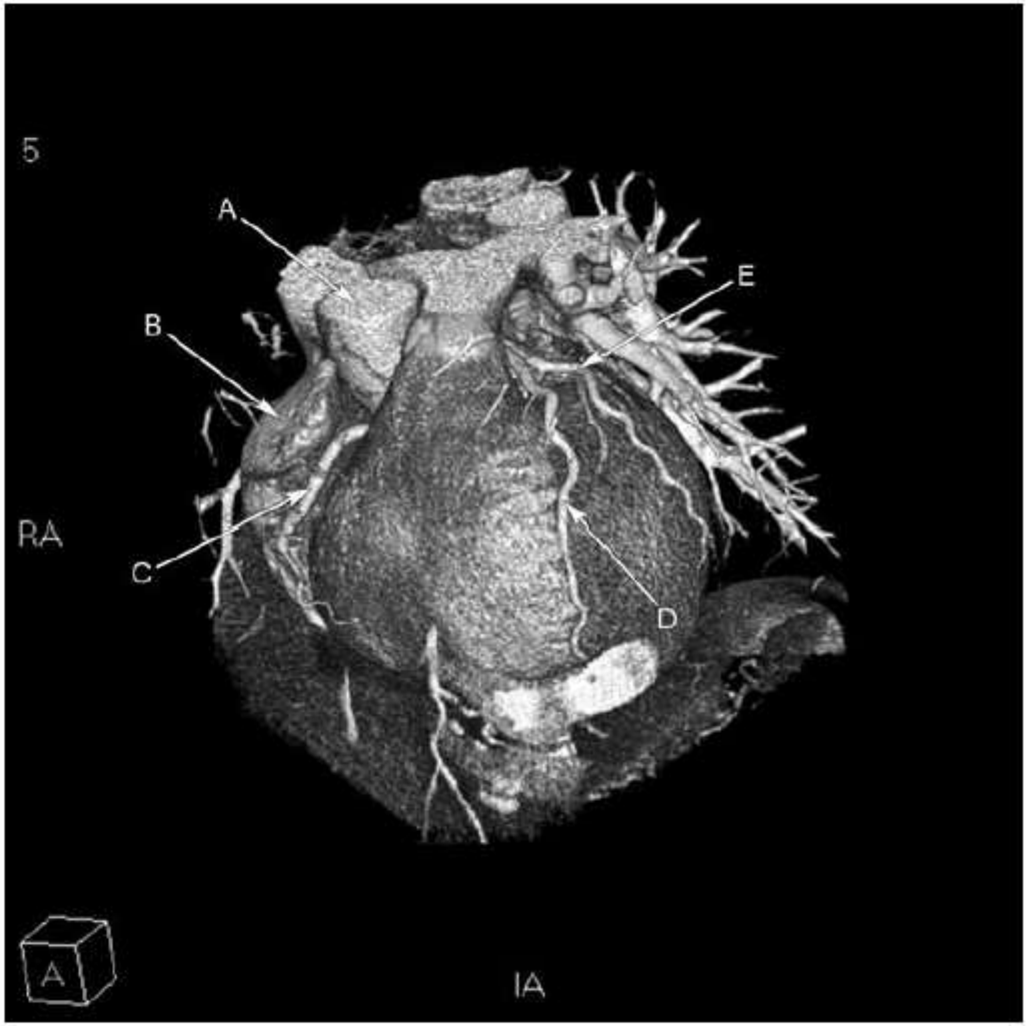
Name the structures labelled **A** to **E**.

7.8 Axial cardiac CT with IV contrast

A Left anterior descending artery.
B Left main coronary artery.
C Root of ascending aorta.
D Left circumflex artery.
E Descending thoracic aorta.

In general, there are two main coronary arteries – left and right. The left coronary artery arises from the left aortic sinus (left sinus of Valsalva) just above the aortic valve. It branches into the left anterior descending artery and the left circumflex artery. The left circumflex artery follows the left part of the coronary sulcus and gives rise to the marginal arteries. It supplies the posterolateral left ventricle and the sinoatrial node (in 40% of people). The left anterior descending artery passes along the anterior interventricular sulcus and typically supplies the anterolateral myocardium, apex, interventricular septum and around 50% of the left ventricle.

Question 8.8



Name the structures labelled **A** to **E**.

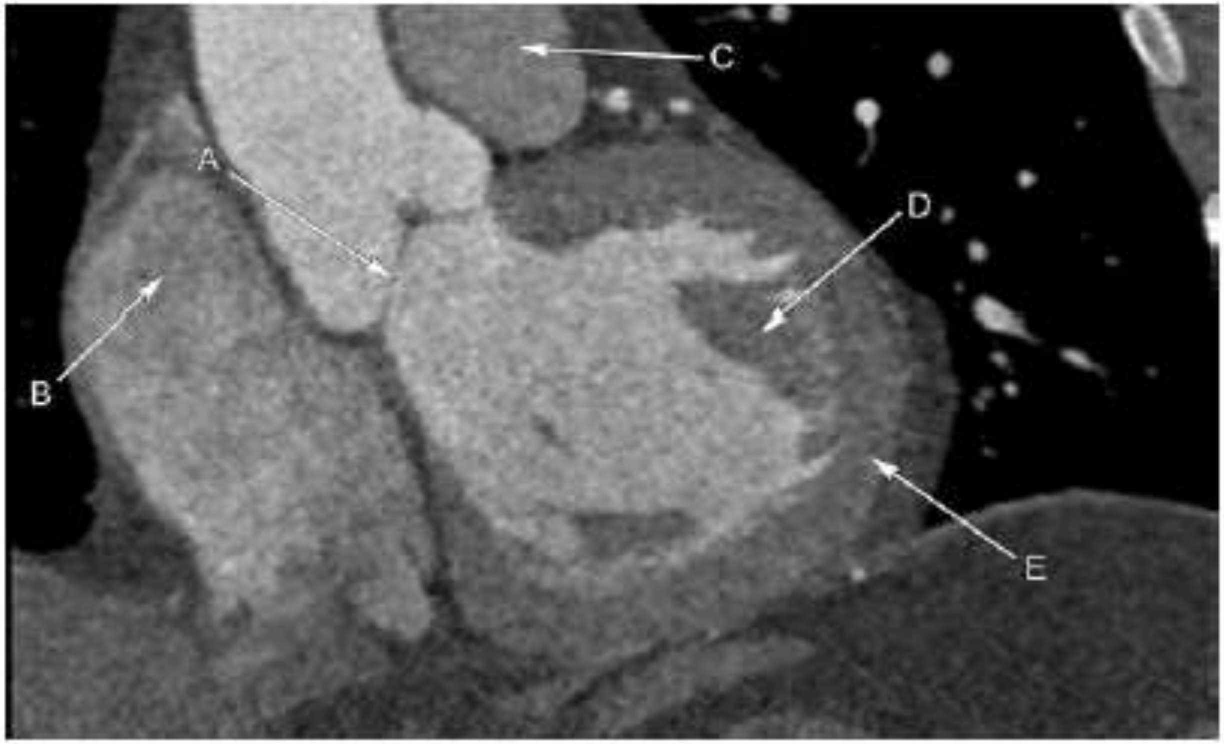
8.8 3D reconstruction of a cardiac CT

A Ascending aorta.
B Right atrial appendage.
C Right coronary artery.
D Left anterior descending artery.
E Left circumflex artery.

The right atrial appendage is a small conical muscular pouch joined to the right atrium. It lies at the root of the ascending aorta, and the right coronary artery emerges from under it.

For further information about the coronary arteries, see Questions 3.6 and 7.8.

Question 10.10



Name the structures labelled **A** to **E**.

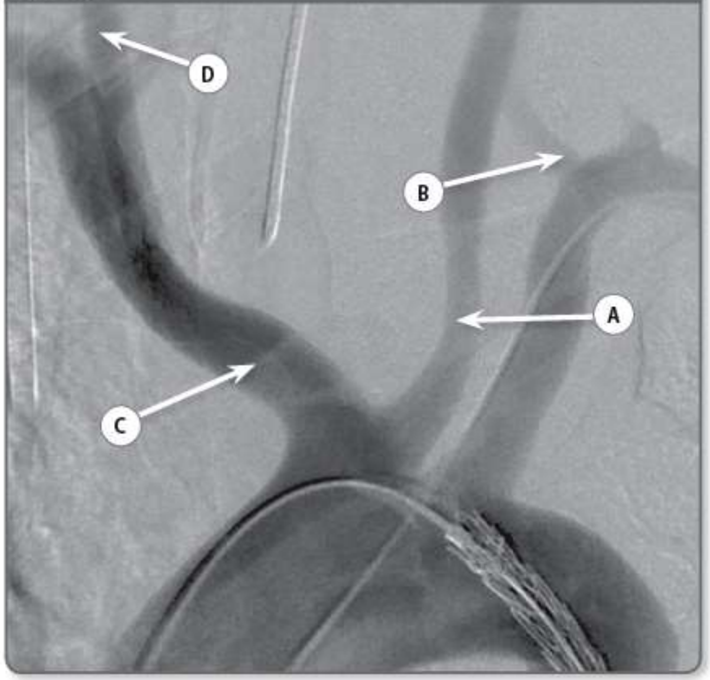
10.10 Coronal cardiac CT

A Aortic valve.
B Right atrium.
C Left atrium.
D Papillary muscle of the left ventricle.
E Left ventricle wall/myocardium.

The aortic valve is found at the left ventricular outflow and separates the left ventricle from the ascending aorta. It is normally tricuspid, but in 1% of the population the valve is bicuspid. This is associated with early-onset aortic stenosis.

The papillary muscles lie within the ventricles of the heart. They attach to the cusps of the atrioventricular valves via the cordae tendinae, which can be seen as thin bands on CT. There are three in the right ventricle (anterior, posterior and septal) and two in the left ventricle (anterior and posterior). The muscles can rupture as a complication of myocardial infarction, which can result in valve prolapse.

Case 1.5



Case 1.5

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Which anatomical variant is present on this image?	

Case 1.5

A Left common carotid artery

B Left vertebral artery

C Brachiocephalic trunk/innominate artery

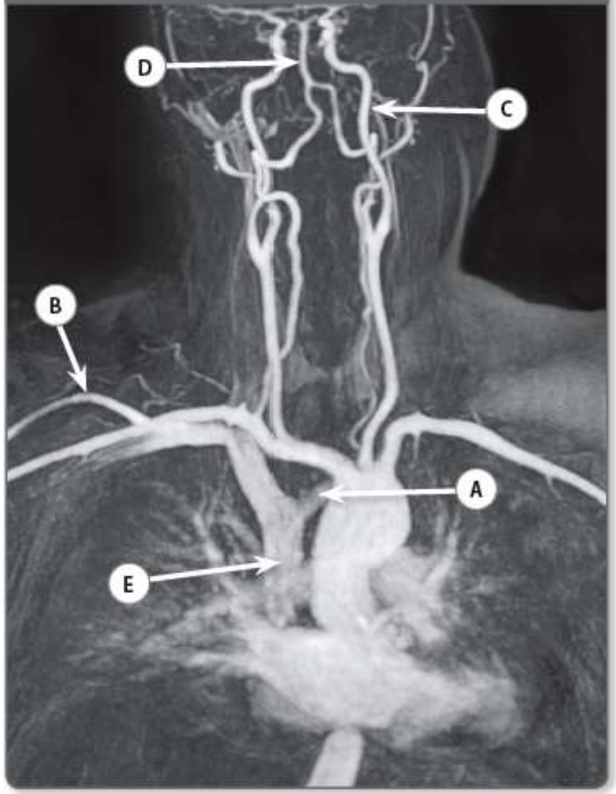
D Right common carotid artery

E Common origin of left common carotid artery and brachiocephalic trunk

The second most common variant of aortic arch branching occurs when the left common carotid artery has a common origin with the innominate artery. Rather

than arising directly from the aortic arch as a separate branch, the left common carotid artery origin is moved to the right and merges with the origin of the innominate artery. This variant is often termed a 'bovine aortic arch' which is a misnomer as it has no resemblance to the arterial branching pattern seen in cattle.

Case 1.12



Case 1.12

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 1.12

A Left brachiocephalic vein

B Right cephalic vein

C Left internal carotid artery

D Basilar artery

E Superior vena cava

This coronal maximum intensity projection (MIP) slab nicely demonstrates the vascular anatomy of the chest and neck.

The cephalic vein joins the axillary vein to form the subclavian vein. The basilar artery is formed by the union of both vertebral arteries.

Case 3.8

Case 3.8

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	How many named branches does the axillary artery usually have?	

Case 3.8

A Right axillary artery

B Right lateral thoracic artery

C Right anterior circumflex artery

D Neck of right humerus

E Six

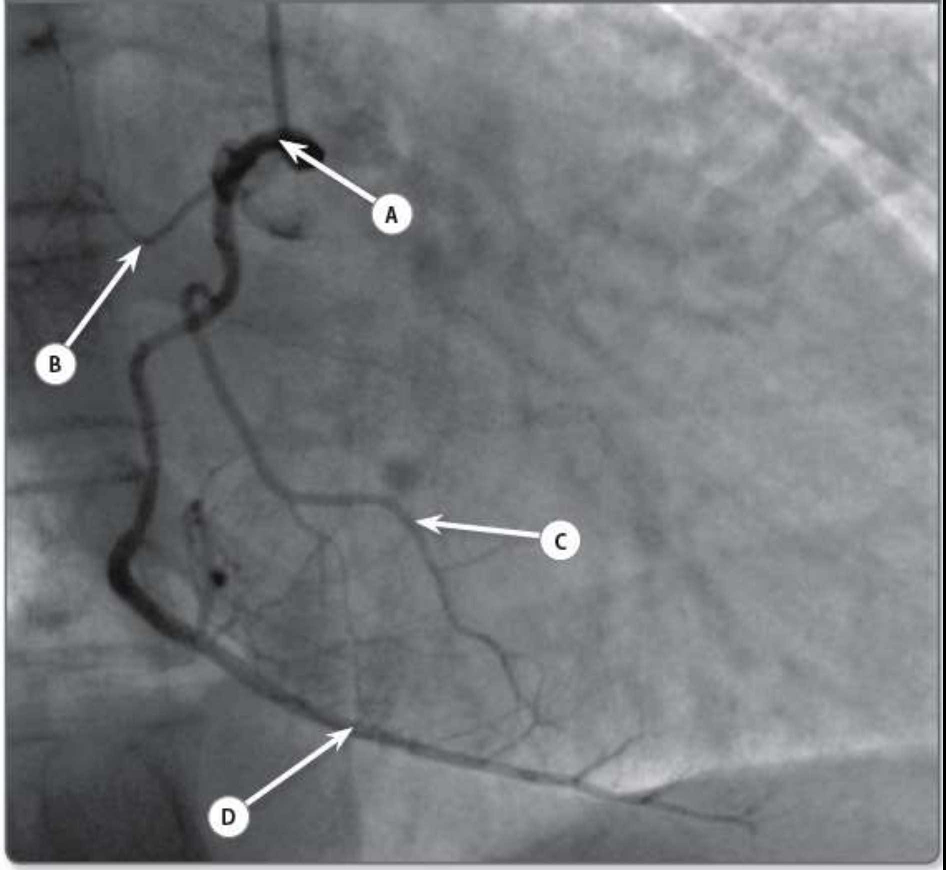
The subclavian artery continues as the axillary artery at the outer margin of the first rib. The artery is divided into three segments by the pectoralis minor muscle. A useful mnemonic for remembering the branches of the axillary artery is Scam The Lawyers, Save A Patient. One arterial branch arises from its first part, two from the second and three from the third part.

The six branches of the axillary artery are as follows:

1. Superior thoracic artery

2. Thoracoacromial artery
3. Lateral thoracic artery
4. Subscapular artery
5. Anterior circumflex artery
6. Posterior circumflex artery

Case 3.13



Case 3.13

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	What determines coronary artery dominance?	

Case 3.13

A Right coronary artery

B Sinoatrial nodal artery

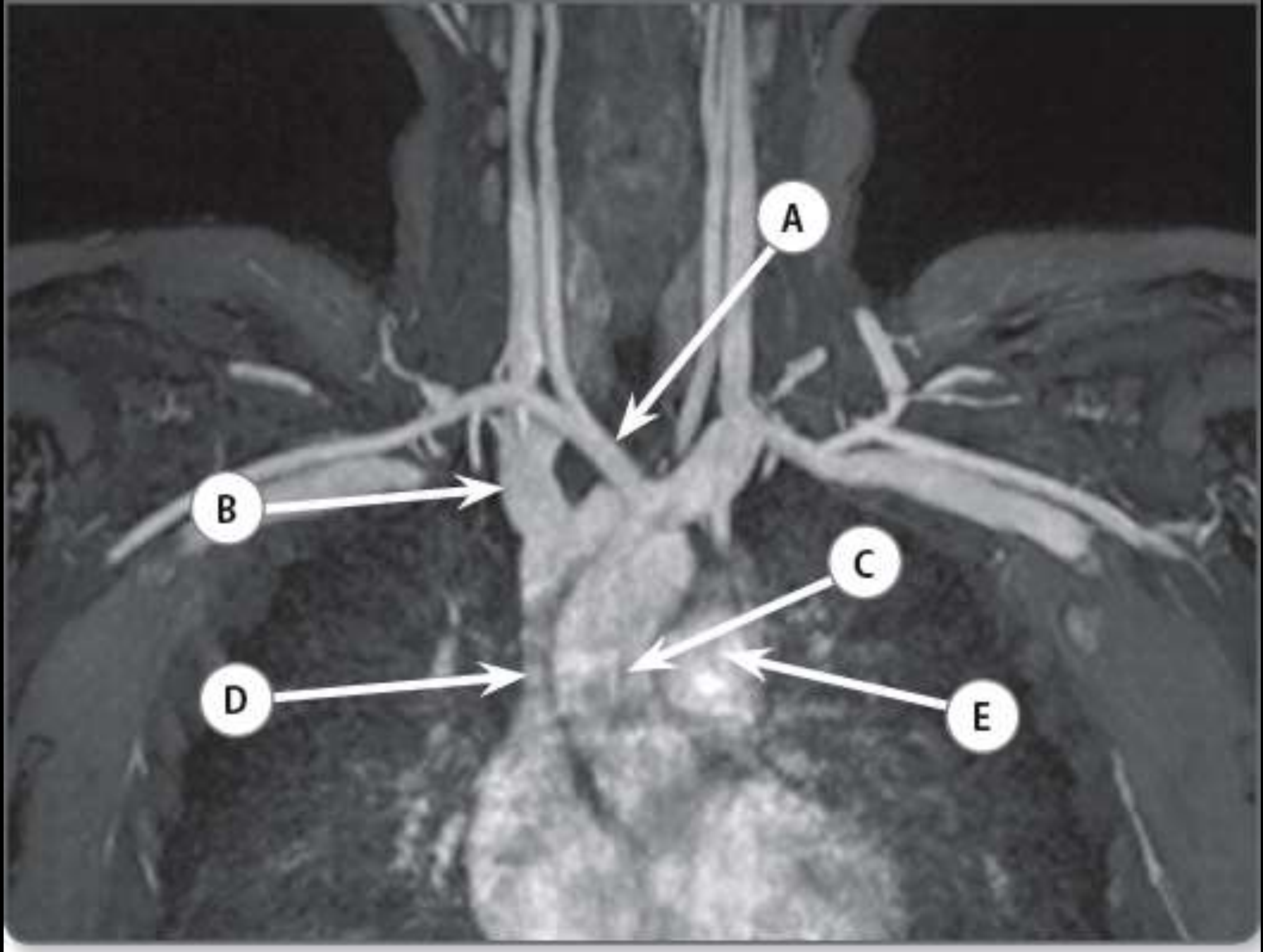
C Ventricular branches

D Posterior descending artery

E The vessel from which the posterior descending artery originates

The right coronary artery arises from the anterior sinus of Valsalva. In 50–60%, the first branch of the right coronary artery (RCA) is the small conus branch that supplies the right ventricular outflow tract. In 60% a sinoatrial nodal artery arises as the second branch of the RCA, which runs posteriorly to the sinoatrial node. The next branches are called diagonals and they run anteriorly to supply the anterior wall of the right ventricle.

Case 5.1



Case 5.1

A Brachiocephalic trunk/innominate artery

B Right brachiocephalic vein

C Ascending aorta

D Superior vena cava

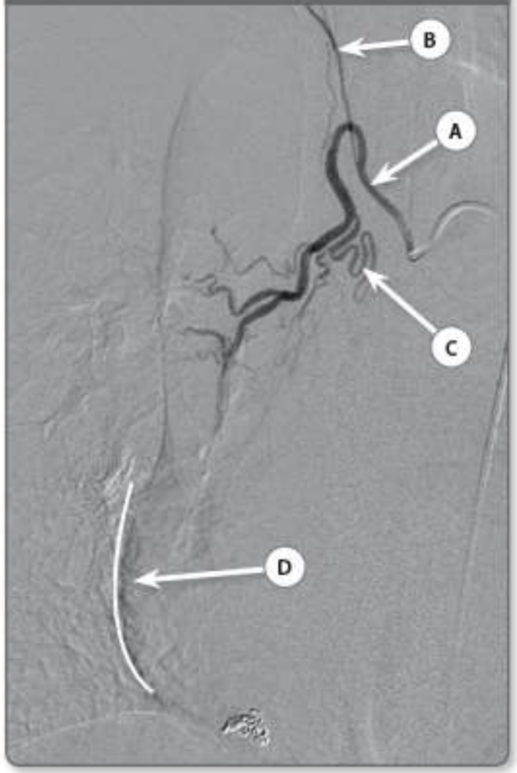
E Pulmonary trunk/main pulmonary artery

This coronal maximum intensity projection (MIP) slab demonstrates the arterial and venous anatomy of the chest and neck.

The brachiocephalic veins combine to form the superior vena cava (SVC). The internal jugular and the subclavian veins unite to form the brachiocephalic veins.

This is the most common anatomical configuration of the aortic arch, with the brachiocephalic trunk, left common carotid and left subclavian artery emerging from the arch from proximal to distal.

Case 6.19



Case 6.19

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure outlined and labelled D.	
E	How many bronchial arteries usually arise from the aorta?	

Case 6.19

A Right bronchial artery

B Right first intercostal artery

C Anterior spinal artery

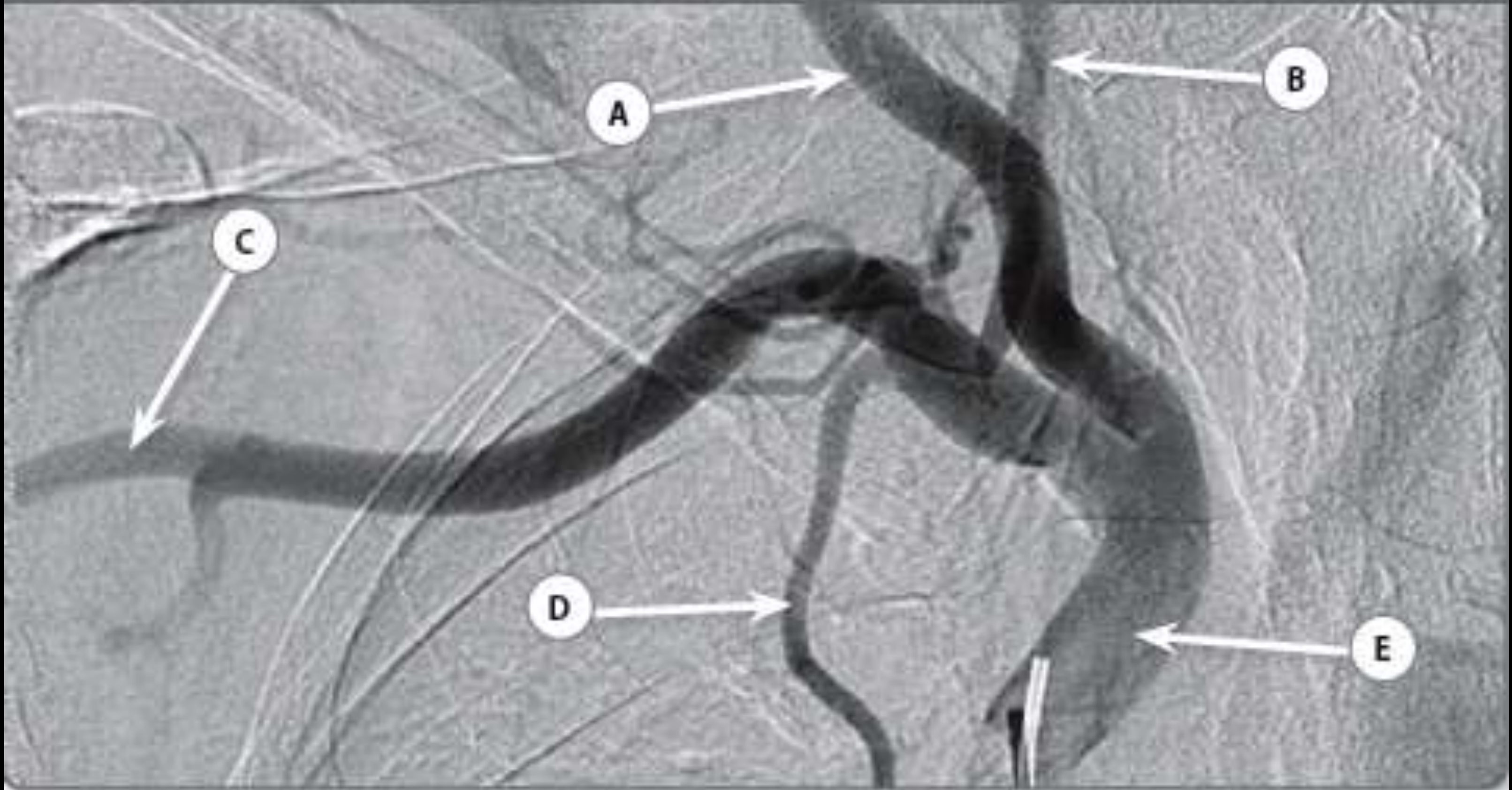
D Right atrium

E Three

Bronchial arterial anatomy is variable. Usually, there is a single artery on the right and two on the left, all arising from the aorta. In chronic pulmonary conditions such as cystic fibrosis, these arteries can enlarge, become friable and, as their blood pressure reaches systemic levels, can lead to haemoptysis which may require embolisation.

The anterior spinal arteries may arise from the bronchial arteries and it is important to ensure that these are not inadvertently embolised as this may lead to spinal cord damage and paralysis.

Case 7.5



Case 7.5

A Right common carotid artery

B Right vertebral artery

C Right axillary artery

D Right internal thoracic/mammary artery

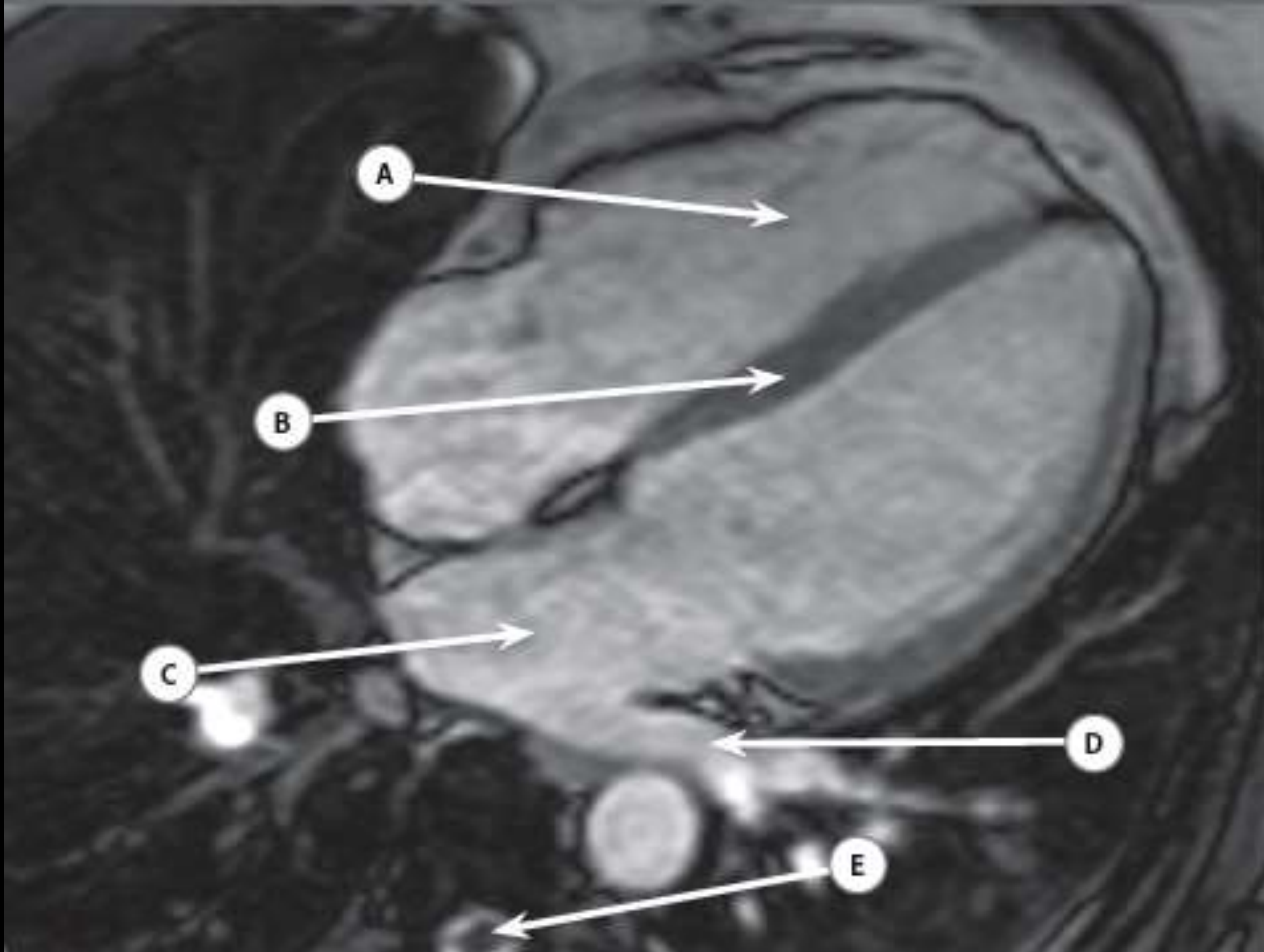
E Brachiocephalic trunk/innominate artery

A mnemonic to remember the branches of the subclavian artery is **VIT C**: **V**ertebral, **I**nternal thoracic, **T**hyrocervical trunk, **C**ostocervical trunk.

There are no branches of the vertebral artery in the neck. The internal thoracic artery terminates by dividing into the superior epigastric and the superior phrenic arteries. The thyrocervical trunk divides into three branches – the **S**uprascapular, **I**nferior thyroid and **T**ransverse cervical arteries (**SIT**). The costocervical trunk divides into the deep cervical and the highest intercostal arteries.

From the outer aspect of the first rib, the subclavian artery continues as the axillary artery.

Case 7.9



Case 7.9

A Right ventricle

B Interventricular septum (muscular part)

C Left atrium

D Left inferior pulmonary vein

E Spinal cord

On axial imaging, the right ventricle is the most anterior chamber of the heart with the left atrium being the most posterior chamber. The right atrium is posterolateral to the right ventricle and to the right of it. The left ventricle lies posterolateral and to the left of the right ventricle. These relationships can be appreciated in **Figure 7.1**.

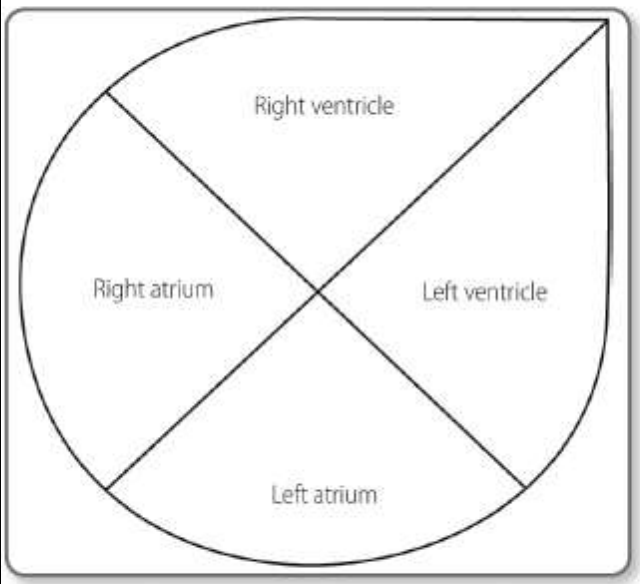
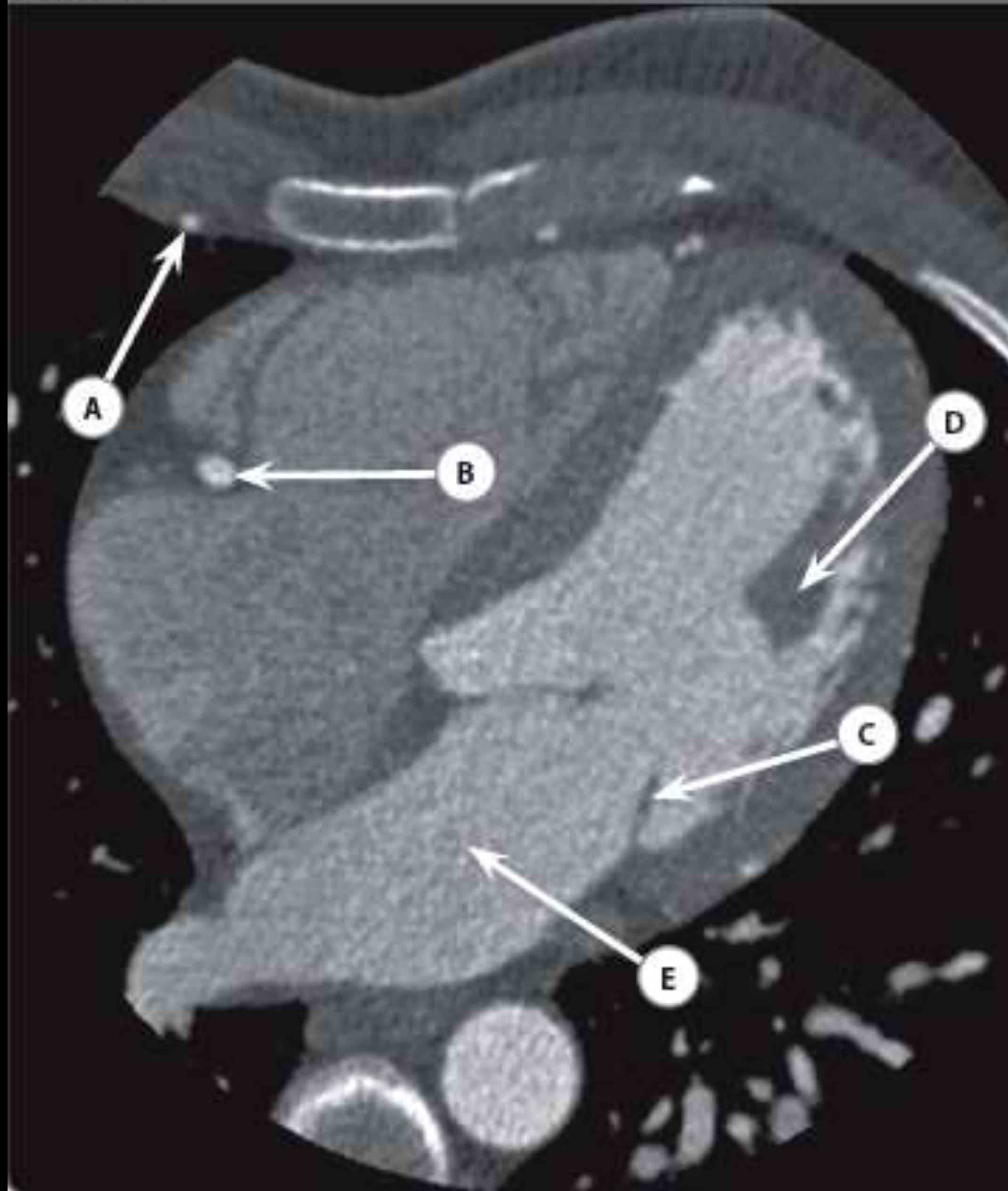


Figure 7.1 The relative positions of the cardiac chambers on an axial view.

Case 9.2



Case 9.2

A Right internal mammary/internal thoracic artery

B Right coronary artery

C Posterior leaflet of the mitral valve

D Papillary muscle

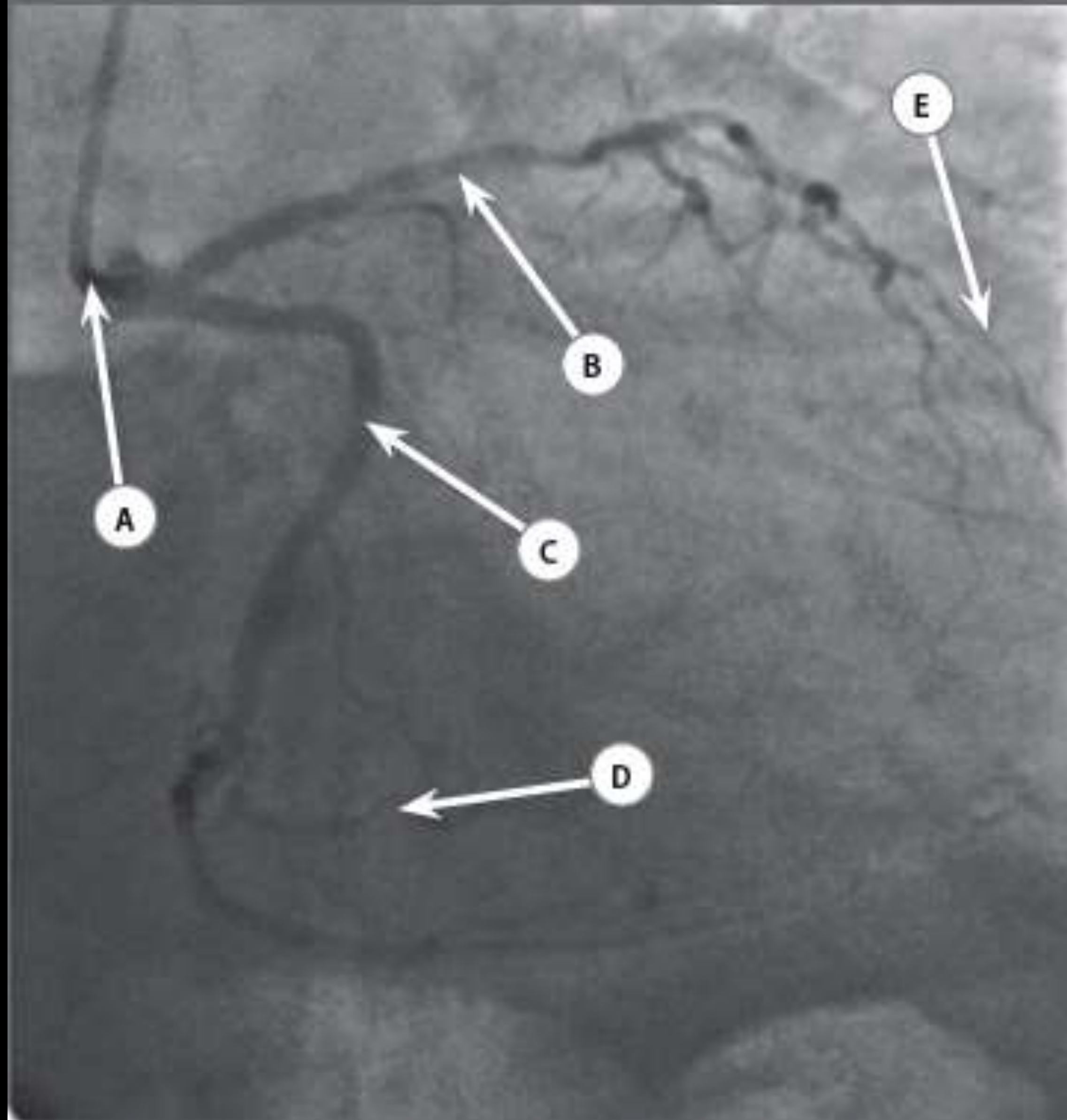
E Left atrium

High resolution cardiac CT scans nicely depict the coronary anatomy. In addition, anatomy of the cardiac valves, chambers and other intrinsic cardiac structures are visible.

The internal mammary arteries are important, particularly the left, if an internal mammary bypass is being considered.

On the current image, the mitral valve – the only bicuspid valve – is evident. The aortic, pulmonary and tricuspid valves all have three cusps.

Case 9.8



Case 9.8

A Left mainstem coronary artery

B Left anterior descending branch

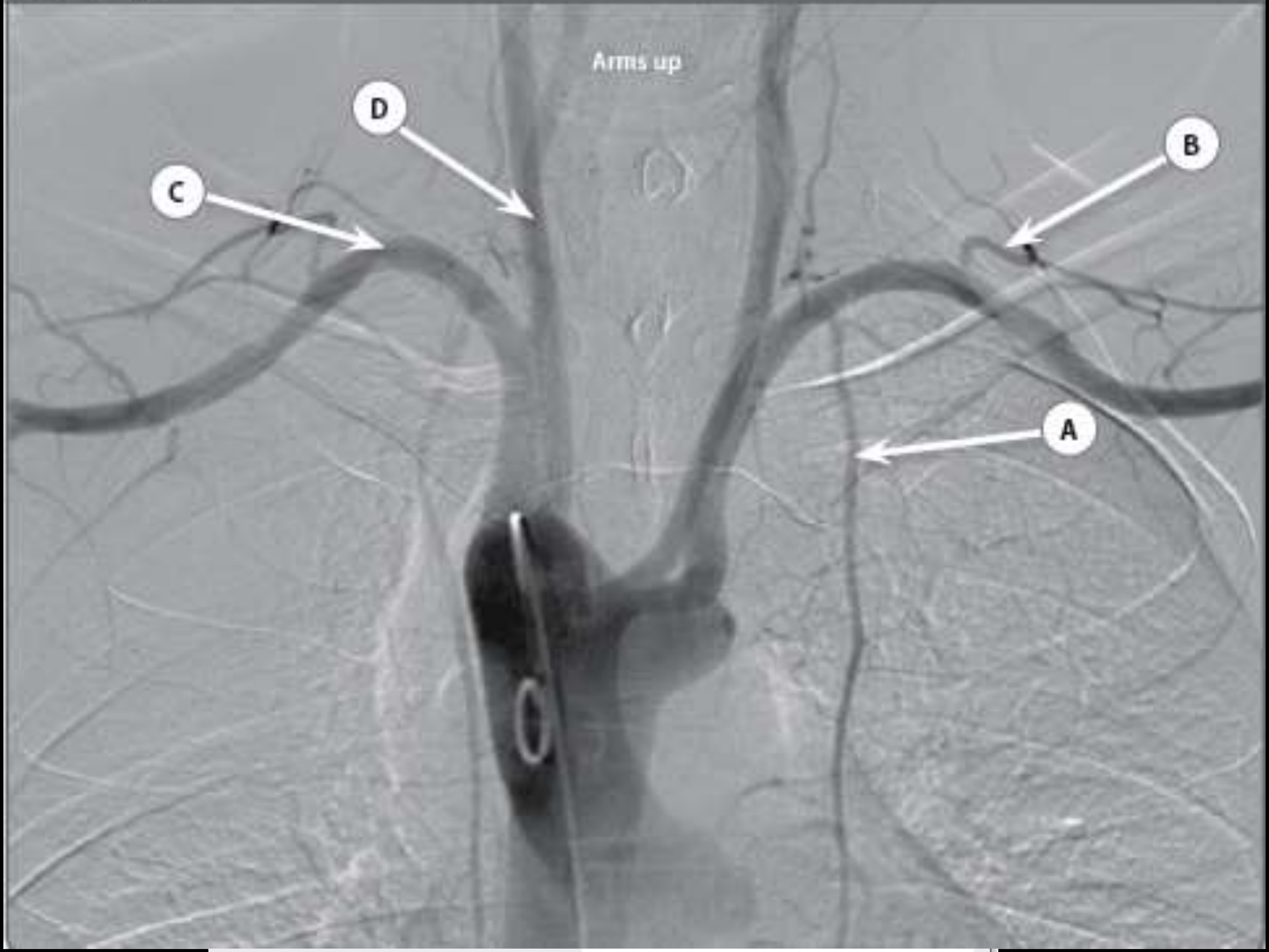
C Left circumflex artery

D Obtuse marginal branch

E Diagonal branch

The left main coronary artery arises from the left coronary sinus and gives rise to the left anterior descending artery and the left circumflex coronary artery. In up to 15 % of cases, a third branch arises at the bifurcation: the intermediate artery.

Case 9.16



E	Which anatomical variant is present on this image?	

Case 9.16

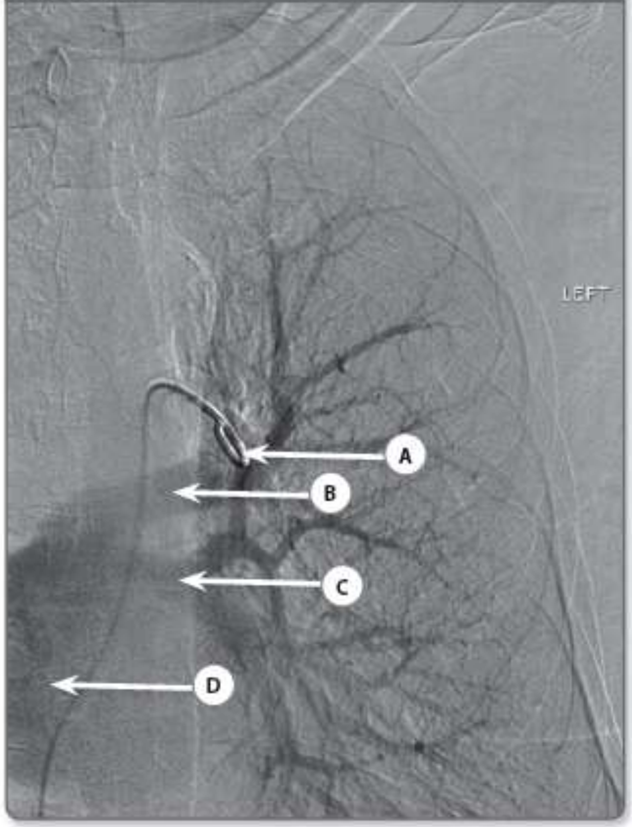
- **A** Left internal mammary artery
- **B** Left costocervical trunk
- **C** Right subclavian artery
- **D** Right common carotid artery
- **E** Double aortic arch (DAA)

A DAA is the most frequent form of vascular ring. DAA may surround the trachea and oesophagus and hence may cause compression of these structures. If the compression is severe, symptoms such as dyspnoea, recurrent pneumonia, stridor, dysphagia, and feeding difficulties may be observed at birth. However, when compression is minimal, DAA can remain undiagnosed until adulthood.

Embryologically, the ventral and dorsal aortas are connected by aortic arches which persist or involute to give rise to the normal aortic arch, its branches and minor arteries of the head. The right fourth aortic arch normally involutes at about 36–38 days and the left fourth aortic arch persists to give rise to the normal left aortic arch. The persistence of both the right and left fourth aortic arches leads to a double aortic arch.

Incidence of congenital heart disease in patients with DAA has been reported to be as high as 20%, the most common being the tetralogy of Fallot and transposition of great vessels.

Case 10.4



Case 10.4

QUESTION		WRITE YOUR ANSWER HERE
A	Where is the catheter tip located at position A?	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	How many pulmonary veins are normally present?	

Case 10.4

A Left pulmonary artery

B Left superior pulmonary vein

C Left inferior pulmonary vein

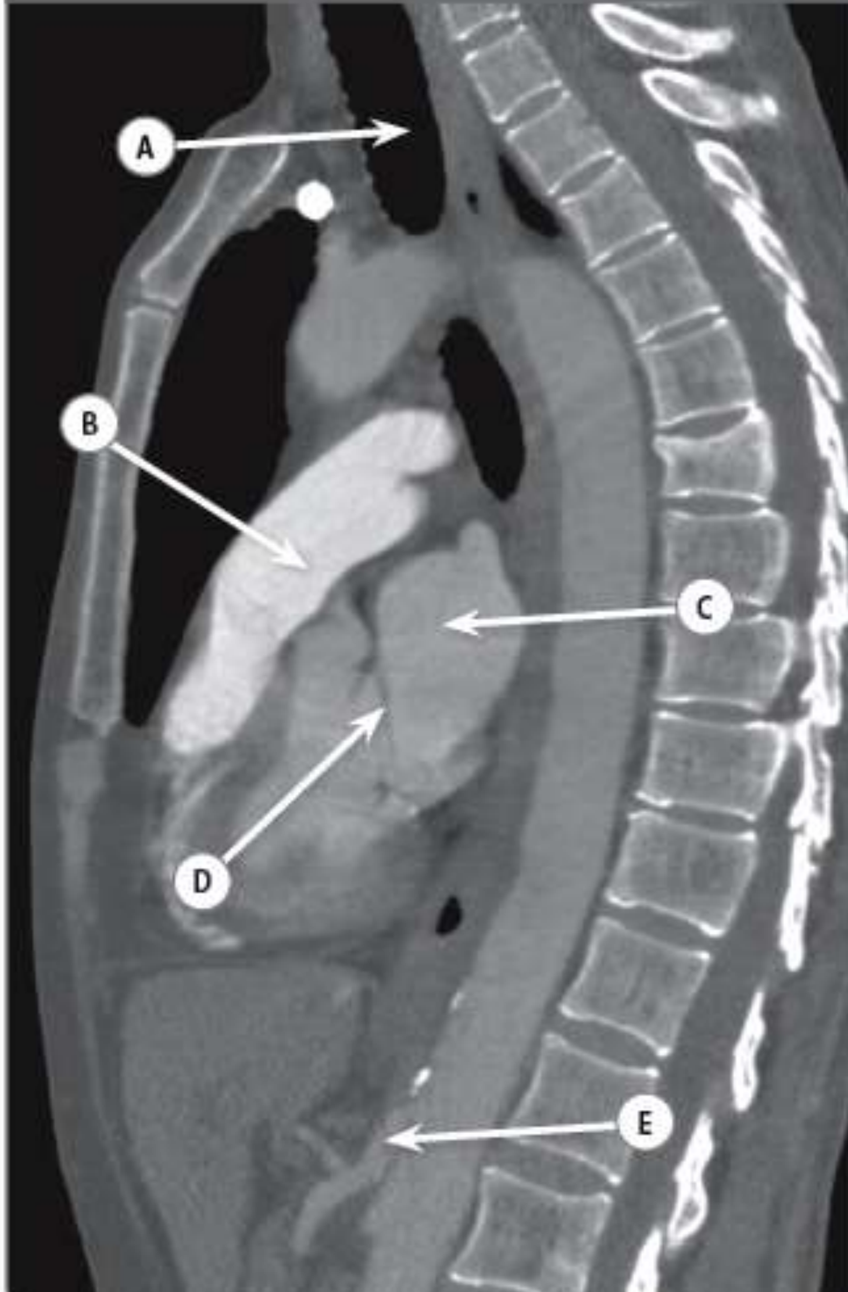
D Left atrium

E Four

A delayed angiographic run of a pulmonary arteriogram is used to visualise the pulmonary veins.

There are four pulmonary veins, with a superior and inferior pulmonary vein on each side. There are a number of possible anomalies, including having three pulmonary veins on the right (upper, middle and lower lobes) and fusion of the two veins on the left resulting in a common trunk.

Case 11.2



Case 11.2

A Trachea

B Pulmonary trunk

C Left atrium

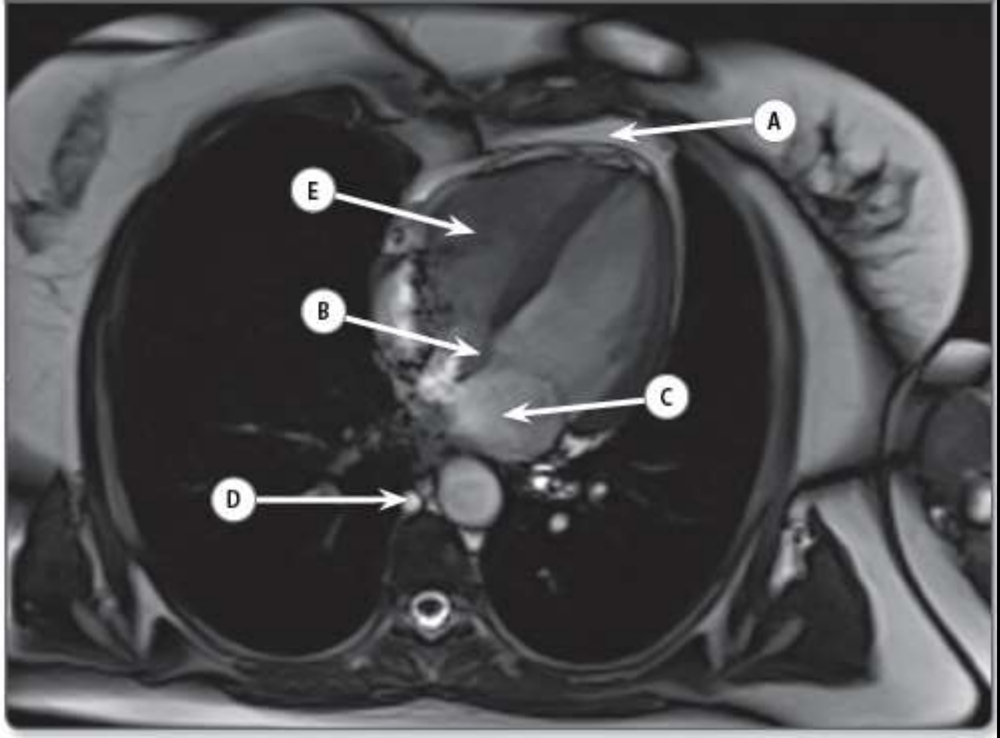
D Posterior leaflet of the mitral valve

E Coeliac trunk

The right ventricle is the most anterior chamber of the heart and the pulmonary outflow tracts arises from this. The left atrium is the most posterior chamber and it drains into the left ventricle, with the mitral valve separating the two.

You will also observe that contrast is more dense within the pulmonary arteries than in the aorta and left atrium. This scan is timed to interrogate the pulmonary arteries (CT pulmonary angiogram).

Case 11.7



Case 11.7

A Pericardial fat

B Membranous interventricular septum

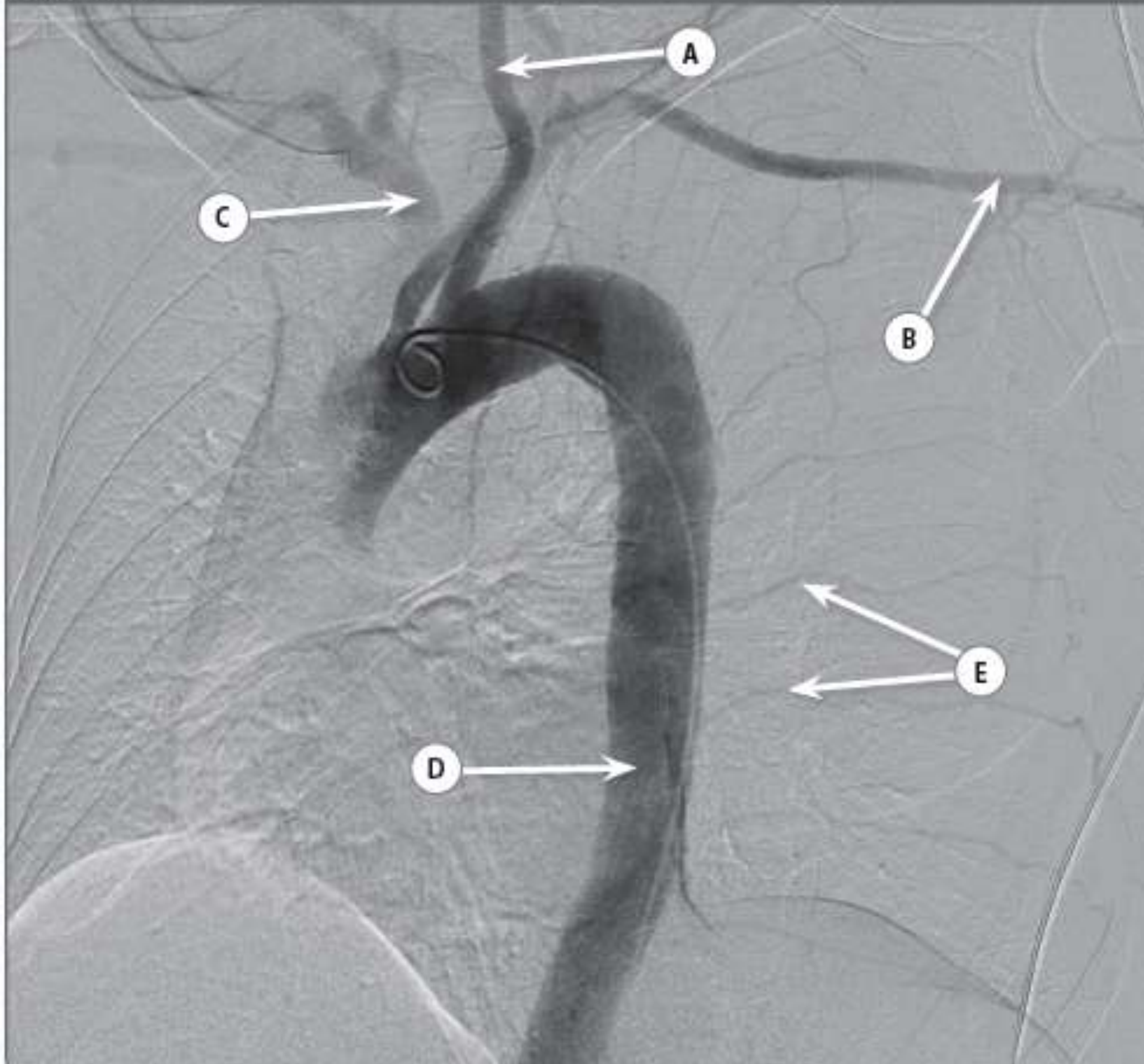
C Left atrium

D Azygos vein

E Right ventricle

Chambers of the heart are easily identified by their location, with the right system situated more anteriorly and the left system more posteriorly. The membranous portion of the interventricular septum is the more superior thinner portion and is the most common site (80%) of ventricular septal defects. The muscular portion is the greater portion of the septum. Each part has an embryologically distinct origin. The muscular part develops from the bulboventricular flange, which forms as a result of differential growth of primitive ventricle and bulbous cordis. The membranous part has a neural crest origin.

Case 11.11



Case 11.11

A Left common carotid artery

B Left axillary artery

C Brachiocephalic trunk/innominate artery

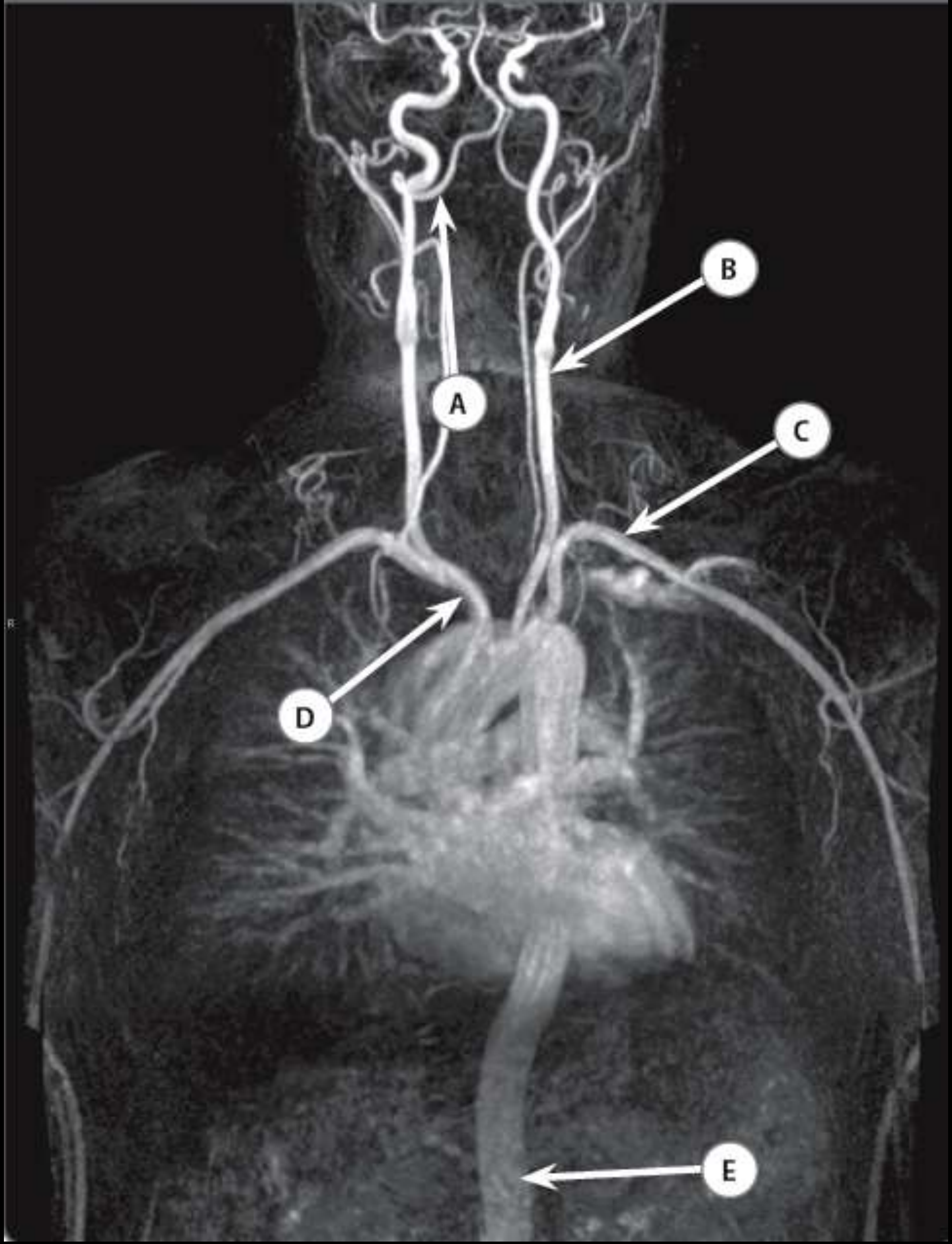
D Descending thoracic aorta

E Left Intercostal vessels

The intercostal arterial branches are evident on this example. There are a total of eleven posterior intercostal arteries on each side. The upper two arise from the superior intercostal artery, which is a branch of the costocervical trunk of the subclavian artery. The lower nine paired branches arise from the thoracic aorta and travel along the inferior border of the corresponding rib. Each artery travels in a neurovascular bundle along with a posterior intercostal vein and intercostal nerve.

The artery is sandwiched between the vein (which lies above) and the nerve (below). Hence, the mnemonic VAN can be used to recall the order of the Vein, Artery and Nerve.

Case 12.10



Case 12.10

A Right vertebral artery

B Left common carotid artery

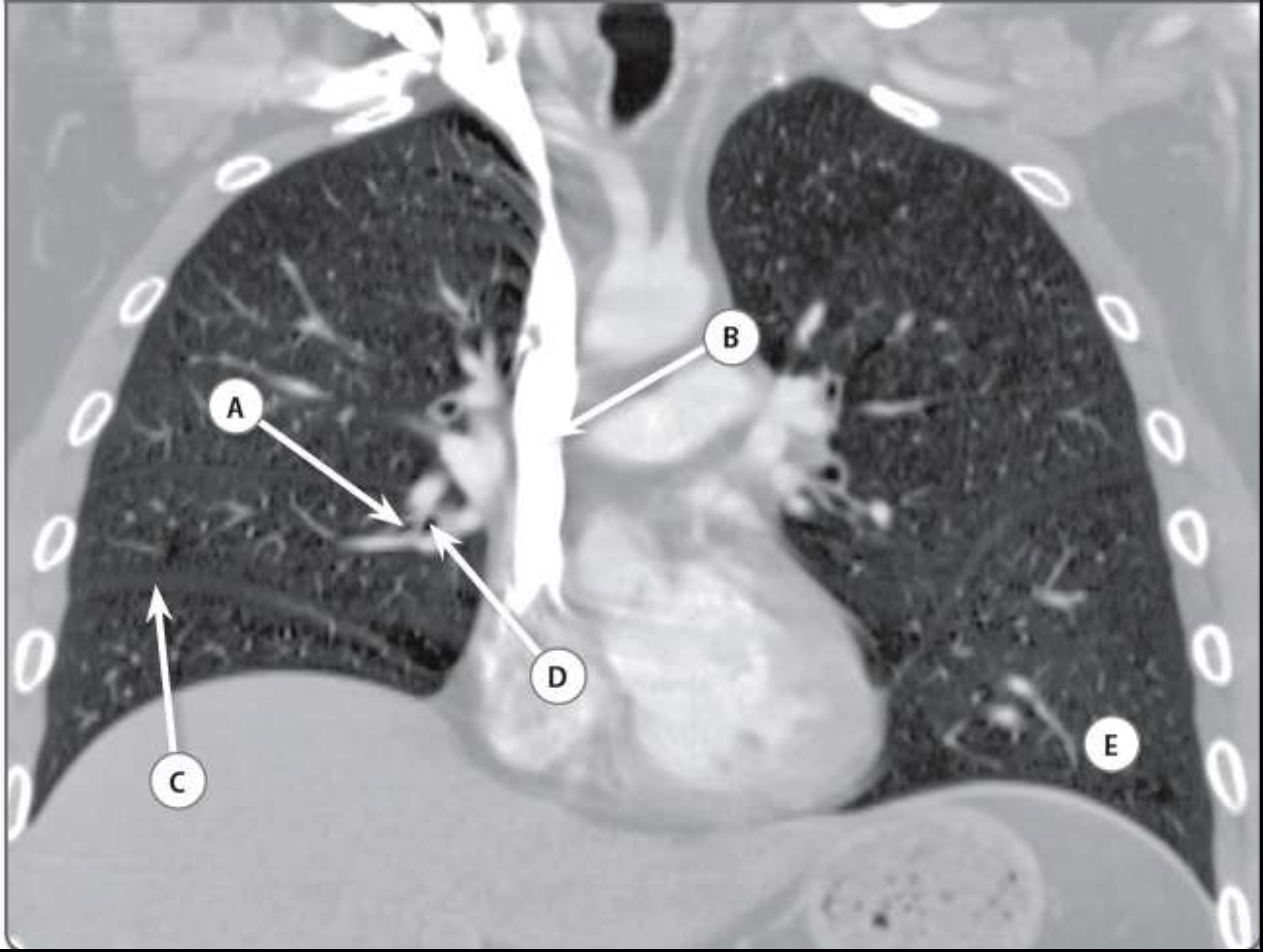
C Left subclavian artery

D Brachiocephalic trunk/innominate artery

E Abdominal aorta

This MR angiogram shows the normal arterial anatomy of the mediastinum and neck. The brachiocephalic trunk gives rise to the right subclavian artery and right common carotid artery, with the left common carotid artery and left subclavian artery representing the next two branches of the aortic arch in most individuals.

Case 12.13



Case 12.13

A Lateral segmental bronchus of middle lobe

B Superior vena cava

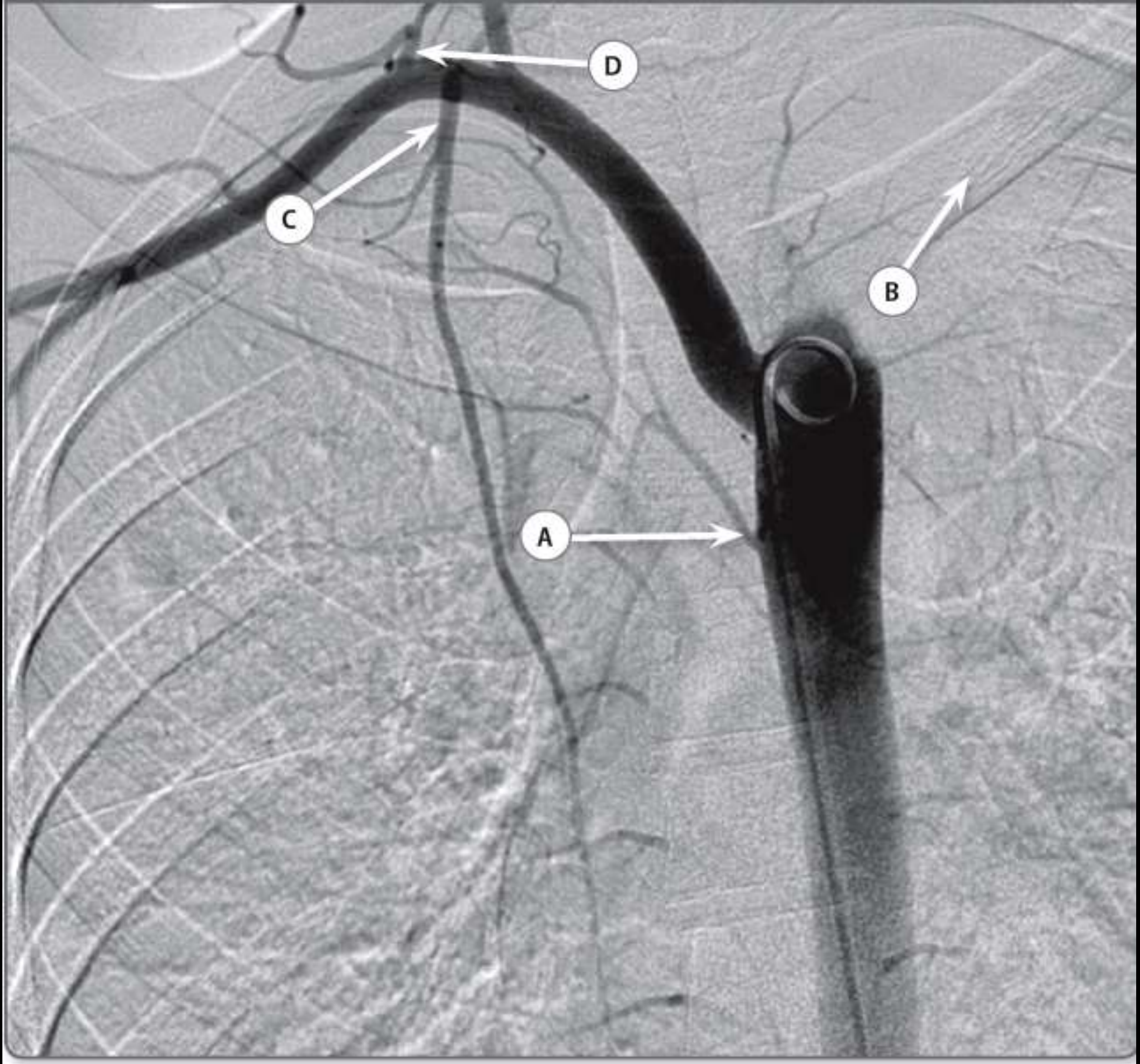
C Right oblique fissure

D Medial segmental bronchus of middle lobe

E Lateral basal segment of left lower lobe

The right lung comprises three lobes: the upper lobe, middle lobe and lower lobe. There is no middle lobe in the left lung, although the lingula of the left upper lobe serves as its homologue. The middle lobe consists of lateral and medial bronchopulmonary segments. Consolidation in the middle lobe will result in loss of clarity (loss of silhouette) of the right heart border.

Case 12.16



E	Which anatomical variant is present on this image?

Case 12.16

A Right costo-bronchial trunk

B Left clavicle

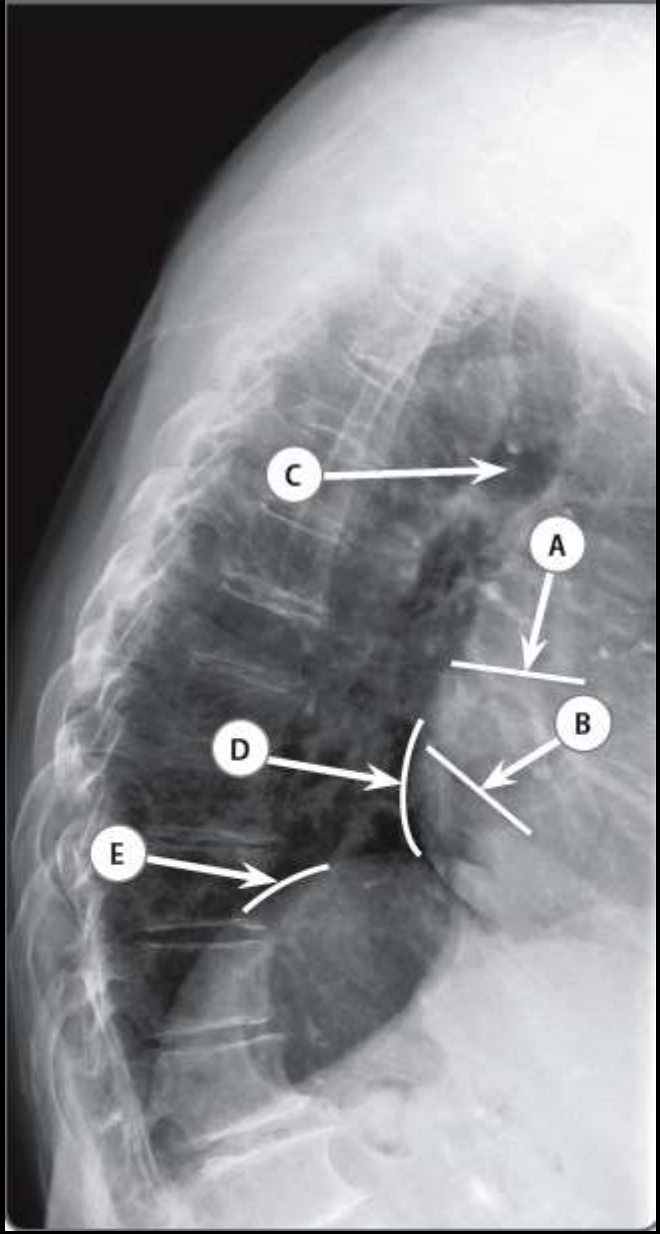
C Right internal mammary artery

D Right costocervical trunk

E Aberrant right subclavian artery

An aberrant right subclavian artery is seen arising directly from the aortic arch. Branches of the subclavian artery are seen to arise as normal. This variant is important when considering vascular intervention.

Case 12.20



Case 12.20

A Horizontal fissure

B Oblique fissure

C Trachea

D Posterior wall of the left atrium

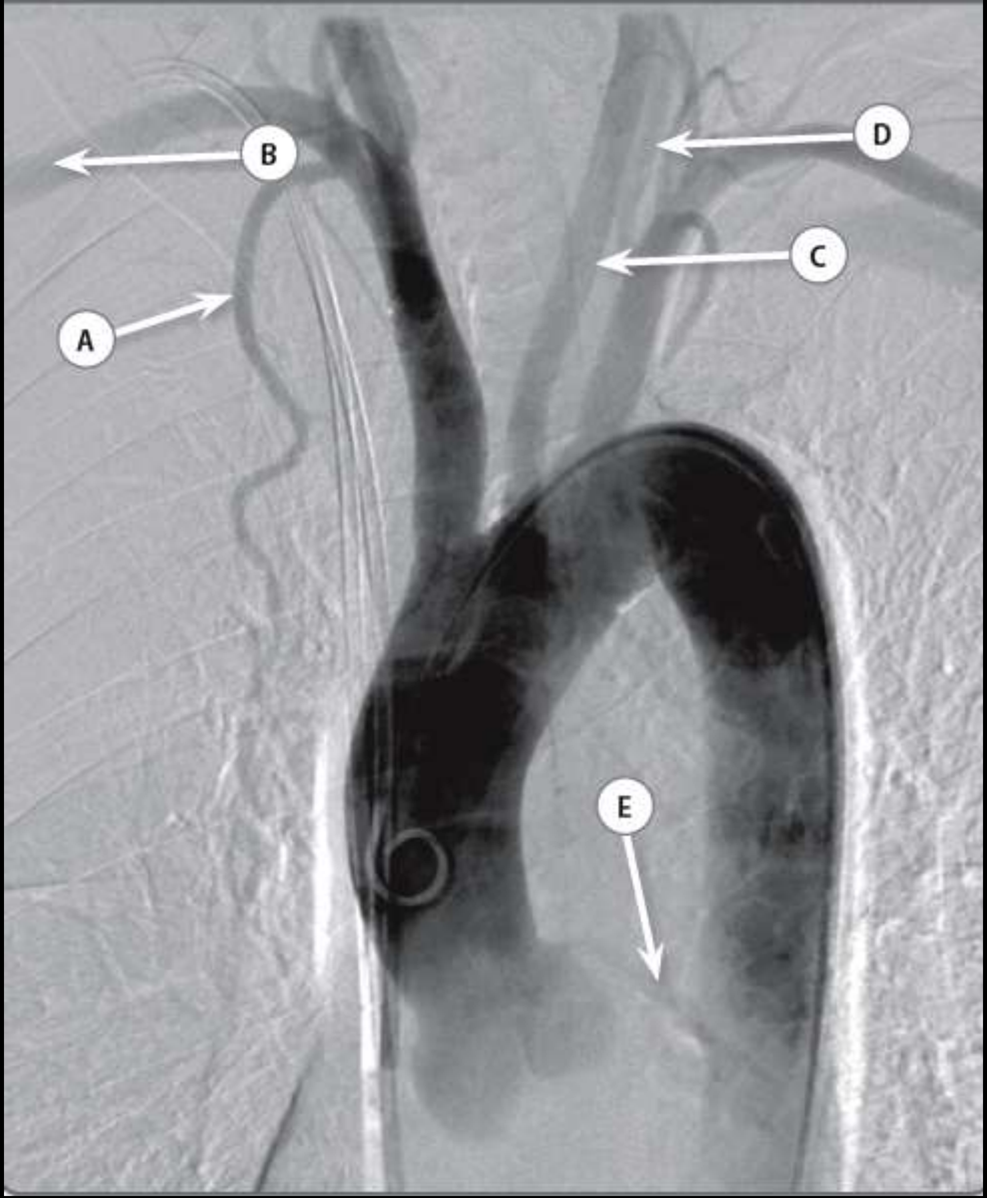
E Left hemidiaphragm

The oblique fissure usually begins at the T4/5 level and runs anteriorly to pass through the hilum. The left oblique fissure is steeper than the right.

The right horizontal fissure runs from the hilum anteriorly at about the level of the fourth rib.

The left hemidiaphragm appears to be higher than the right on the current radiograph but this is projectional as the fundal gas shadow is seen beneath it.

Case 13.5



Case 13.5

A Right internal mammary/thoracic artery

B Right subclavian artery

C Left common carotid artery

D Left vertebral artery

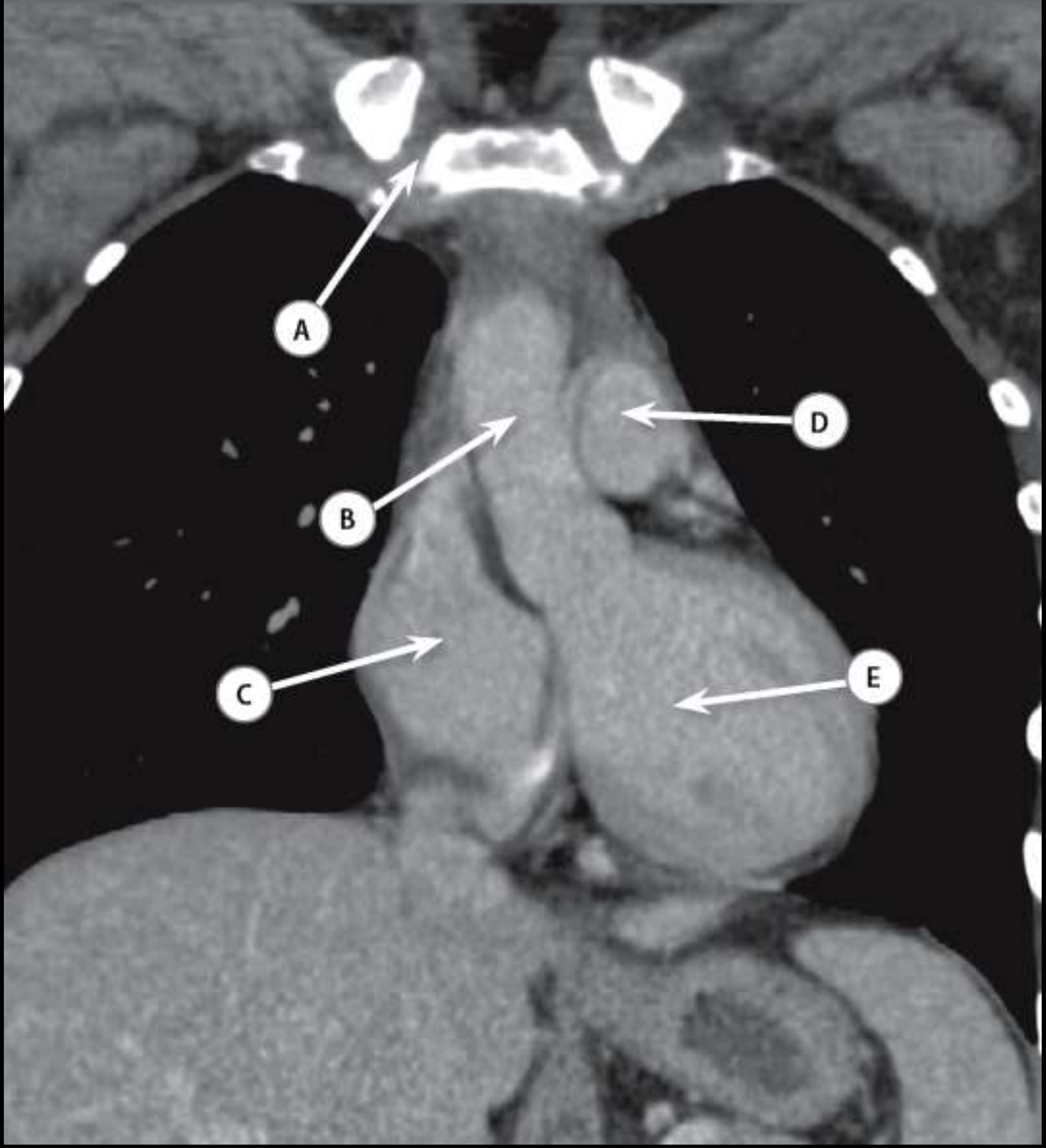
E Left coronary artery

This is a DSA angiogram of the aortic arch, left anterior oblique (LAO) projection. LAO is the best projection to view the unfolded aortic arch. A number of anatomical variants may arise here and it is important to look out for these, particularly when considering vascular intervention.

Common variations to look out for include:

1. Aberrant right subclavian artery arising distal to the origin of the left subclavian artery
2. Common origin of the left common carotid artery and the brachiocephalic trunk

Case 14.8



Case 14.8

A Right sternoclavicular joint

B Ascending aorta

C Right atrium

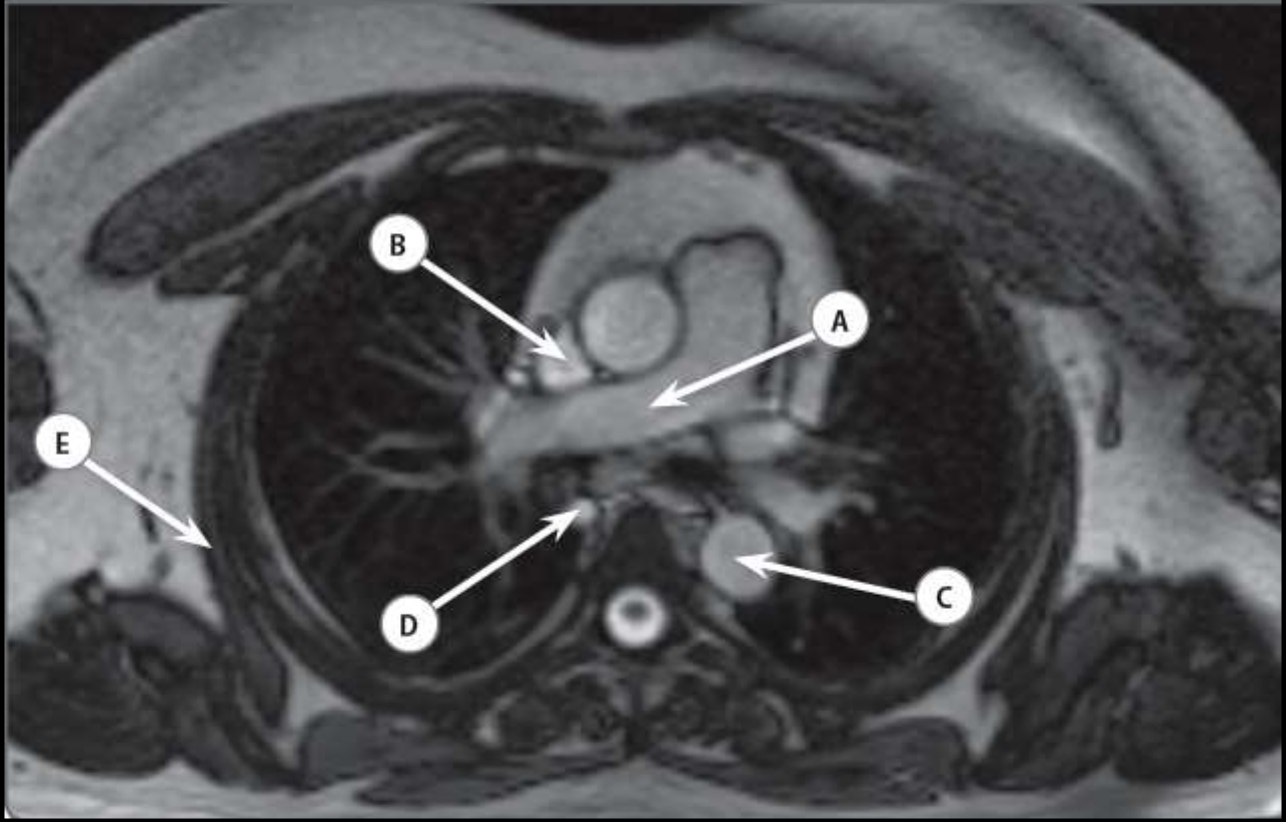
D Pulmonary trunk

E Left ventricle

The papillary muscles are evident in the cavity of the left ventricle. There are two papillary muscles in the left ventricle and three in the right ventricle. They attach to the cusps of the mitral and tricuspid valves respectively and prevent regurgitation of ventricular blood into the atria during systole.

The aortic valve is normally tricuspid but is congenitally bicuspid in 1% of individuals. This abnormal valve is more prone to aortic stenosis.

Case 14.15



Case 14.15

A Right pulmonary artery

B Superior vena cava

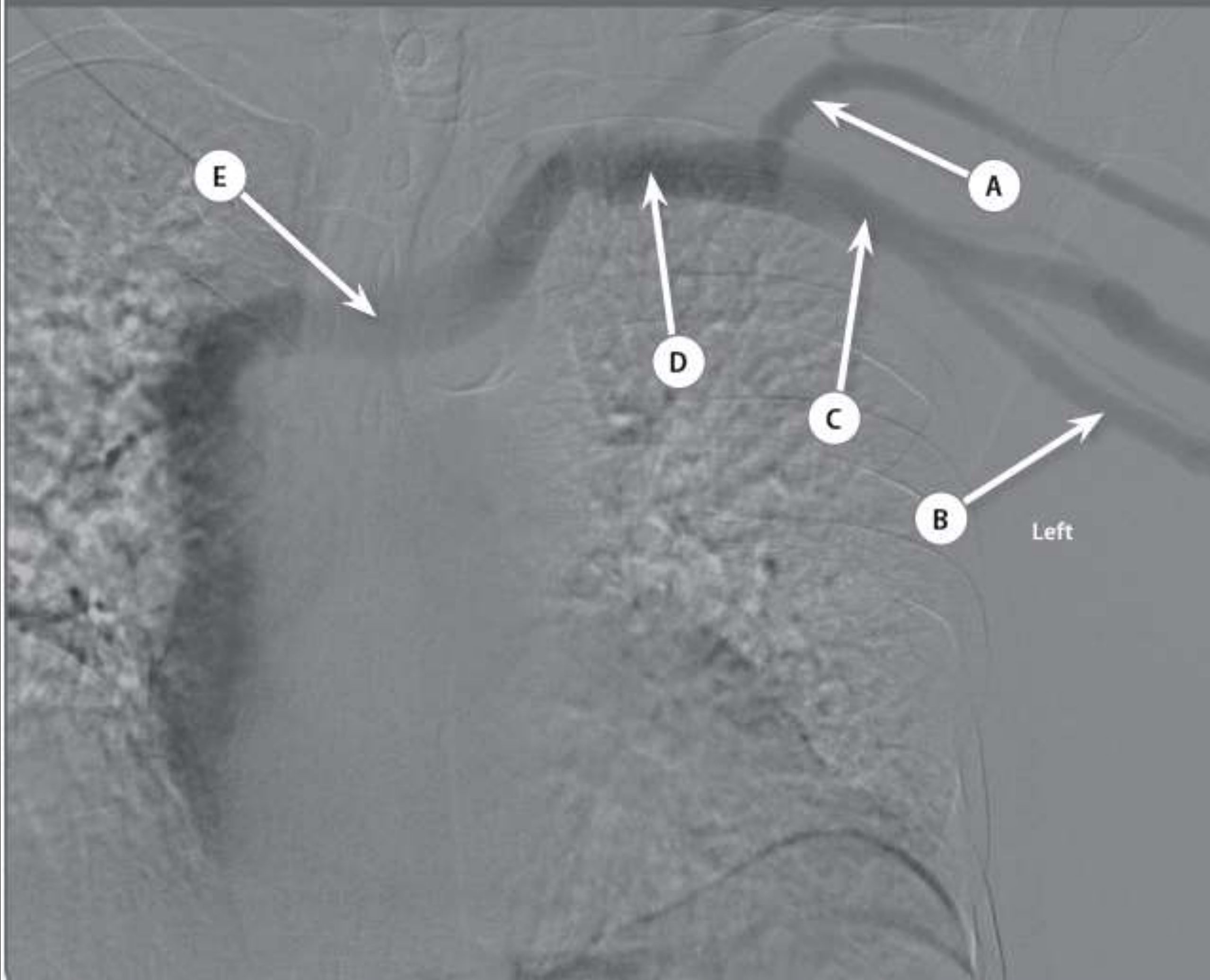
C Descending thoracic aorta

D Azygos vein

E Right serratus anterior muscle

The right pulmonary artery lies horizontal at this level, passing posterior to the ascending aorta and the superior vena cava and anterior to the two major bronchi and the oesophagus. There is a fair amount of anterior pericardial fat (shown as a white crescent anterior to the great vessels), the same appearance as the fat in the axillae and breasts. Note that a trace amount of pericardial fluid (up to 5 mL) is often visible on both MRI and ultrasound of the heart and is a normal finding.

Case 14.18



Case 14.18

A Left cephalic vein

B Left basilic vein

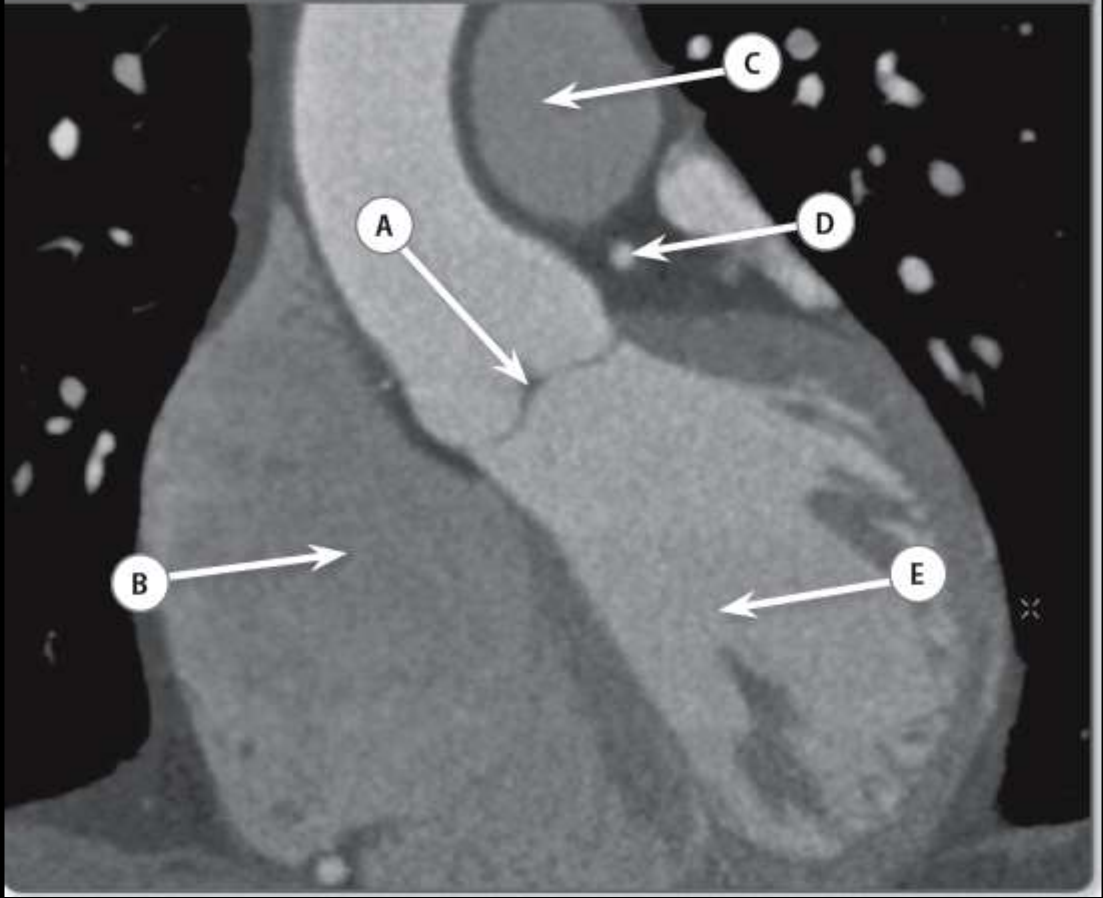
C Left axillary vein

D Left subclavian vein

E Left brachiocephalic vein

Venous drainage of the arm is highly variable. The most constant veins are the cephalic, basilic and brachial veins. The brachial and basilic veins unite to form the axillary vein. The subclavian vein is formed by the confluence of the axillary and cephalic veins. The internal jugular vein joins the subclavian vein to form the brachiocephalic vein.

Case 15.5



Case 15.5

A Aortic valve

B Right atrium

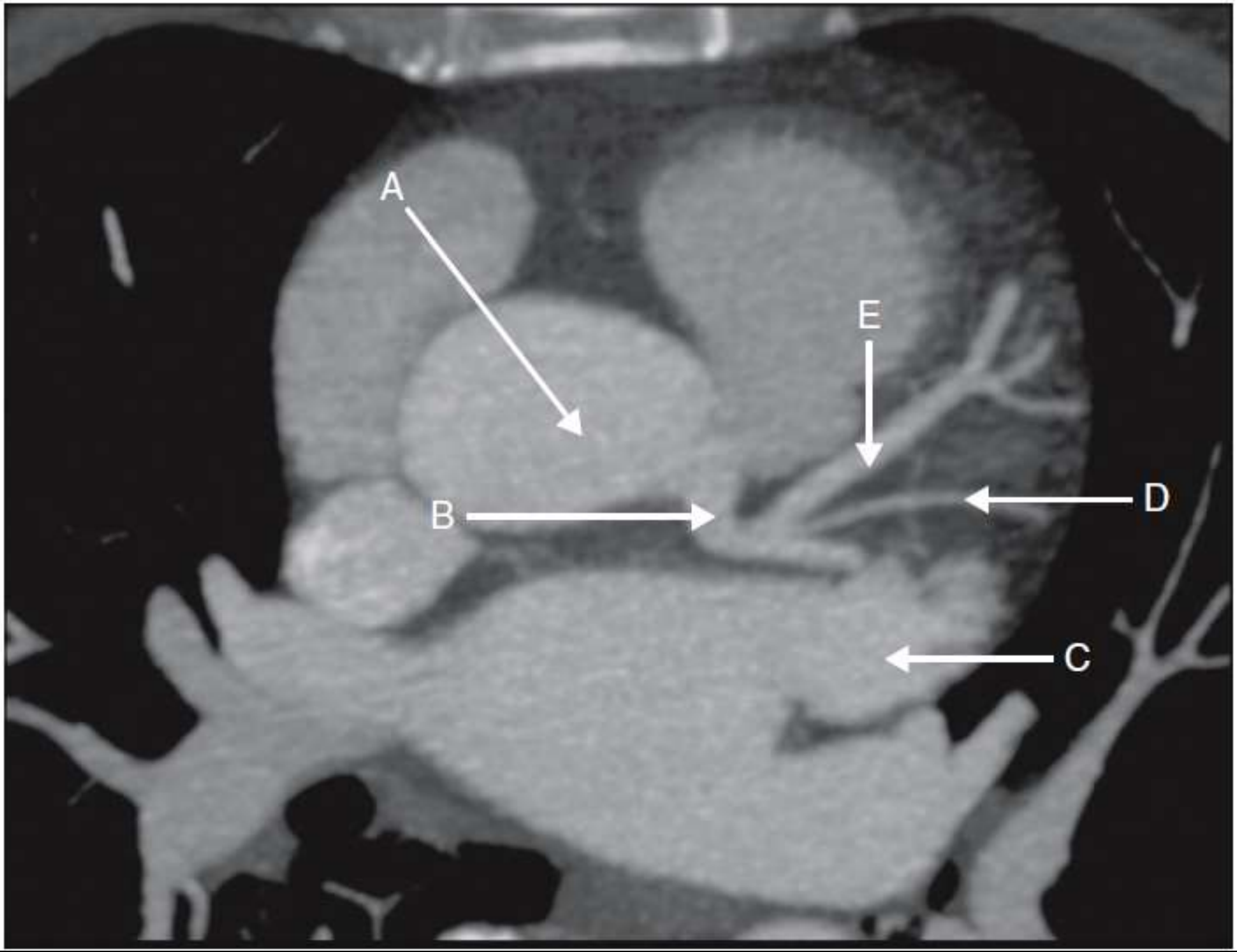
C Pulmonary trunk /main pulmonary artery

D Left coronary artery

E Left ventricle

The left coronary artery arises from the left posterior aortic sinus and courses posterior to the pulmonary trunk in the left atrioventricular groove, in which it bifurcates into the left circumflex artery and the left anterior descending artery.

Case 1.7

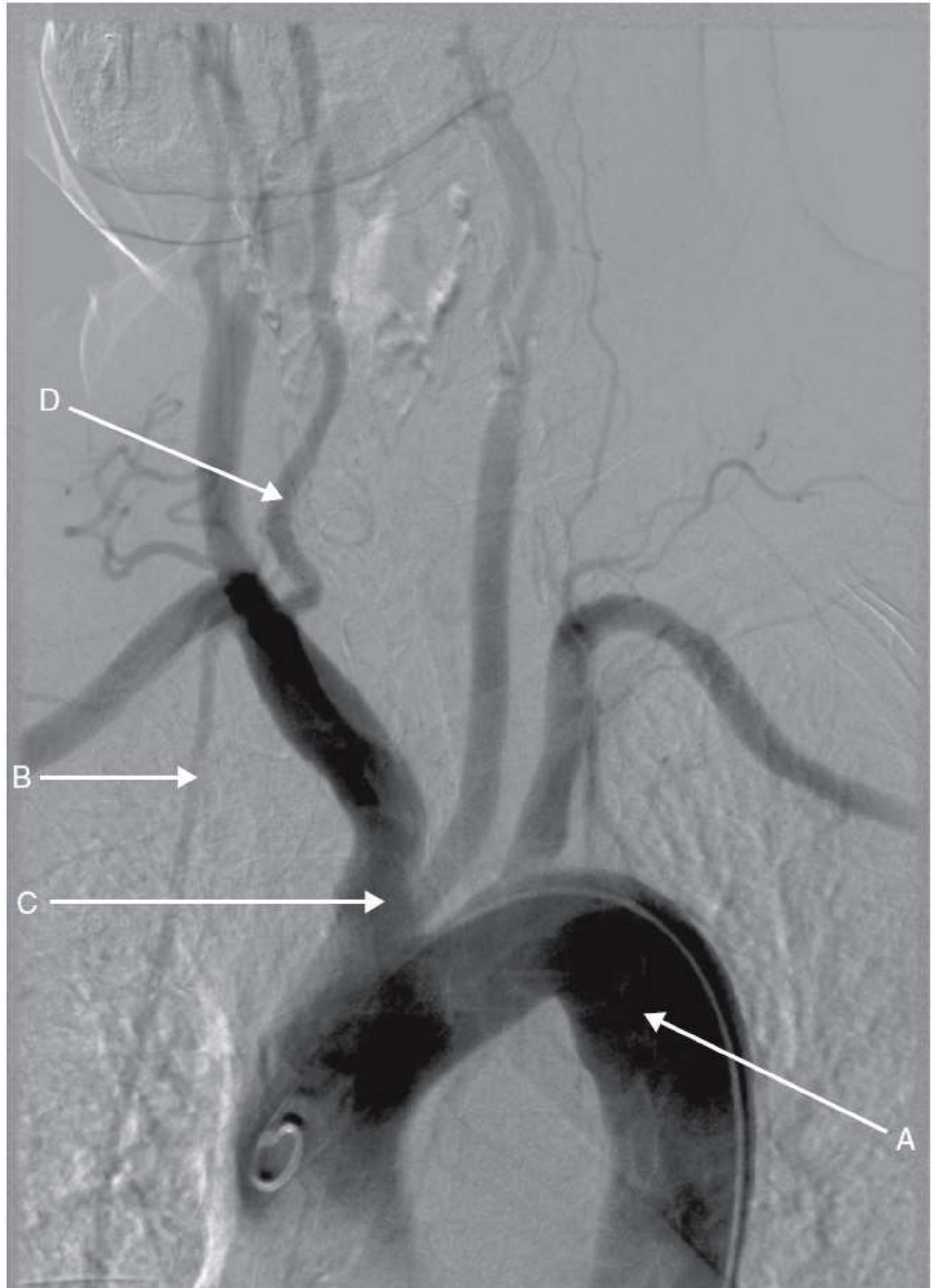


1.7 CT coronary angiography

(a) Aortic root.
(b) Left main coronary artery. The left main coronary artery arises from the left coronary cusp. It bifurcates into the left anterior descending artery (LAD), which runs in the anterior inter-ventricular groove, and the left circumflex artery (LCX), which runs in the left atrio-ventricular groove.
(c) Left atrial appendage.
(d) Ramus intermedius. Occasionally (as in this case) there is a third branch from the distal left main, the ramus intermedius.
(e) Left anterior descending artery.

The LAD gives rise to diagonal branches which run over the surface of the left ventricle (LV) and also to septal perforator branches which are not well demonstrated on CT angiography (CTA). The LCX gives rise to obtuse marginal branches which run along the lateral border of the LV.

Case 1.12



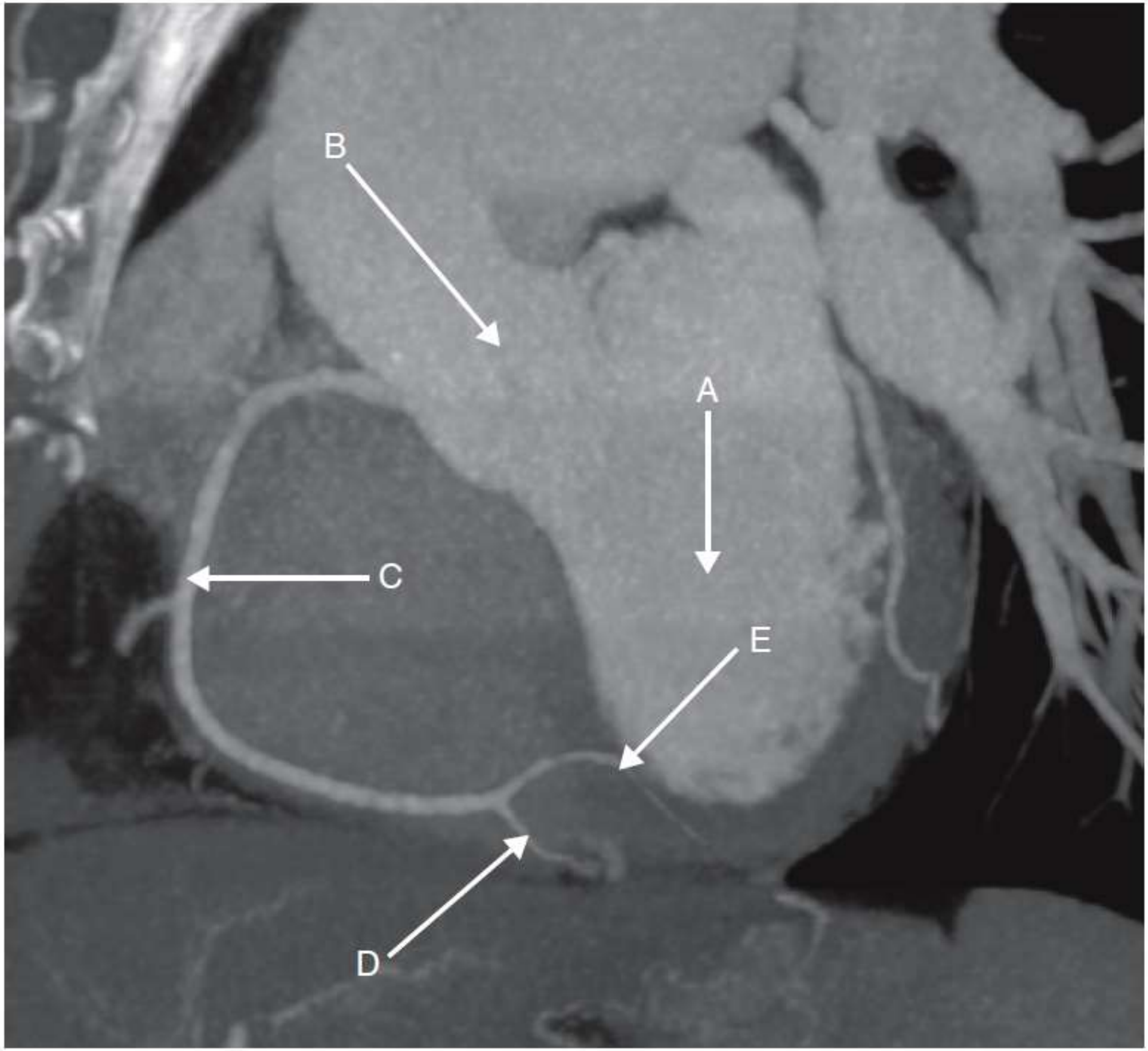
(e)	Which normal variant is present on this image?

1.12 Arch aortogram

(a) Aortic arch. The ascending aorta extends to the branch of the right brachiocephalic artery and the descending aorta commences at the distal aspect of the left subclavian artery. The aortic arch lies between these two points.
(b) Right internal thoracic (or mammary) artery. This is the first branch of the subclavian artery and can act as a bypass conduit in aortic occlusion via the inferior epigastric artery. This is known as the path of Winslow.
(c) Right brachiocephalic (or innominate) artery.
(d) Right vertebral artery. This arises from the subclavian artery. The subclavian 'steal' syndrome occurs when there is a subclavian stenosis distal to the origin of the vertebral artery. The arm 'steals' its blood supply from the vertebral artery.
(e) Common origin of the left common carotid and innominate artery (bovine arch). This occurs in 22% of individuals and accounts for 73% of all arch vessel anomalies.

Other common variants include left vertebral artery arising directly from the aortic arch (6% of individuals), thyroid ima artery (6%) and aberrant right subclavian artery (1%).

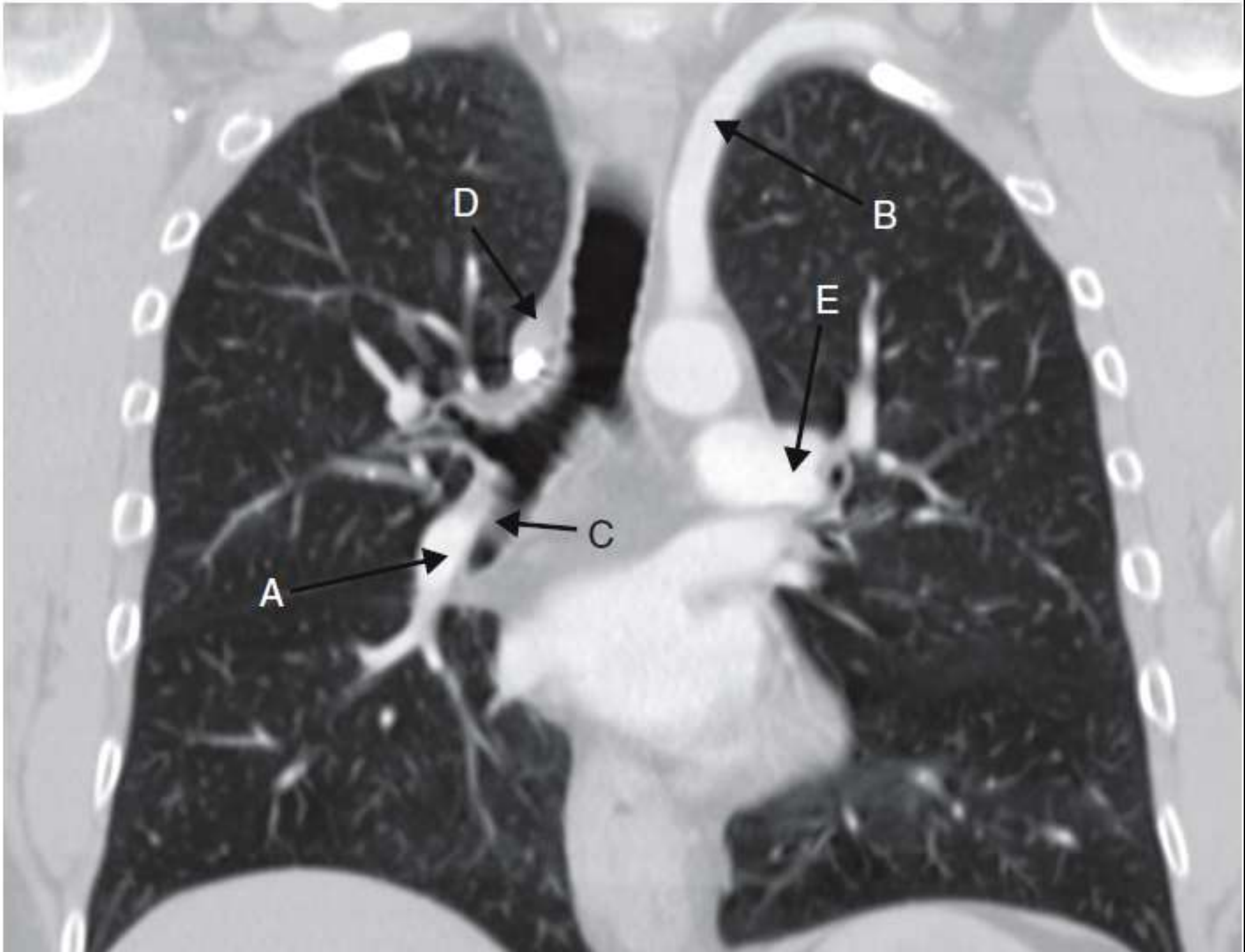
Case 2.10



2.10 Coronary CT angiography

(a) Left ventricle.
(b) Aortic root.
(c) Right coronary artery (RCA). The RCA arises from the right coronary cusp (anterior sinus of Valsalva) and runs in the right atrio-ventricular (AV) groove. The proximal segment gives rise to a conal branch supplying the right ventricular outflow tract and a sino-atrial (SA) branch supplying the SA node in about 65% of individuals. The mid segment gives rise to an acute marginal branch supplying the right ventricle wall. The distal RCA continues in the right AV groove where a branch supplies the AV node, before continuing to the inferior surface of the heart.
(d) Posterior descending artery (PDA). In a right dominant system, the RCA supplies the PDA running in the inferior interventricular groove but in a small number individuals it is a branch of the left circumflex artery.
(e) Posterior left ventricle wall branch. This artery is a continuation of the RCA.

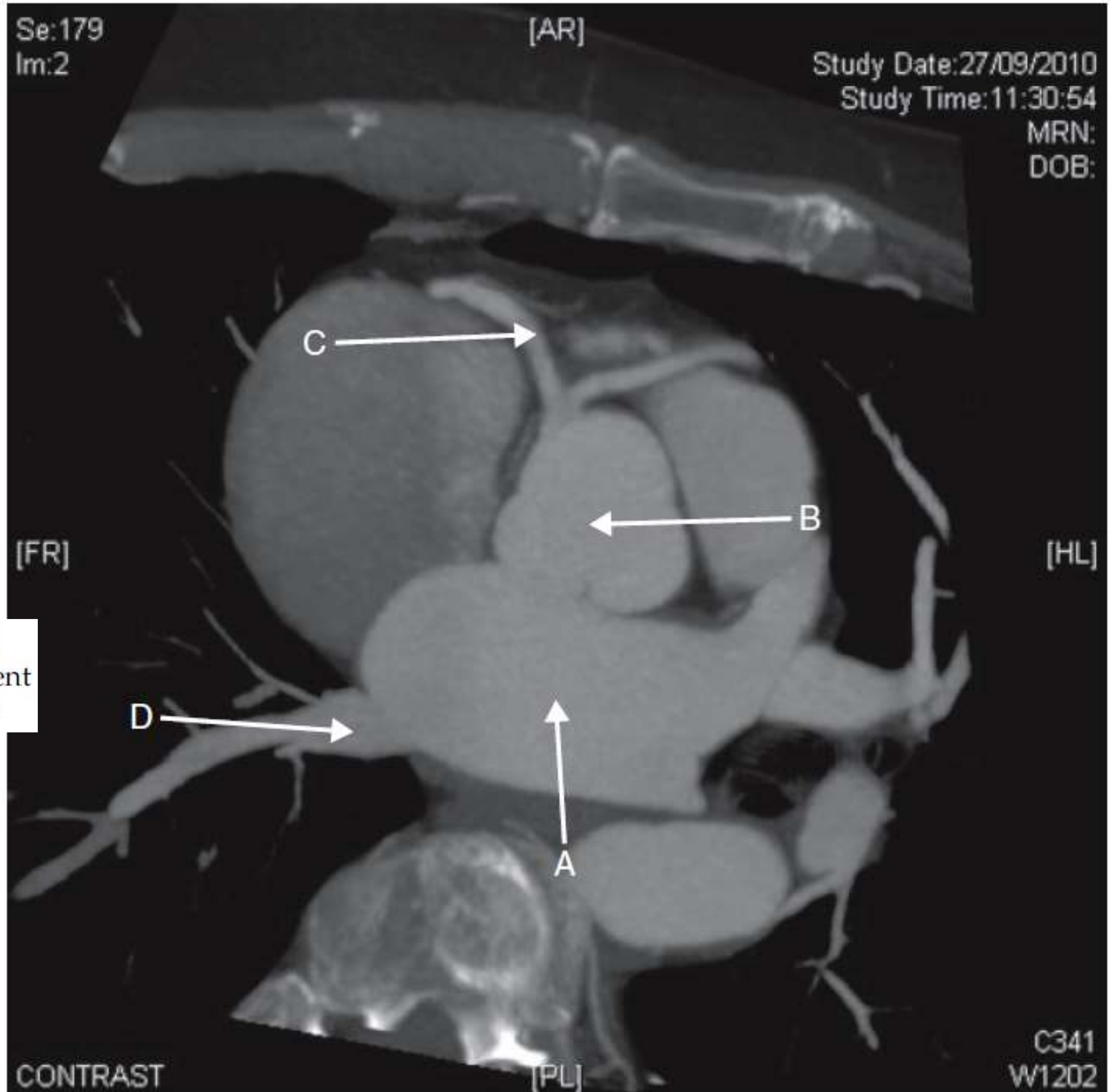
Case 2.17



2.17 Coronal CT thorax

(a) Right interlobar pulmonary artery. The right interlobar artery lies lateral to bronchus intermedius. This is useful in the recognition of these structures on a PA chest radiograph.
(b) Left subclavian artery.
(c) Bronchus intermedius.
(d) Azygos vein. Note the right paratracheal stripe which lies superior to the azygos vein.
(e) Left main pulmonary artery.

Case 4.8



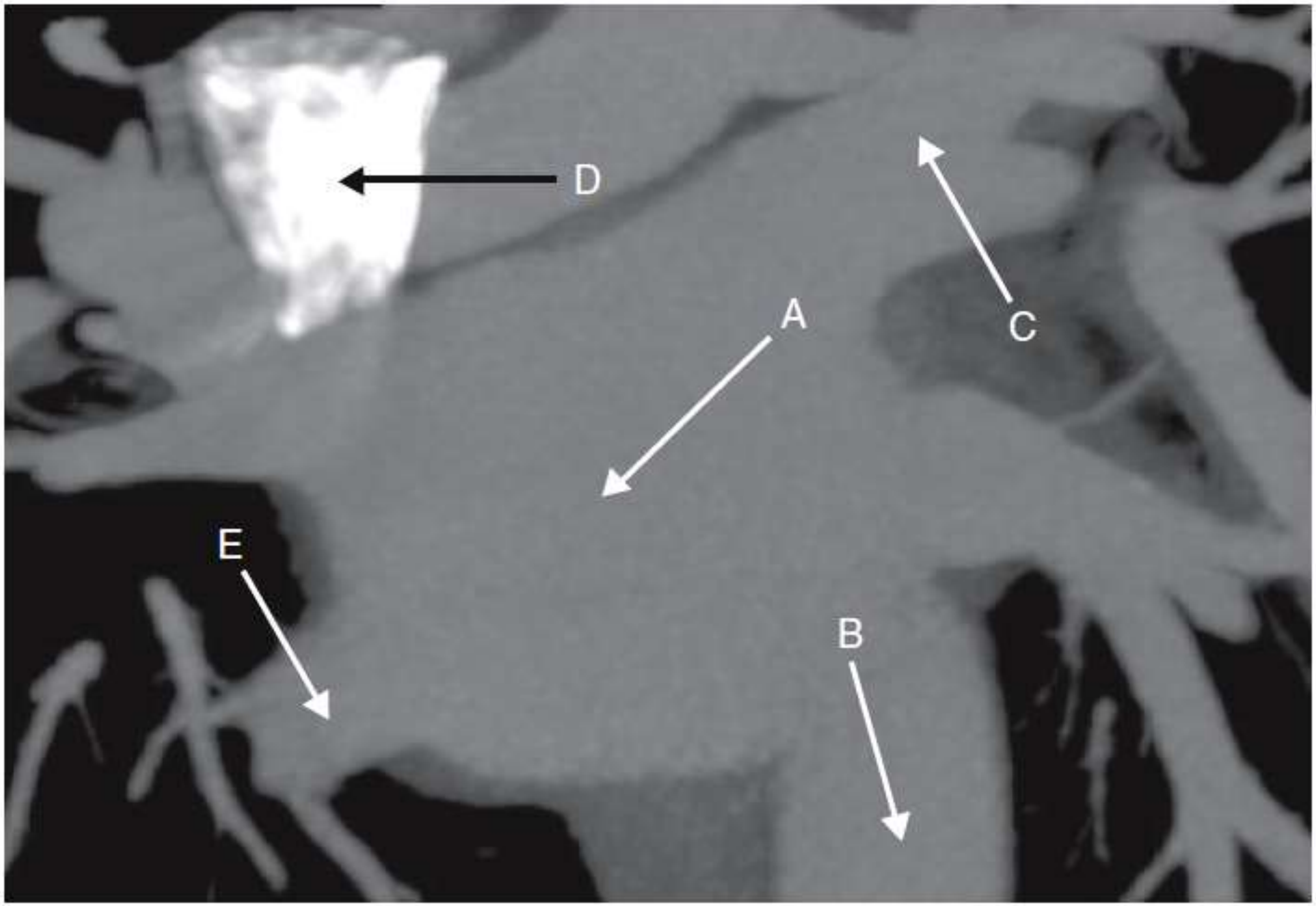
(e)	Which normal variant is present on this image?

4.8 CT coronary angiography

(a) Left atrium.
(b) Aortic root.
(c) Right coronary artery.
(d) Right inferior pulmonary vein.
(e) Aberrant left coronary artery. There are several normal variants of coronary artery anatomy. The illustrated example is of an aberrant left coronary artery which has a common origin with the right coronary artery from the right coronary cusp. Normally the left coronary artery arises from the left coronary cusp.

In this case the aberrant left coronary artery has a 'benign' course passing anterior to the right ventricular outflow tract (RVOT). If the aberrant artery runs a 'malignant' course between the aortic root and the RVOT this is associated with an increased incidence of sudden cardiac death.

Case 5.8



5.8 Cardiac CT

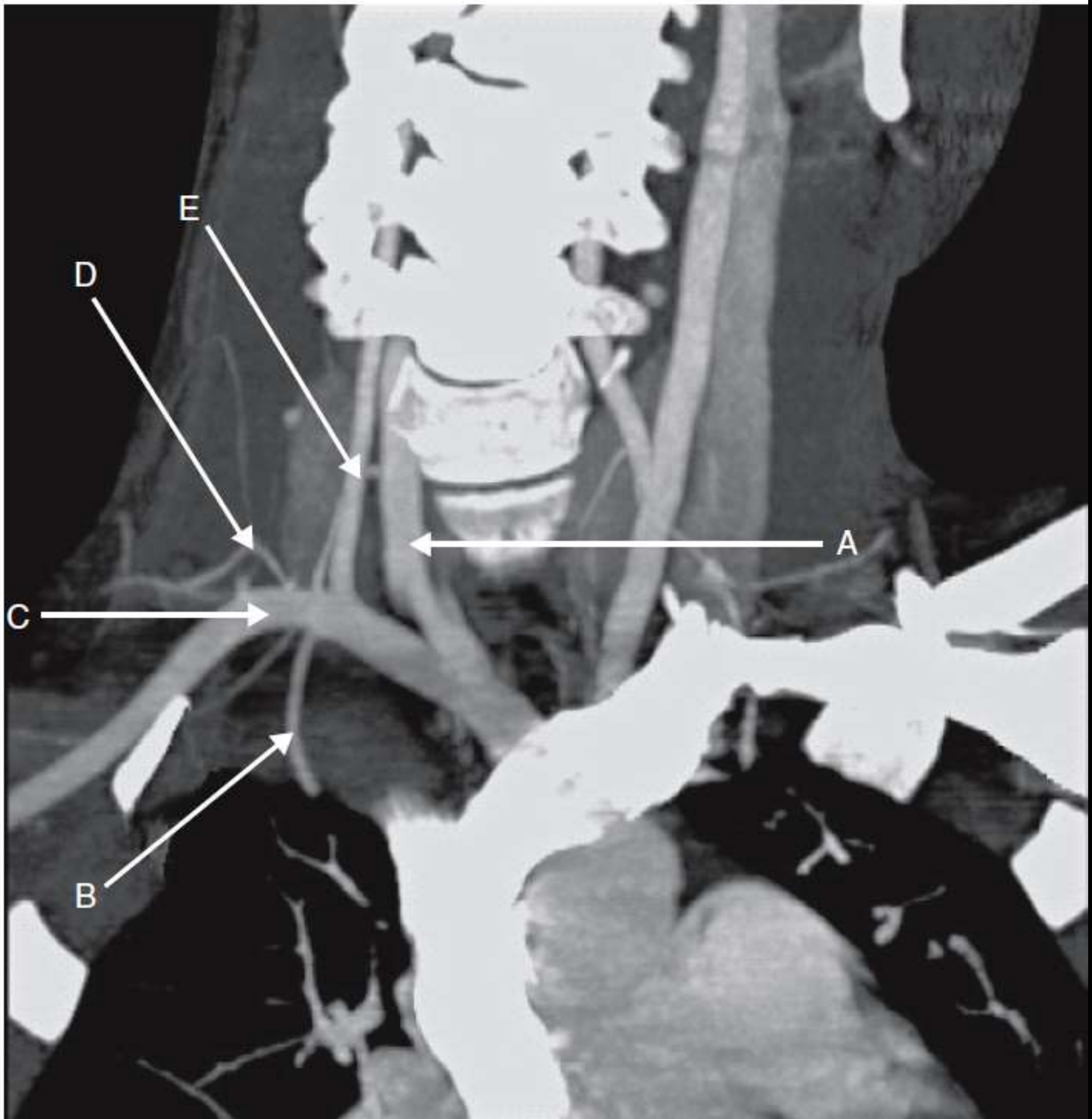
(a) Left atrium.
(b) Descending thoracic aorta.
(c) Left superior pulmonary vein.
(d) Superior vena cava.
(e) Right inferior pulmonary vein.

Normal pulmonary venous anatomy consists of a superior and inferior pulmonary veins on each side, draining into the left atrium. It is important to remember these carry oxygenated blood.

In addition to the normal pulmonary veins on the right, there may also be one or two middle pulmonary veins and/or an upper pulmonary vein draining into the superior surface of the left atrium. On the left, the superior and inferior pulmonary veins may join to form a common trunk, either short or long. All these variant veins drain directly into the left atrium.

At the root of the lung, the superior pulmonary vein lies anterior and inferior to the pulmonary artery while the inferior pulmonary vein lies in the inferior part of the lung hilum.

Case 5.13



5.13 Oblique coronal maximum intensity projection (MIP) aortic arch vessels

(a) Right common carotid artery. This bifurcates at C4 level. It lies in the carotid sheath medial to the jugular vein with the vagus nerve interposed in between and posterior to them.

Neither the common carotid or internal carotid arteries have any other branches. The external carotid artery gives off seven branches.

Diseases of the carotid arteries are investigated using primarily Duplex ultrasound or MRA, or usually both if there is indeterminate pathology.

(b) Right internal thoracic (or mammary) artery.

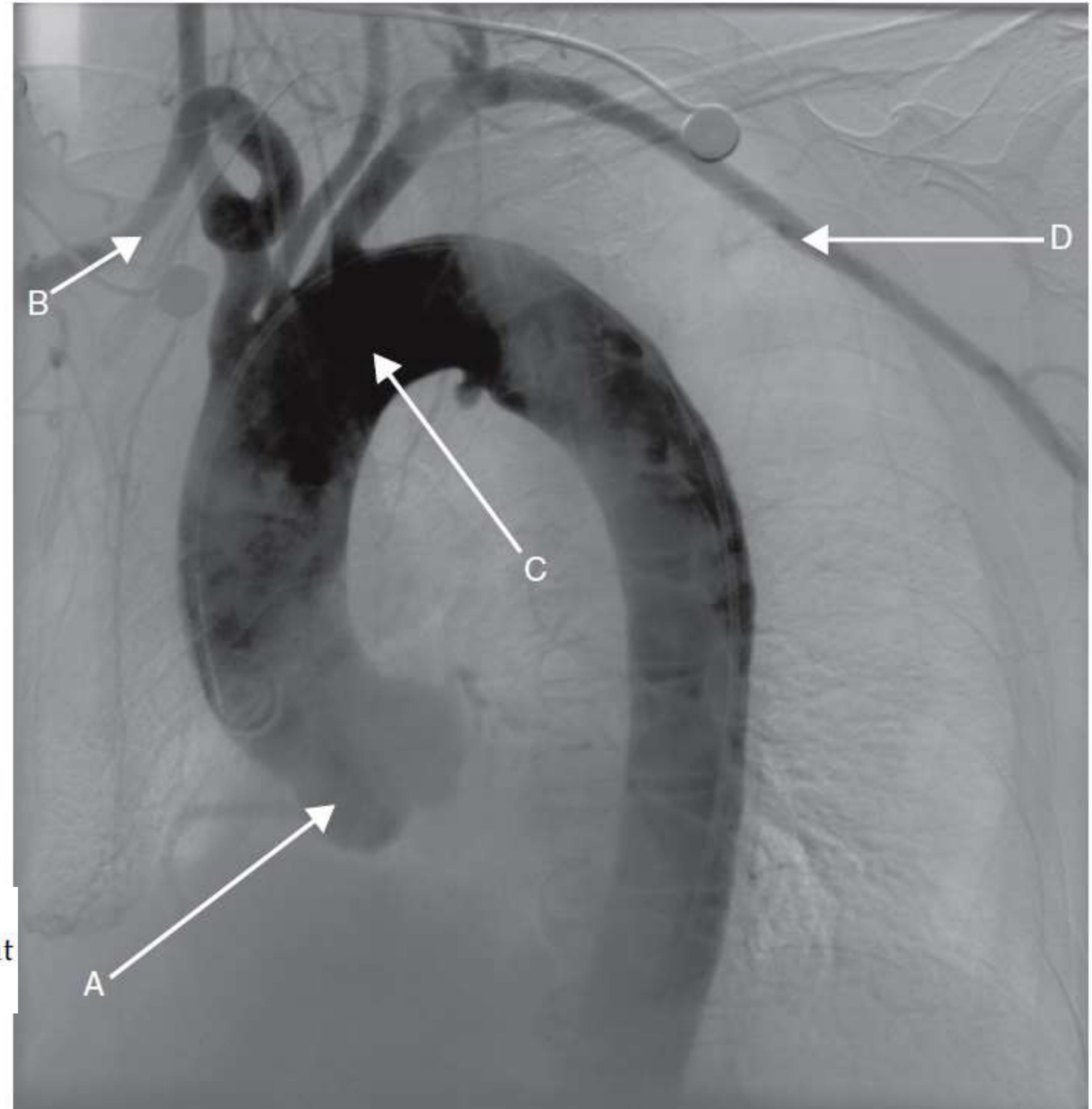
(c) Right subclavian artery. The right subclavian and carotid arteries arise from the innominate (or brachiocephalic) artery. There is no equivalent on the contralateral side where the two vessels have a separate origin from the aortic arch.

The subclavian artery lies in a groove in the superior surface of the first rib behind the subclavian vein, the two being separated by the scalene muscle, which divides the artery, into three parts. At the outer border of the first rib it becomes the axillary artery which in turn becomes the brachial artery at the lower border of teres major.

(d) Right thyrocervical trunk.

(e) Right vertebral artery. This vessel acts as a bypass conduit in subclavian steal syndrome where the ostium of the subclavian artery is blocked. The upper limb is then perfused via retrograde blood flow down the vertebral artery from the cerebral circulation.

Case 7.20



(e)	Which normal variant is present on this image?

7.20 Arch aortogram

(a) Anterior aortic cusp (or sinus of Valsalva). The right coronary artery arises from here. The left coronary artery arises from the left posterior sinus.

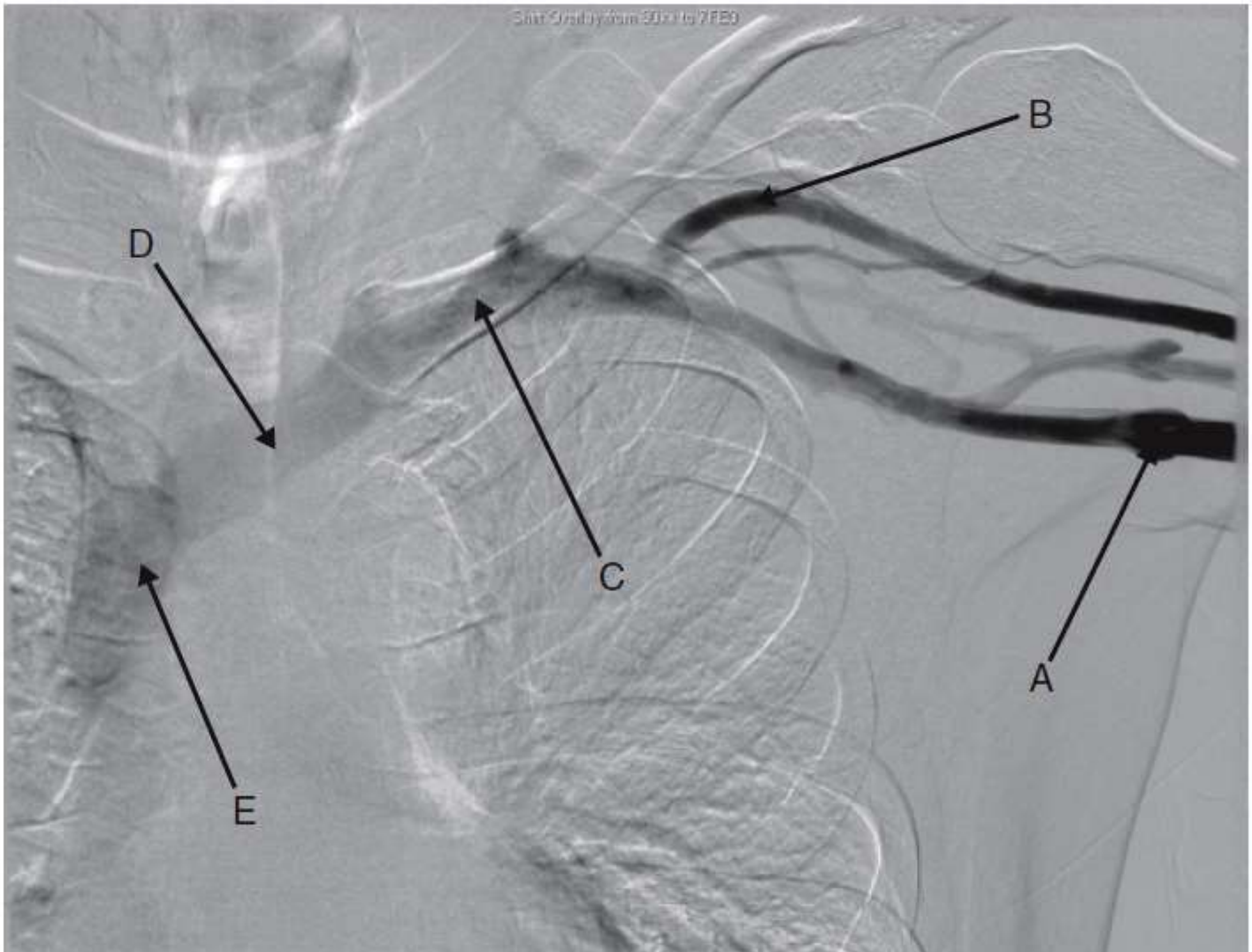
(b) Right subclavian artery.

(c) Aortic arch. The aortic arch is defined as the aorta from the right brachiocephalic artery to the attachment of the ligamentum arteriosum. It can be further subdivided into proximal arch (right brachiocephalic artery to left subclavian artery (LSA)) and distal (LSA to attachment of ligament arteriosum). The distal arch is sometimes referred to as the isthmus or 'bridge' and may be narrower than the proximal descending aorta. The isthmus represents the weakest part of the arch and is prone to transection, intimal laceration and false aneurysm formation in decelerating road traffic accidents.

(d) Left axillary artery.

(e) Ductus diverticulum ('ductus bump'). This is a fusiform dilatation along the ventro-medial aspect of the descending aorta adjacent to the ligamentum arteriosum. It is present in up to 9% of adults. Its appearances are sometimes confounding in blunt trauma as it can be confused with a false aneurysm. This point on the aorta is a transition between the fixed descending aorta and mobile aortic arch, and therefore represents a site where transection and focal aneurysm can occur.

Case 8.4



8.4 Venogram left upper limb

(a) Valve in left basilic vein.

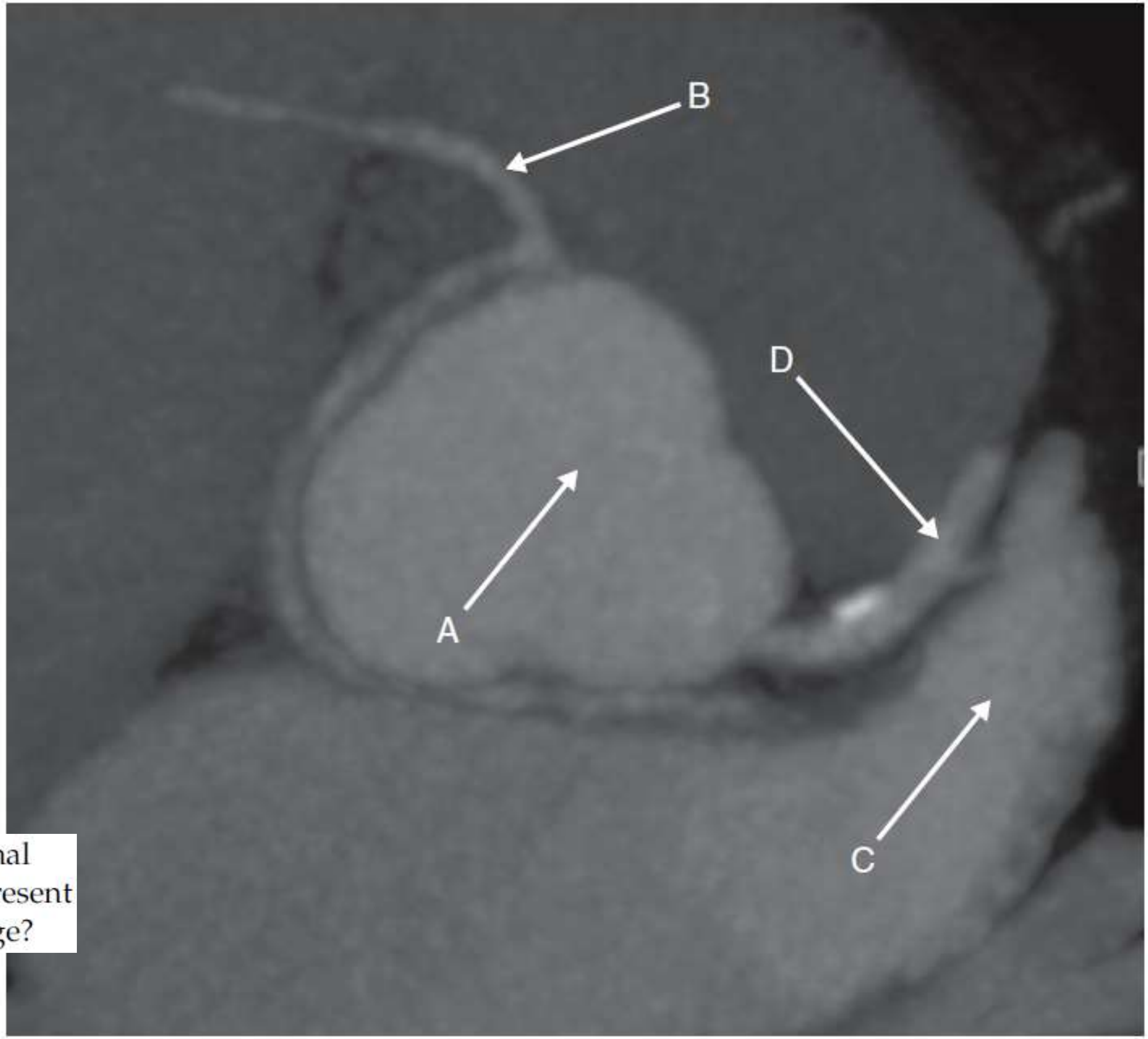
(b) Left cephalic vein. The cephalic vein, in the forearm and at the elbow, is the primary vein utilized in fashioning arteriovenous fistulae (AVF) for haemodialysis. The arrowed segment is known as the terminal arch and is notorious for developing stenoses secondary to distal AVF.

(c) Left subclavian vein. This is a continuation of the axillary vein at the outer border of the first rib and combines with the jugular vein at the sternal end of the clavicle.

(d) Left brachiocephalic vein.

(e) Superior vena cava (SVC).

Case 8.6



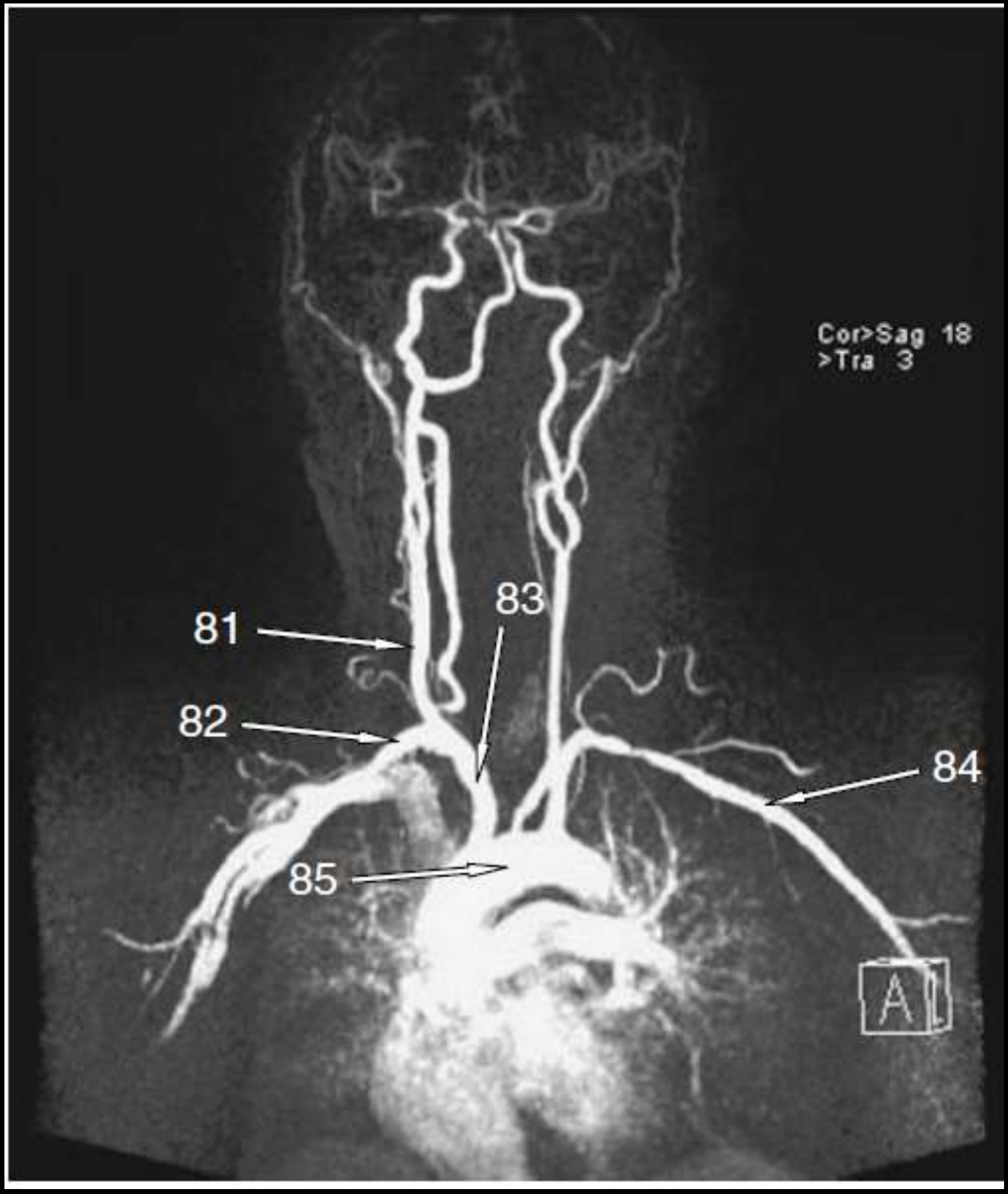
(e)	Which normal variant is present on this image?

8.6 Coronary CT

(a) Aortic root.
(b) Right coronary artery (RCA).
(c) Left atrial appendage.
(d) Left anterior descending artery.

(e) Aberrant left circumflex artery (LCX). In this case the anomalous LCX arises from the right sinus of Valsalva and shares a common origin with the RCA. It then runs behind the aortic root to reach the left atrioventricular groove and supply the lateral left ventricular wall. The anomalous LCX may have a separate origin from the RCA in the right sinus of Valsalva.

Anomalous coronary arteries are seen in 0.6–1.5% of catheter angiograms and an anomalous LCX is the commonest normal variant of coronary artery anatomy. CT coronary angiography is the examination of choice if anomalous coronary artery anatomy is suspected, and it is essential to know the variant anatomy if percutaneous coronary intervention or aortic root surgery is being considered.


Cor>Sag 18
>Tra 3
81
82
83
84
85
A

MR Angiogram

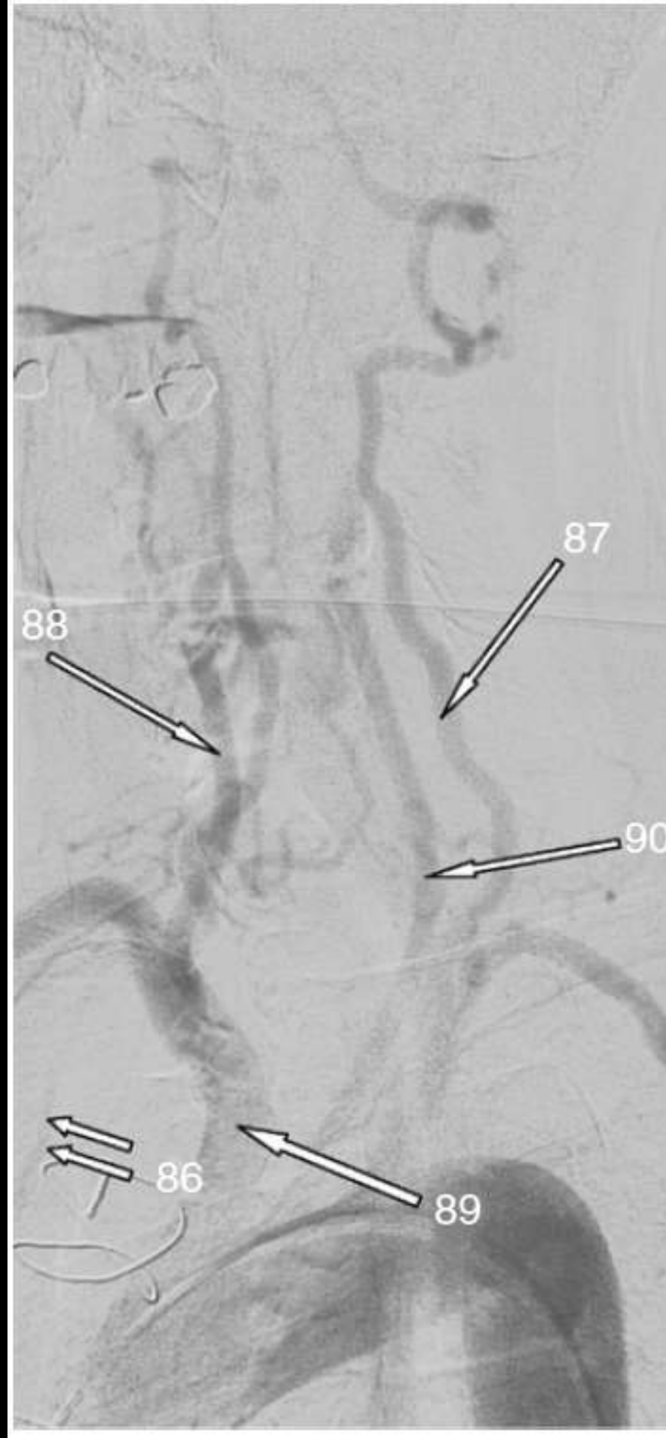
81. Right common carotid artery
82. Right subclavian artery
83. Brachiocephalic trunk
84. Left subclavian artery
85. Arch of the aorta


35
34
33
31
32

DSA

31. Anterior cusp of aortic valve
32. Left posterior cusp of aortic valve
33. Circumflex artery
34. Right coronary artery
35. Left subclavian artery

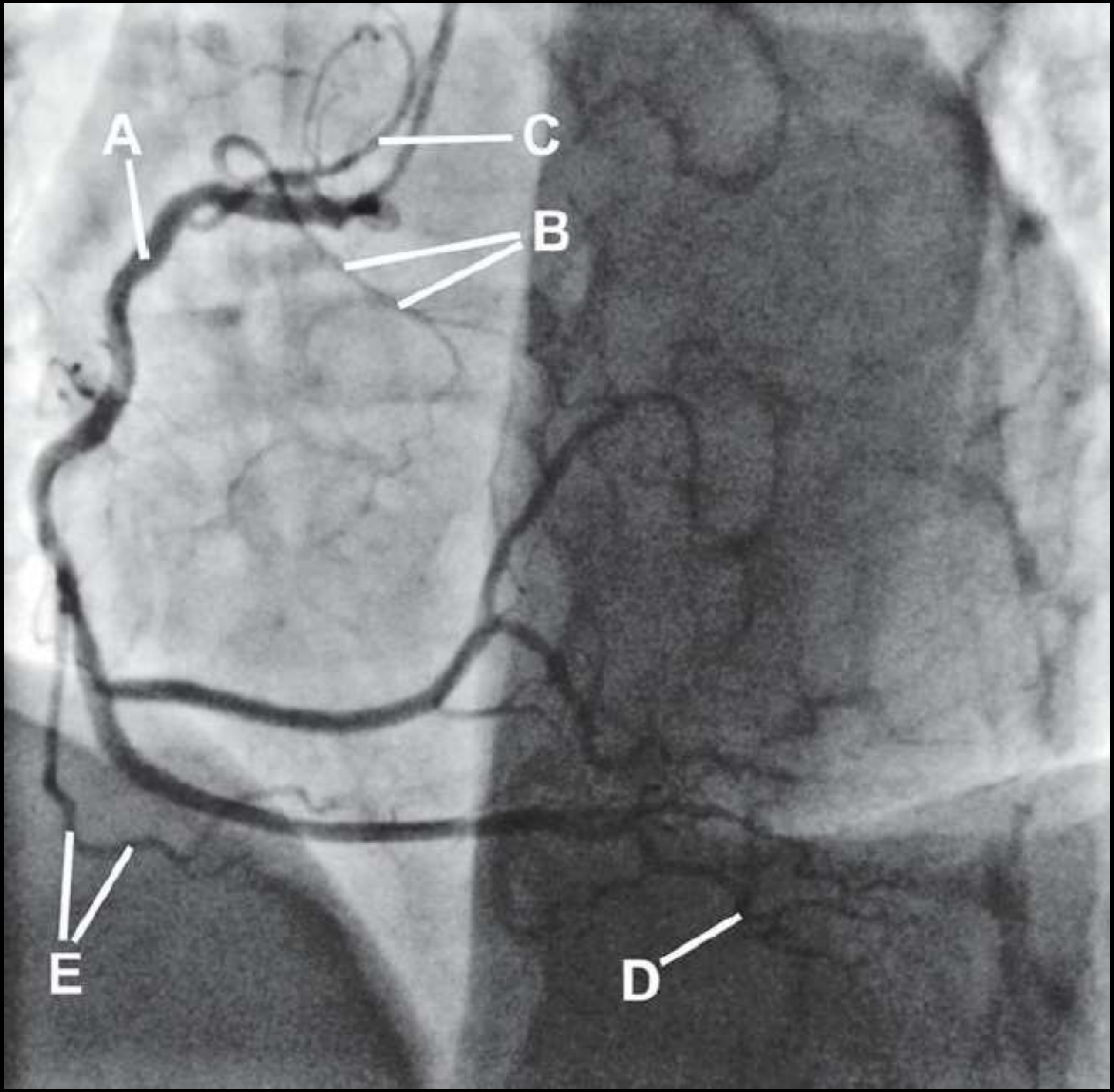
The ascending aorta begins at the aortic valve at the level of the lower border of the third costal cartilage. There are three cusps of the aortic valve of which two are related to the respective sinuses that give rise to coronary arteries.


87
88
90
86
89

DSA

86. Right internal thoracic artery
87. Left vertebral artery
88. Right common carotid artery
89. Brachiocephalic artery
90. Left common carotid artery

The normal patterns of the branches of the aorta are seen in only 65 % of subjects. The vertebral artery arises from the first part of the subclavian artery. The left vertebral artery is dominant in 80 % of cases.


A
B
C
D
E

Q13 Answers

a Right coronary artery (RCA)
b Conus branch artery
c Sino-atrial node artery
d Posterior descending artery (PDA)
e Acute marginal branch artery

Right coronary angiogram, left anterior oblique (LAO)/cranial projection

Several angled projections are usually obtained to demonstrate all the parts of the tortuous coronary arteries. This example is a predominantly LAO projection with cranial angulation.

The conus branch supplies the right ventricular outflow tract. It arises as the first branch from the RCA (or occasionally from a separate small ostium in the right coronary sinus) in 60%. This artery arises from the circumflex in 40%.

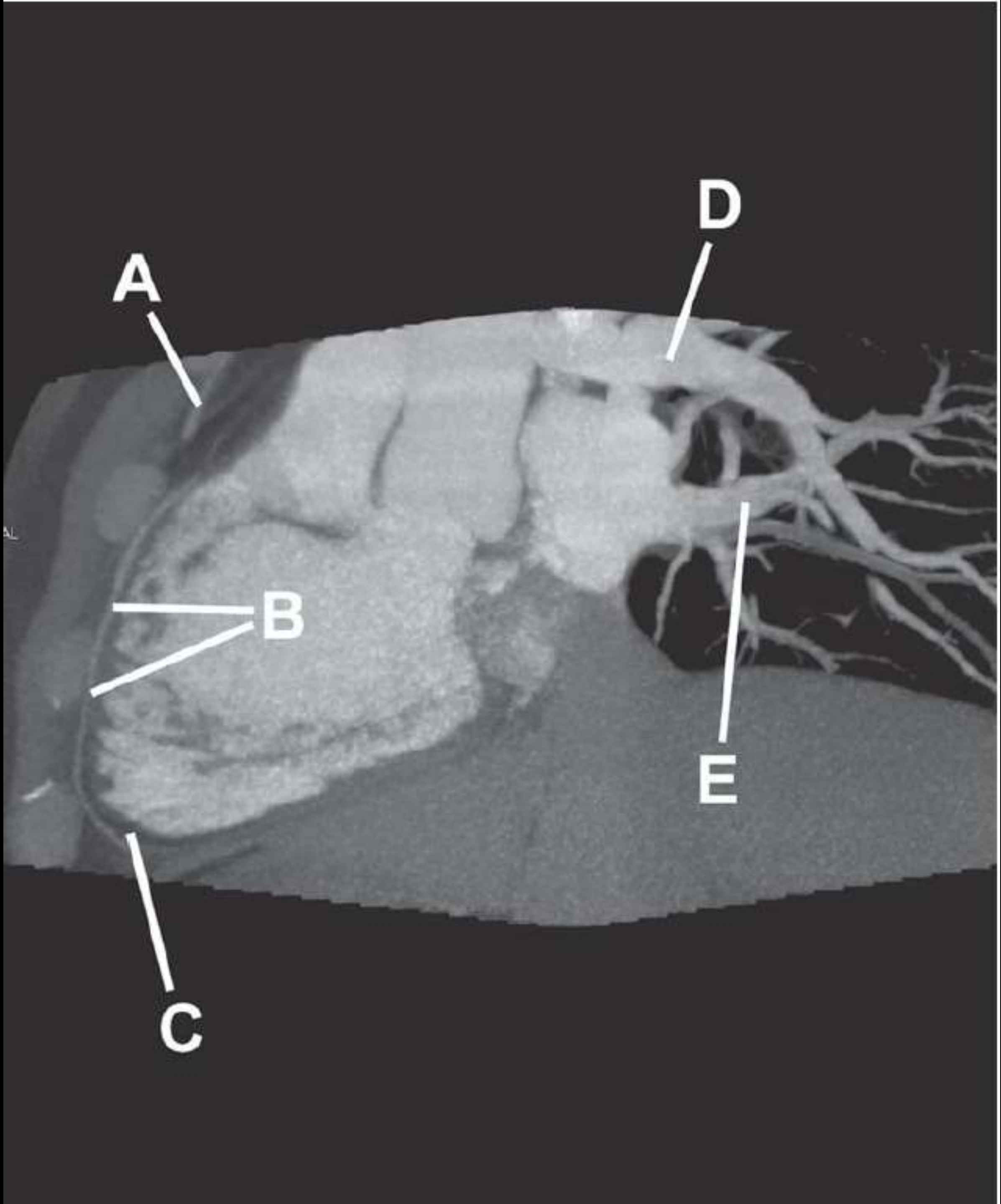
The sino-atrial node artery is supplied in 60% from the RCA (the second branch). This heads posteriorly to supply the sino-atrial node, which is located in the superior aspect of the crista terminalis in the right atrium. In 40% this artery arises from the circumflex artery.

Branches given off by the mid-RCA supply the atria and ventricles including one or more acute marginal branches. In 85% the RCA terminates by becoming the PDA and one or more postero-lateral branches. At this point, there is usually a branch given off to the atrio-ventricular node.

'Dominance' in the coronary circulation is determined by the arterial system which supplies the PDA. In the example provided, the RCA gives rise to the PDA (right-dominant, the typical configuration). In 15% of individuals, either the circumflex artery supplies the PDA (left dominant) or there is combined supply of the PDA and postero-lateral arteries by the RCA and circumflex arteries respectively (co-dominant).

Libby P, Bonow RO, Zipes DP, Mann DL. *Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine*, 8th Ed, Saunders, Philadelphia, 2007.

Lin EC *et al* . Coronary CT Angiography. 2010; eMedicine: www.emedicine.medscape.com


A
B
C
D
E

Q21 Answers

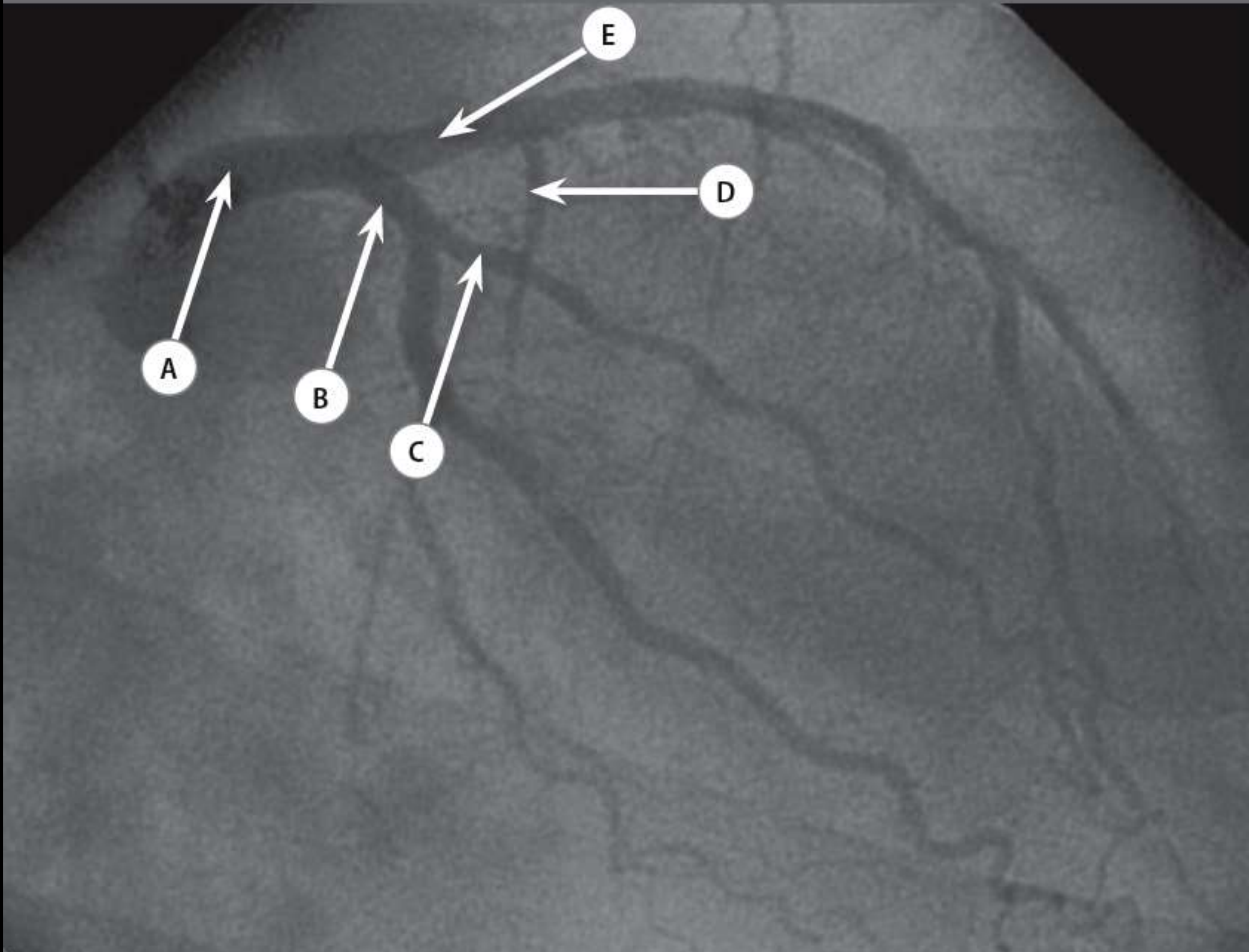
a Left internal mammary (thoracic) artery
b Left anterior descending (LAD) artery
c Epicardial fat
d Right main pulmonary artery
e Right inferior pulmonary vein

Cardiac CT, maximum intensity projection, oblique section

This image demonstrates the close proximity of the LAD and left internal mammary artery. This is an oblique section taken approximately along the line of the interventricular septum/long cardiac axis.

The serous pericardium consists of two layers, the parietal and visceral pericardium. The visceral pericardium is attached to the surface of the heart whereas the parietal pericardium is attached to the inner aspect of the fibrous pericardium. The space between the visceral and parietal pericardia is the pericardial space or cavity which in health is little more than a potential space containing a few millilitres of lubricating pericardial fluid. These layers cannot normally be differentiated on CT. It is common to see a layer of epicardial fat in between the myocardium and the visceral pericardium.

Case 2.12



Case 2.12

A Left main stem coronary artery

B Circumflex

C 1st obtuse marginal branch

D Septal branch

E Left anterior descending

Conventional coronary angiogram, right anterior oblique. Selective catheterisation of left main stem.

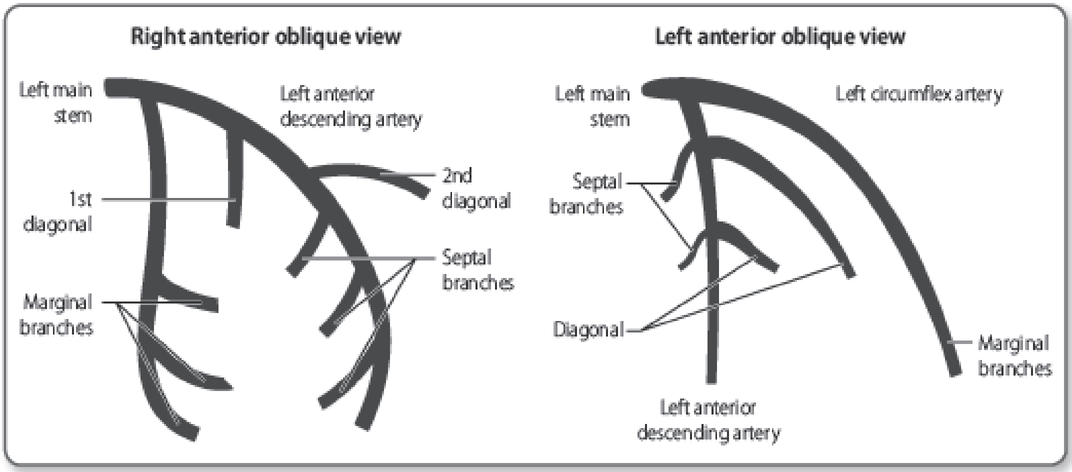


Figure 2.2 The left coronary artery.

The left coronary artery (LCA) arises as the left main stem from the posterior sinus of Valsalva/left coronary sinus, and travels between the left atrial appendage and the pulmonary trunk in the left atrioventricular groove. It bifurcates early into the left anterior descending artery (LAD), which continues in the interventricular groove, and the left circumflex which continues laterally in the atrioventricular groove.

The LAD travels over the anterior aspect of the heart in the interventricular groove, it turns around the inferior border to anastomose with the posterior descending branch of the right coronary artery. The LAD gives off septal and diagonal branches.

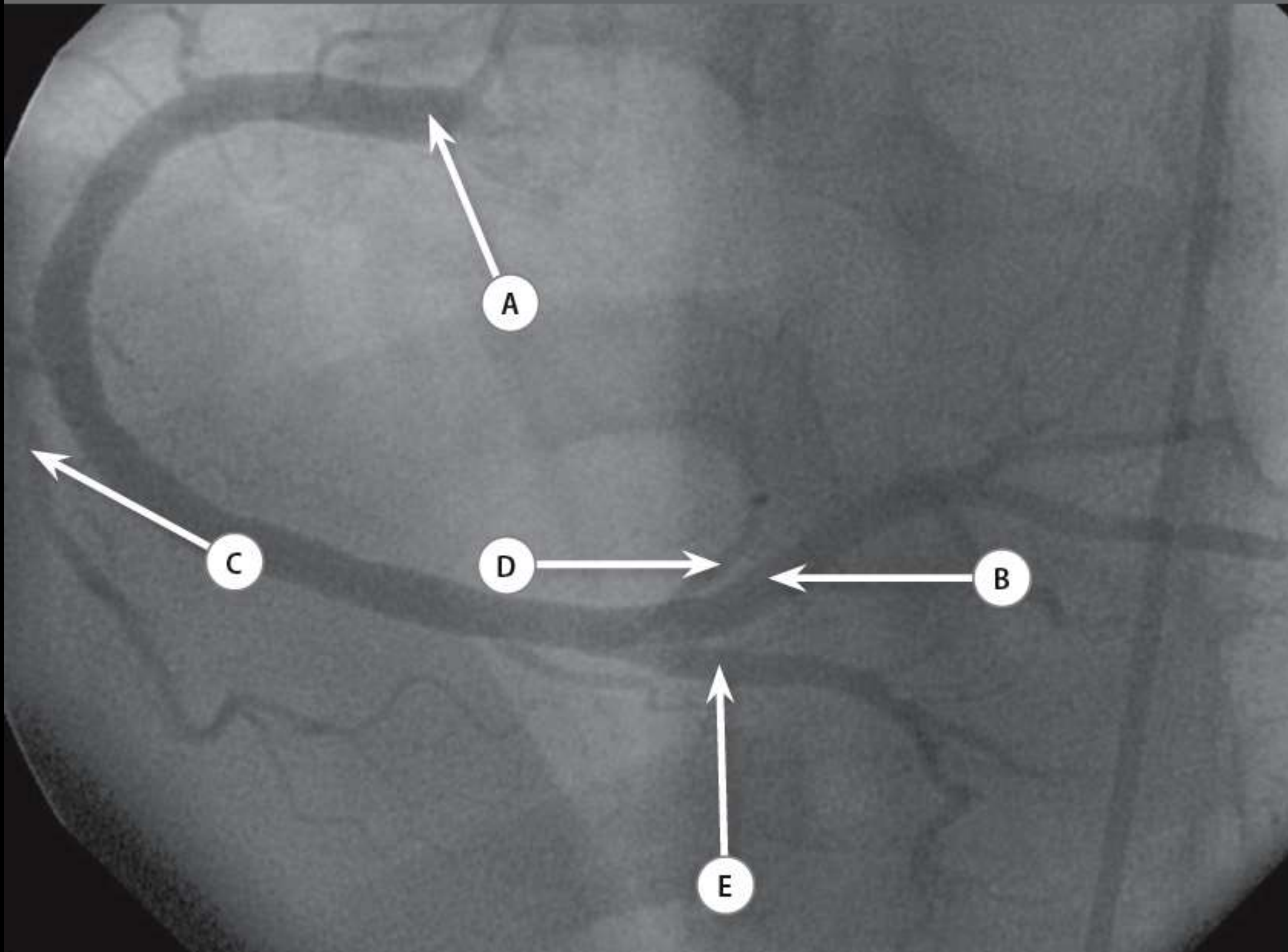
The left circumflex travels down the posterior aspect of the heart and gives off obtuse marginal and atrial branches (**Figure 2.2**).

The LCA supplies:

- the left atrium
- most of the left ventricle
- part of the right ventricle
- most of the interventricular septum, including the bundle of His
- the sinoatrial node (in 40% of people).

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 135–165.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 113.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 135.

Case 2.13



Case 2.13

A Right coronary artery

B Posterolateral branch

C Right ventricular branch

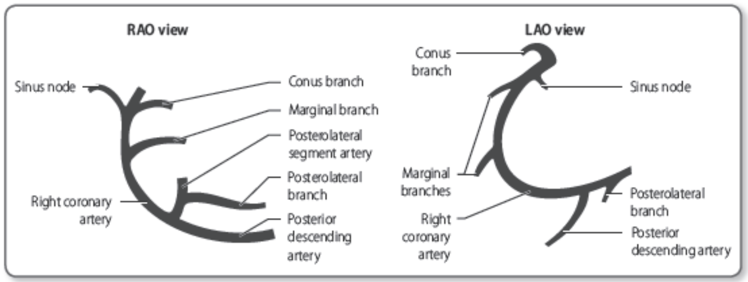


Figure 2.3 The right coronary artery.

D Atrioventricular nodal artery

E Posterior descending artery

Conventional coronary angiogram, left anterior oblique. Selective catheterisation of right coronary artery.

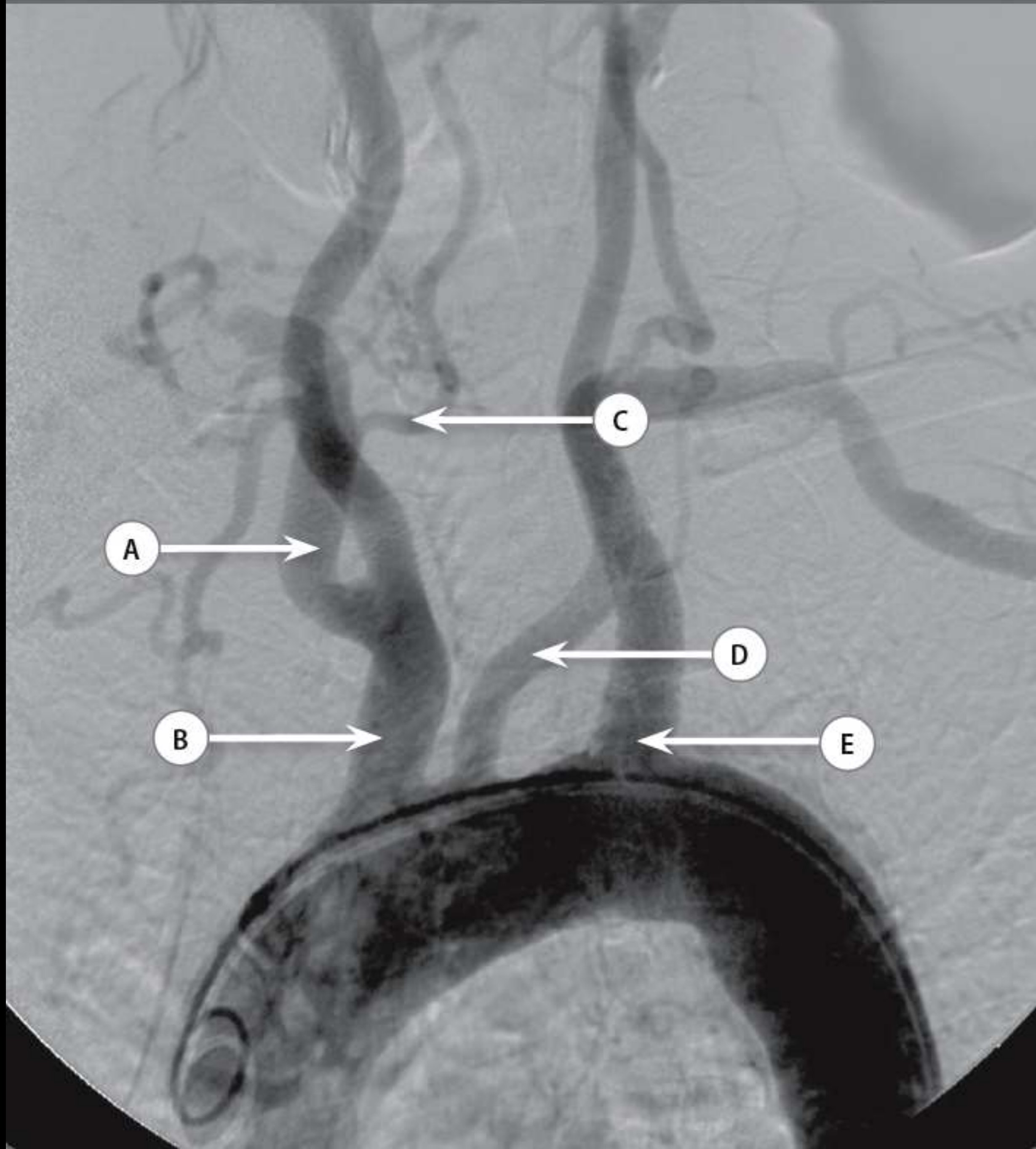
The right coronary artery (RCA) arises from the anterior sinus of Valsalva/right coronary sinus and travels between the right atrium and pulmonary trunk in the right atrioventricular groove. The sinoatrial nodal branch, given off near the origin of the RCA, supplies the sinoatrial node. The marginal branch supplies the right border of the heart. The RCA continues to the posterior aspect of the heart where is gives off the posterior descending artery (PDA). The dominance of the coronary system is defined by which coronary supplies the PDA (**Figure 2.3**).

The RCA supplies:

- the right atrium
- most of the right ventricle
- the diaphragmatic surface of the left ventricle
- part of the atrioventricular septum
- the sinoatrial node (in 60% of people)
- the atrioventricular node (in 80% of people).

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 135–165.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 113.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 135.

Case 2.14



Case 2.14

A Right subclavian artery

B Brachiocephalic artery

C Right vertebral artery

D Left common carotid artery

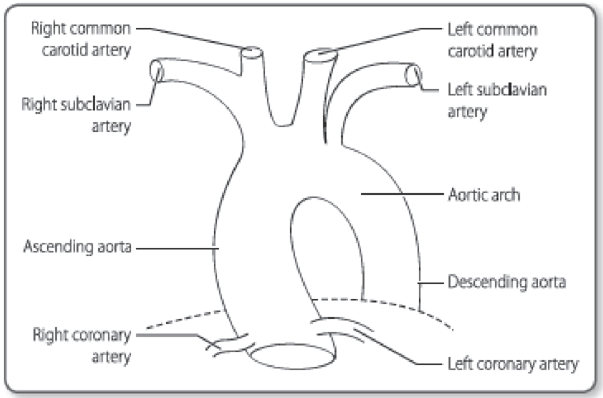


Figure 2.4 Branches of the arch of the aorta.

E Left subclavian artery

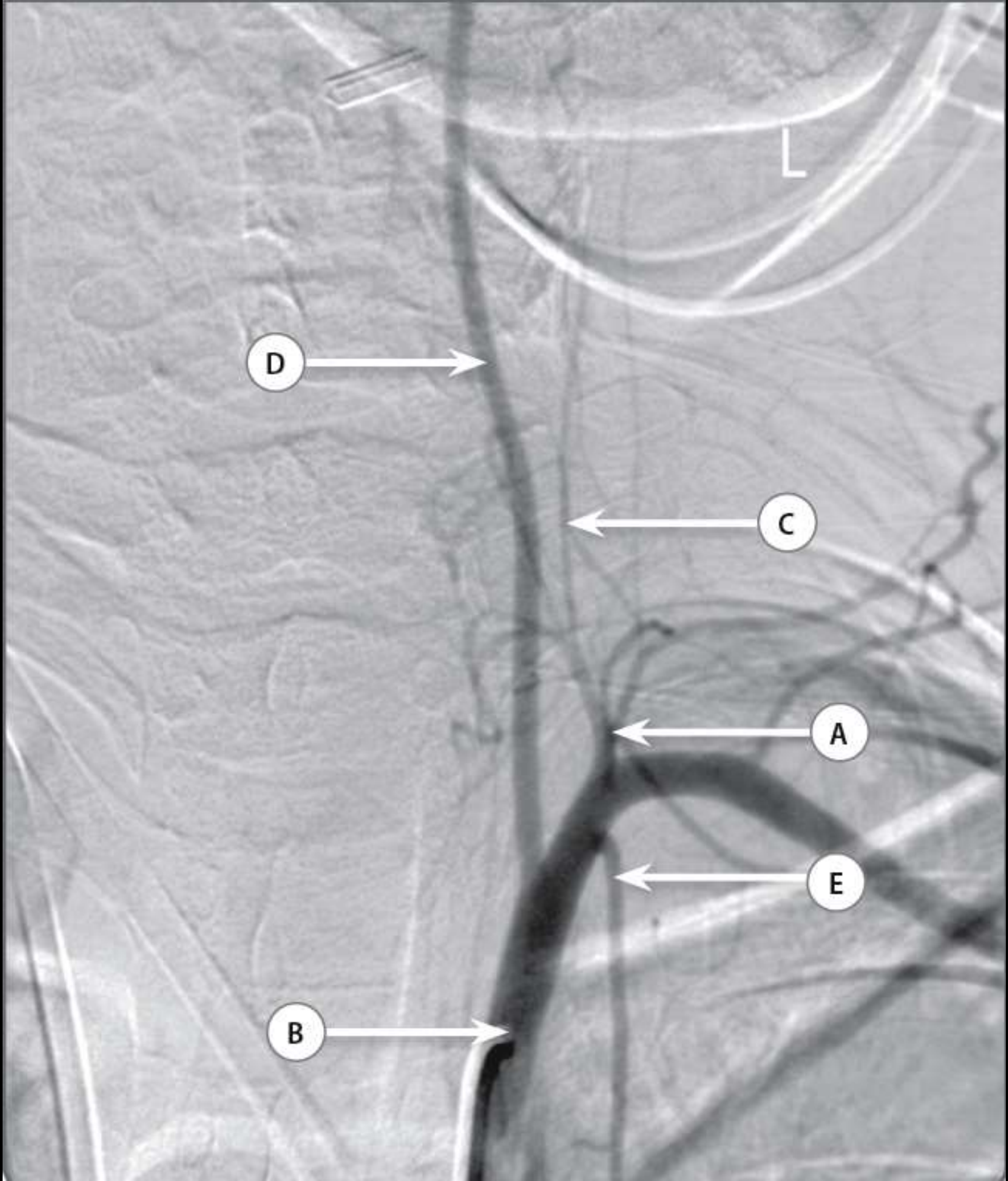
Digital subtraction arch aortogram.

The common pattern for the branches of the arch of the aorta (**Figure 2.4**) is:

1. brachiocephalic trunk, which gives off the right subclavian and right common carotid arteries
2. left common carotid artery
3. left subclavian artery

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 94.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 117.

Case 2.16



Case 2.16

A Thyrocervical trunk

B Catheter in left subclavian artery

C Ascending cervical artery

D Left vertebral artery

E Left internal thoracic artery

Selective catheterisation and angiogram of the left subclavian artery.

The branches of the subclavian artery (shown in **Figure 2.5**) can be recalled with the mnemonic **VIT**amin **C** and **D**.

The first part (from origin to medial border of scalenus anterior):

- **V**ertebral artery: runs in the foramen transversarium of the vertebra to supply the posterior circulation of the brain
- **I**nternal thoracic artery: runs along the inside of the thoracic cage

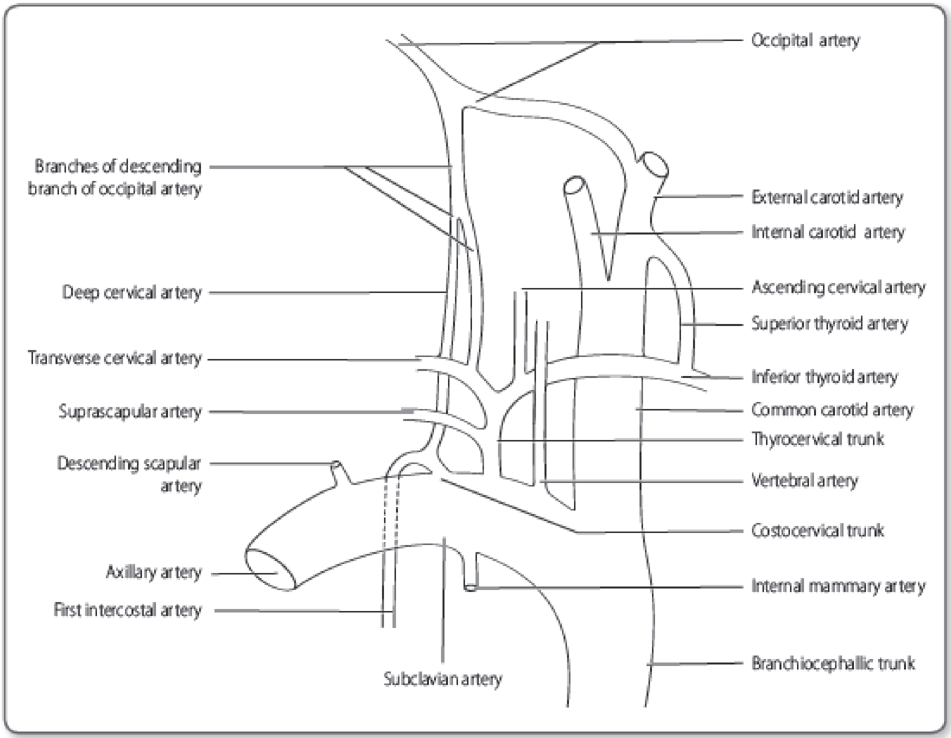


Figure 2.5 Branches of the subclavian artery.

- **T**hyrocervical trunk: is short in length and quickly divides into inferior thyroid, suprascapular and transverse cervical arteries.

The second part (posterior to scalenus anterior):

- **C**ostocervical trunk: divides into superior intercostal and deep cervical arteries.

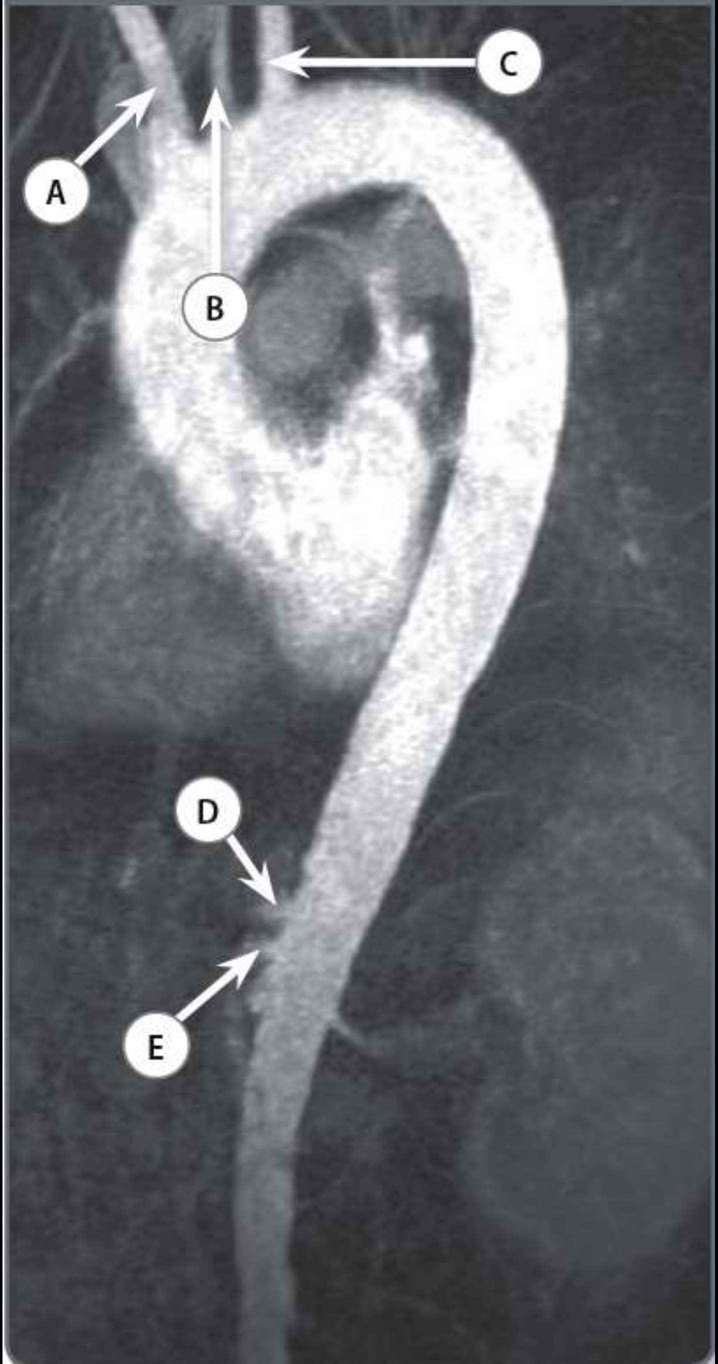
The third part (between scalenus anterior and 1st rib):

- **D**orsal scapular artery, which may also originate from the second part of subclavian. This supplies the levator scapulae and rhomboid muscles.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 1003.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 33.

Case 2.17



Case 2.17

A Brachiocephalic artery

B Left common carotid artery

C Left subclavian artery

D Coeliac axis

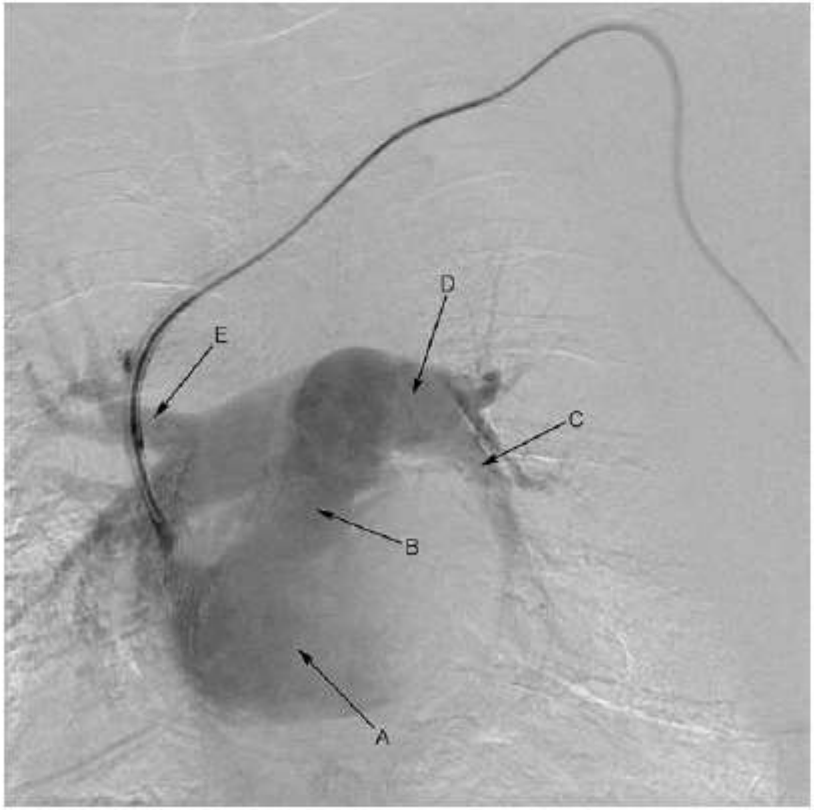
E Superior mesenteric artery

MR angiogram.

An MR angiogram showing the great vessels of the aorta. The first two unpaired abdominal aortic branches are the coelic axis and the superior mesenteric artery.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 142.

Question 10.20



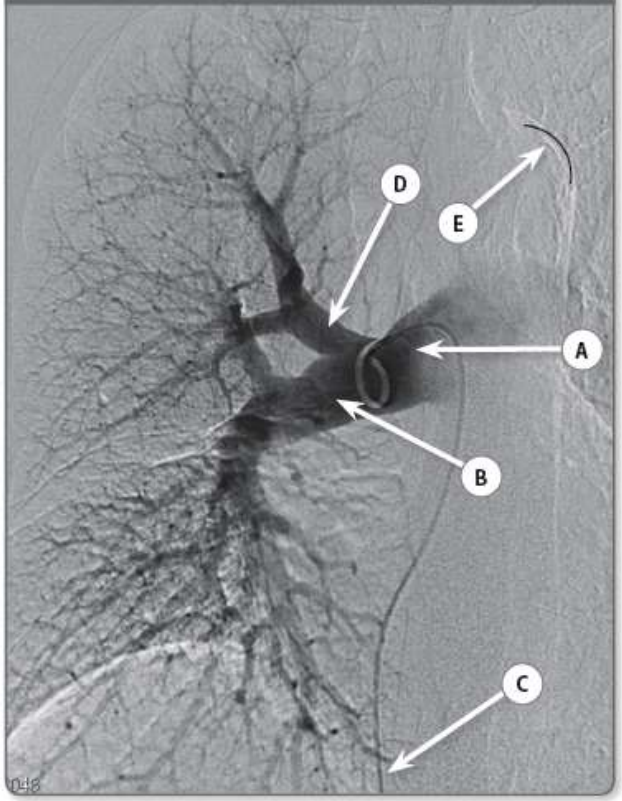
Name the structures labelled **A** to **E**.

10.20 Angiogram of the pulmonary arteries

A Right ventricle.
B Pulmonary trunk.
C Left interlobar pulmonary artery.
D Left main pulmonary artery.
E Truncus anterior.

The venous catheter on this image is following the path of the left subclavian vein, brachiocephalic vein and superior vena cava. The inferior vena cava and the superior vena cava drain deoxygenated blood into the right atrium. Blood subsequently travels into the right ventricle via the tricuspid valve before entering the pulmonary trunk via the pulmonary valve. The pulmonary trunk originates from the right ventricle and divides into the right and left main pulmonary arteries under the aortic arch. The right main pulmonary artery then bifurcates into the truncus anterior (main branch to the upper lobe) and the interlobar artery (main branch to the middle and lower lobe). The slightly superior course of the left main pulmonary artery compared with the right explains why the left hilum is higher than the right in the 97% of individuals. It divides into two branches at the hilum – the upper division and the interlobar artery.

Case 2.5



Case 2.5

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Through which infra-diaphragmatic vessel does the catheter pass through at point C?	
D	Name the structure labelled D.	
E	Name the outlined structure labelled E.	

Case 2.5

A Right pulmonary artery

B Right lower lobe pulmonary artery

C Inferior vena cava

D Right upper lobe pulmonary artery

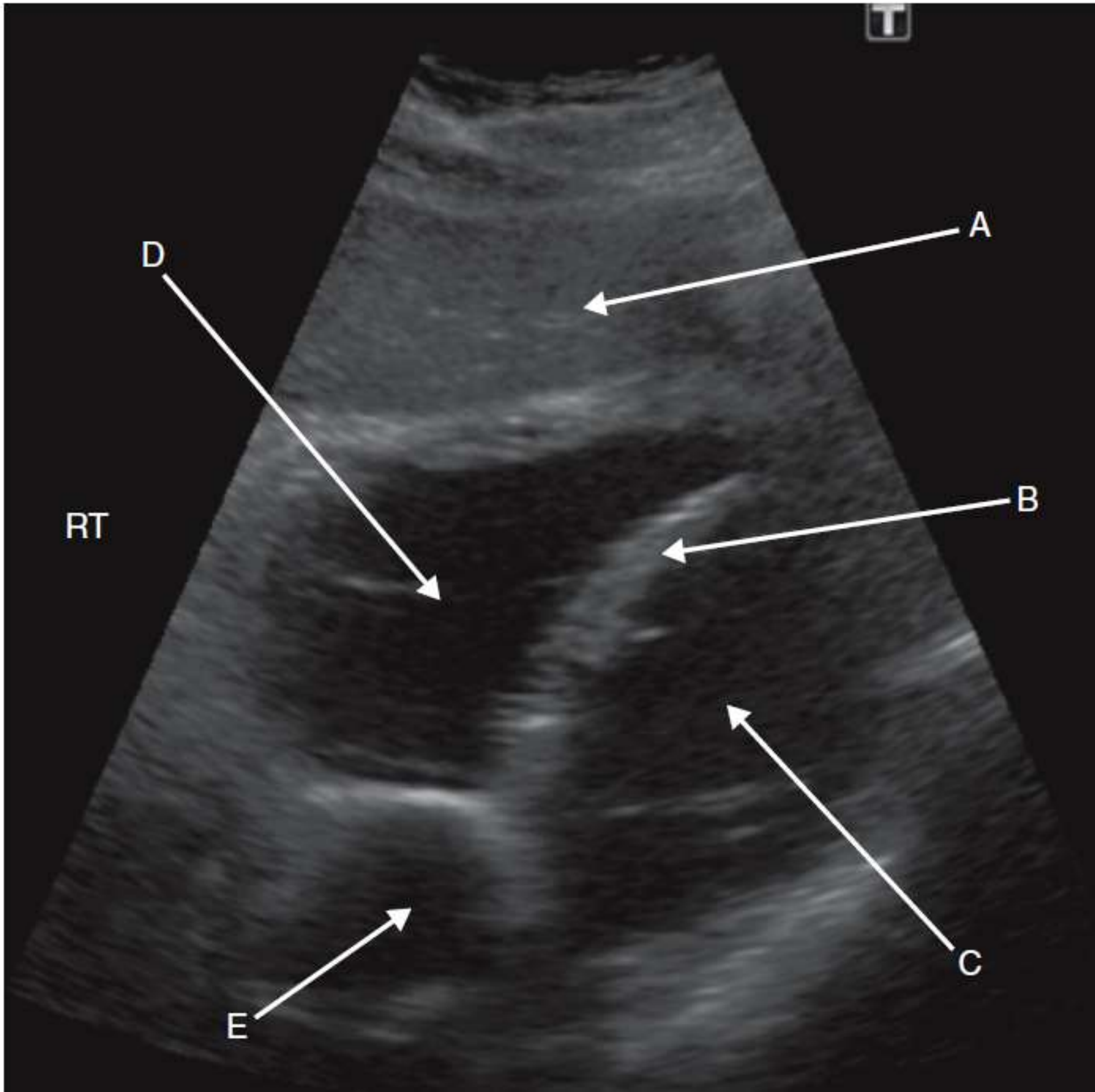
E Aortic arch

The pulmonary trunk arises from the right ventricular outflow tract. The approach to the pulmonary artery is usually via the femoral vein, the external and common iliac veins and on up the inferior vena cava (IVC) into the right atrium, through the tricuspid valve and right ventricle. The pulmonary valve is crossed before parking the catheter in the pulmonary trunk for angiography.

Hint: an easy way to differentiate between an arterial pulmonary angiogram and a pulmonary venogram is by focusing on the centre of the chest: venography will show contrast in the left atrium whereas pulmonary arteriography will show a lack of contrast in the heart.

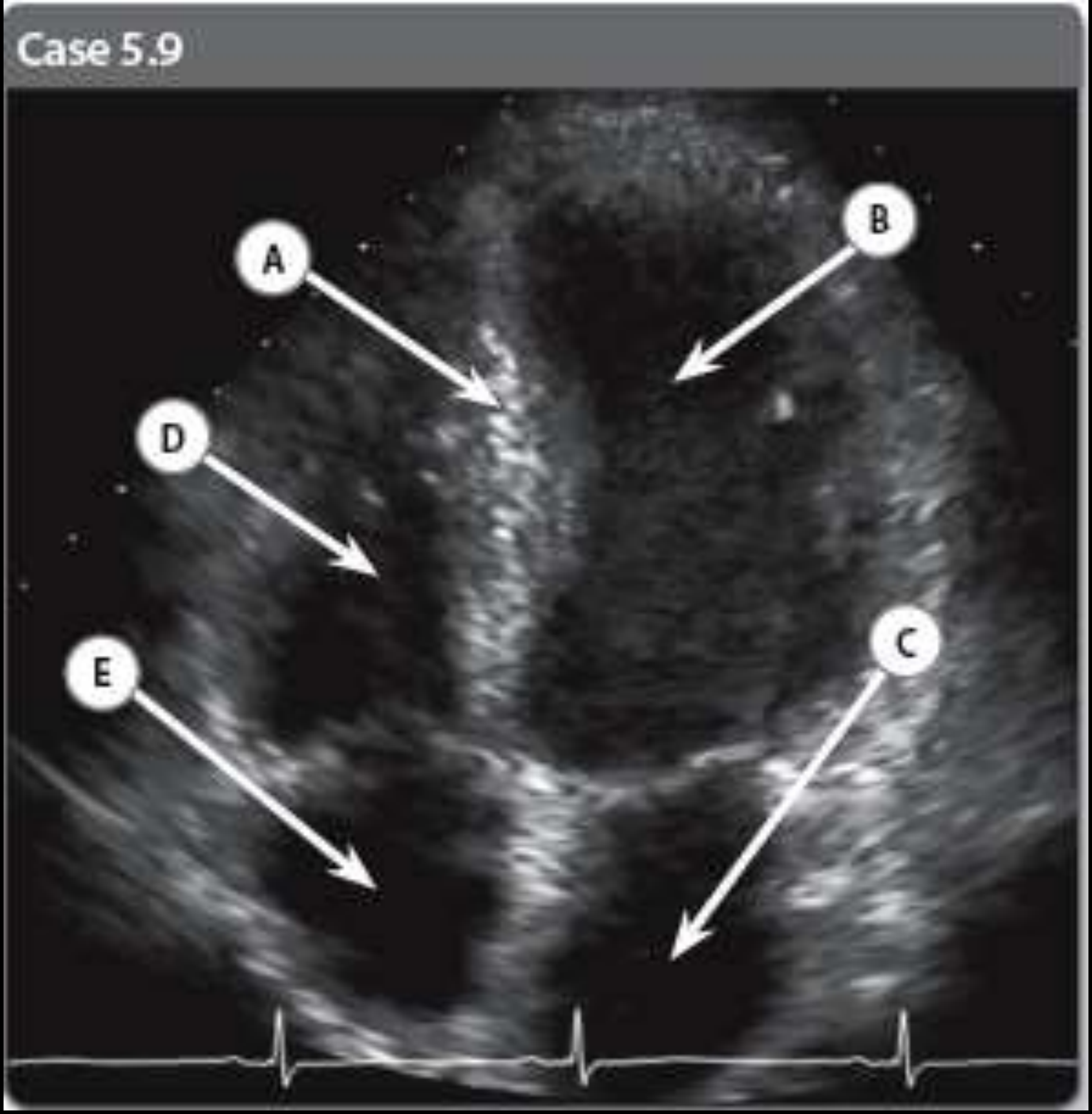
ULTRASOUND

Case 7.9



7.9 Echocardiogram

(a) Left lobe of the liver.
(b) Interventricular septum (IVS). This is composed of muscular and membranous parts. Due to the high blood pressure in the left ventricle the muscular part of the IVS forms the majority of the septum.
(c) Left ventricle. This forms the apex and nearly all the left surface of the heart.
(d) Right ventricle. This forms the majority of the anterior surface of the heart.
(e) Left atrium. This forms most of the base of the heart. Four pulmonary veins enter its smooth posterior wall.


Case 5.9
A
B
D
C
E

Case 5.9

A Interventricular septum

B Left ventricle

C Left atrium

D Right ventricle

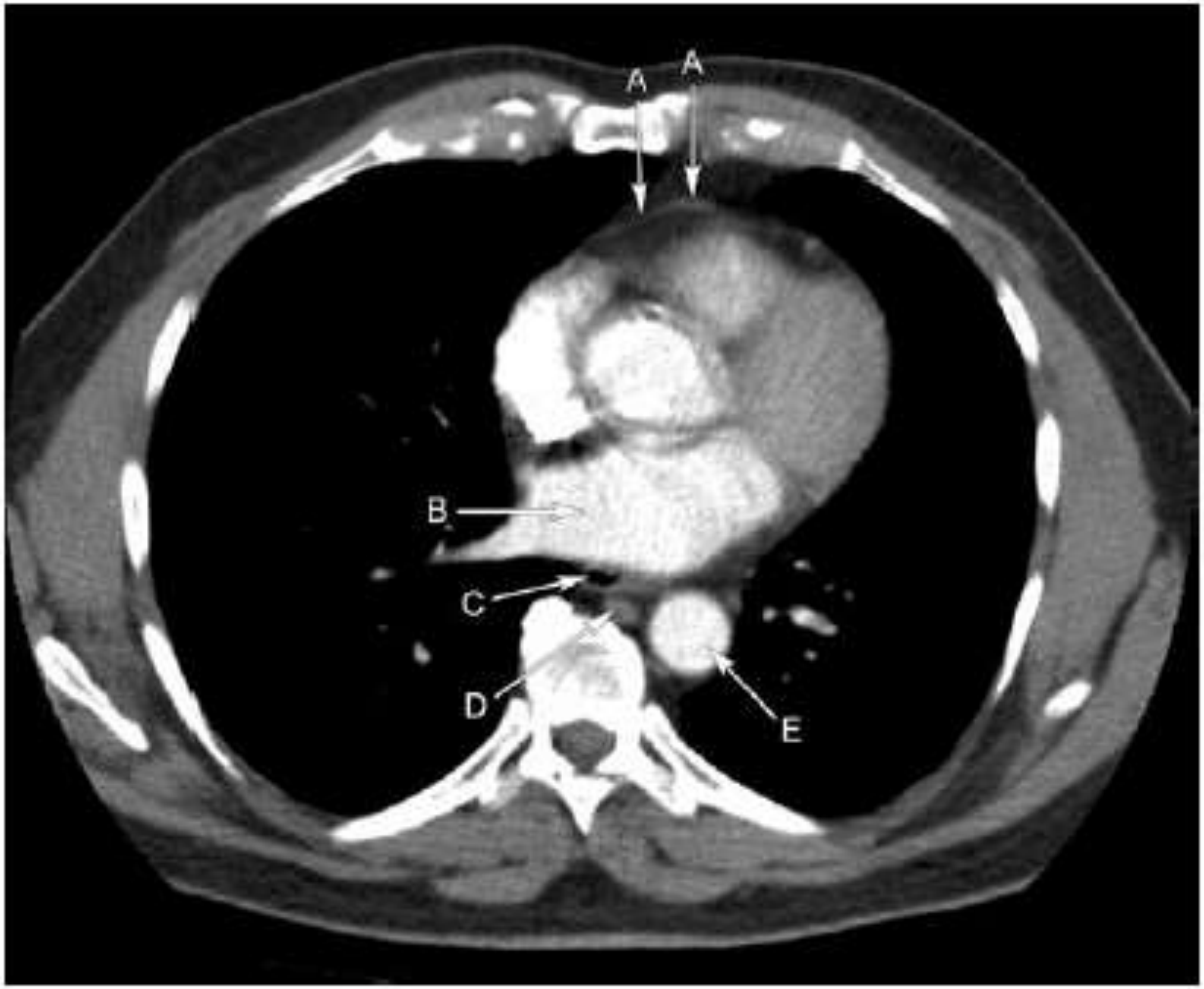
E Right atrium

This is an apical four-chamber view echocardiogram. The transducer is placed close to the palpated apex beat of the heart, on the left side of the chest. The left ventricle is usually the larger of the two chambers and is thick walled. The atria are noted at the base of the view.

In this view, the left ventricle is on the top right with the left atrium opening into it through the mitral valve, and the right ventricle is on the left side with the right atrium opening into it through the tricuspid valve. This view is useful to compare the thickness of the left and right ventricular walls and to determine whether or not a pericardial effusion is present.

CROSS-SECTIONAL

Question 1.7



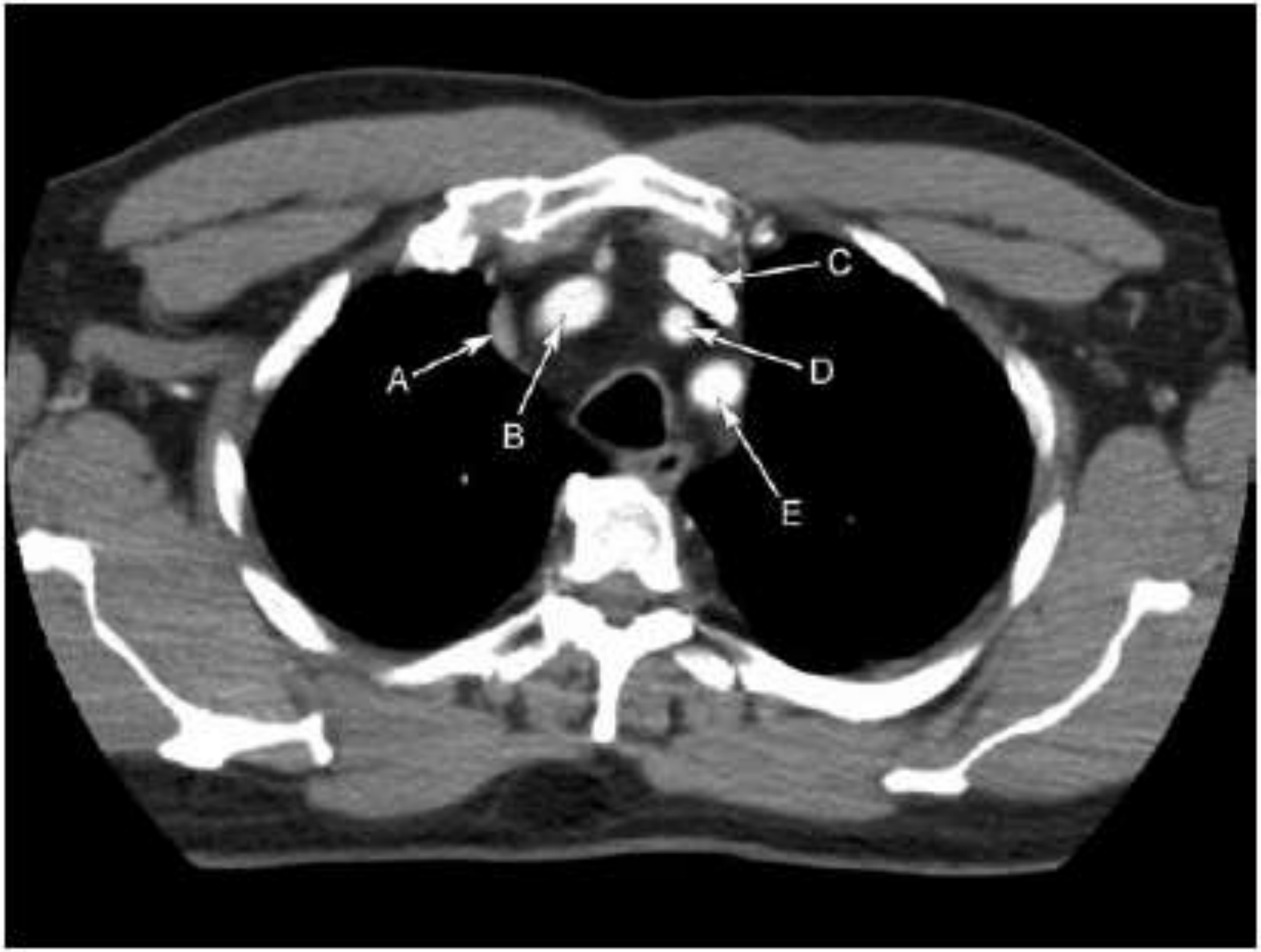
Name the structures labelled **A** to **E**.

1.7 Axial CT chest with contrast

A Pericardium.
B Left atrium.
C Oesophagus.
D Azygos vein.
E Descending thoracic aorta.

The pericardium consists of visceral and parietal layers, envelops the heart and great vessels and is seen on axial CT as a thin dense line separated from the myocardium by epicardial fat. The azygos vein commences at the level of L2 and ascends anteriorly to the vertebral bodies of the thoracic vertebrae up to the level of T4 and to the right of the descending thoracic aorta. At T4, the azygos vein crosses superior to the right hilum and drains into the superior vena cava. The left atrium lies anterior to the oesophagus, which explains why left atrial enlargement can cause dysphagia.

Question 1.8



Name the structures labelled **A** to **E**.

1.8 Axial CT chest with contrast

A Right brachiocephalic (innominate) vein.
B Brachiocephalic (innominate) artery.
C Left brachiocephalic (innominate) vein.
D Left common carotid artery.
E Left subclavian artery.

From right to left, the branches of the arch of the aorta are the brachiocephalic artery, left common carotid artery and left subclavian artery. The left common carotid and left subclavian arteries lie to the left of the trachea. All three branches are crossed anteriorly by the left brachiocephalic vein. The brachiocephalic veins are formed by the union of the subclavian and internal jugular veins. The right brachiocephalic vein lies to the far right side of the great vessels.

Question 2.9

Name the structures labelled **A** to **E**.

2.9 Axial CT of the chest with IV contrast

A Sternum.
B Right superior pulmonary vein.
C Right latissimus dorsi.
D Oesophagus.
E Superior vena cava.

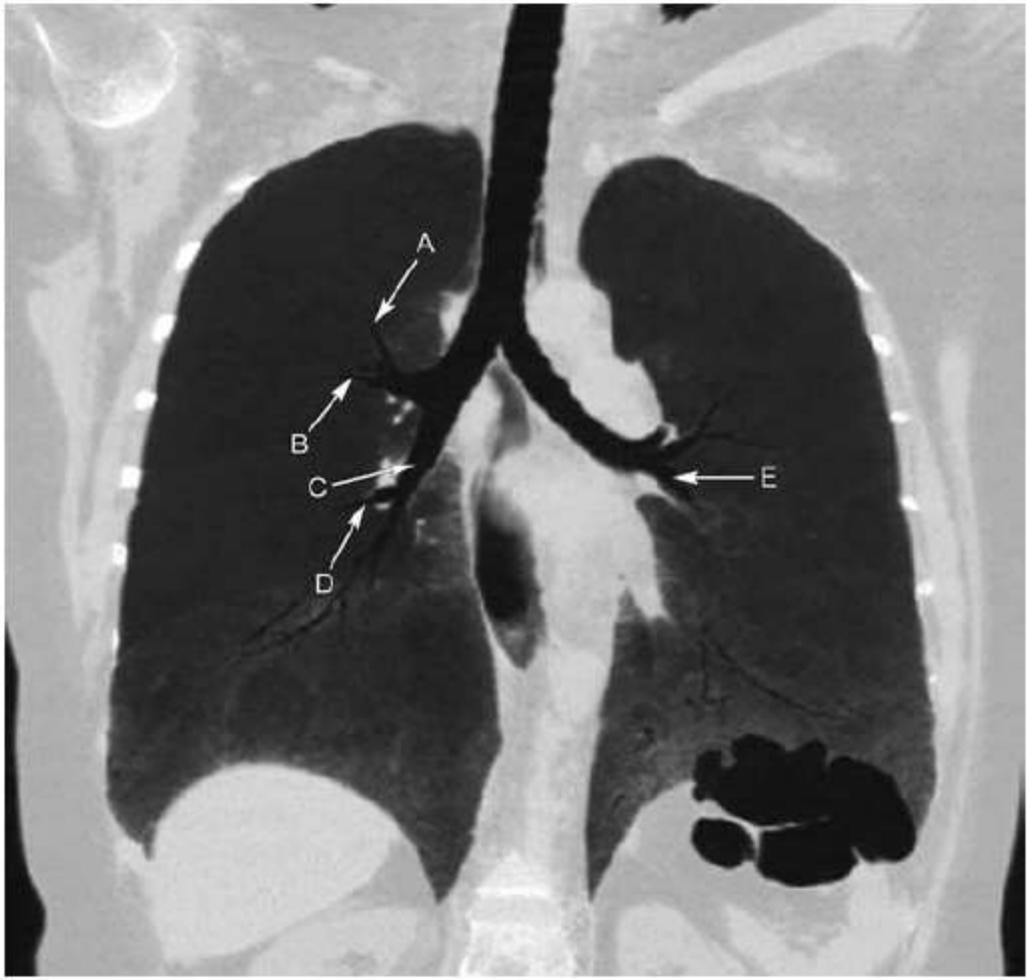
Latissimus dorsi literally translated in Latin means 'broadest muscle of the back'. It is a large triangular muscle, and is supplied by the thoracodorsal nerve, a branch of the brachial plexus derived from the C6–8 nerves.

There are four pulmonary veins (two from each lung) that carry oxygenated blood from the lungs to the left atrium. These are:

- Right superior pulmonary vein.
- Right inferior pulmonary vein.
- Left superior pulmonary vein.
- Left inferior pulmonary vein.

At the level of the lung roots, the pulmonary veins lie inferior to the pulmonary arteries. The left atrium receives the four pulmonary veins and forms the posterior structure of the heart, lying anterior to the descending thoracic aorta and oesophagus.

Question 2.19



Name the structures labelled **A** to **E**.

2.19 Coronal CT of the chest

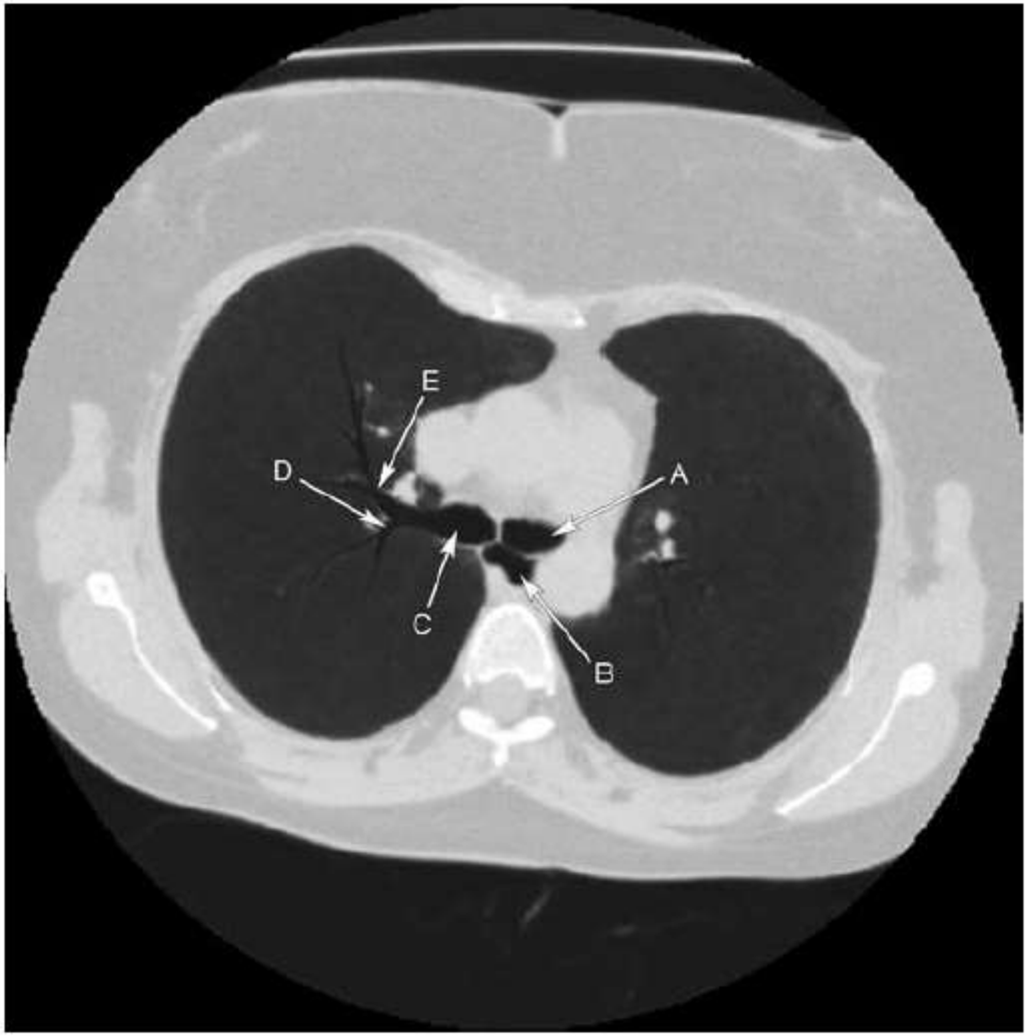
A Apical segment of the right upper lobe bronchus.
B Anterior segment of the right upper lobe bronchus.
C Bronchus intermedius.
D Right middle lobe bronchus.
E Inferior segment of the left lingular bronchus.

The right main bronchus is shorter, wider and more vertical than the left main bronchus. For this reason there is a predisposition for foreign bodies preferentially to enter the right main bronchus over the left.

The right main bronchus divides into three main bronchi that then subdivide into a total of ten segmental bronchi. The right upper lobe bronchus arises almost immediately after the tracheal bifurcation. The right main bronchus then continues as the bronchus intermedius, which then subdivides into the right lower and middle lobe bronchi.

The left main bronchus divides into two main bronchi that then subdivide into a total of eight segmental bronchi. The left upper lobe bronchus gives off the lingular lobe bronchus, which then subdivides into the superior and inferior lingular bronchi.

Question 3.2



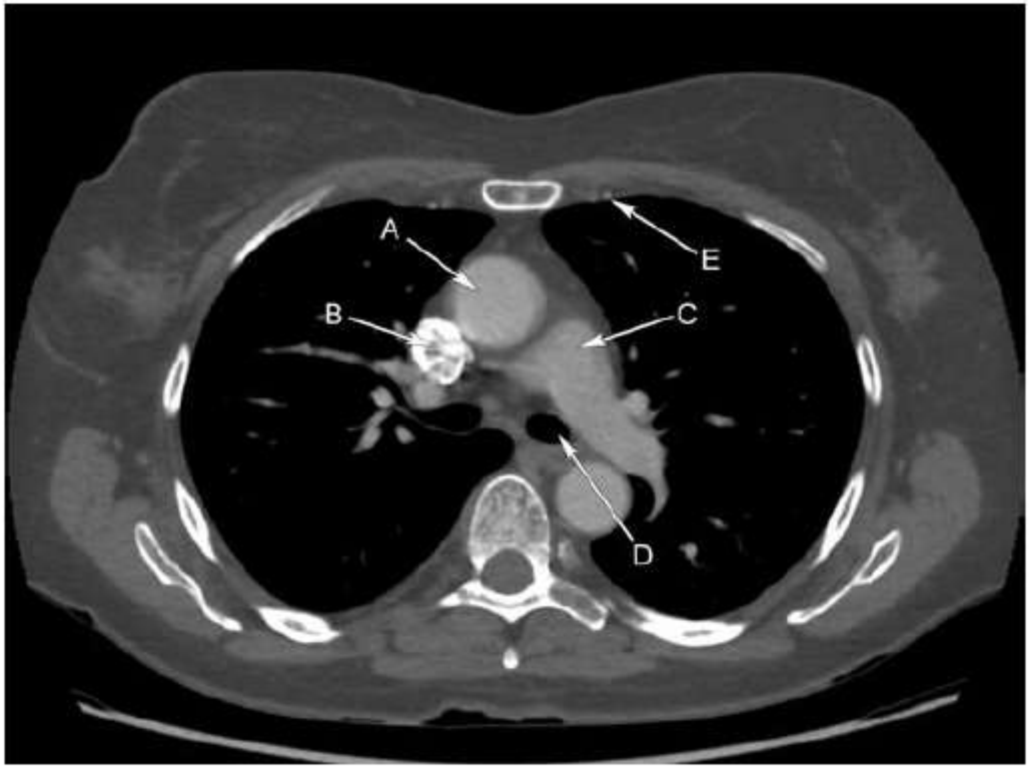
Name the structures labelled A to E.

3.2 Axial CT of the chest

A Left main bronchus.
B Oesophagus.
C Right main bronchus.
D Posterior segment of the right upper lobe bronchus.
E Anterior segment of the right upper lobe bronchus.

The level of this axial section must be demonstrating the upper lobe bronchi as it is above the level of the carina. The right upper lobe bronchus divides into the apical, posterior and anterior subsegmental bronchi. The anterior and posterior subsegmental bronchi are orientated in the transverse plane opposite each other (as demonstrated) whereas the apical branch is orientated vertically. See the answer to Question 2.19 for further detail and a table of the bronchi.

Question 3.7



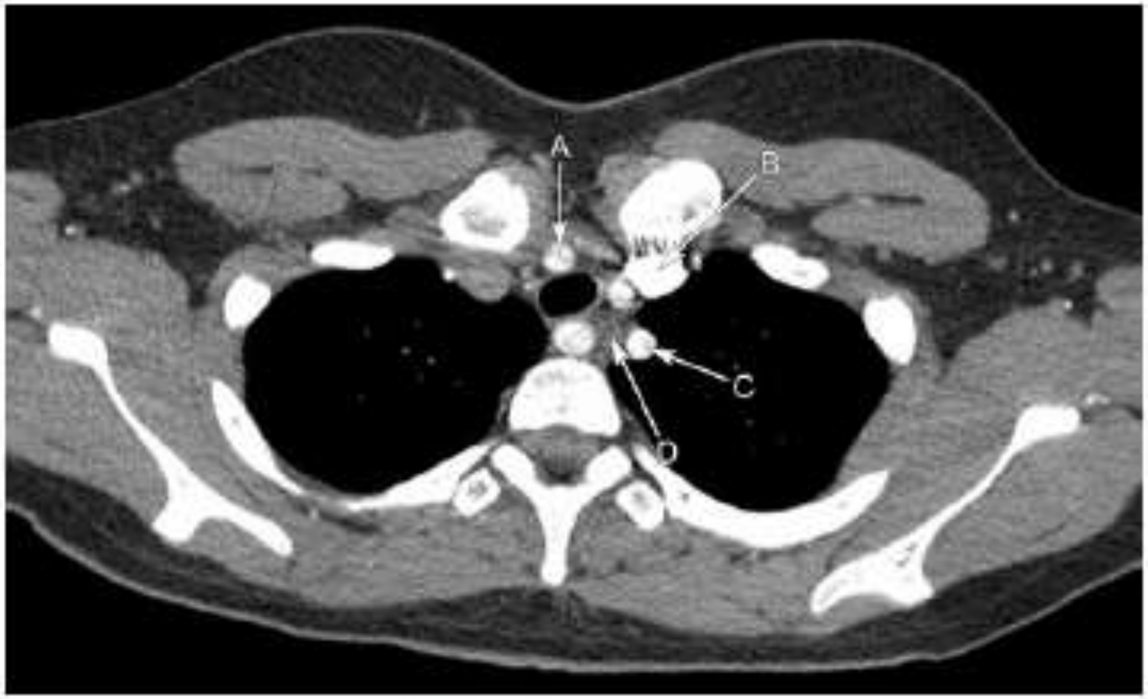
Name the structures labelled **A** to **E**.

3.7 Axial CT of the chest with IV contrast

A Ascending aorta.
B Superior vena cava.
C Pulmonary trunk.
D Left main bronchus.
E Left internal thoracic artery.

The superior vena cava is formed from the left and right brachiocephalic veins. It is the most lateral of the right-sided mediastinal vessels which makes it particularly susceptible to compression by right upper-lobe tumours and lymphadenopathy. The pulmonary trunk commences from the right atrium, lies to the left of the ascending aorta and divides into the right and left main pulmonary arteries. The right main pulmonary artery is longer than the left as it has to pass under the aortic arch to enter the hilum of the right lung.

Question 4.3



Name the structures labelled **A** to **D**.

E What normal variant is present?

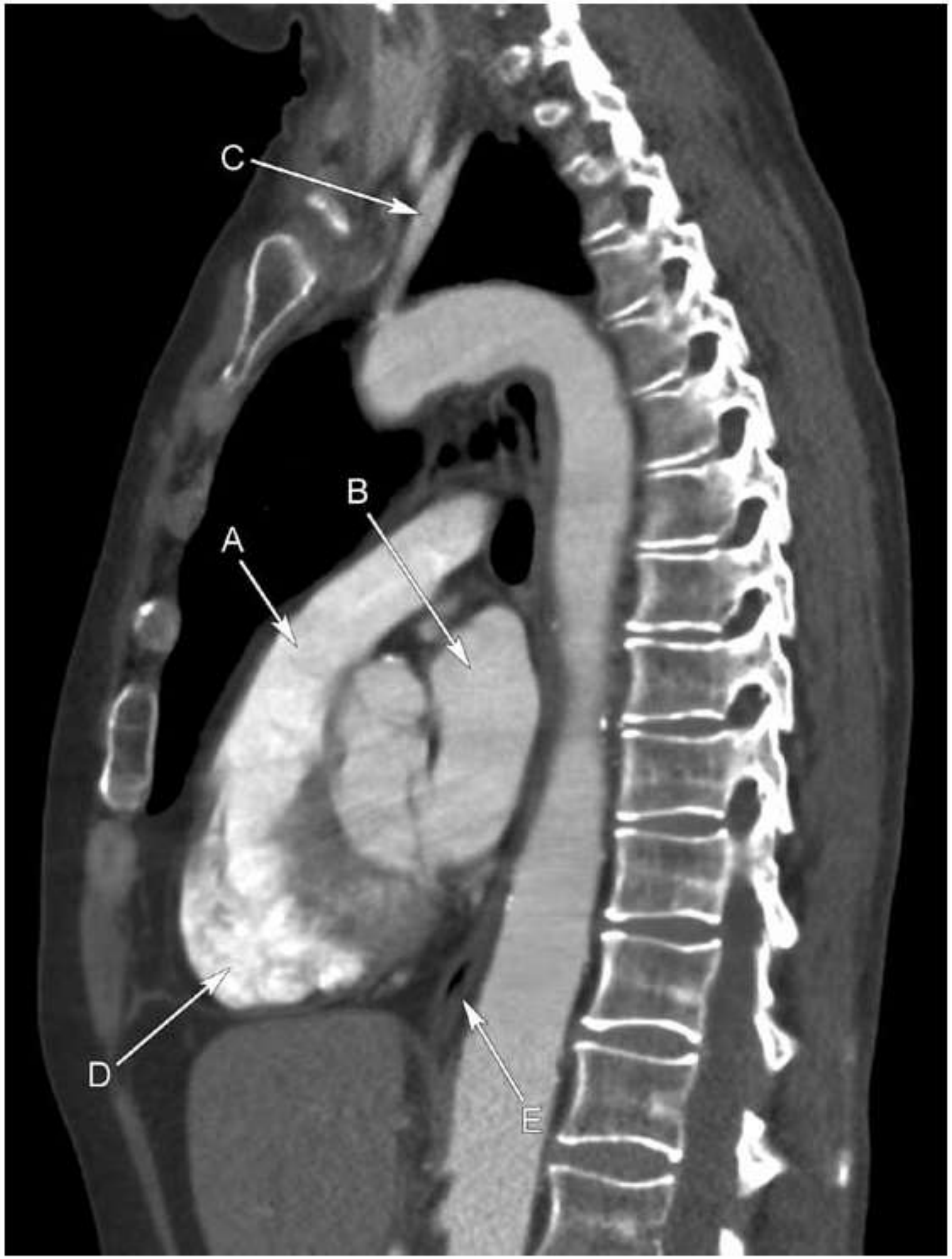
4.3 Axial CT of the chest with IV contrast

A Brachiocephalic artery.
B Left brachiocephalic vein.
C Left subclavian artery.
D Oesophagus.
E Aberrant right subclavian artery.

A left-sided aortic arch with an aberrant right subclavian artery is the most common congenital anomaly of the aortic arch. The aberrant right subclavian artery usually arises distal to the origin of the left subclavian, passes behind the oesophagus and anterior to the vertebral column in the superior mediastinum. The aberrant right subclavian may cause dysphagia due to external compression. This is termed dysphagia lusoria. A barium swallow classically demonstrates an oblique posterior extrinsic impression on the oesophagus with an inferior-to-superior (left-to-right) course.

See Question 5.13 for further discussion of the oesophageal impressions seen on barium swallow.

Question 4.6



Name the structures labelled **A** to **E**.

4.6 Sagittal CT chest with IV contrast

A Pulmonary trunk.
B Left atrium.
C Left subclavian artery.
D Right ventricle.
E Oesophagus.

The pulmonary trunk arises from the right ventricle, lies anterior to the aorta and passes posteriorly and inferiorly to the arch of the aorta where it bifurcates into the left and right pulmonary arteries.

There are openings in the diaphragm to allow the passage of structures between the thorax and abdomen. The three major openings and their corresponding vertebral levels are:

Vertebral level	Structure
T8	Inferior vena cava Right phrenic nerve
T10	Oesophagus Vagus nerve Oesophageal branches of the left gastric artery
T12	Aorta Azygos and hemiazygos vein Thoracic duct

The vertebral levels are easy to remember as they are multiples of two starting from eight. And the number of structures in each can be recalled as the 2–3–3 formation.

Question 5.6

Name the structures labelled **A** to **E**.

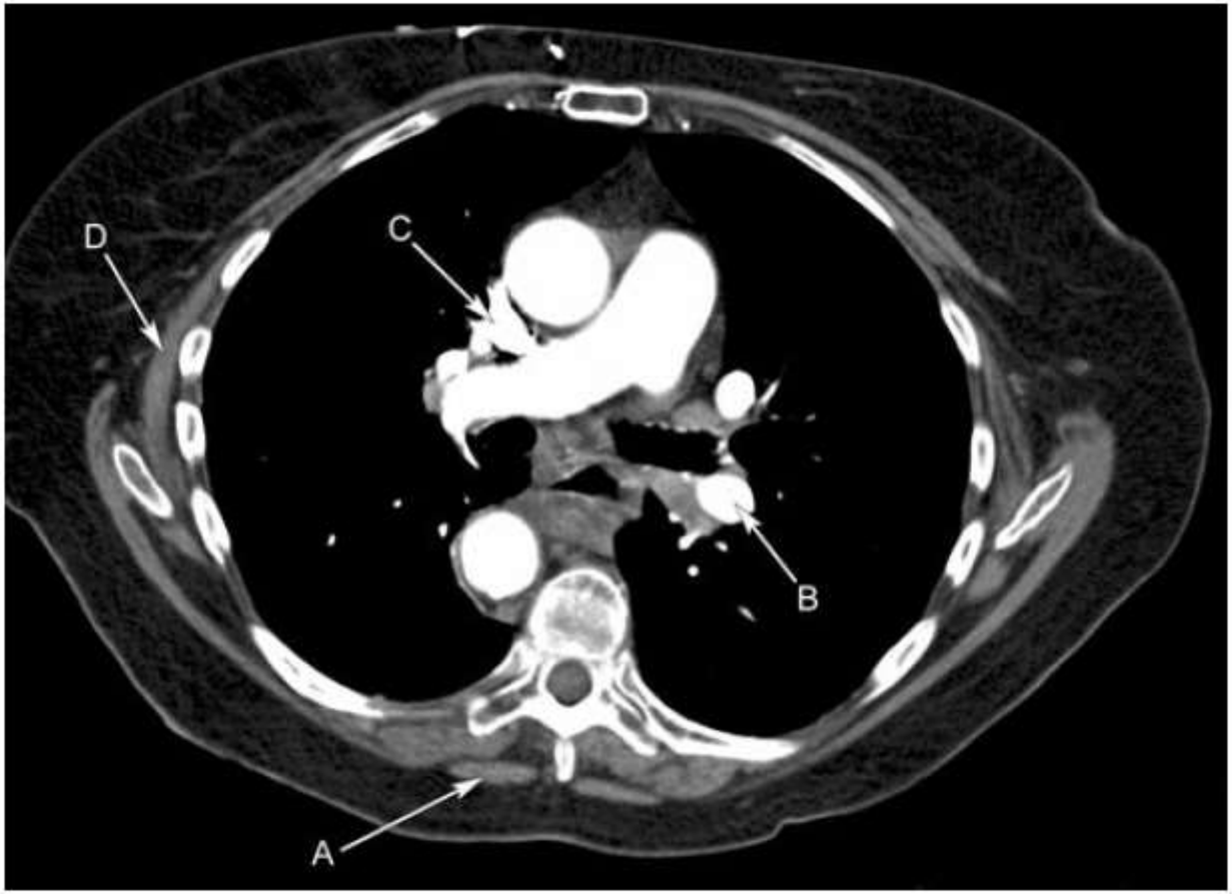
5.6 Axial CT chest with IV contrast

A Right pectoralis minor muscle.
B Right pectoralis major muscle.
C Right internal thoracic artery.
D Azygos vein.
E Ascending thoracic aorta.

The pectoralis major is the largest most anterior muscle of the anterior chest wall, underneath which lies the smaller pectoralis minor. The internal thoracic artery is one of the three branches of the first part of the subclavian artery (the other two being the thyrocervical trunk and the vertebral artery). It descends on the posterior surface of the anterior thorax lateral to the sternum, running deep to the internal intercostal muscles (and superficial to the transverse thoracic muscles). It divides at the sixth intercostal space into the musculophrenic artery and the superior epigastric artery (which continues the same inferior vertical course as the internal thoracic artery).

The azygos vein starts anterior to the L2 vertebra (variable), passes through the aortic hiatus and ascends along the posterior mediastinum to the right of the vertebral column. It provides venous return from the posterior thorax and abdomen to the superior vena cava. From T12–T5 the azygos vein travels anterior to the vertebral bodies and to the right of the aorta (as demonstrated in this image). At the level of T4, it arches anteriorly over the right main bronchus at the root of the right lung to drain into the superior vena cava.

Question 5.14



Name the structures labelled **A** to **D**.
E What normal variant is present?

5.14 Axial CT of the chest with IV contrast

A Right trapezius muscle.
B Left interlobar pulmonary artery.
C Superior vena cava.
D Right serratus anterior muscle.
E Right-sided descending thoracic aorta.

The trapezius muscle is a large superficial muscle of the back. There is one on each side, and taken together their shape resembles a trapezium. It has origins in the spinous processes of C7–T12 vertebrae and inserts into the lateral aspect of the clavicle and scapula. Its primary motor innervation is the accessory nerve (CN XI).

The image illustrates a right-sided descending thoracic aorta. This is a relatively common anomaly and is generally secondary to a right-sided aortic arch (although there are rare cases of a left-sided aortic arch with a right-sided descending thoracic aorta (circumflex aorta)).

There are several types of right-sided aortic arch, of which the most common are:

- **Type I**: mirror image (the great vessels originate in the normal order); 95% association with congenital cardiac abnormality.
- **Type II**: right-sided arch with aberrant left subclavian; 5–15% association with congenital cardiac abnormality.

Question 6.8

Name the structures labelled **A** to **E**.

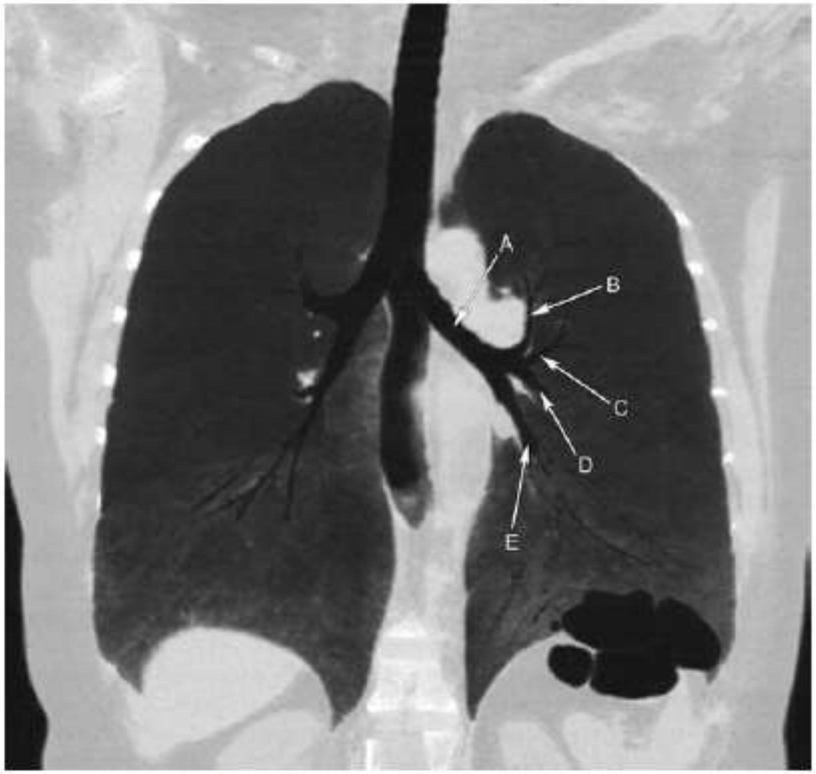
6.8 Axial CT of the chest with IV contrast

A Right ventricle.
B Right atrium.
C Left atrium.
D Left ventricle.
E Descending thoracic aorta.

Some tips to help identify the cardiac chambers:

- **Left atrium**: upper-posterior; square-shaped; smooth-walled; lies anterior to the oesophagus.
- **Right atrium**: right side of heart; right heart border on chest X-ray; anterior to left atrium.
- **Right ventricle**: anterior; triangular; lower part often touches lower part of sternum.
- **Left ventricle**: left side; thick walled; trabeculated; thickest chamber.

Question 6.13



Name the structures labelled **A** to **E**.

6.13 Coronal CT of the chest

A Left main bronchus.
B Left upper-lobe bronchus.
C Superior segment of the lingular bronchus.
D Inferior segment of the lingular bronchus.
E Left lower-lobe bronchus.

The trachea divides into the left and right main bronchi. Each main bronchus then divides into secondary bronchi (lobar bronchi), of which there are two on the left and three on the right (left upper and lower lobe, right upper, middle and lower lobe). These secondary bronchi then subdivide into tertiary (segmental) bronchi that supply the bronchopulmonary segments, which are roughly pyramidal in shape.

There are three left upper-lobe bronchi (apical, posterior and anterior). The apical and posterior bronchi usually share a common apico-posterior bronchus prior to their division.

There are two lingular-lobe bronchi (superior segment and inferior segment). They arise from the left upper-lobe bronchus.

There are four left lower-lobe bronchi (apical, anterior, lateral and posterior). Unlike the right lower lobe, there is no medial basal bronchus.

For a table of the bronchial anatomy see Question 2.19.

Question 6.18

Name the structures labelled **A** to **E**.

6.18 Axial CT of the thoracic spine

A Right articular tubercle of the rib.
B Right head of the rib.
C Right lamina.
D Vertebral canal/spinal cord.
E Left pedicle.

There are 12 thoracic vertebrae. The thoracic vertebrae have a smaller, more rounded vertebral canal than the cervical and lumbar vertebrae. T1–T10 vertebrae have facets for articulation with the tubercle of a rib. The pedicle is the segment between the transverse process and the vertebral body. The laminae are two broad plates, which extend dorsally and medially from the pedicles to fuse and complete the ring.

Question 7.6

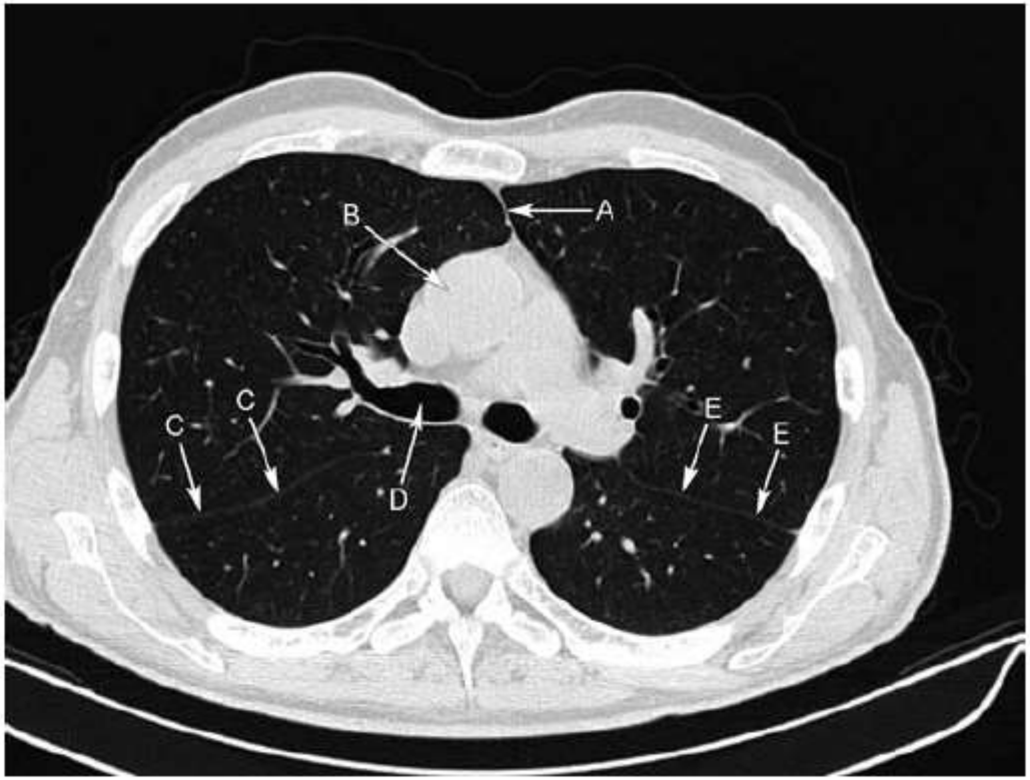
Name the structures labelled **A** to **E**.

7.6 Axial high resolution CT of the chest

A Right oblique fissure.
B Oesophagus.
C Azygos vein.
D Lingula of the left upper lobe.
E Left oblique fissure.

The right lung is divided into three lobes (upper, middle and lower) divided by two interlobar fissures. The right oblique fissure separates the right lower lobe from the right upper and middle lobes. The right horizontal fissure separates the right upper lobe from the right middle lobe. The left lung is divided into two main lobes (upper and lower), plus a lingular lobe (part of the left upper lobe). The left oblique fissure separates the left lower lobe from the left upper lobe. A knowledge and appreciation of the lung fissures is important when planning CT-guided lung biopsies. It is generally undesirable to insert the instrument into more than one lobe during a lung biopsy, therefore traversing fissures should be avoided where possible.

Question 8.6



Name the structures labelled A to E.

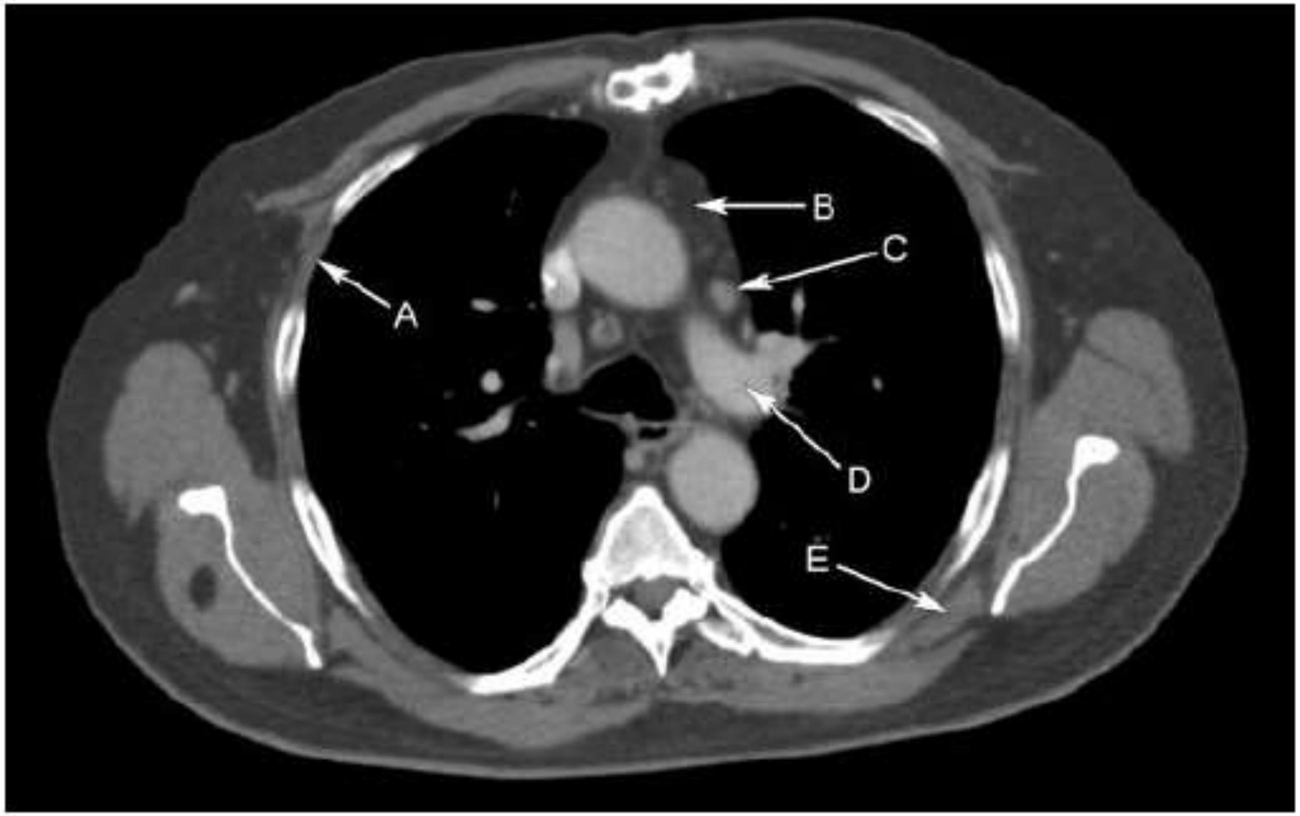
8.6 Axial high resolution CT (HRCT) of the chest

A Anterior junctional line.
B Ascending aorta.
C Right oblique fissure.

D Right main bronchus.
E Left oblique fissure.

The anterior junctional line is formed by the apposition of the visceral and parietal pleura of the lungs. In the right lung, the oblique fissure divides the lower lobe from the middle lobe. In the left lung, the oblique fissure divides the lower lobe from the upper lobe.

Question 8.7



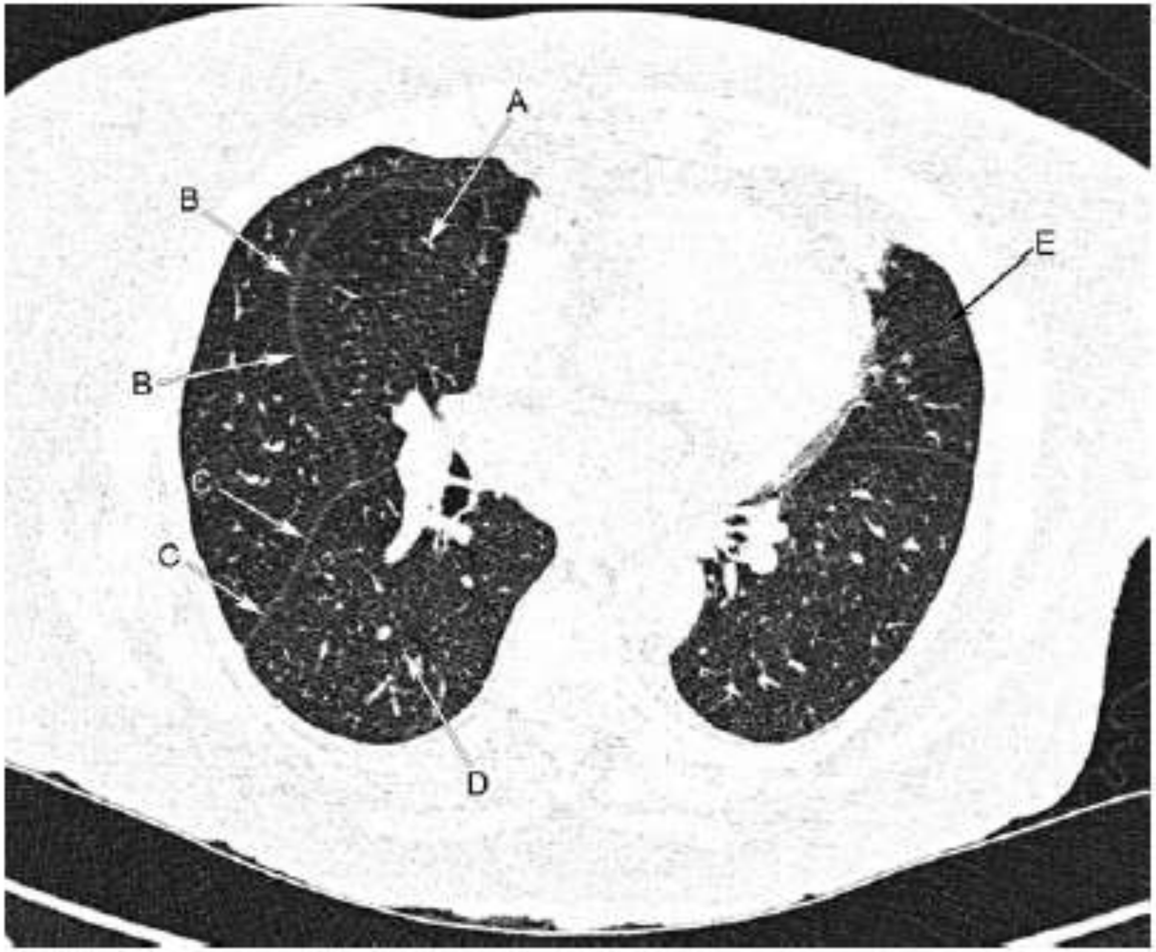
Name the structures labelled A to E.

8.7 Axial CT of the chest with IV contrast

A Right intercostal muscle.
B Mediastinal fat.
C Lymph node in aorto-pulmonary window.
D Left main pulmonary artery.
E Left rhomboid major muscle.

There are three principal layers of intercostal muscle – external, internal and innermost intercostal muscles. The neurovascular bundle runs in between the internal and innermost intercostal muscles. The rhomboid major muscle connects the scapula with the vertebrae and acts to retract and downwardly rotate the scapula.

Question 10.17



Name the structures labelled **A** to **E**.

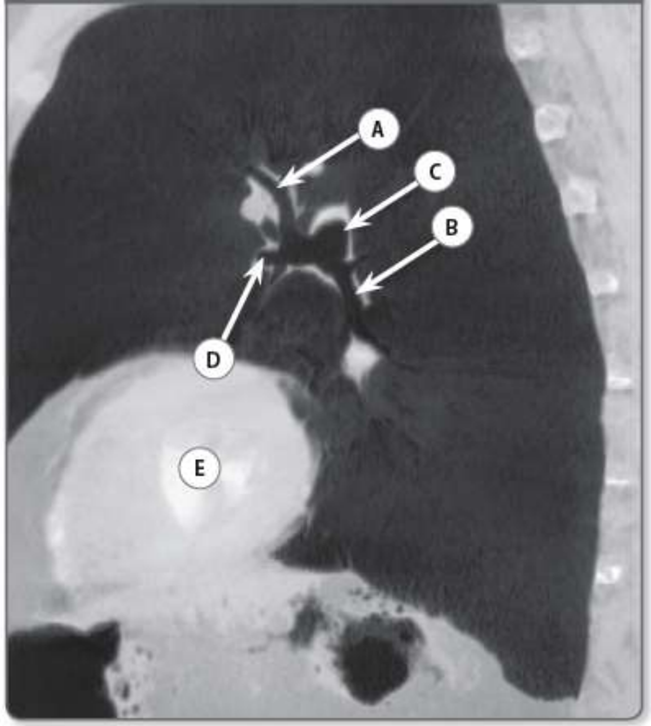
10.17 Axial CT of the chest

A Right middle lobe.
B Right horizontal (transverse) fissure.
C Right oblique fissure.
D Right lower lobe.
E Lingula of the left upper lobe.

The right lung is composed of three lobes – upper, middle and lower. The left lung is composed of two lobes – upper and lower, with an additional lingula lobe corresponding to the middle lobe of the right lung. Both lungs have an oblique fissure that extends from the spinous process of T2 posteriorly to the sixth costal cartilage anteriorly and separates all three lobes in the right lung and both lobes in the left lung. The transverse fissure is only located within the right lung and runs in line with the fourth costal cartilage to the meet the oblique fissure at the level of the sixth rib in the mid axillary line. It separates the right upper lobe from the right middle lobe.

See Question 7.6 for a further description of the lung fissures.

Case 1.2



Case 1.2

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the lobar segment labelled D.	
E	Name the chamber labelled E.	

Case 1.2

A Apicoposterior segment bronchus of the left upper lobe

B Anteromedial basal segment of the left lower lobe

C Left lower lobe bronchus

D Superior lingular segmental bronchus

E Left ventricle

The left lung comprises two lobes, the upper and lower lobes.

The segmental anatomy of the left upper lobe includes:

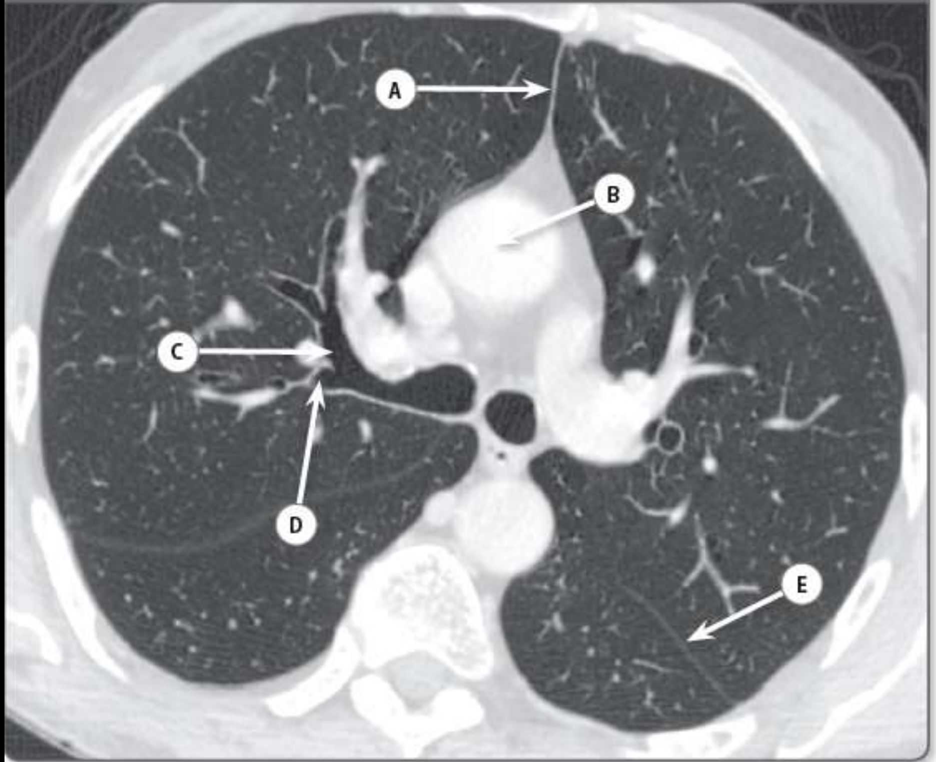
- apicoposterior segment
- anterior segment
- lingula
  - superior lingular segment
  - inferior lingular segment

The segmental anatomy of the left lower lobe includes:

- superior (apical) segment
- anteromedial basal segment
- lateral basal segment
- posterior basal segment

The key to answering this question is dependent on identifying whether one is on the left or right side of the thorax. The clue lies in (E), a thick muscular walled chamber of the heart – the left ventricle.

Case 1.9



Case 1.9

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the linear structure labelled E.	

Case 1.9

A Anterior junctional line

B Ascending aorta

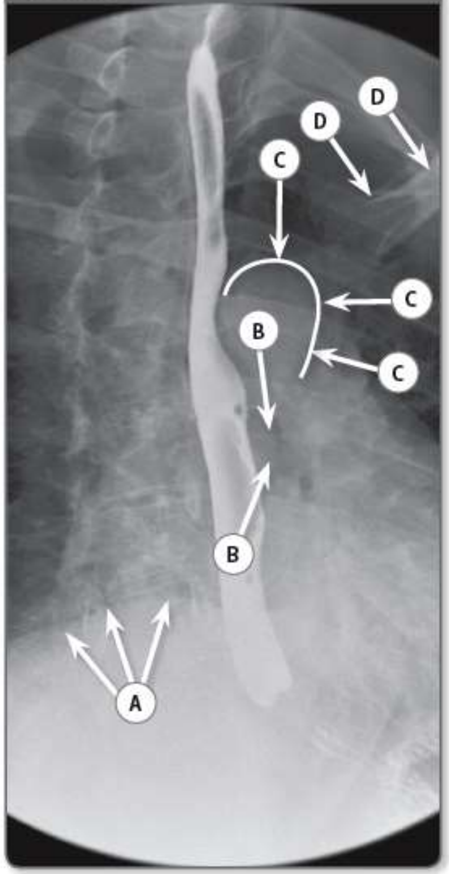
C Anterior segmental bronchus of right upper lobe

D Apical segmental bronchus of right upper lobe

E Left oblique fissure

The right main bronchus divides into the right upper lobe bronchus and bronchus intermedius. The bronchus intermedius gives off the middle and lower lobe bronchi.

Case 1.16



Case 1.16

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the lucent structure labelled B.	
C	Name the soft tissue density structure outlined by the arrows labelled C.	
D	Name the structure labelled D.	
E	At what vertebral level does the oesophagus normally traverse the diaphragm?	

Case 1.16

A Right hemidiaphragm

B Left main bronchus

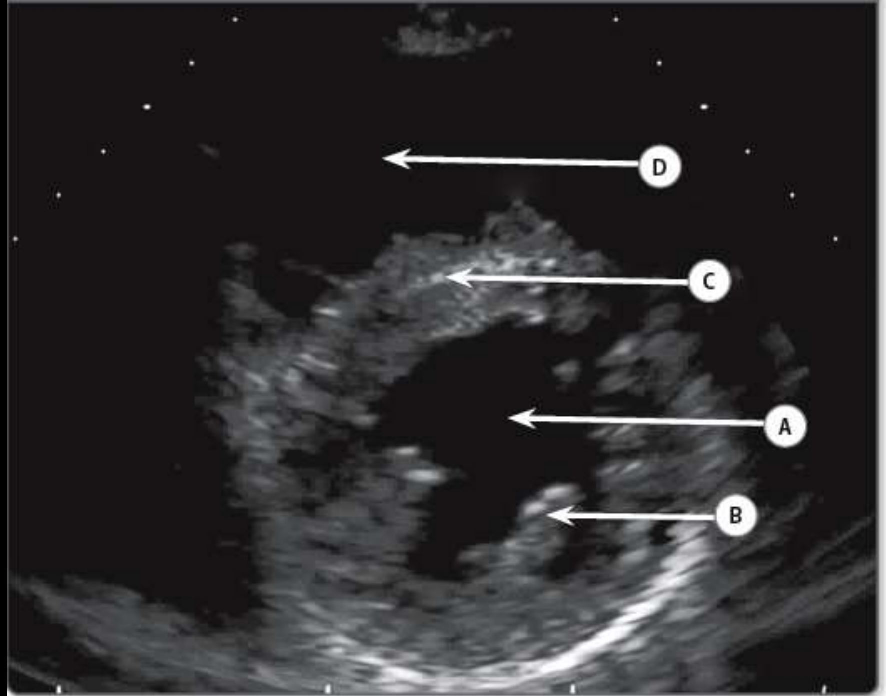
C Aortic arch

D Left clavicle

E T10

There are three main diaphragmatic hiatuses: the caval hiatus at T8 (most anterior); the oesophageal hiatus at T10 (middle); and the aortic hiatus at T12 (most posterior). The oesophagus is normally indented at several points along its length by anatomical structures. The most inferior of these is at the oesophageal hiatus, caused by a diaphragmatic impression. The left atrium causes a longer impression above this; due to this anatomical relationship, contrast swallow examinations have been used as a means of diagnosing left atrial enlargement. Superiorly to this a combination of the aortic arch and the left main bronchus cause an indentation in the left anterior aspect of the oesophagus.

Case 2.10



Case 2.10

QUESTION		WRITE YOUR ANSWER HERE
A	Name the chamber labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C	
D	Name the chamber labelled D.	
E	How many papillary muscles are usually present in the heart?	

Case 2.10

A Left ventricle

B Papillary muscle

C Interventricular septum

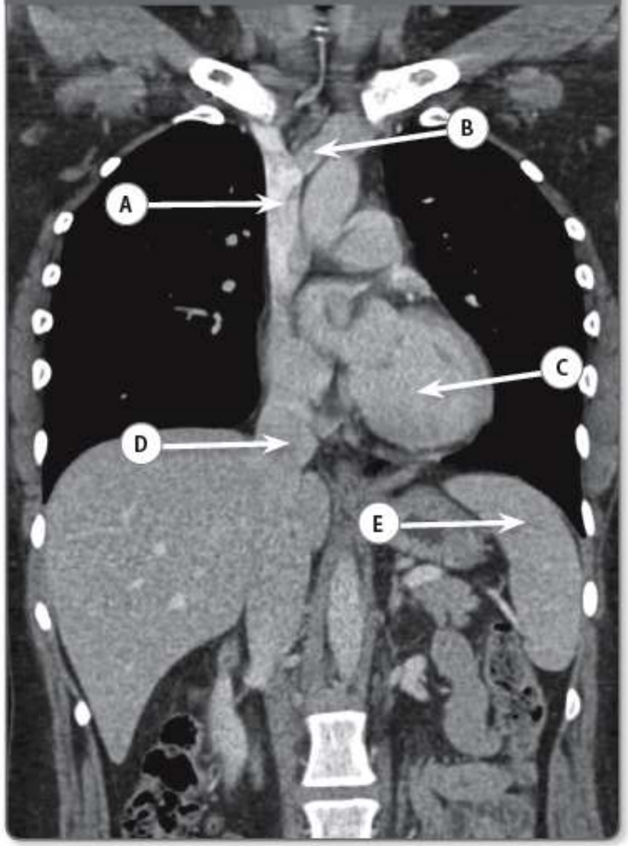
D Right ventricle

E Five

This is a parasternal short axis echocardiographic view of the left ventricle at the level of the papillary muscles which demonstrates the circumferential configuration of the left ventricle. Similar views are also obtained at the level of the mitral valve. The right ventricle is lies anterior to the left ventricle.

There are three papillary muscles in the right ventricle and two in the left ventricle.

Case 3.20



Case 3.20

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the chamber labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 3.20

A Superior vena cava

B Left brachiocephalic vein

C Left ventricle

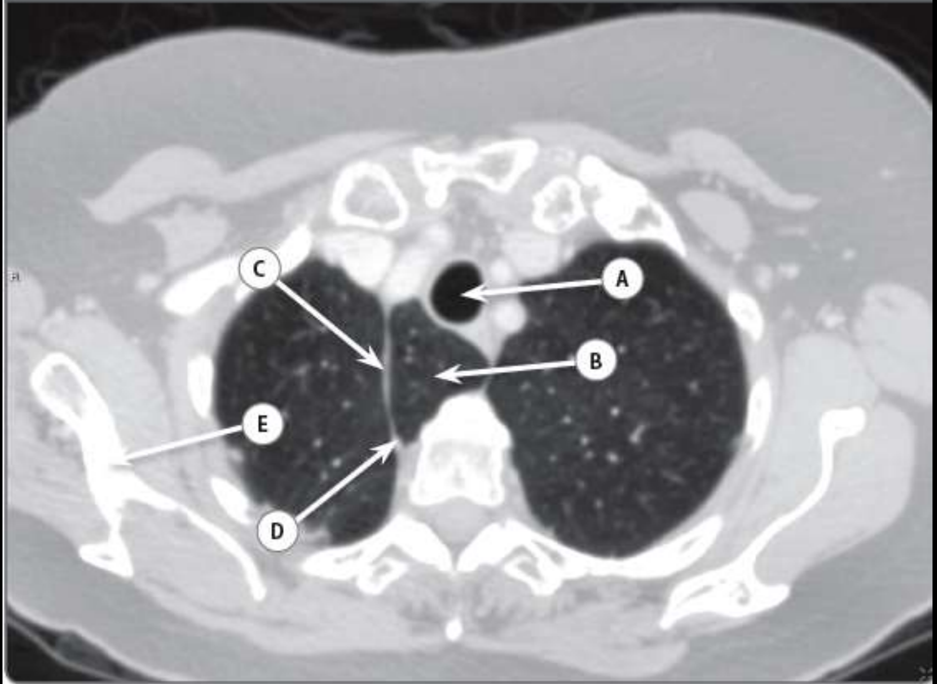
D Suprahepatic inferior vena cava

E Spleen

This example shows the systemic venous drainage via the large central veins draining into the heart. The superior vena cava (SVC) is almost always right-sided but can occasionally be left-sided or even bilateral.

In the 5th week of intrauterine life, three pairs of major veins can be distinguished: (a) the vitelline, carrying blood from the yolk sac to the sinus venosus; (b) the umbilical veins, carrying oxygenated blood to the embryo; and (c) the cardinal veins, draining the body of the embryo. This system consists of the anterior cardinal veins, which drain the cephalic part of the embryo, and the posterior cardinal veins, which drain the remainder of the embryo. The anterior and posterior veins join before entering the sinus horn and form the common cardinal veins. Formation of the vena cava system is characterised by the appearance of anastomoses between the left and right sides in such a manner that the blood from the left side is channelled to the right side. The anastomosis between the anterior cardinal veins develops into the left brachiocephalic vein. The superior vena cava is formed by the right common cardinal vein and the proximal portion of the right anterior cardinal vein.

Case 4.2



Case 4.2

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 4.2

A Trachea

B Azygos lobe

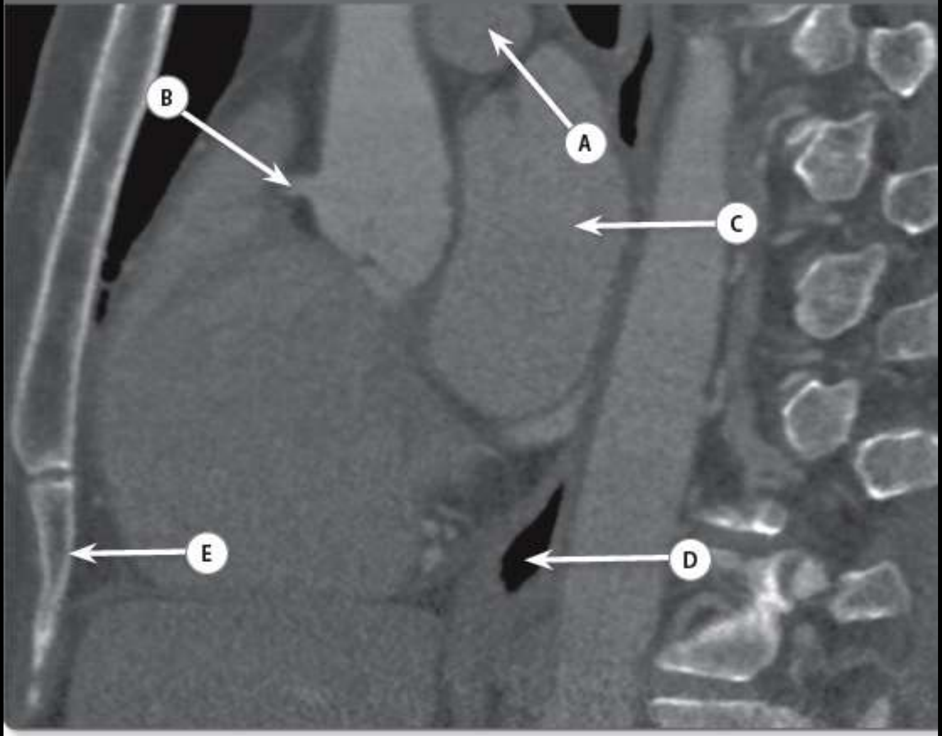
C Azygos fissure

D Azygos vein

E Right scapula

The azygos fissure/lobe is a normal anatomical variant seen in up to 0.4% of chest radiographs and 1% of anatomical specimens. This occurs when one of the precursors of the azygos vein fails to migrate over the apex of the right lung, leading to a mesentery-like fold of pleura, containing two layers of parietal and two of visceral pleura, at the bottom of which lies the azygos vein.

Case 4.7



Case 4.7

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the chamber labelled C.	
D	In what structure does the gas labelled D lie?	
E	Name the structure labelled E.	

Case 4.7

A Pulmonary artery

B Right coronary artery

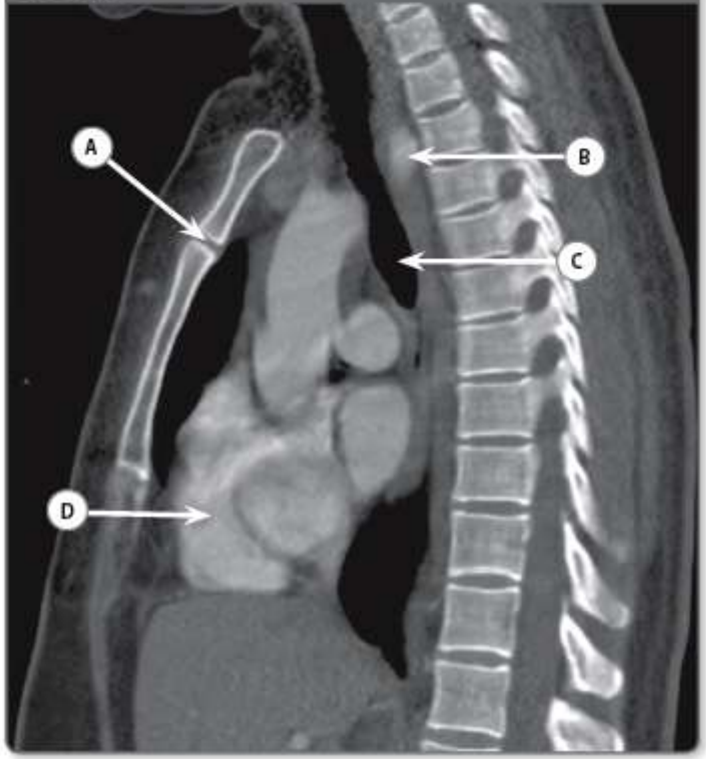
C Left atrium

D Oesophagus

E Xiphoid process or xiphisternum

The right coronary artery is seen to arise from the anterior aortic cusp. On sagittal images, the left atrium is the most posterior chamber. The ascending aorta is anterior to this. Density of contrast is higher in the aorta and the right coronary artery as this is timed as a CT coronary angiogram.

Case 5.14



Case 5.14

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the chamber labelled D.	
E	What is the focal dilatation of the aorta called (caused by the anatomical variant present)?	

Case 5.14

A Manubriosternal joint

B Aberrant right subclavian artery

C Trachea

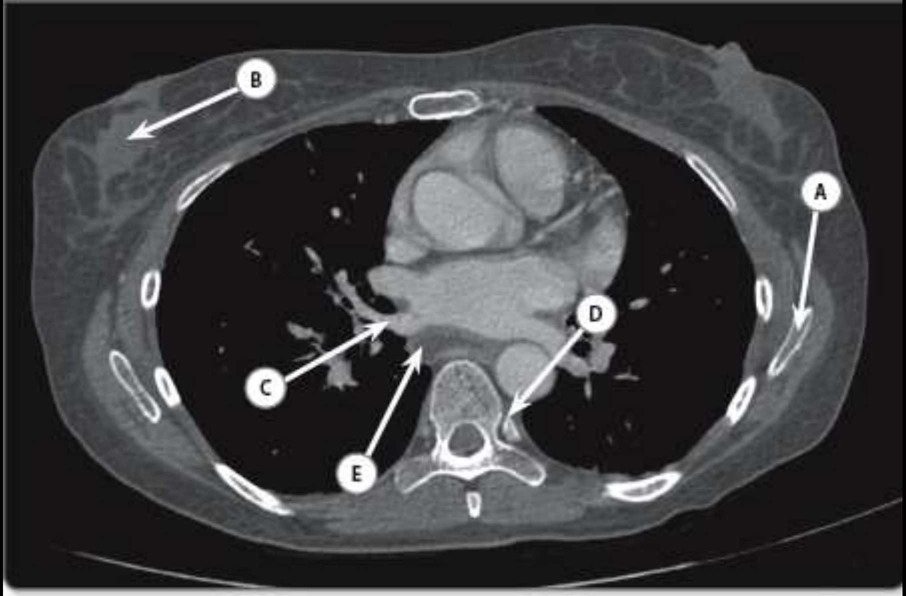
D Right ventricle

E Diverticulum of Kommerell

The course of an aberrant right subclavian artery is often retro-oesophageal and it will cause a posterior indentation of the oesophagus on a barium swallow.

On this sagittal view, orientation is important. The right ventricle is the most anterior chamber of the heart in the midline sagittal view. The left ventricle can be seen appearing into view just posterior to this.

Case 5.18



Case 5.18

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the joint labelled D.	
E	Name the structure labelled E.	

Case 5.18

A Left scapula

B Right breast tissue

C Right inferior pulmonary vein

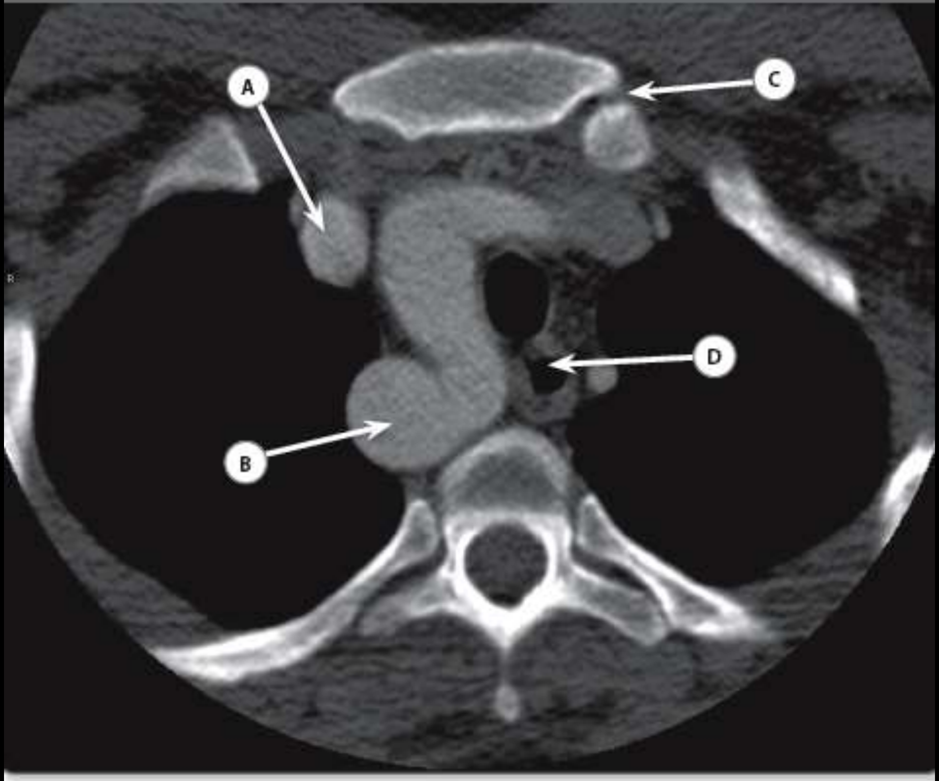
D Left costovertebral joint

E Oesophagus

There are three aortic sinuses or sinuses of Valsalva: the anterior or right coronary sinus, giving off (as its name suggests) the right coronary artery; the left posterior or left coronary sinus giving off the left coronary artery (seen on this image lying in the fat to the left of the ascending aorta and posterior to the pulmonary trunk); and the right posterior or non-coronary sinus.

The oesophagus on this image contains a small amount of fluid which is a common finding on CT examinations, particularly in older patients, and does not necessarily imply obstruction.

Case 6.4



Case 6.4

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C	
D	Name the structure labelled D.	
E	Which anatomical variant is present on this image?	

Case 6.4

A Superior vena cava

B Descending thoracic aorta

C Left sternoclavicular joint

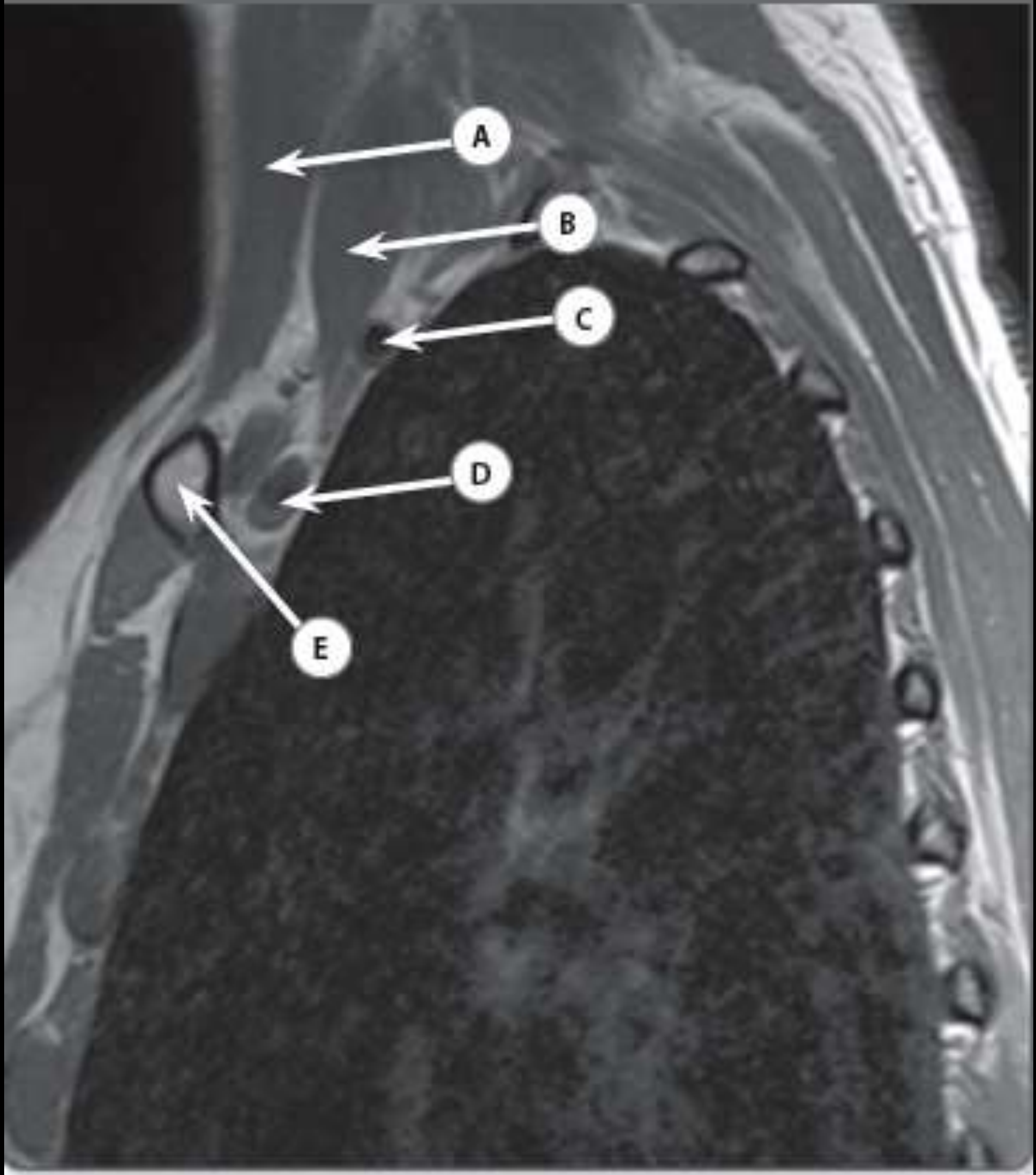
D Oesophagus

E Right aortic arch

A right-sided aortic arch can be of two types, commonly:

1. Mirror image type, in which the aorta is interrupted distal to the ductus arteriosus, with a 98% chance of a congenital heart disease.
2. Right aortic arch with an aberrant left subclavian artery – this is due to interruption of the aortic development between the left subclavian and the left common carotid arteries. The aberrant subclavian artery is retrotracheal or retro-oesophageal. Association with congenital heart disease is low (5%).

Case 6.9



Case 6.9

A Sternocleidomastoid muscle

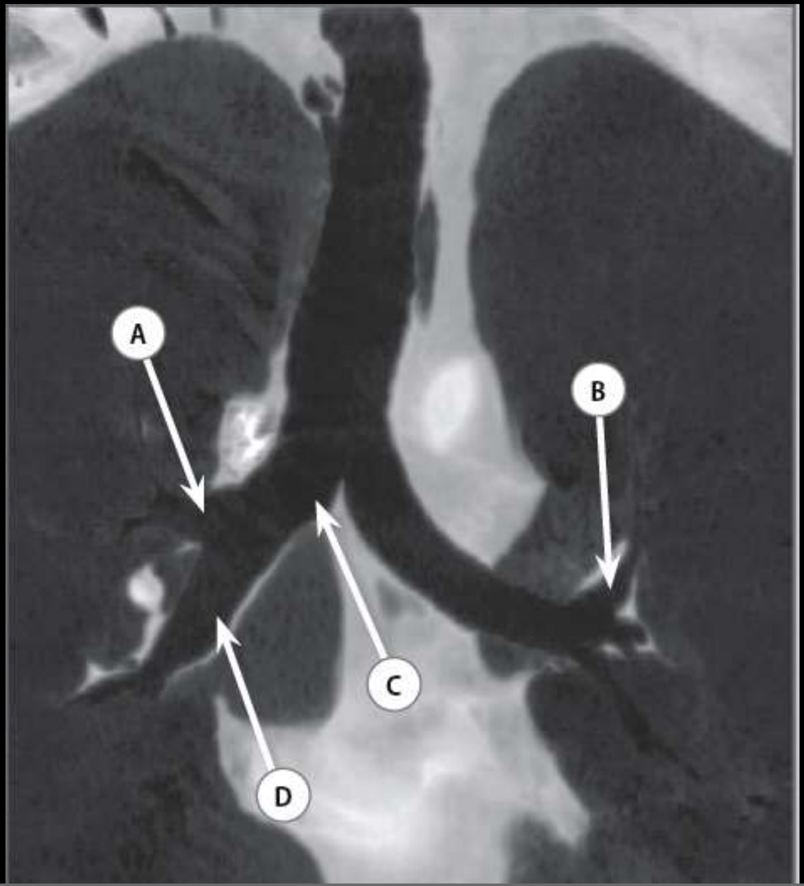
B Scalenus anterior muscle

C Subclavian artery

D Subclavian vein

E Clavicle

The subclavian vein and the phrenic nerve pass anterior to the scalenus anterior muscle whilst the subclavian artery and brachial plexus run posterior to it. Lesions in this region can involve the cords of the brachial plexus and cause neurological symptoms.



Case 7.1

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	What is the normal total number of bronchopulmonary segments?	

Case 7.1

A Right upper lobe bronchus

B Left upper lobe bronchus

C Right main bronchus

D Bronchus intermedius

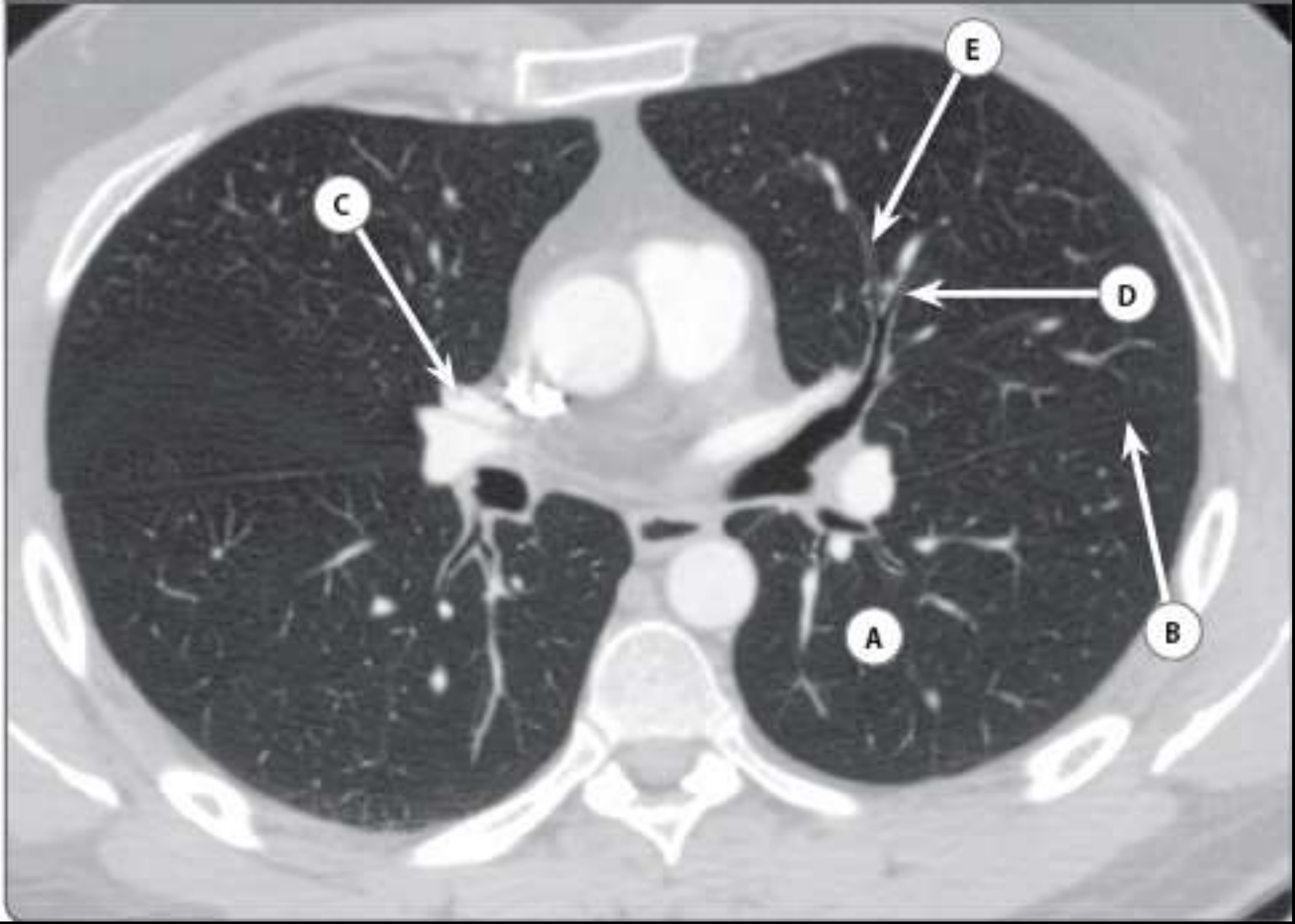
E 18

Each bronchopulmonary segment is supplied by a segmental bronchus of the same name. A summary is given in **Table 7.1**.

Table 7.1 Segmental architecture of the lungs

Right lung	Left lung
Upper lobe	*Upper lobe*
Apical segment	Apicoposterior segment
Posterior segment	
Anterior segment	Anterior segment
Middle lobe	*Lingula (upper lobe)*
Lateral segment	Superior lingular segment
Medial segment	Inferior lingular segment
Lower lobe	*Lower lobe*
Superior (apical) segment	Superior (apical) segment
Anterior basal segment	Anteromedial basal segment
Medial basal segment	
Lateral basal segment	Lateral basal segment
Posterior basal segment	Posterior basal segment

Case 8.6



Case 8.6

A Left lower lobe

B Left oblique fissure

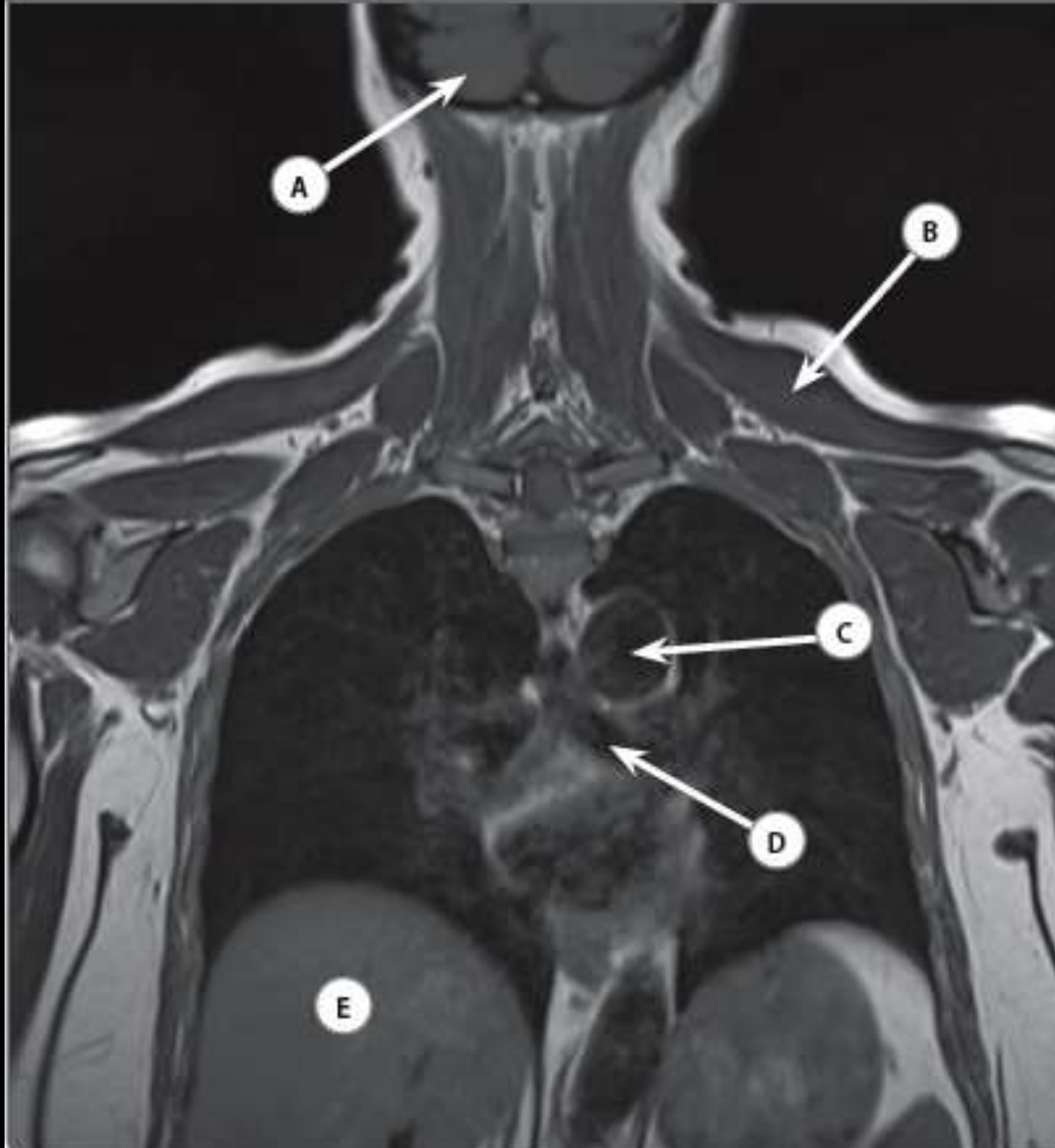
C Right superior pulmonary vein

D Inferior lingular segment bronchus

E Superior lingular segment bronchus

The lingula of the left lung is homologous to the middle lobe of the right lung. The lingula is composed of the superior and inferior lingular segments. Being adjacent to the left heart border, consolidation in the lingula will result in loss of the left heart border silhouette, an important radiographic finding.

Case 9.19



Case 9.19

A Right cerebellar hemisphere

B Left trapezius muscle

C Arch of the aorta

D Left main bronchus

E Right lobe of liver

The trapezius is a large fan-shaped muscle. Its superior fibres arise from: the external occipital protuberance; the superior nuchal line of the occipital bone; and ligamentum nuchae. From these origins they pass inferolaterally to insert into the posterior border of the lateral third of the clavicle.

The middle fibres of the trapezius arise from the spinous process of the C7 and the spinous processes of the upper three thoracic vertebrae. They insert into the medial margin of the acromion.

The inferior fibres arise from the spinous processes of the remaining thoracic vertebrae (T4–T12) and pass superolaterally, converging near the scapula to insert into a tubercle at the apex of the spine of the scapula.

In addition to the anatomical structures of the chest, the brain stem and upper abdominal organs are visible and should routinely be scrutinised for the presence of incidental pathology.

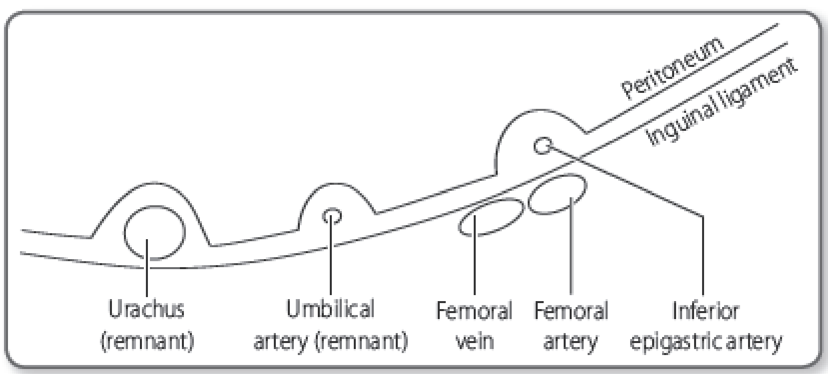
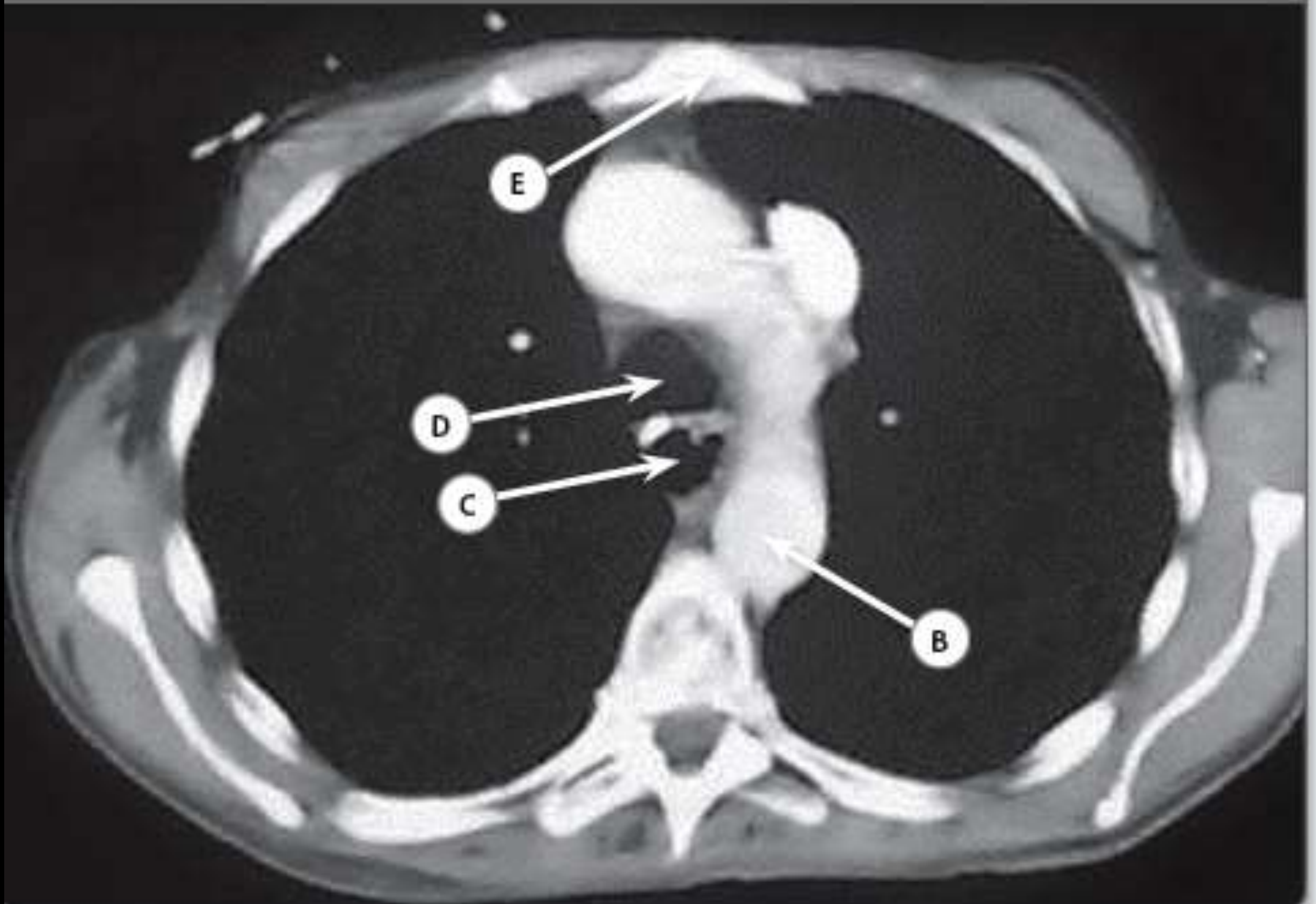


Figure 9.3 Peritoneal reflections at the level of the umbilical ligament.

Case 10.9



A	Which anatomical variant is present on this image?	

Case 10.9

A. Left superior vena cava (SVC)

B. Descending thoracic aorta

C. Oesophagus

D. Trachea

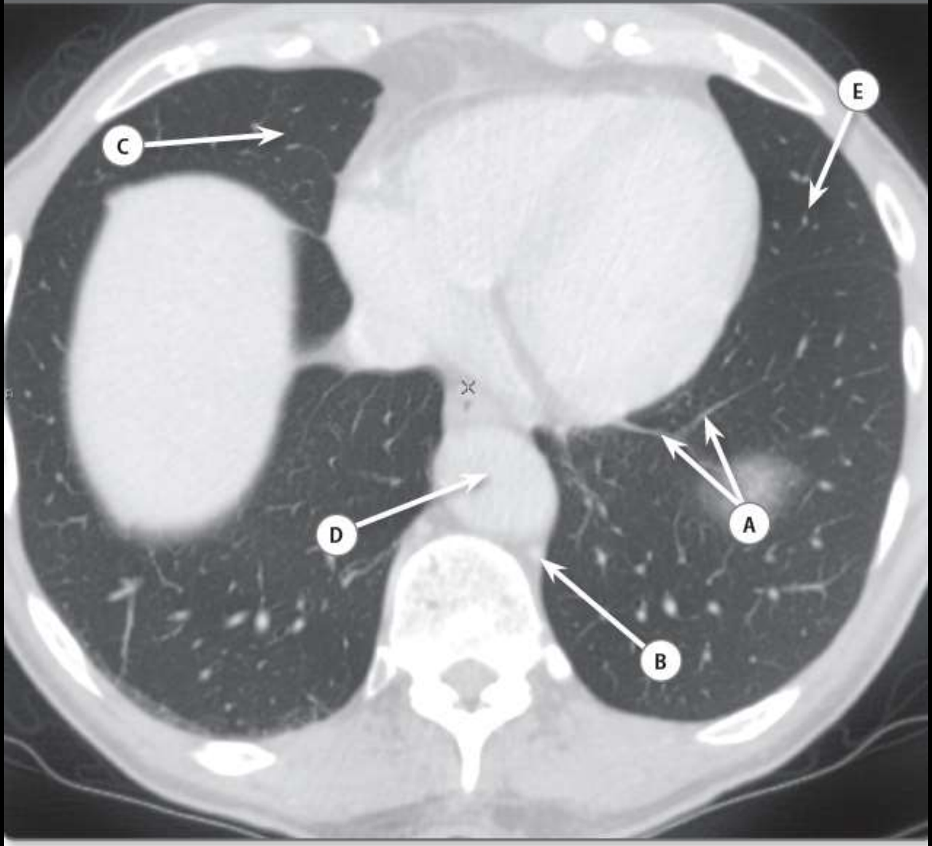
E. Sternum

A persistent left SVC is an anatomical variant which usually drains via the coronary sinus into the right atrium. This occurs due to failure of regression of the left anterior and common cardinal veins and the left sinus horn.

Persistence of the embryonic cardinal vein on the left in addition to a normal vein on the right leads to formation of a double SVC. The right SVC drains into the right atrium and the left into the coronary sinus.

In 10% of individuals with a left SVC, the SVC drains into the left atrium producing an asymptomatic right-to-left shunt. This is commonly present in heterotaxy syndromes.

Case 13.6



Case 13.6

	QUESTION	WRITE YOUR ANSWER HERE
A	What anatomical variant is marked A?	
B	Name the structure labelled B	
C	Which segment of the lung is labelled C?	
D	Name the structure labelled D.	
E	Which segment of the lung is labelled E?	

Case 13.6

A Left inferior accessory fissures

B Hemiazygos vein

C Medial segment of the middle lobe

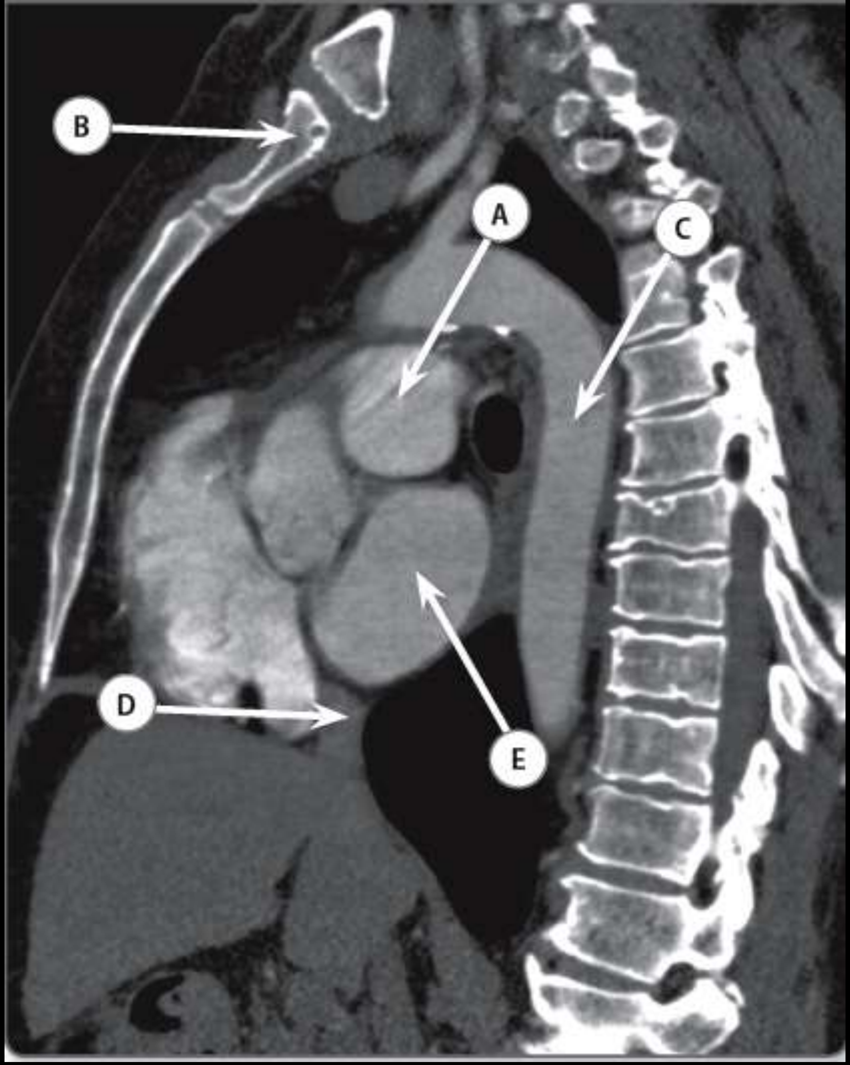
D Descending thoracic aorta

E Inferior segment of the lingula

Accessory fissures are seen on up to 10% of chest radiographs and 20% of CT scans. The inferior accessory fissures separate the medial and the lateral basal segments of the lower lobes. They can be easily mistaken for linear atelectasis or pleural bands.

On the current slice, the oblique fissures can be seen at both lung bases. On the right, it separates the middle lobe (abutting the heart) from the lower lobe. On the left, it separates the left upper lobe from the lower lobe.

Case 13.10



Case 13.10

A Pulmonary trunk

B Manubrium of sternum

C Descending thoracic aorta

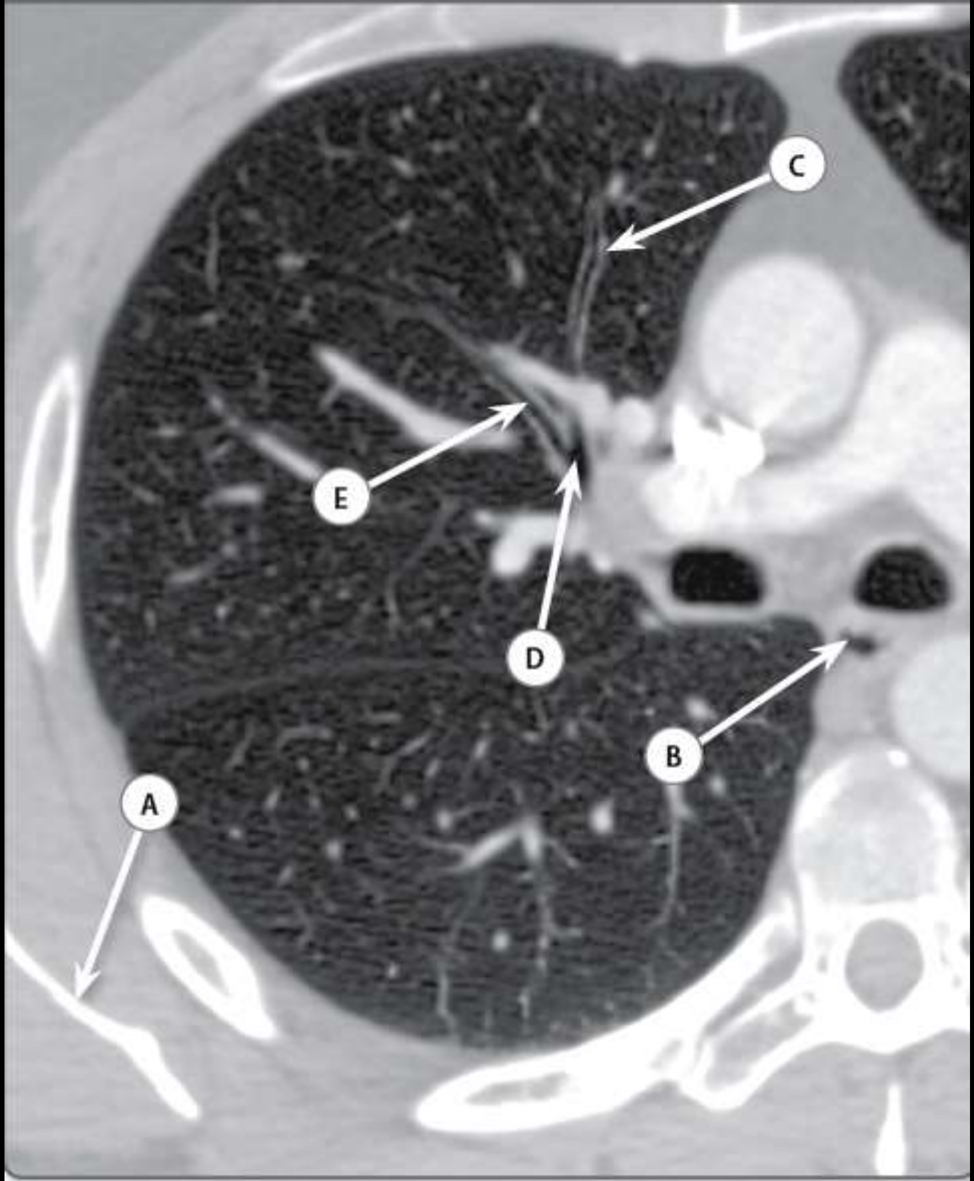
D Inferior vena cava

E Left atrium

The main pulmonary trunk is identified within the concavity of the aortic arch. The aortopulmonary window (the fat-containing space between the aortic arch and the pulmonary artery) is also noted. The ligamentum arteriosum and the left recurrent laryngeal nerve lie within this window.

The left atrium is the most posterior cardiac chamber and is thus a useful anatomical landmark when assessing cross-sectional images.

Case 14.4



Case 14.4

A Blade of right scapula

B Oesophagus

C Medial segment bronchus of middle lobe

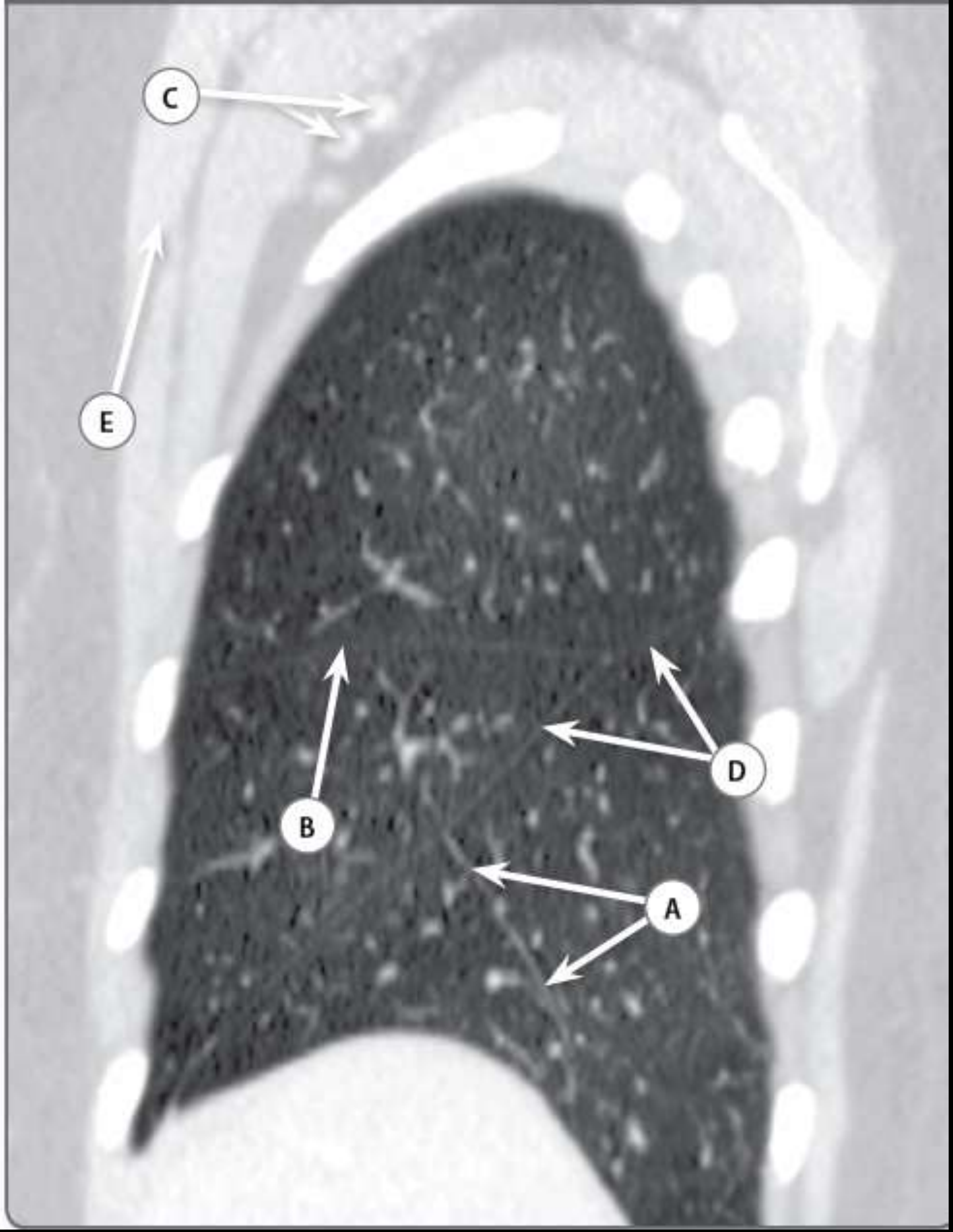
D Middle lobe bronchus

E Lateral segment bronchus of middle lobe

The right main bronchus (RMB) is wider, shorter and more vertical than the left main bronchus, which accounts for the greater tendency for aspirated material to pass down the RMB. The right upper lobe bronchus is the first lobar bronchus to branch off the RMB, which continues as the bronchus intermedius. The bronchus intermedius terminates as the middle and lower lobe bronchi.

This question requires that you understand the bronchopulmonary segments of the middle lobe. The middle lobe comprises lateral and medial bronchopulmonary segments.

Case 15.3



Case 15.3

A Right superior accessory fissure

B Horizontal fissure

C Right subclavian vessels

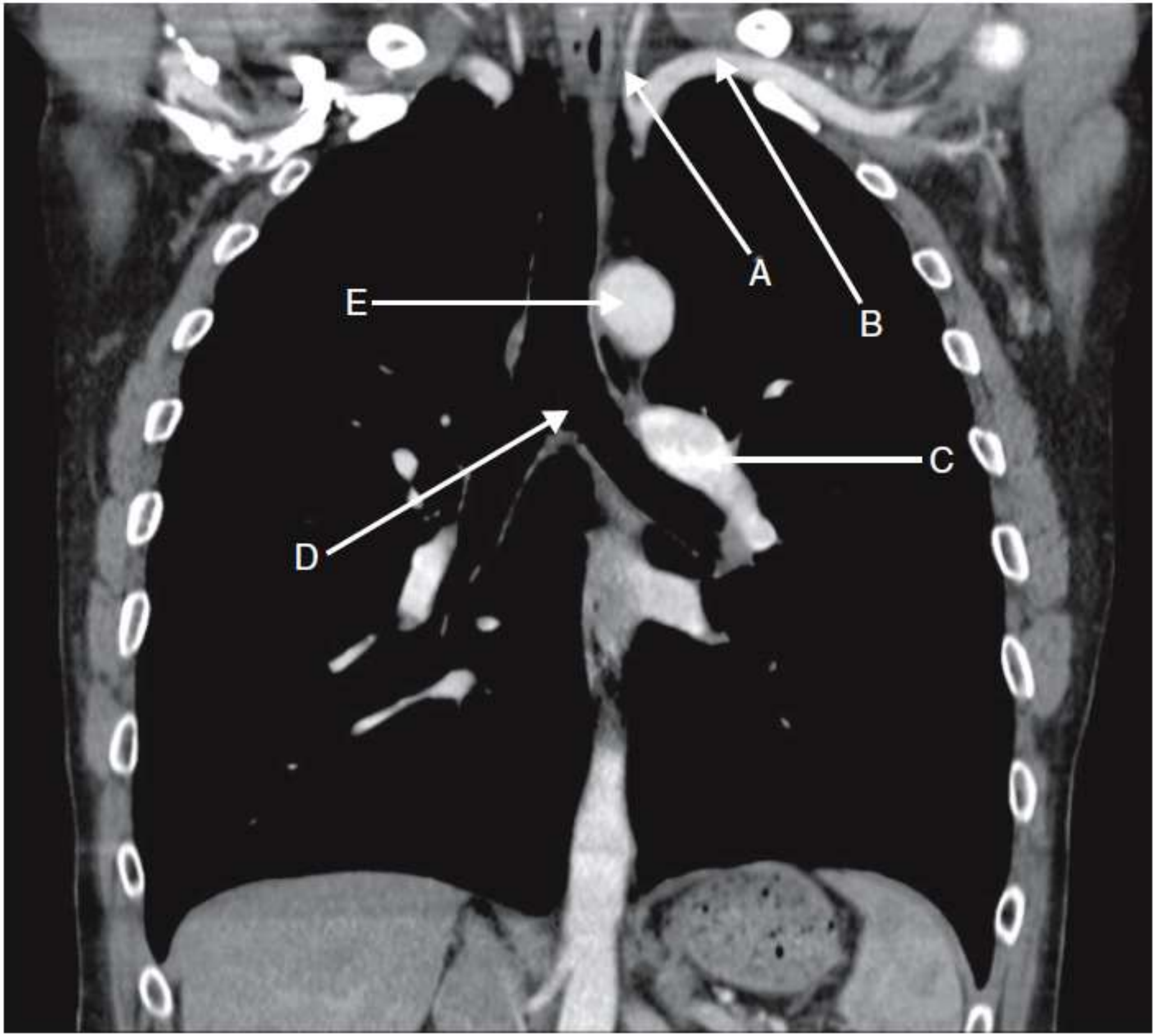
D Right oblique fissure

E Right pectoralis major muscle

The superior accessory fissure is seen in up to 4% of chest CT scans and separates the superior segment from the basal segments of the right lower lobe. Other accessory fissures include the inferior accessory fissure and the azygos lobe fissure.

A left minor fissure is present in approximately 8% of individuals, but can only be identified on chest radiographs in 1.6% of patients. The left minor fissure, when present, typically separates the lingula from the rest of the left upper lobe.

Case 1.18

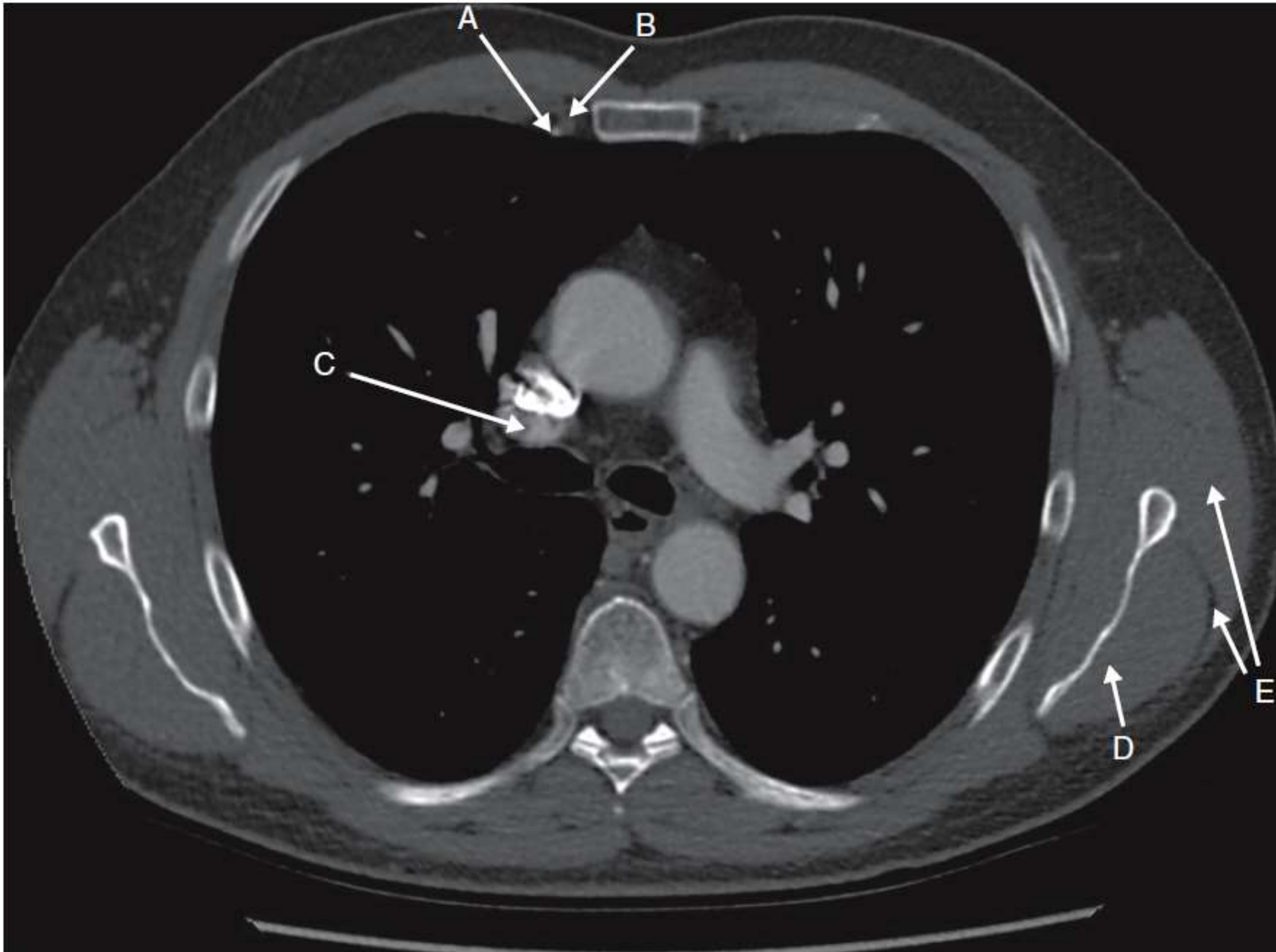


1.18 Coronal enhanced CT thorax

(a) Left vertebral artery.
(b) Left subclavian artery.
(c) Left pulmonary artery.
(d) Carina.
(e) Aortic knuckle (arch).

A CT scan can be seen to be enhanced when there is contrast in the vessels. usually the thorax is scanned in the arterial phase and thereby there will be contrast in the arteries. (There will be residual denser contrast within the superior vena cava (SVC) from the venous administration.) The abdomen is commonly scanned in portal venous phase (60–70 second delay after administration of contrast), which means the portal vein will enhance more avidly compared to the arteries.

Case 3.19

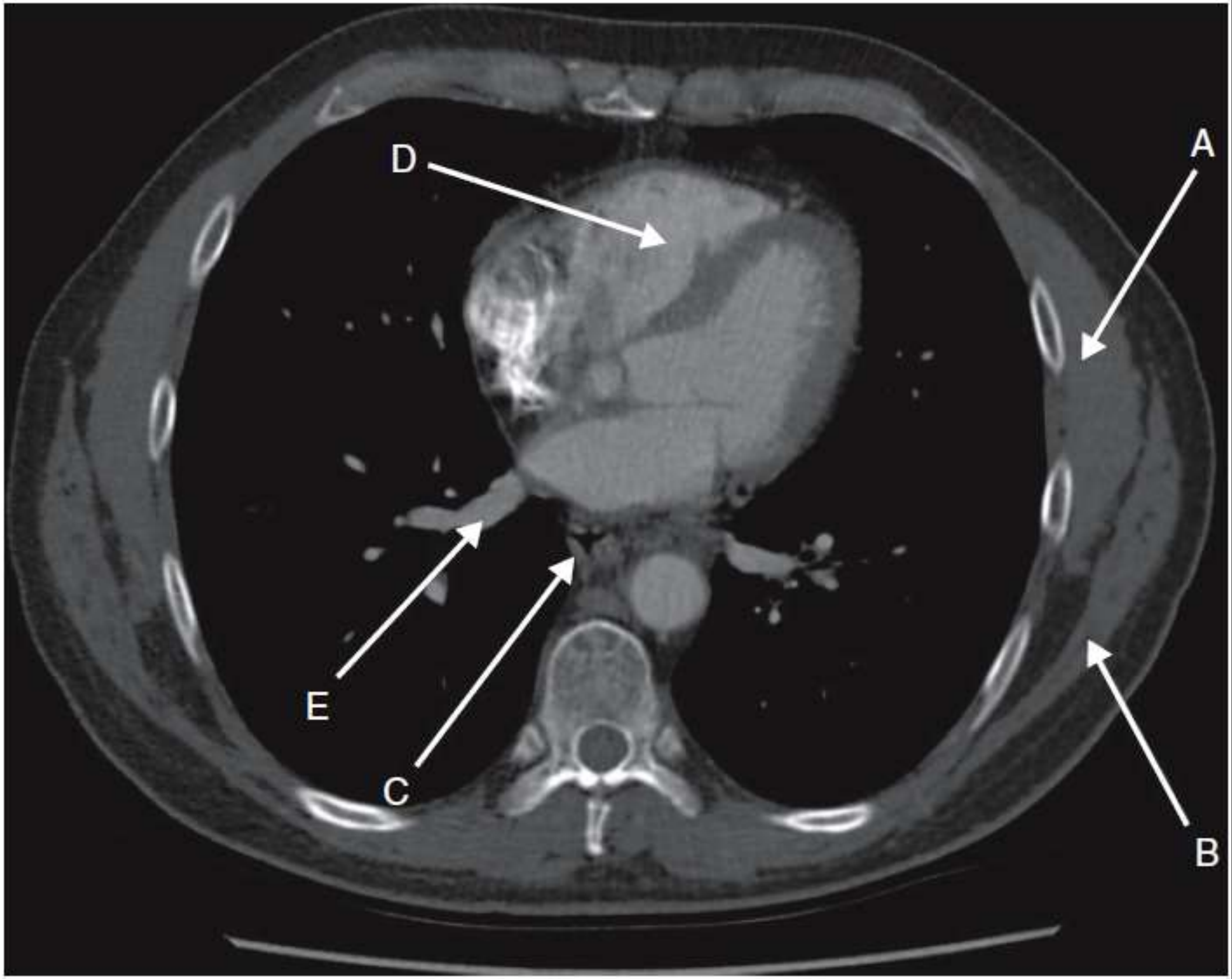


3.19 Axial enhanced thorax CT

(a) Right internal thoracic (mammary) artery. The internal thoracic artery arises from the inferior subclavian artery and descends deep to the internal intercostal muscles and costal cartilages to supply the anterior chest wall and breasts, and divides at the level of the sixth intercostal space into the superior epigastric and musculophrenic arteries.

(b) Right internal thoracic (mammary) vein. This vein lies *medial* to the artery.
(c) Right main pulmonary artery.
(d) Left infraspinatus muscle.
(e) Left latissimus dorsi muscle.

Case 4.17



4.17 Axial enhanced CT thorax

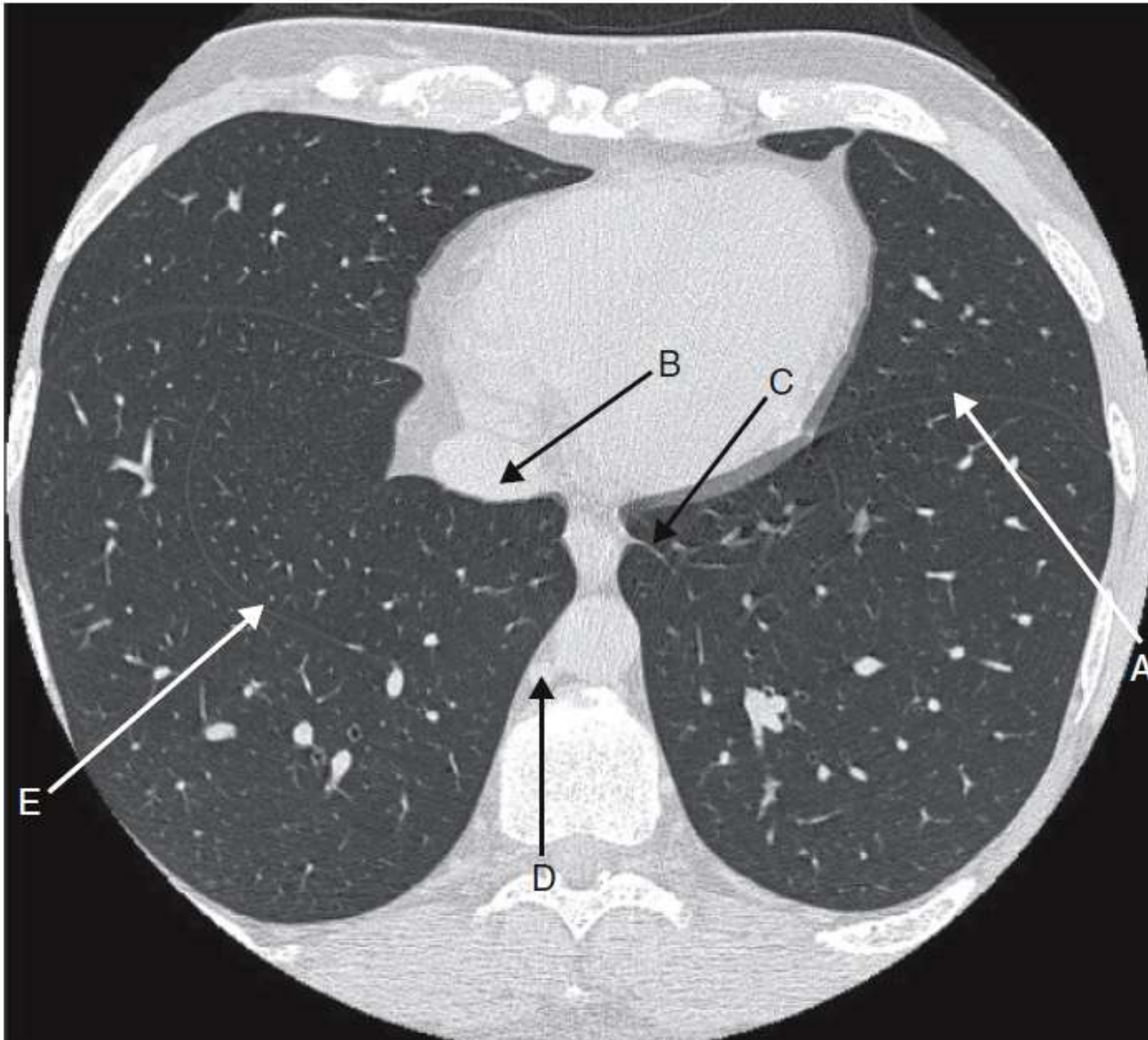
(a) Left serratus anterior muscle.
(b) Left latissimus dorsi muscle.
(c) Oesophagus.
(d) Right ventricle.
(e) Right inferior pulmonary vein.

The pulmonary veins enter the left atrium almost perpendicular to the lateral atrial walls. The inferior and superior pulmonary veins enter the atrium very close to each other.

Pulmonary veins run in the interlobular septa along with lymphatics. They enter the left atrium at the hilum and may enter the atrium separately – one for each lobe – or may conjoin before entering the atrium.

Pulmonary veins lie *anterior* to pulmonary arteries bilaterally.

Case 5.16



5.16 Axial CT thorax (lung windows)

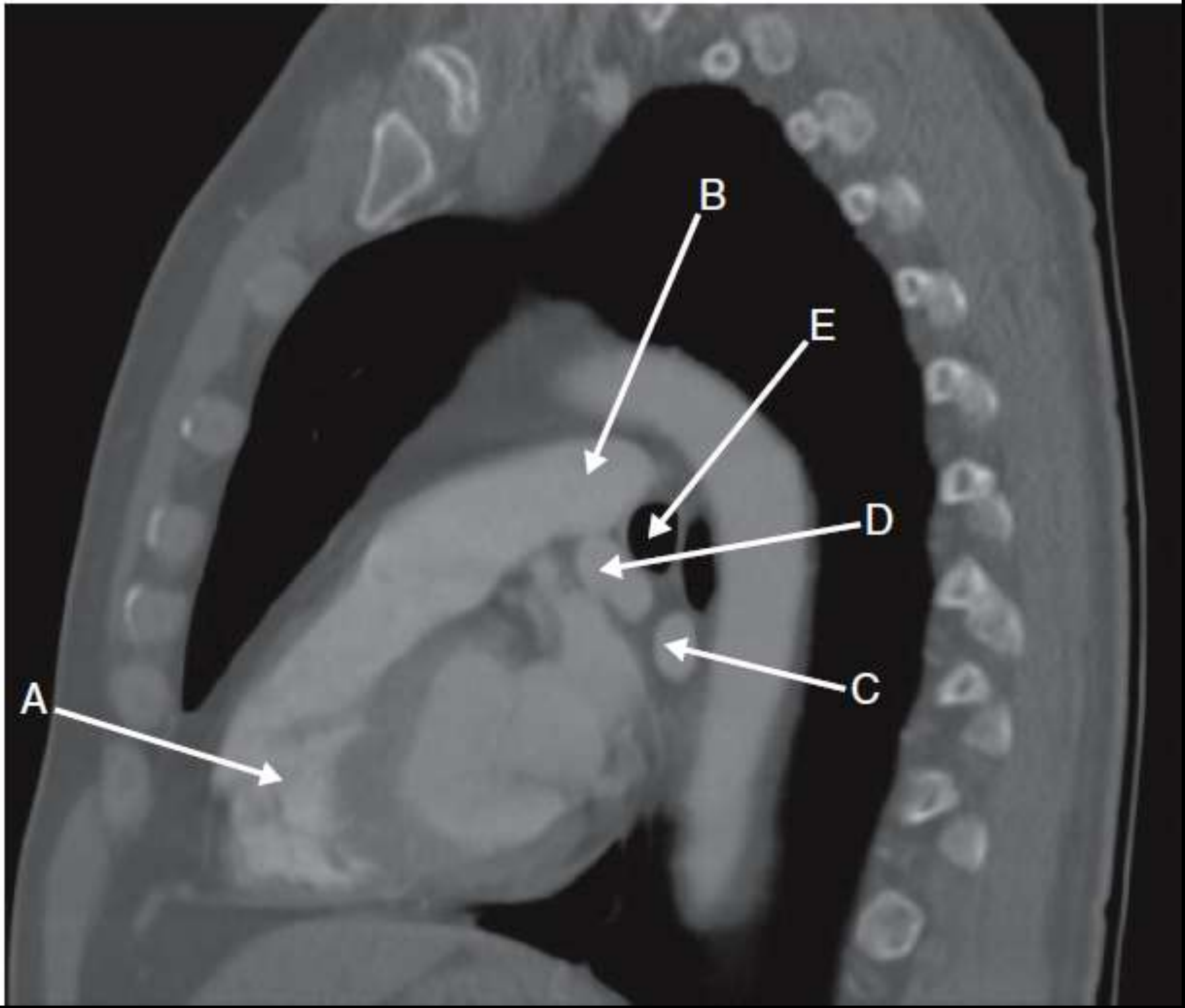
(a) Left oblique (major) fissure.
(b) Inferior vena cava.
(c) Left inferior pulmonary ligament or left pulmonary ligament. The pulmonary ligament is present bilaterally and comprises two pleural layers that extend downwards from the hilum of the lung between the inferior part of the mediastinal surface of the lung and the pericardium, joining the medial lower lobe to the mediastinum and diaphragm. It is situated inferior to the inferior pulmonary vein.
(d) Azygos vein.
(e) Right inferior accessory fissure. The right inferior accessory fissure is detected with high resolution CT (HRCT) in approximately 20% of patients. It is seen in 8% of PA chest radiographs and will only be detected if the x-ray beam is tangential to the fissure. It separates the medial basal segment from the rest of the right lower lobe. Note: the incidence of accessory fissures varies widely from study to study.

Consolidation in the medial basal segment of the right lower lobe may have a clear demarcation line at the site of this fissure.

Other accessory fissures are:

Azygos fissure – 1–4% of PA chest radiographs (depending on study)
Superior accessory fissure – 5% of PA chest radiographs
Left minor fissure – 2% of PA chest radiographs.

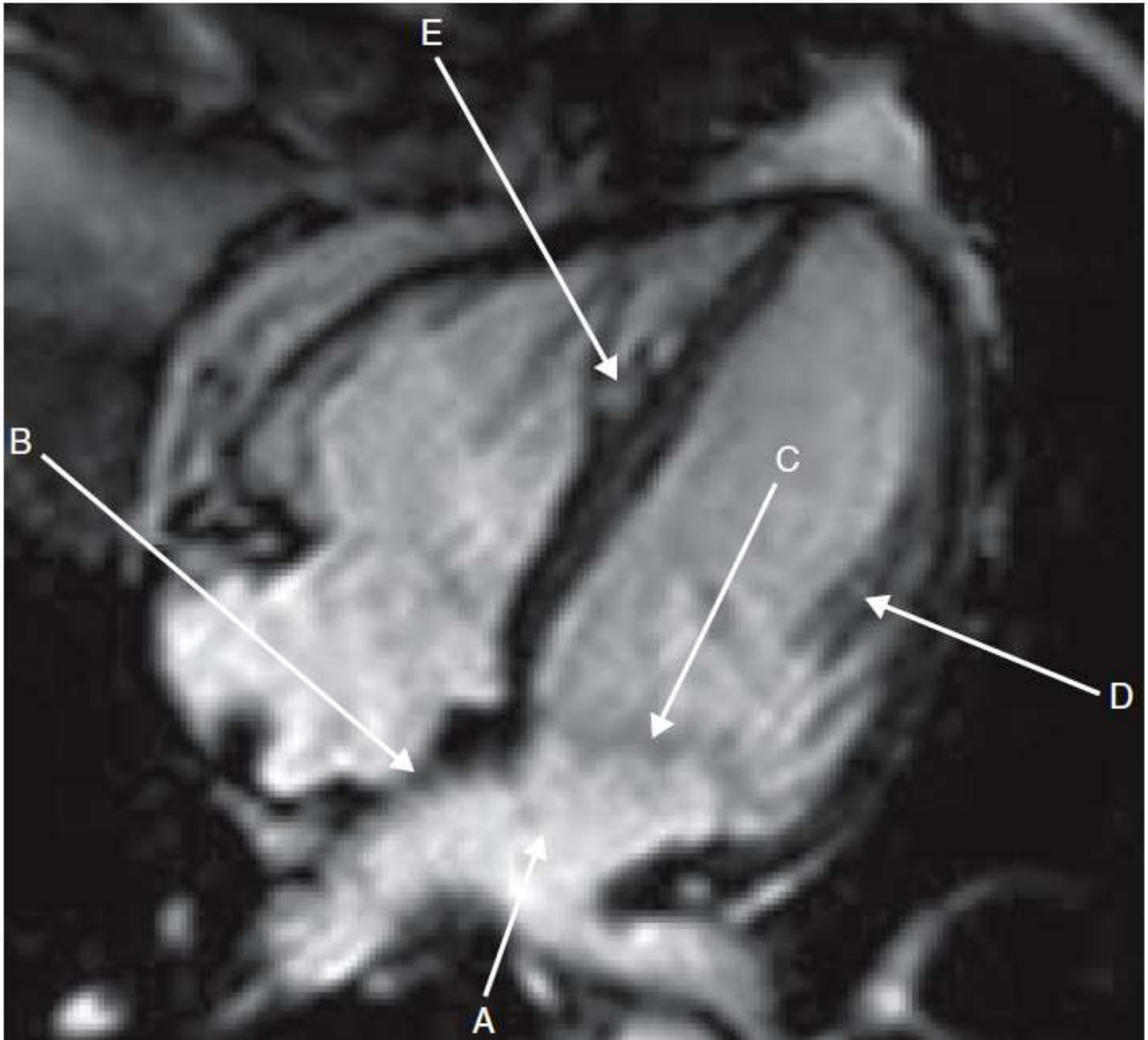
Case 5.19



5.19 Sagittal thorax CT

(a) Right ventricle.
(b) Pulmonary trunk.
(c) Left inferior pulmonary vein.
(d) Left superior pulmonary vein.
(e) Left main bronchus. The left main bronchus has a more horizontal course than the right main bronchus. Consequently the left main bronchus is ovoid on lateral chest radiographs and sagittal CT images, unlike the right main bronchus, which is tubular and more 'vertical'.

Case 6.11

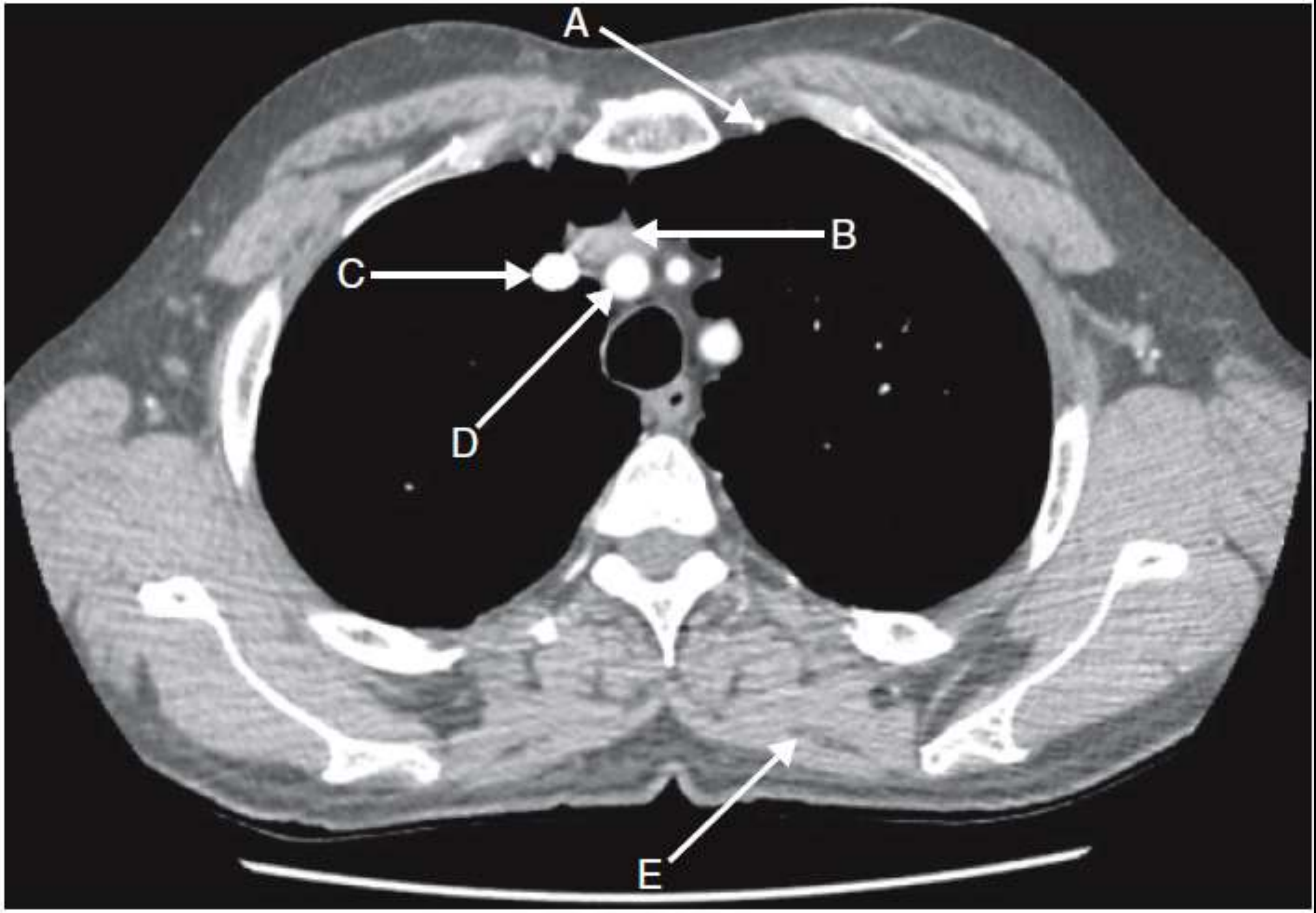


6.11 Cardiac MR

This image is a single frame from a 4-chamber cardiac MR white blood cine (steady state free precession) examination.

(a) Left atrium.
(b) Inter-atrial septum.
(c) Mitral valve.
(d) Papillary muscle.
(e) Moderator band. The right ventricle (RV) is more heavily trabeculated than the left and also has a thick muscular band running across the distal RV cavity from the septum to the base of the anterior papillary muscle. This is called the moderator band and carries the right bundle branch of the atrio-ventricular (AV) conduction system to the anterior papillary muscle. The moderator band is only seen in the RV and its presence is used to identify the RV on fetal echocardiogram.

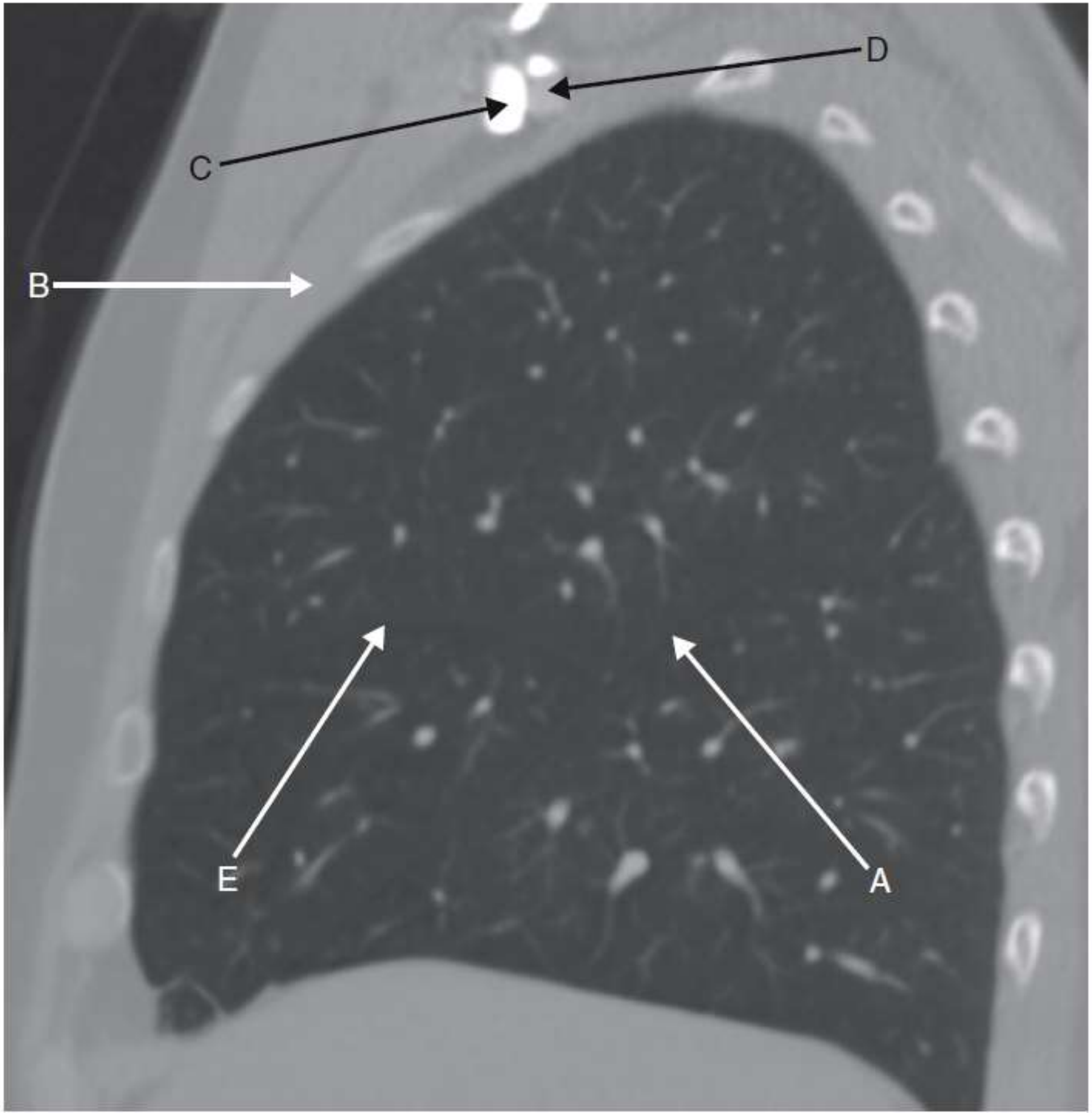
Case 6.13



6.13 Contrast-enhanced CT thorax

(a) Left internal thoracic (mammary) artery.
(b) Left brachiocephalic vein.
(c) Superior vena cava.
(d) Brachiocephalic (innominate) trunk (artery).
(e) Left trapezius muscle.

Case 6.16

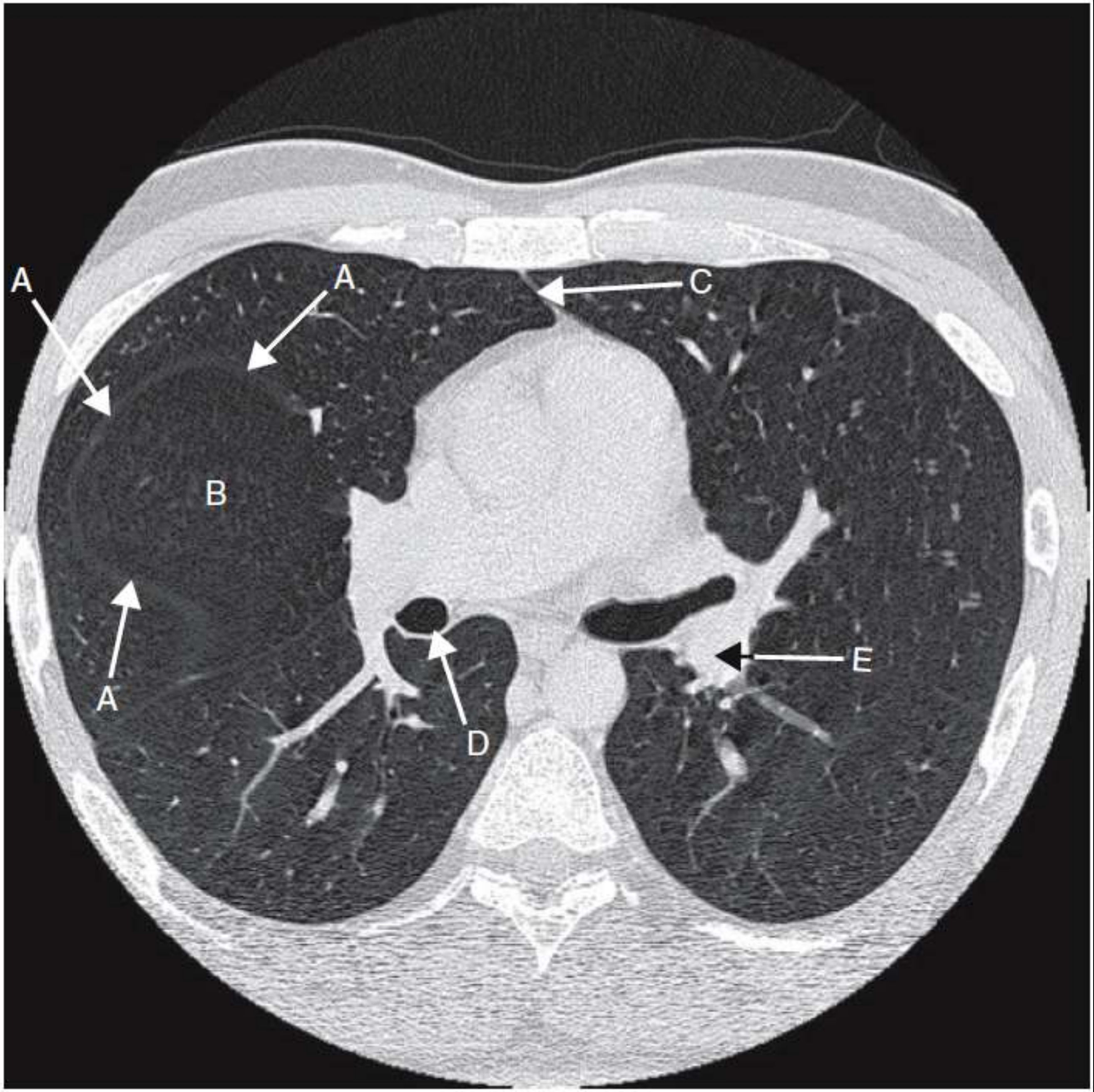


6.16 Sagittal CT thorax

(a) Right oblique (major) fissure.
(b) Right pectoralis minor muscle.
(c) Right subclavian vein. This is dense on this image as it contains the intravenously administered contrast.
(d) Right subclavian artery.
(e) Horizontal (minor) fissure. The horizontal fissure bulges so that there is a convex upper border.

The horizontal fissure is higher medially than laterally and higher posteriorly than anteriorly. It is only present in the right lung since the left lung lacks a middle lobe. It normally extends from the oblique fissure at the level of the fourth rib.

Case 7.11



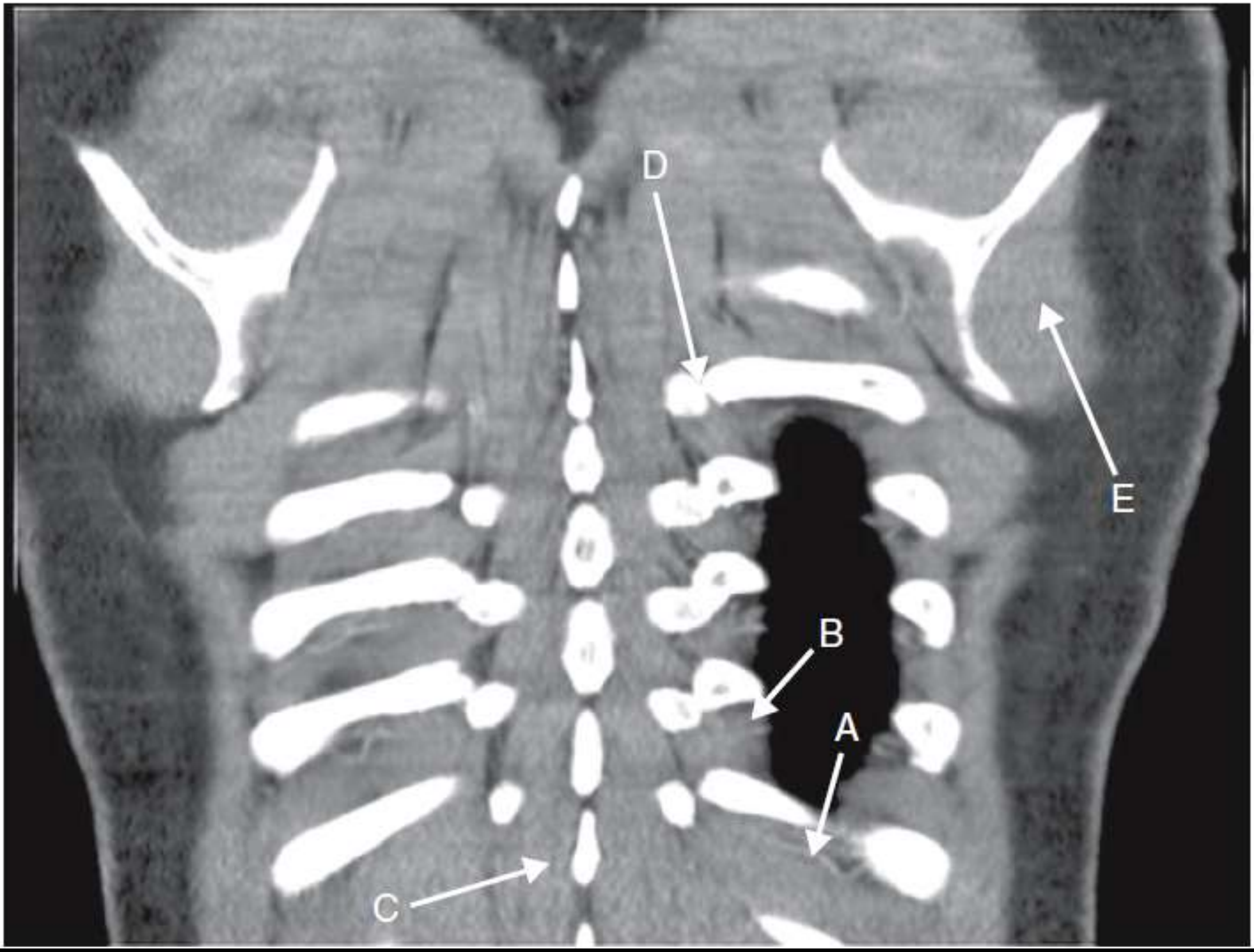
7.11 Axial CT thorax (bone windows)

(a) Minor or horizontal fissure.
(b) Right middle lobe.
(c) Anterior junction line.
(d) Posterior wall of bronchus intermedius.
(e) Left lower lobe pulmonary artery.

HRCT has sufficient resolution to depict the fissures as thin lines. On conventional non-thin slice CT, low attenuation areas of avascularity represent the fissures.

The horizontal fissure on axial slices encircles the right middle lobe. This is because the horizontal fissure is convex superiorly.

Case 7.17

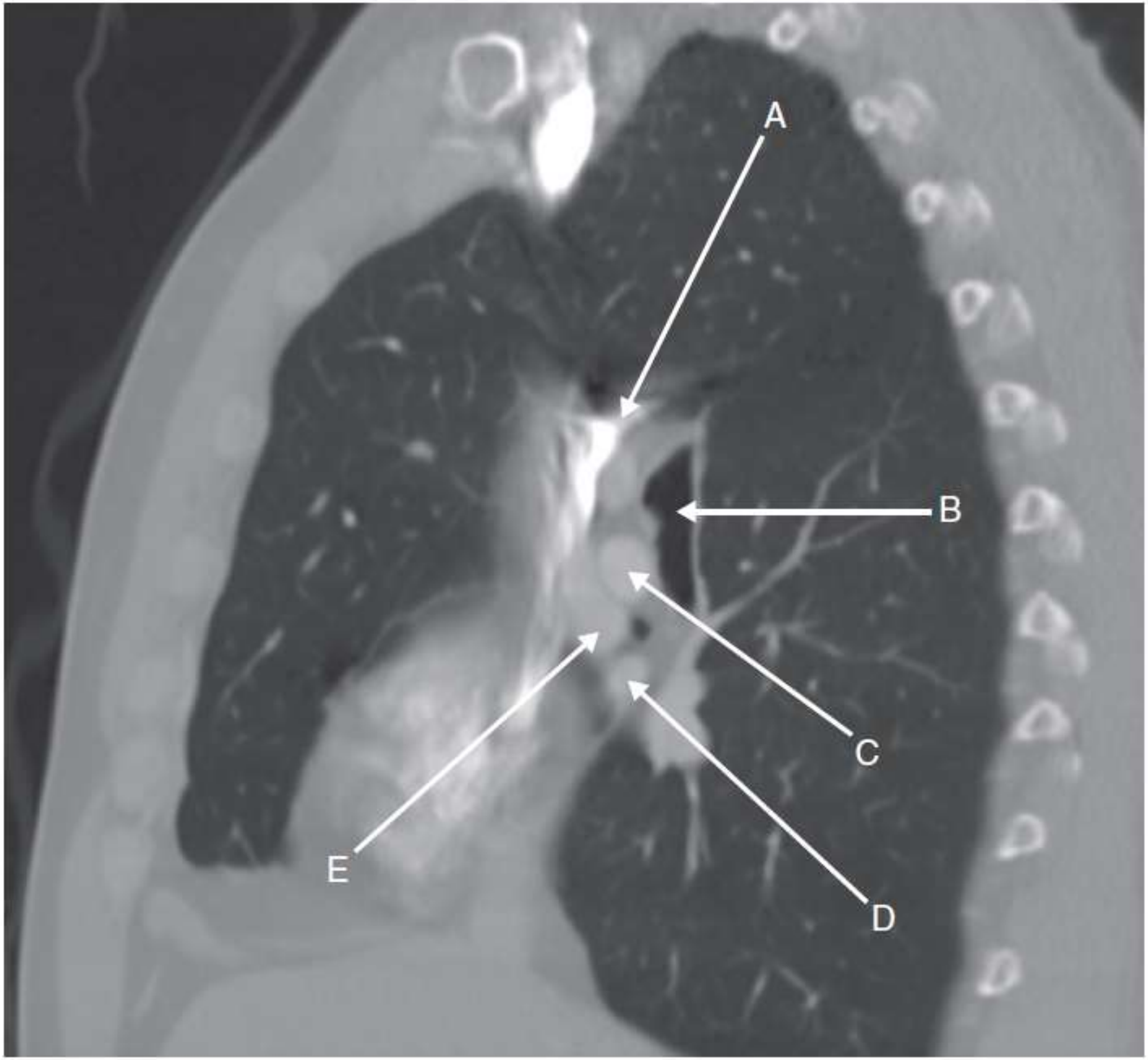


7.17 Coronal enhanced thorax CT

(a) Left intercostal artery.
(b) Left intercostal vein.
(c) Left erector spinae muscle.
(d) Left costotransverse joint.
(e) Left infraspinatus muscle.

The intercostal neurovascular bundle is exposed posteriorly and has no protection from the bony intercostal groove. This is very different to the situation that exists in the antero-lateral chest wall where the neurovascular bundle is protected by the subcostal groove. The neurovascular bundle is situated between the internal and innermost intercostal muscles. The lack of protection posteriorly makes chest drain insertion and percutaneous intrathoracic biopsy procedures particularly hazardous with resulting haemothoraces as the most serious complication if there is arterial puncture. Therefore, great care must be taken when accessing the thorax via a posterior approach. Avoidance of this route is preferable but if access must be made at this site, a caudal tilt to the needle so that it glances the superior aspect of the rib below is advisable in order to reduce the risk of arterial puncture.

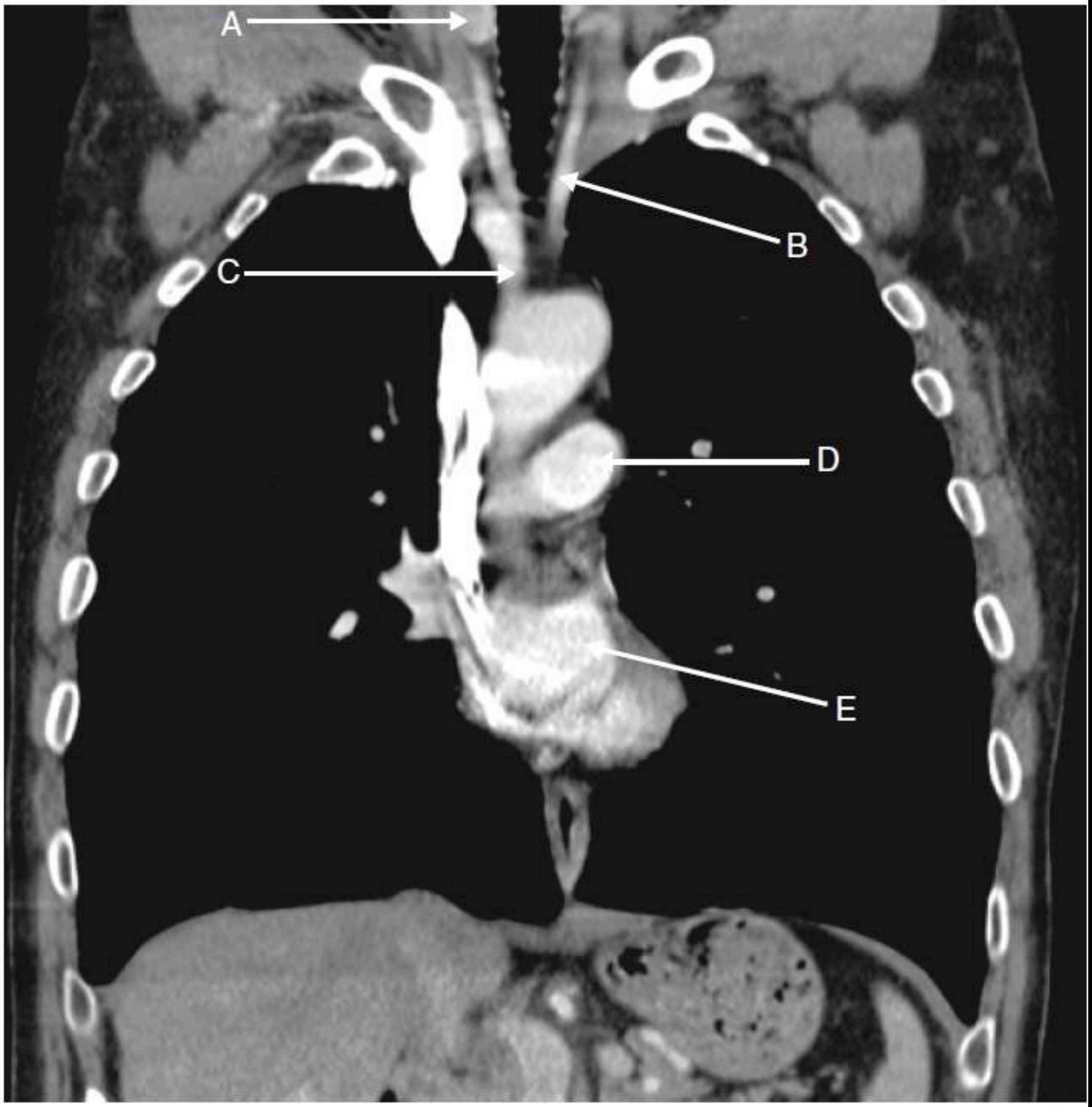
Case 8.11



8.11 Sagittal CT chest

(a) Azygos vein.
(b) Bronchus intermedius.
(c) Right interlobar pulmonary artery. The right interlobar and upper lobe pulmonary arteries both lie *anterior* to bronchus intermedius. (On the left side the pulmonary artery lies *posterior* to the left main bronchus.)
(d) Right inferior pulmonary vein.
(e) Right superior pulmonary vein. The right pulmonary veins lie *anterior* to the pulmonary arteries.

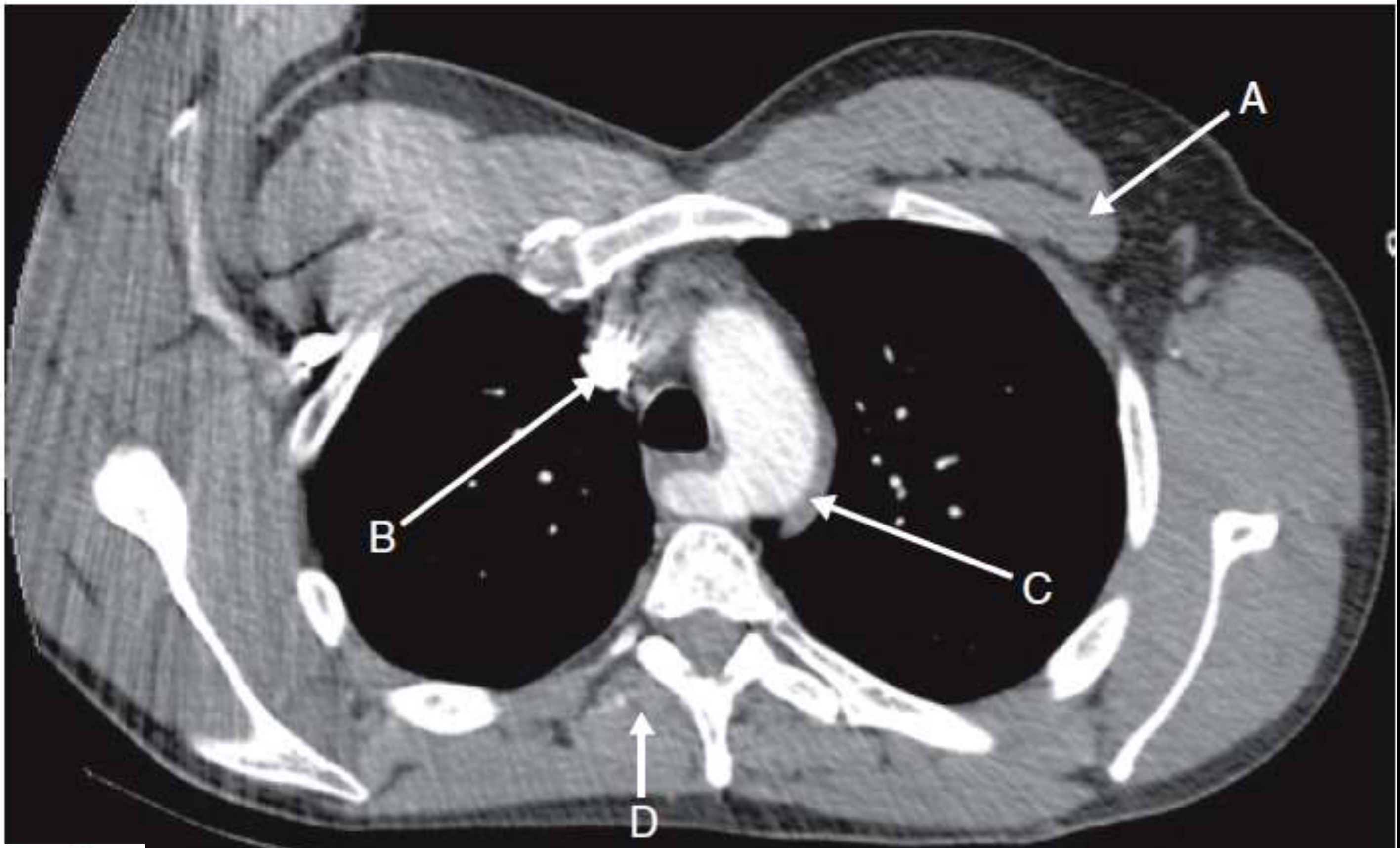
Case 8.13



8.13 Coronal contrast-enhanced CT chest

(a) Right thyroid lobe.
(b) Left common carotid artery.
(c) Brachiocephalic trunk.
(d) Left pulmonary artery.
(e) Left atrium.

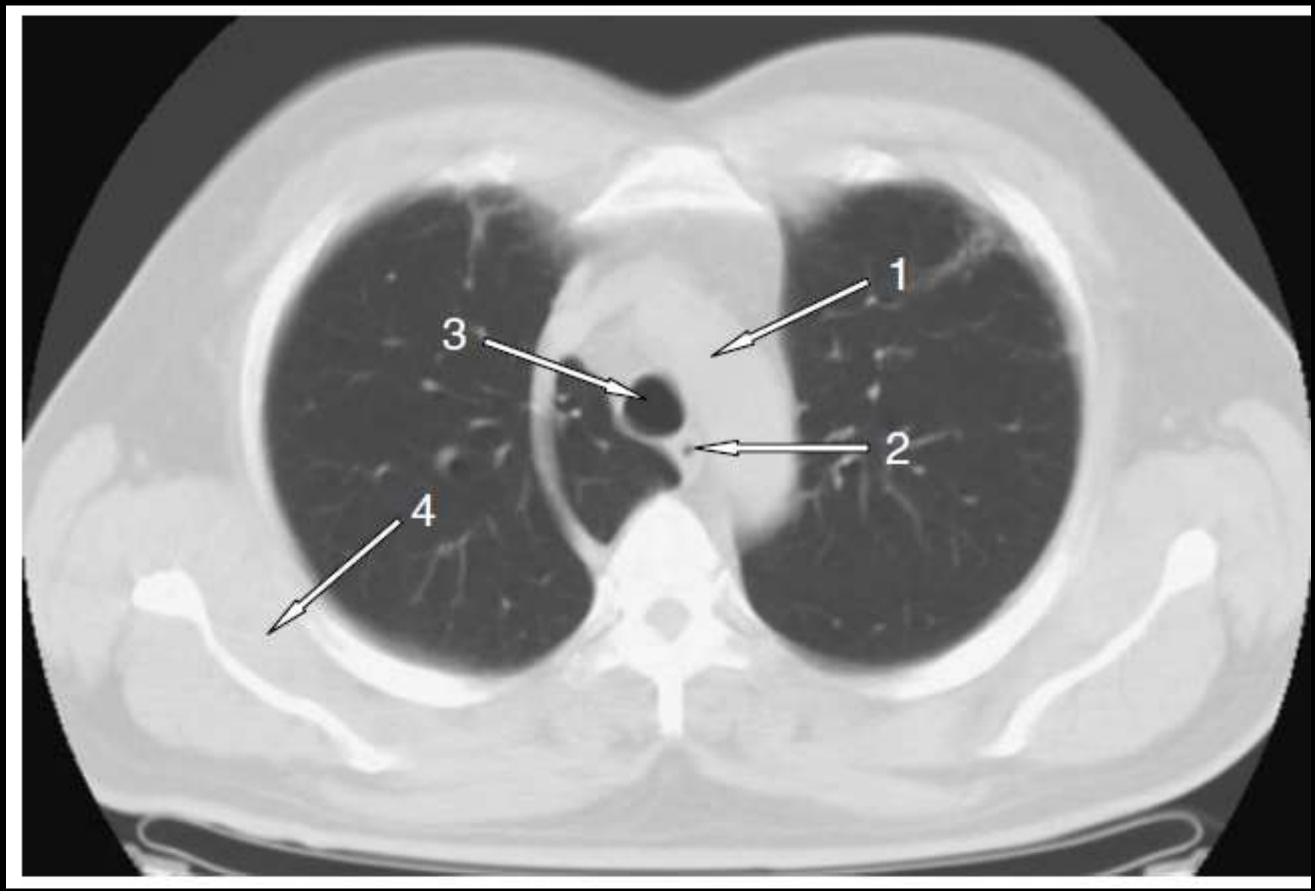
Case 8.15



(e) Which normal variant is present on this image?

8.15 Axial arterial phase CT thorax

(a) Left pectoralis minor muscle.
(b) Superior vena cava.
(c) Left superior intercostal vein.
(d) Right erector spinae muscle.
(e) Aberrant right subclavian artery.



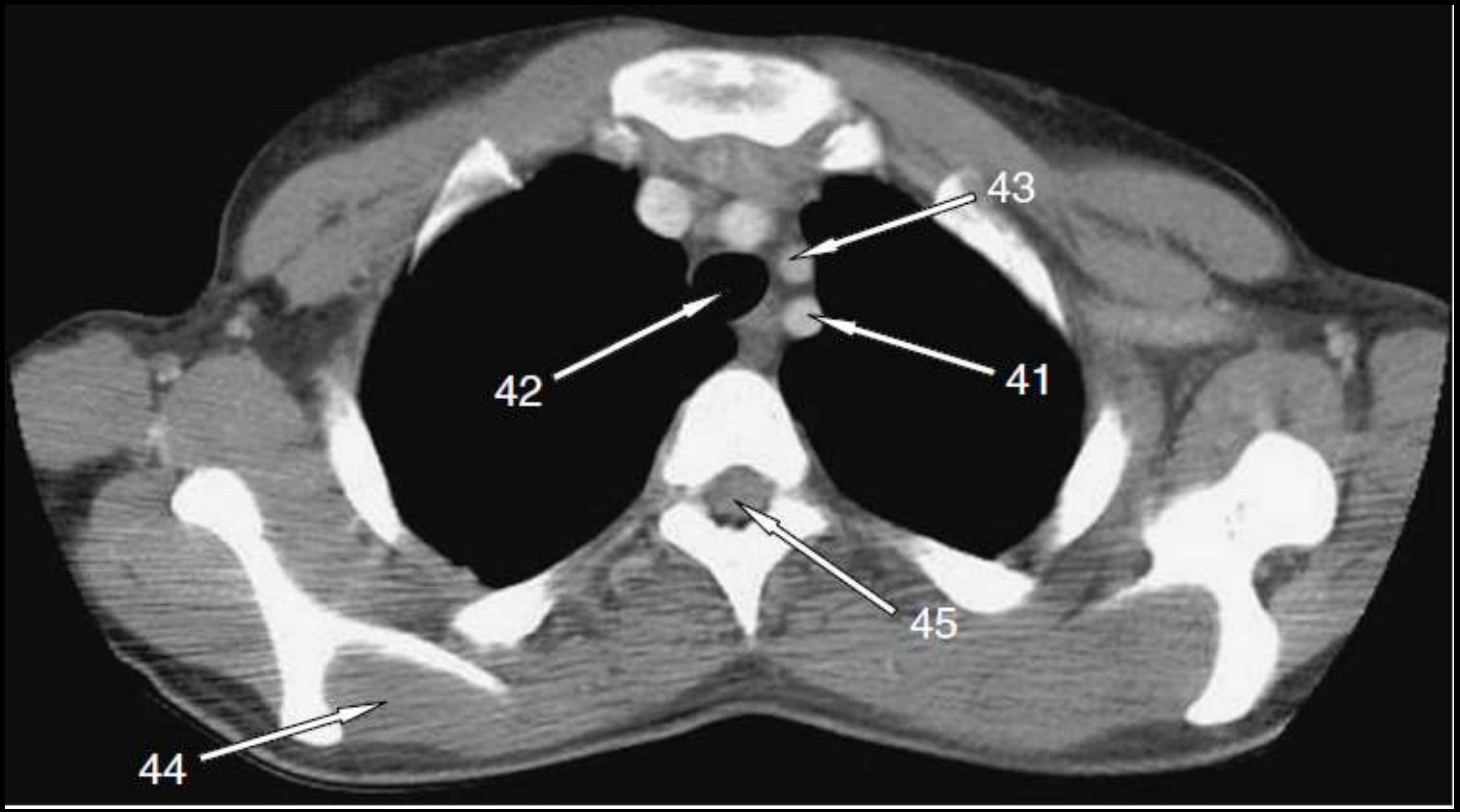
5.	What normal variant is present in this image?

CT Chest

1. Arch of the aorta
2. Oesophagus
3. Trachea
4. Right subscapularis muscle
5. Azygos lobe/fissure

This is the appearance of a collapsed oesophagus which is always found behind a much more easily recognised trachea.

An azygos lobe is a normal anatomical variant found in 1 % of people. It is separated from the rest of the upper lobe by two folds of parietal and two folds of visceral pleura.


43
42
41
45
44

CT Chest

41. Left subclavian artery
42. Trachea
43. Left common carotid artery
44. Right supraspinatus muscle
45. Spinal canal (spinal cord)

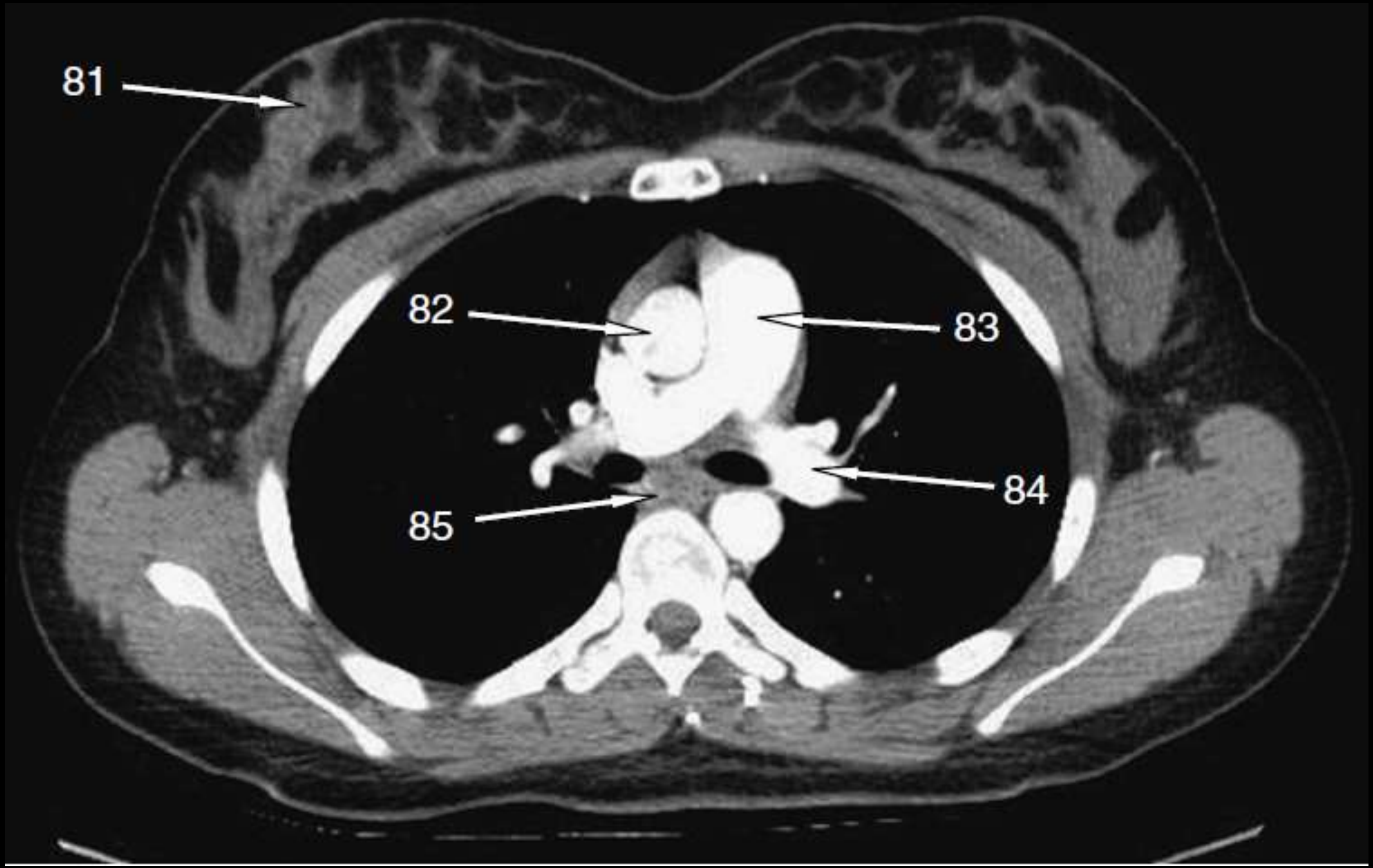
The supraspinatus muscle is superior to the spine of the scapula and therefore medial to it on axial section.


51
52
53
54
55

Cardiac CT

51. Right atrium
52. Aortic root
53. Left main stem coronary artery
54. Right bronchus intermedius
55. Descending thoracic aorta

The left coronary artery arises from the left posterior aortic sinus. It then divides into left anterior descending and circumflex branches. The right coronary artery arises from the anterior aortic sinus, runs in the atrioventricular groove and anastamoses with the circumflex branch of the left coronary artery.


81
82
83
84
85

CT Chest

81. Right breast tissue
82. Ascending aorta
83. Pulmonary trunk
84. Left main pulmonary artery
85. Oesophagus

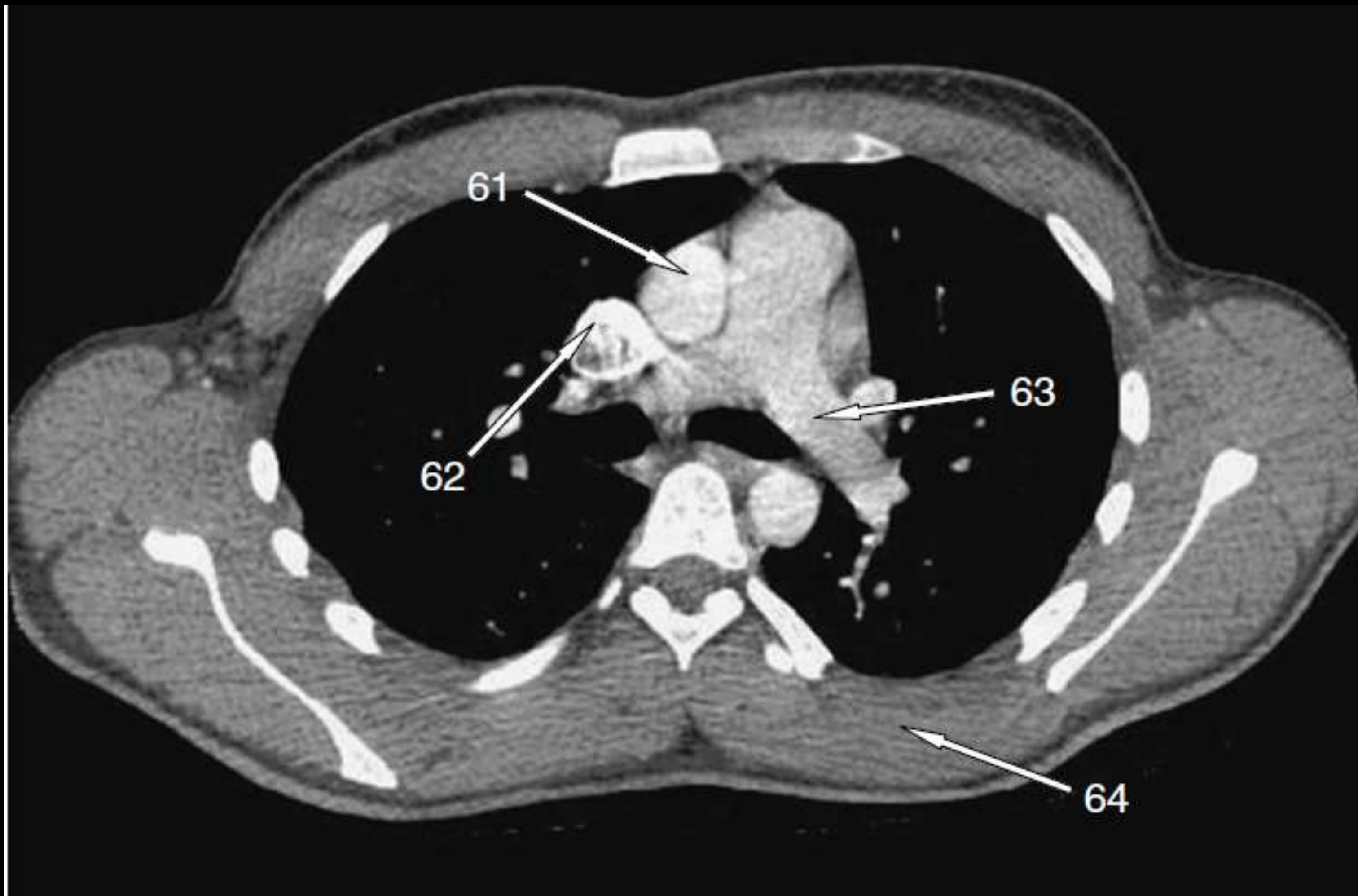
This axial CT chest (CTPA) is taken in the arterial phase. There is an apparent discontinuation between the pulmonary trunk and the left pulmonary artery because of the orientation of the slice.

Remember the oesophagus is always found behind the trachea and here behind the carina.


16
17
18
19
20

CT Chest

16. Right hemidiaphragm (right lobe of liver)
17. Medial segment of right lower lobe
18. Interventricular septum
19. Left ventricular cavity
20. Lingula segment of left upper lobe

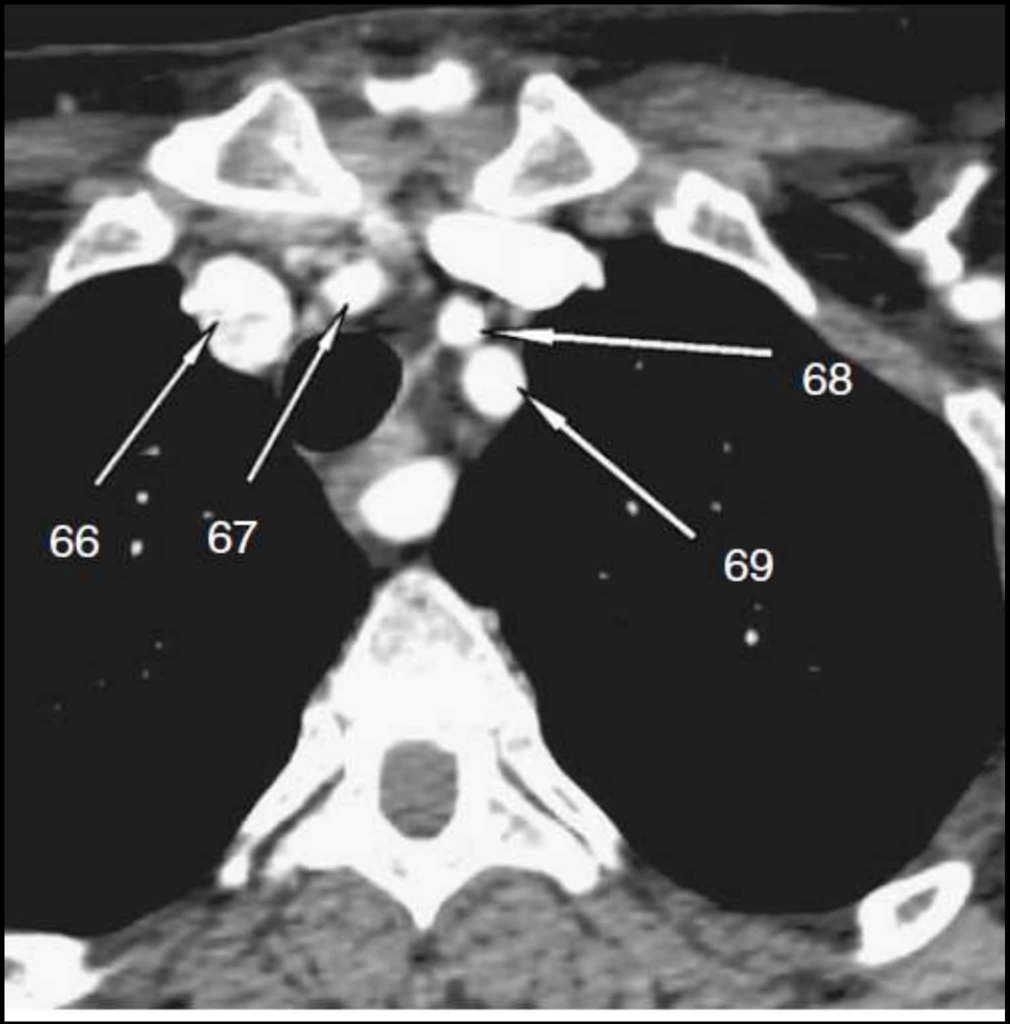


What vertebral level is this axial slice?

CT Chest

61. Ascending thoracic aorta
62. Superior vena cava
63. Left main pulmonary artery
64. Left trapezius
65. T5–T7

Bifurcation of carina occurs at T5–T7 level.

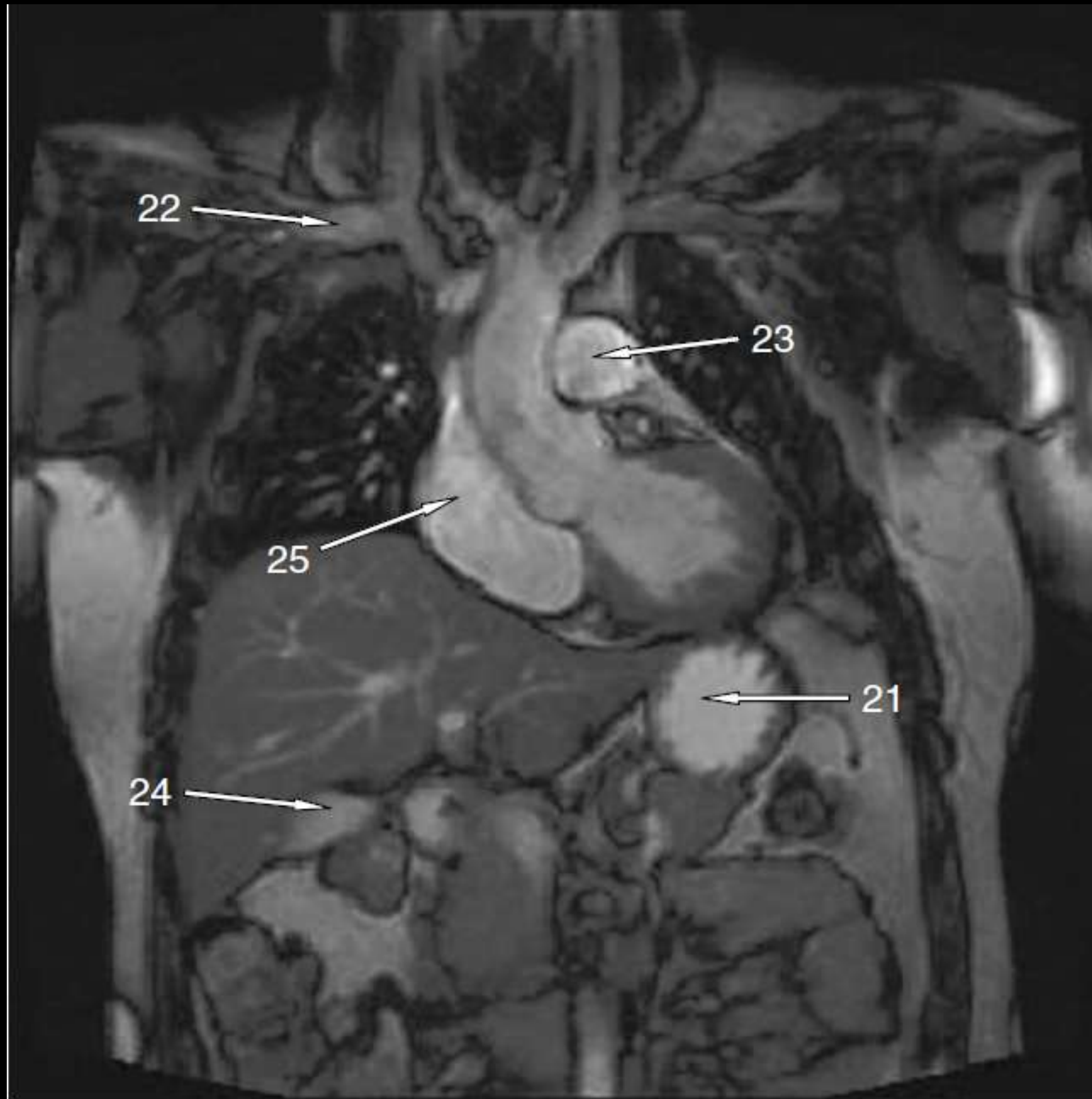


What anatomical variant is present?

CT Chest

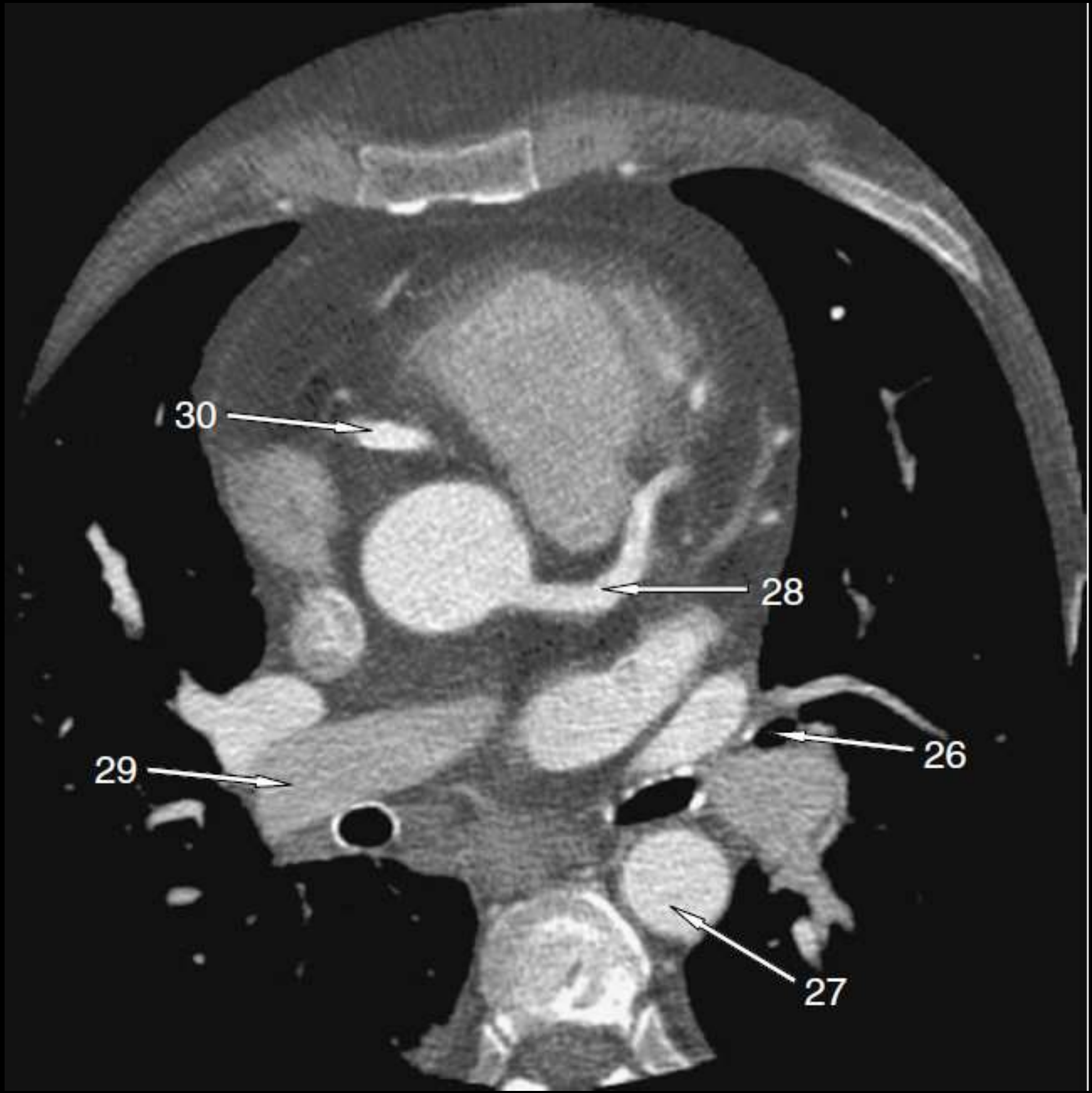
66. Right Brachiocephalic vein
67. Right common carotid artery
68. Left common carotid artery
69. Left subclavian artery
70. Aberrant origin of right subclavian artery

This anatomical variant is also known as arteria lusoria and is the most common intrathoracic abnormality of the aortic arch, with an incidence of 1–2 %.


22
23
25
21
24

MRI Chest

21. Fundus of stomach
22. Right subclavian vein
23. Pulmonary trunk
24. Gallbladder
25. Right atrium

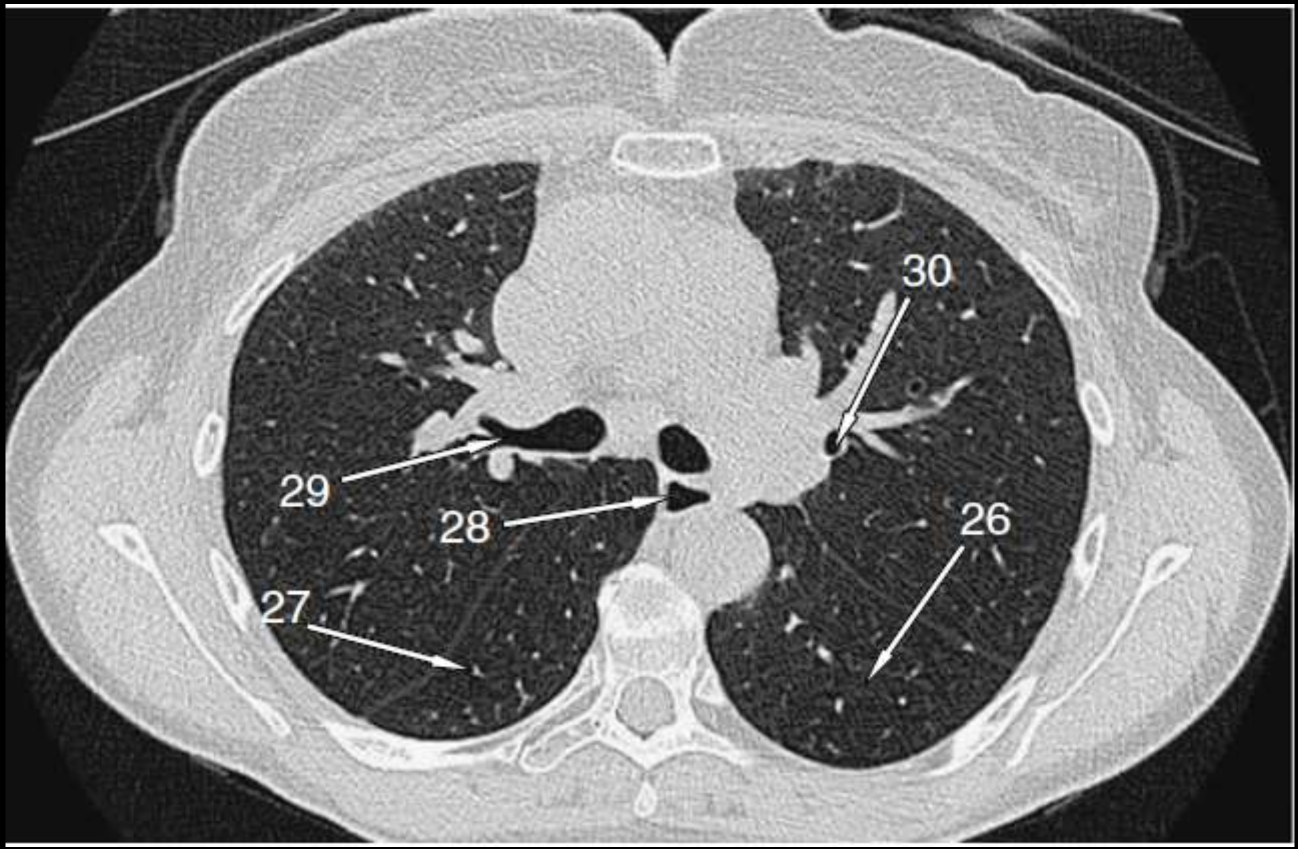


30
28
29
26
27

CT Heart

26. Left upper lobe bronchus
27. Descending thoracic aorta
28. Left coronary artery
29. Right superior pulmonary artery
30. Right coronary artery

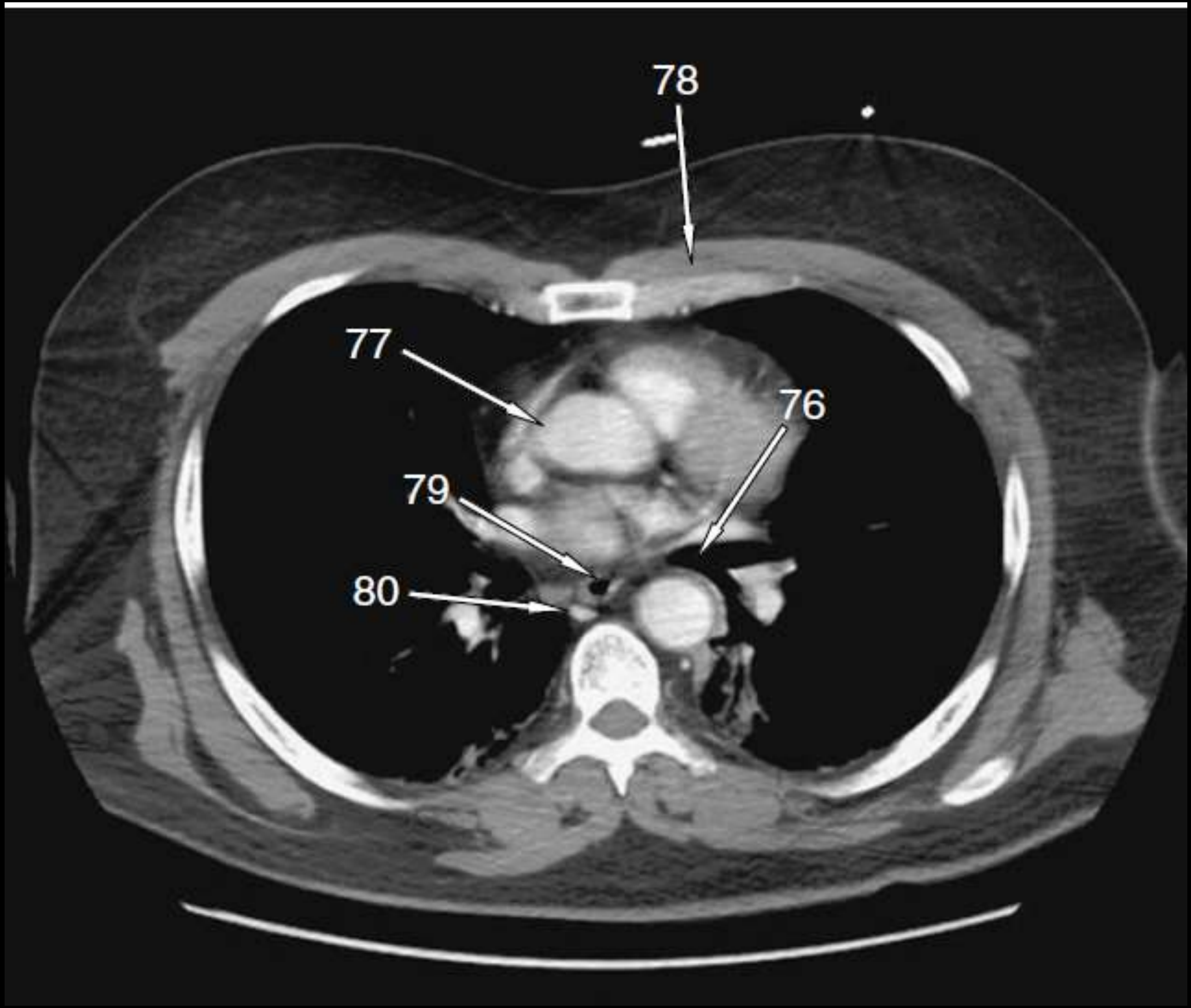
The pericardium can be identified as a thin dense line separated from the myocardium by a thin layer of epicardial fat. Coronary artery dominance is determined by the vessel that supplies the inferior and lateral walls of the left ventricle.



30
29
28
26
27

CT Chest

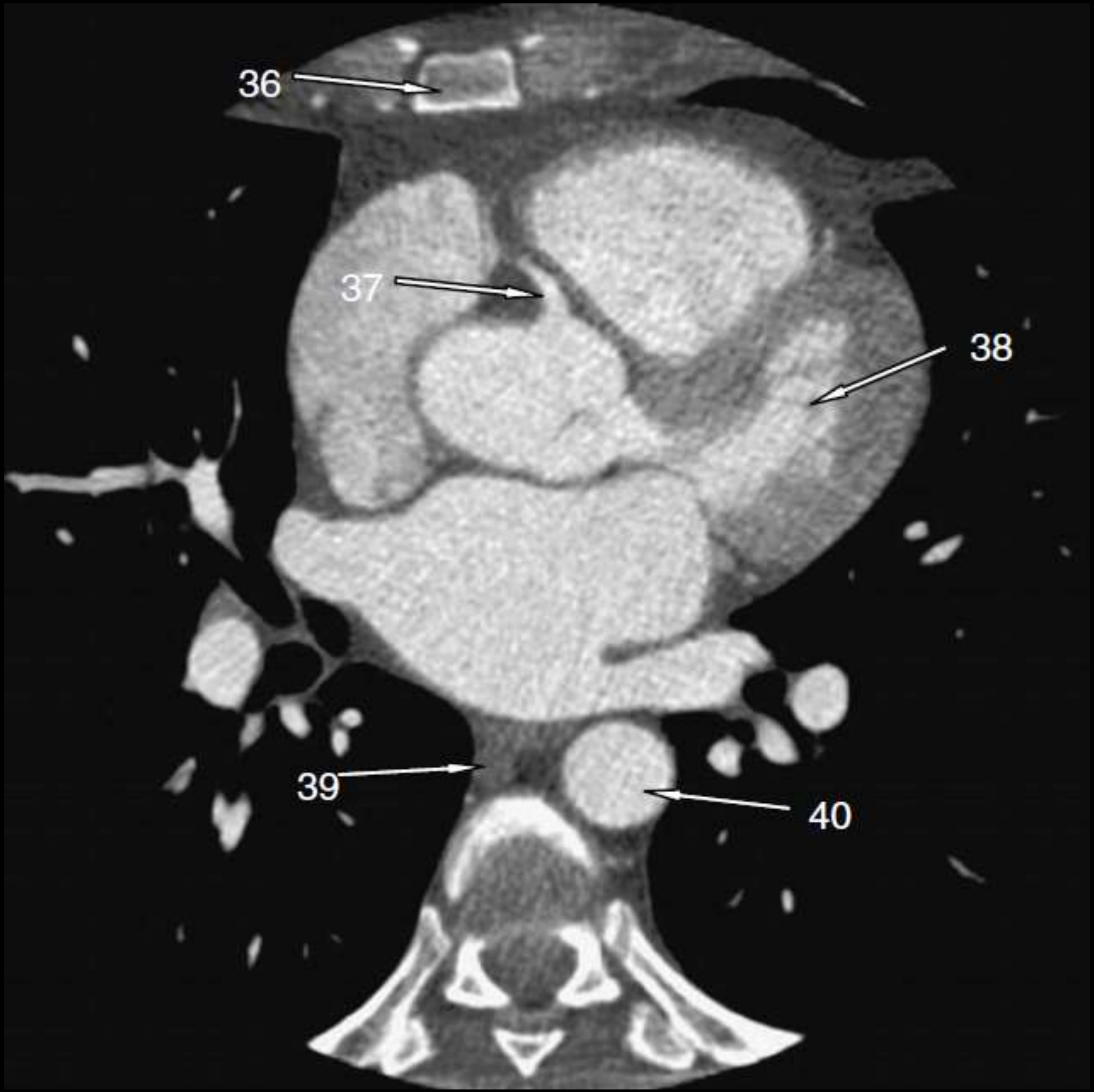
26. Left lower lobe (Superior/apical segment of)
27. Right lower lobe
28. Oesophagus
29. Bronchus intermedius
30. Left superior lobe bronchus


78
77
76
79
80

CT Chest

76. Left main bronchus
77. Ascending thoracic aorta
78. Left pectoralis major muscle
79. Oesophagus
80. Azygos vein

Note the hemiazygos vein behind the descending thoracic aorta.
The azygos vein drains the posterior walls of the thorax and abdomen into the superior vena cava at T4.


36
37
38
39
40

CT Heart

36. Sternum
37. Right coronary artery
38. Left ventricle
39. Azygos vein
40. Descending aorta

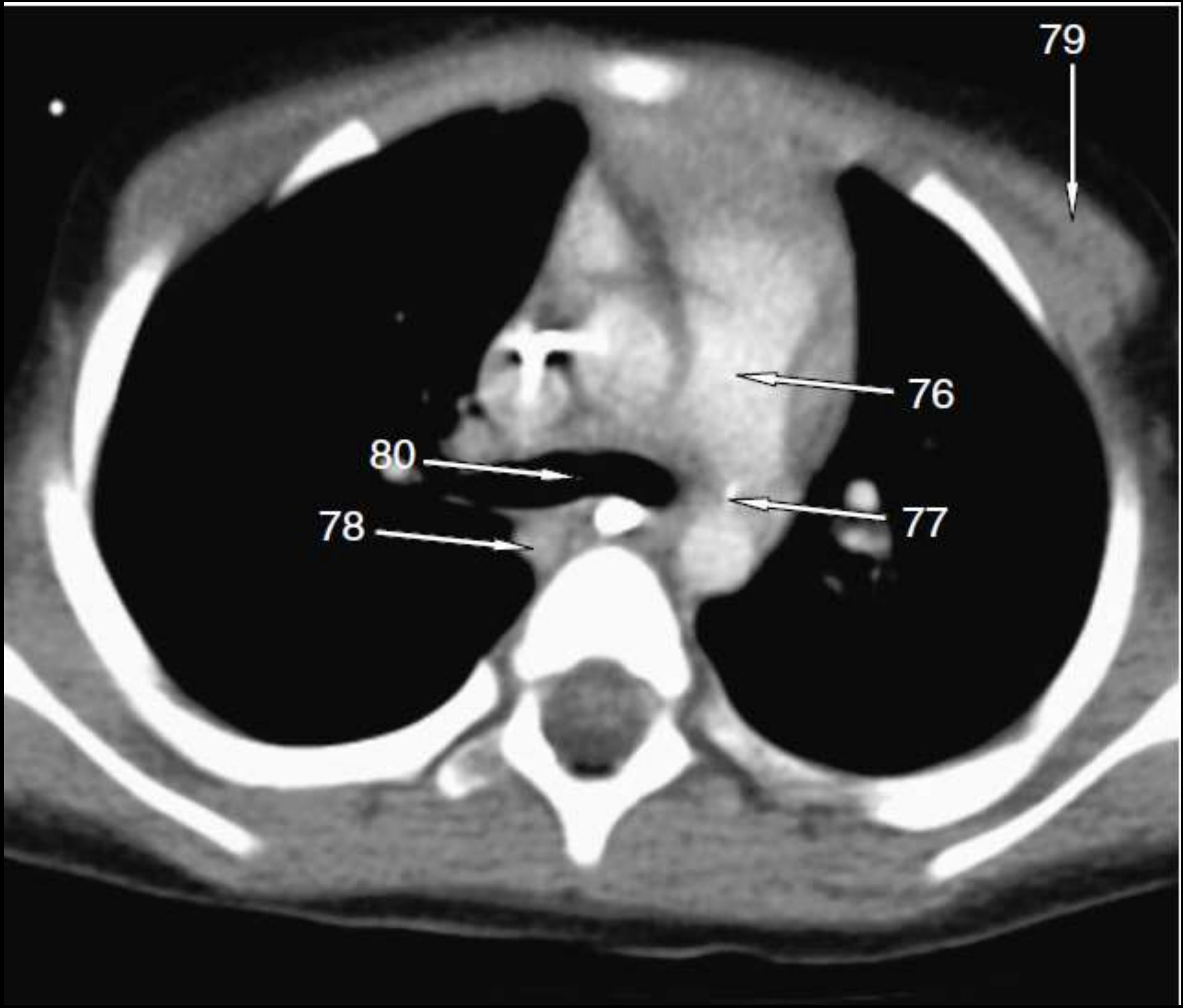
On this view, recognising the anterior and posterior orientation is important in identifying the relevant anatomy. The right heart is anterior and closest to the sternum. The right coronary artery arises from the anterior (right) sinus of Valsalva of the aortic root and passes through the right atrioventricular groove anteriorly in the direction of sternum. In a normal heart, the left ventricular wall is more muscular than the right ventricle.

77
80
76
79
78

MRI Chest

76. Right head of humerus
77. Right main pulmonary artery
78. Stomach
79. Right ventricle
80. Aortic root

On a coronal view, the right ventricle forms the base of the heart. The left ventricular wall is more muscular than the right. On this view, the pulmonary trunk can be seen originating from the right ventricle and dividing into right and left main pulmonary arteries.

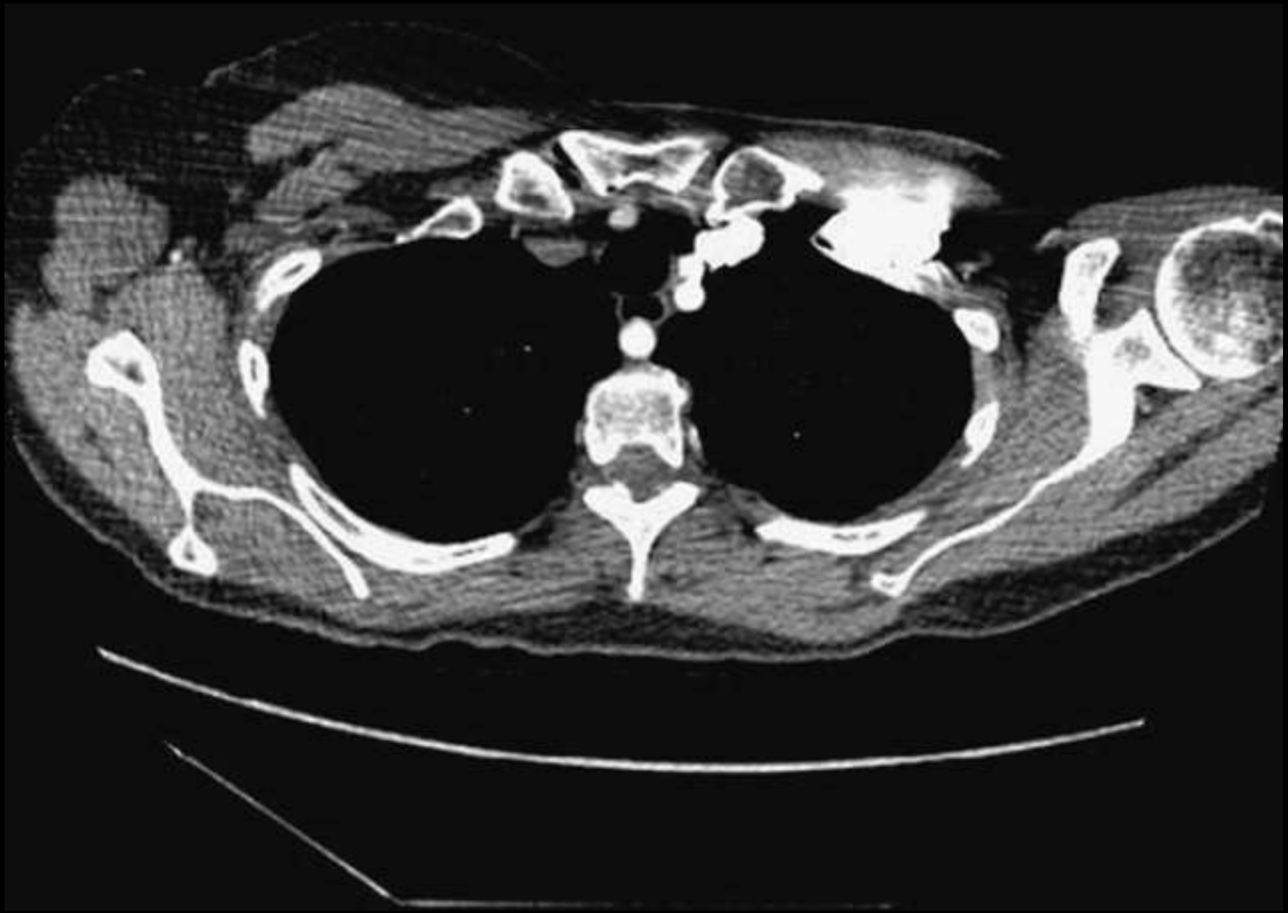


79
76
80
77
78

CT Chest

76. Main pulmonary artery
77. Calcified remnant of the ductus arteriosus
78. Azygous vein
79. Left pectoralis major
80. Carina

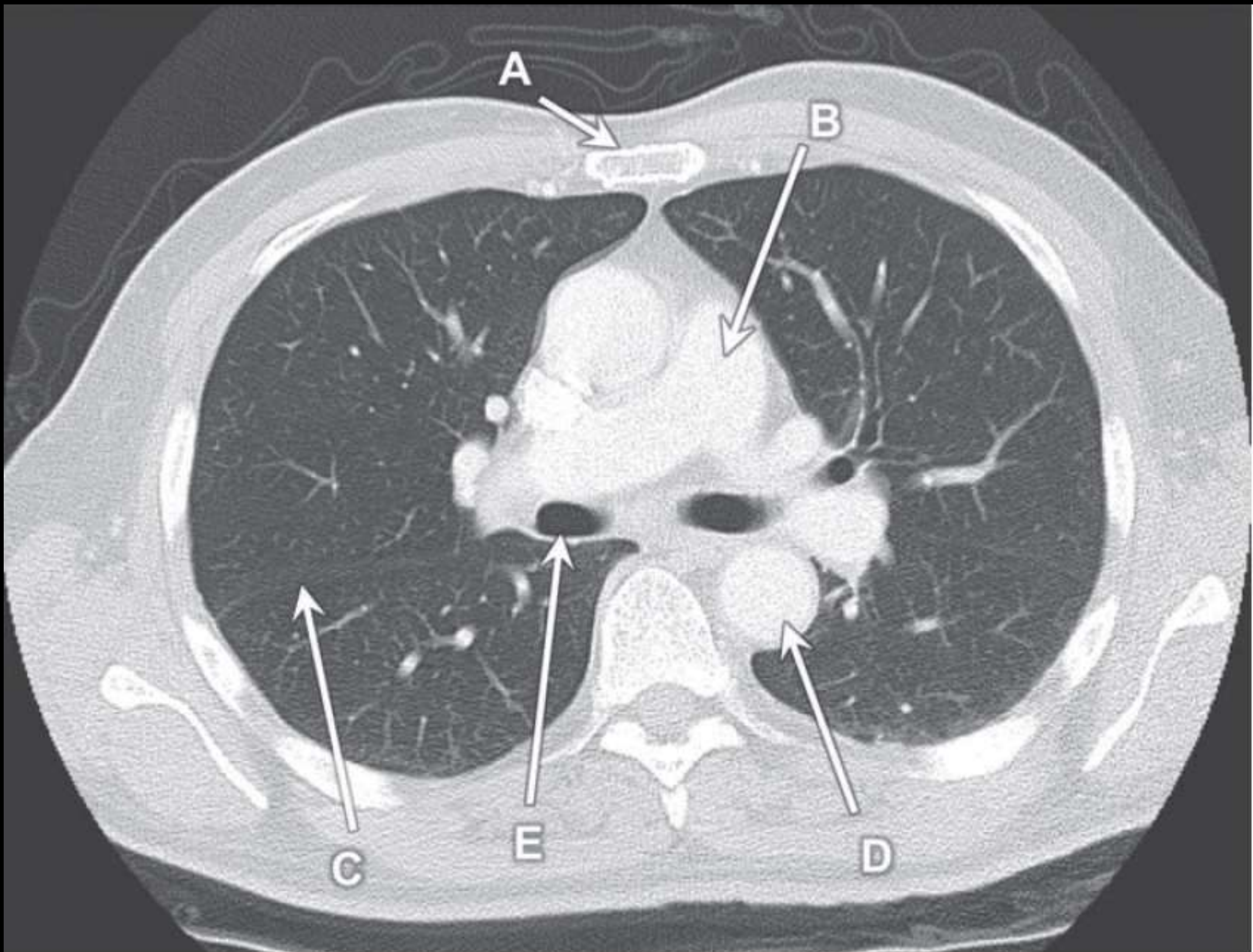
A fleck of calcification is often seen between the pulmonary artery and descending thoracic aorta at the site of the normally obliterated ductus arteriosus. It is less dense than a surgical ligation clip, which would also be at this site.



Name the normal variant

CT Chest

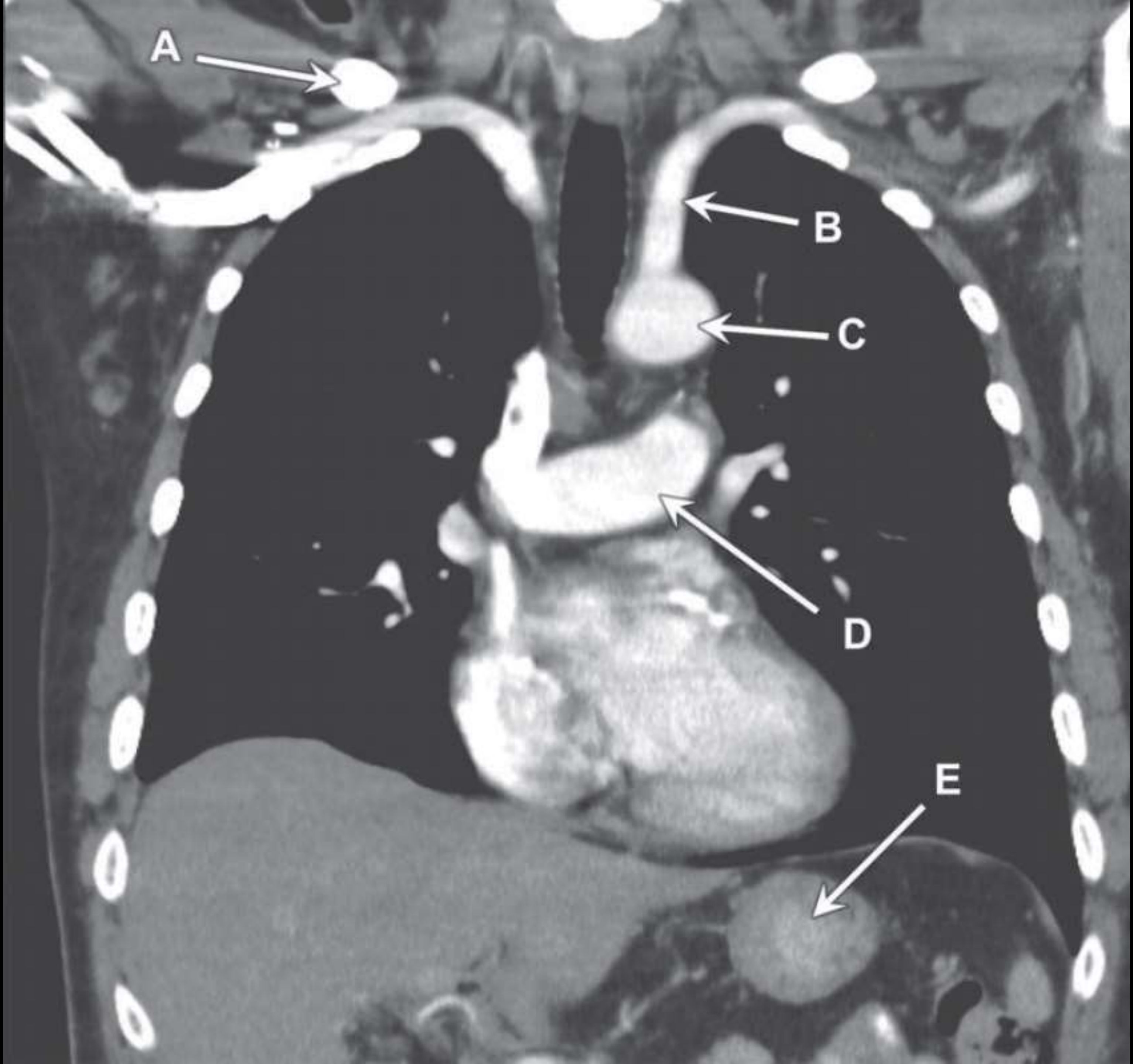
Aberrant right subclavian artery
This variant is seen in 0.5 %. The right subclavian artery arises distal to the left subclavian artery and passes to the right, posterior to the oesophagus. In the example given, an artery can be seen behind the oesophagus, where no vessel is usually seen.


A
B
C
E
D

Case 9

CT chest. Axial section.

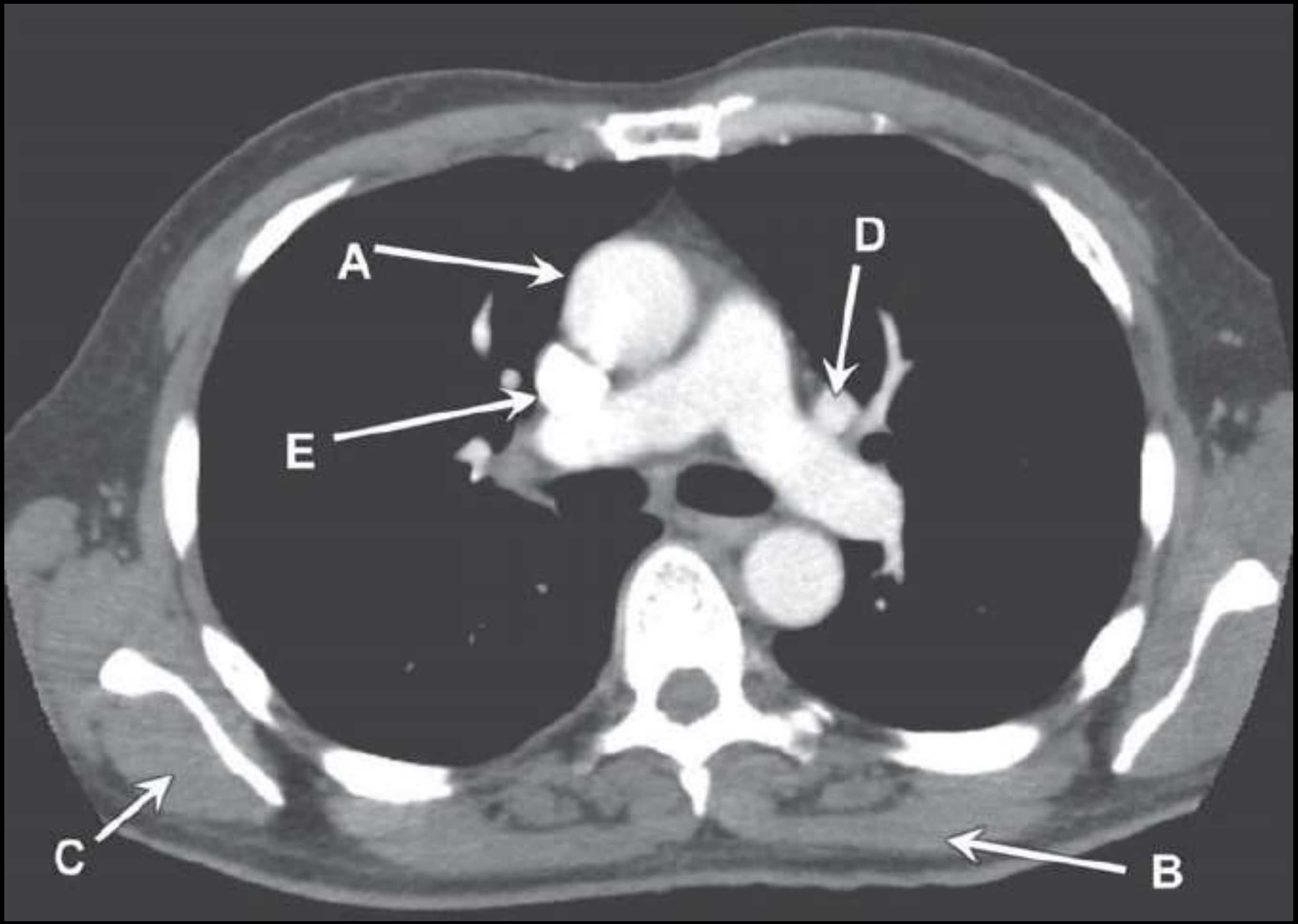
1. Sternum
2. Pulmonary trunk
3. Right oblique fissure
4. Descending thoracic aorta
5. Right main bronchus


A
B
C
D
E

Case 20

CT-pulmonary arteriogram (CTPA). Coronal section.

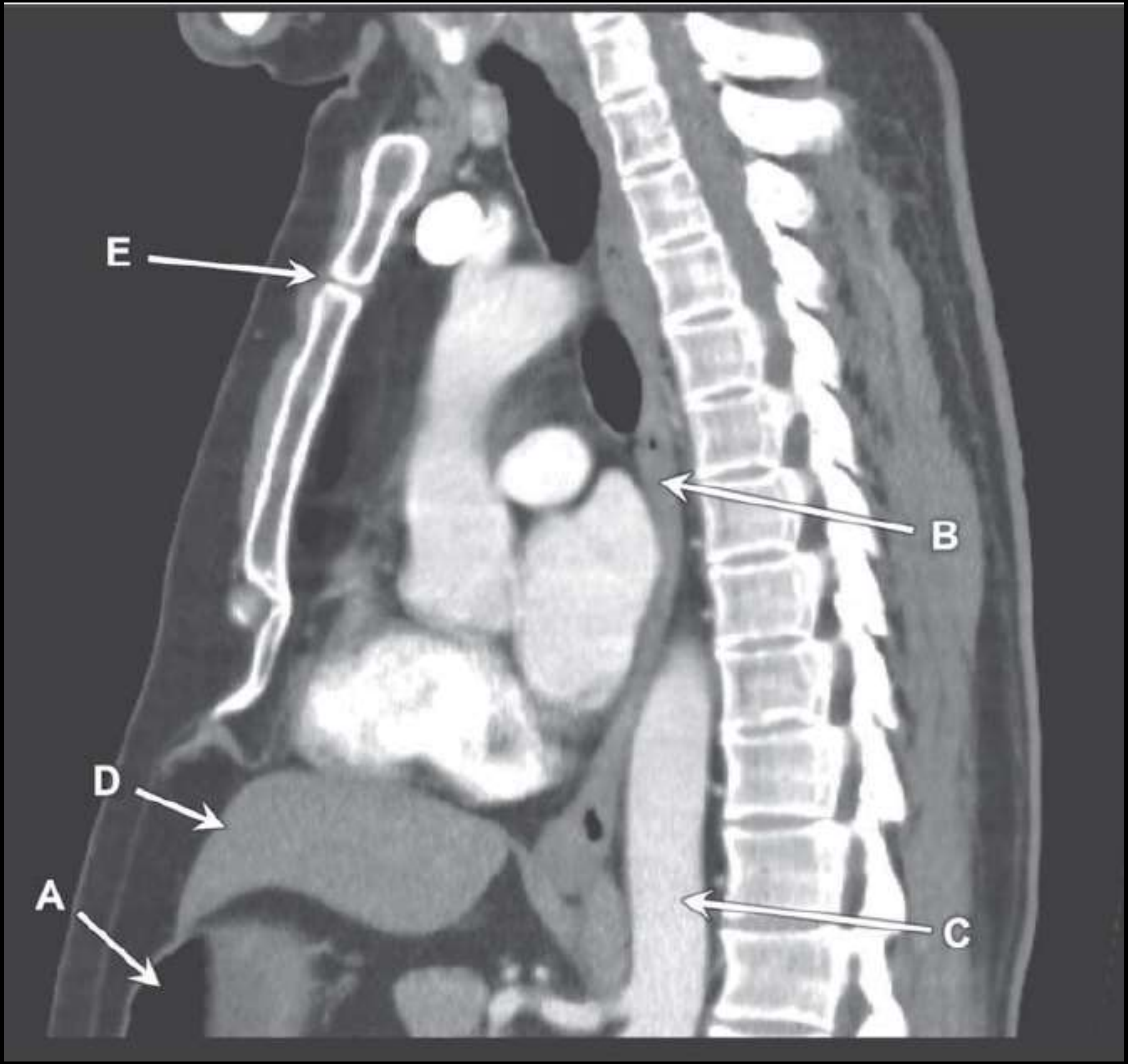
1. Right clavicle
2. Left subclavian artery
3. Aortic arch
4. Pulmonary trunk
5. Stomach


A
D
E
C
B

Case 3

CT thorax. Axial section.

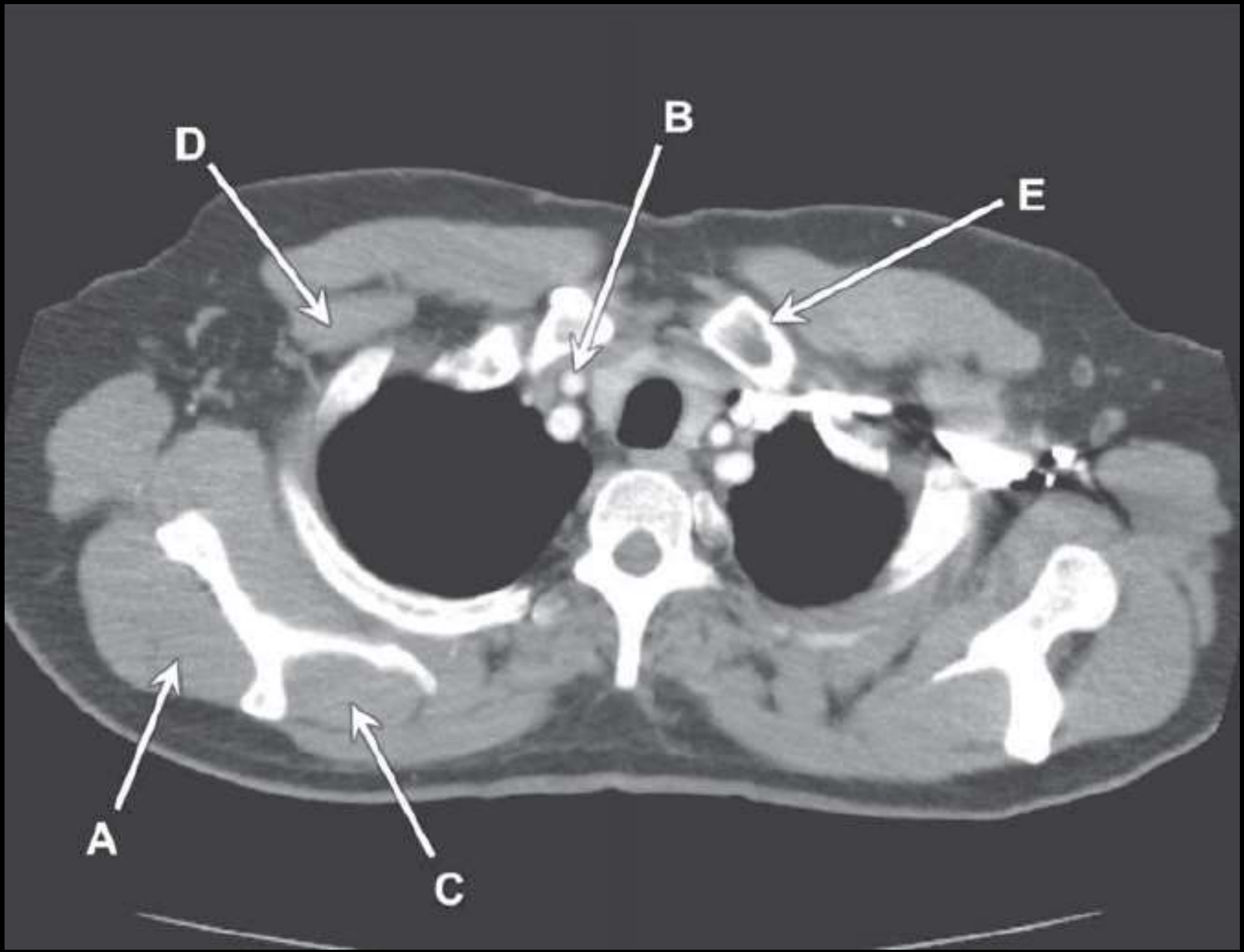
1. Ascending aorta/ aortic root
2. Left trapezius muscle
3. Right infraspinatus muscle
4. Left superior pulmonary vein
5. Superior vena cava


E
B
D
A
C

Case 10

CT thorax. Sagittal section.

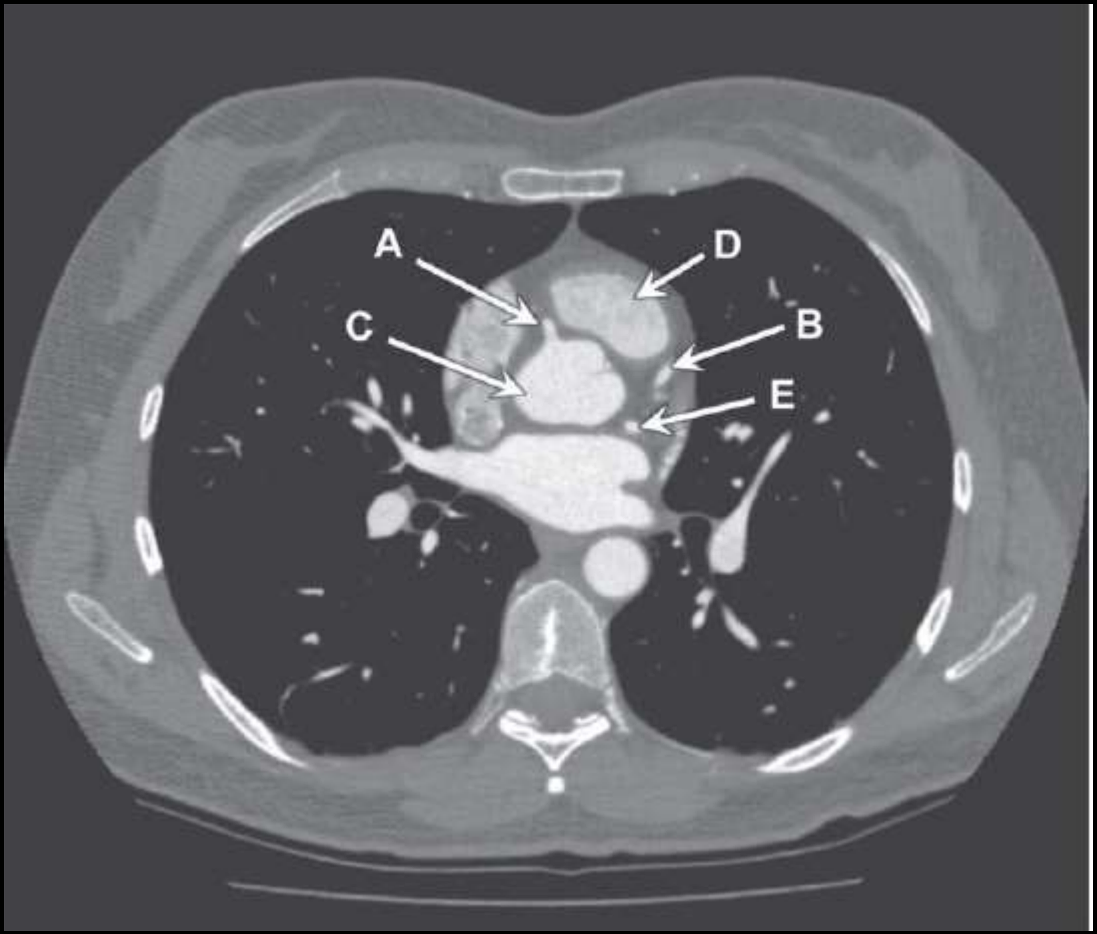
1. Stomach
2. Oesophagus
3. Descending aorta
4. Left lobe of liver
5. Manubriosternal joint (sternal angle)


D
B
E
A
C

Case 18

CT chest. Axial section.

1. Right infraspinatus muscle
2. Right common carotid artery
3. Right supraspinatus muscle
4. Right pectoralis minor muscle
5. Head of left clavicle

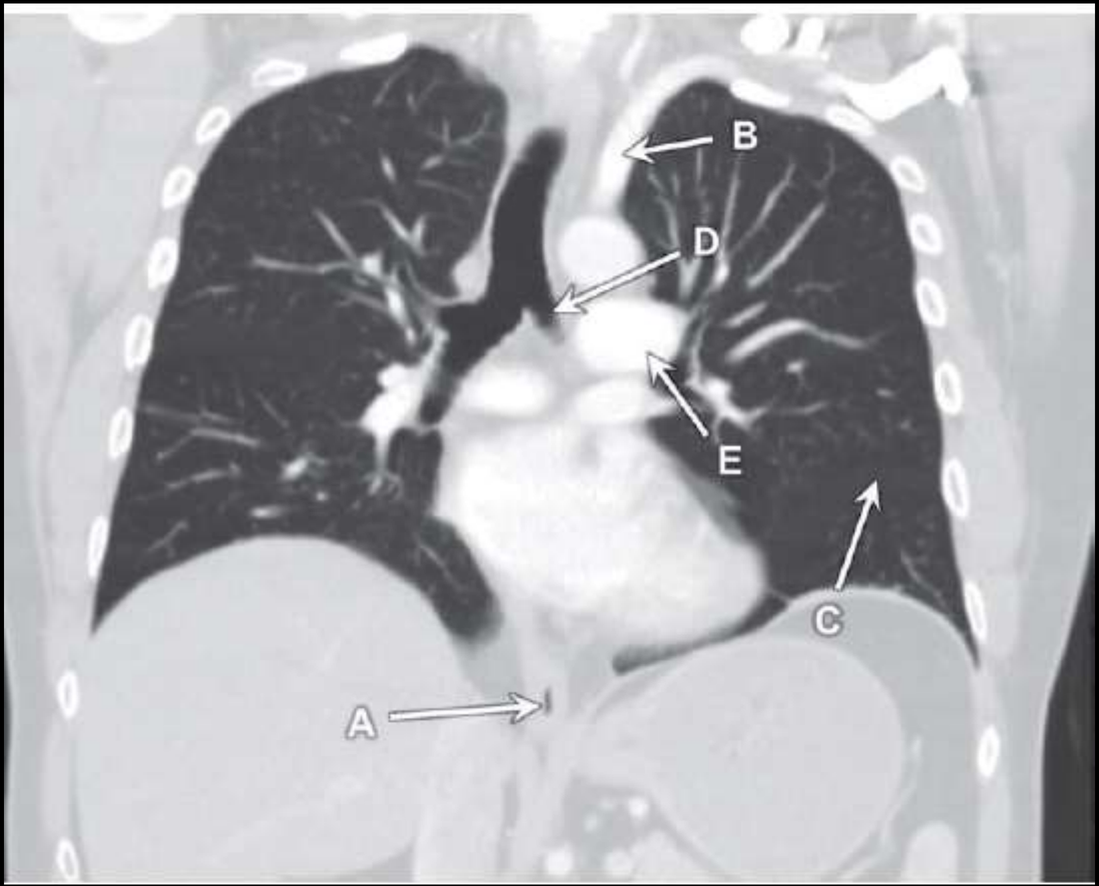


A
D
C
B
E

Case 7

CT coronary angiogram. Axial section.

1. Right main coronary artery
2. Left anterior descending artery
3. Aortic root
4. Right ventricular outflow tract
5. Circumflex artery

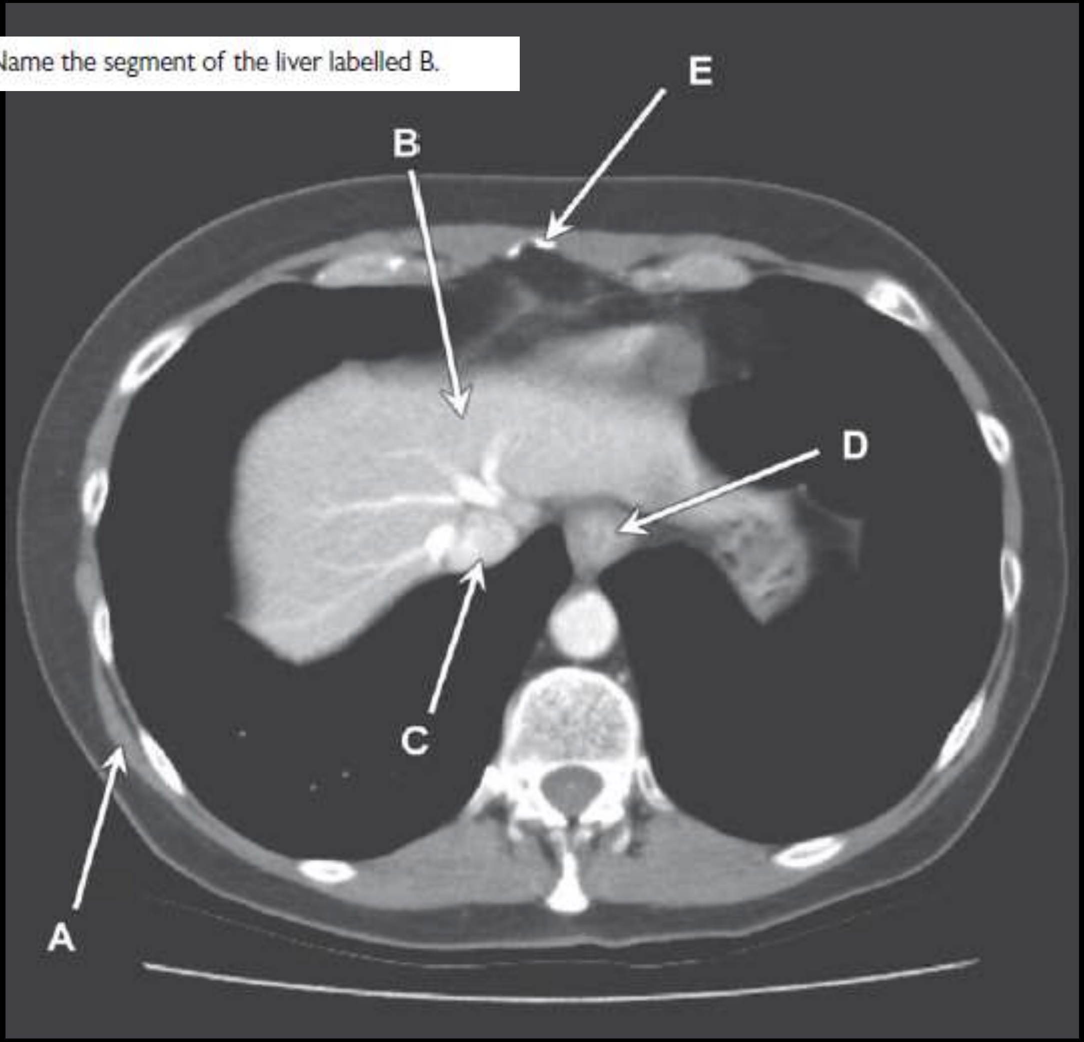

B
D
E
C
A

Case 2

CT Chest, coronal section.

1. Oesophagus
2. Left subclavian artery
3. Left oblique fissure
4. Left main bronchus
5. Left main pulmonary artery

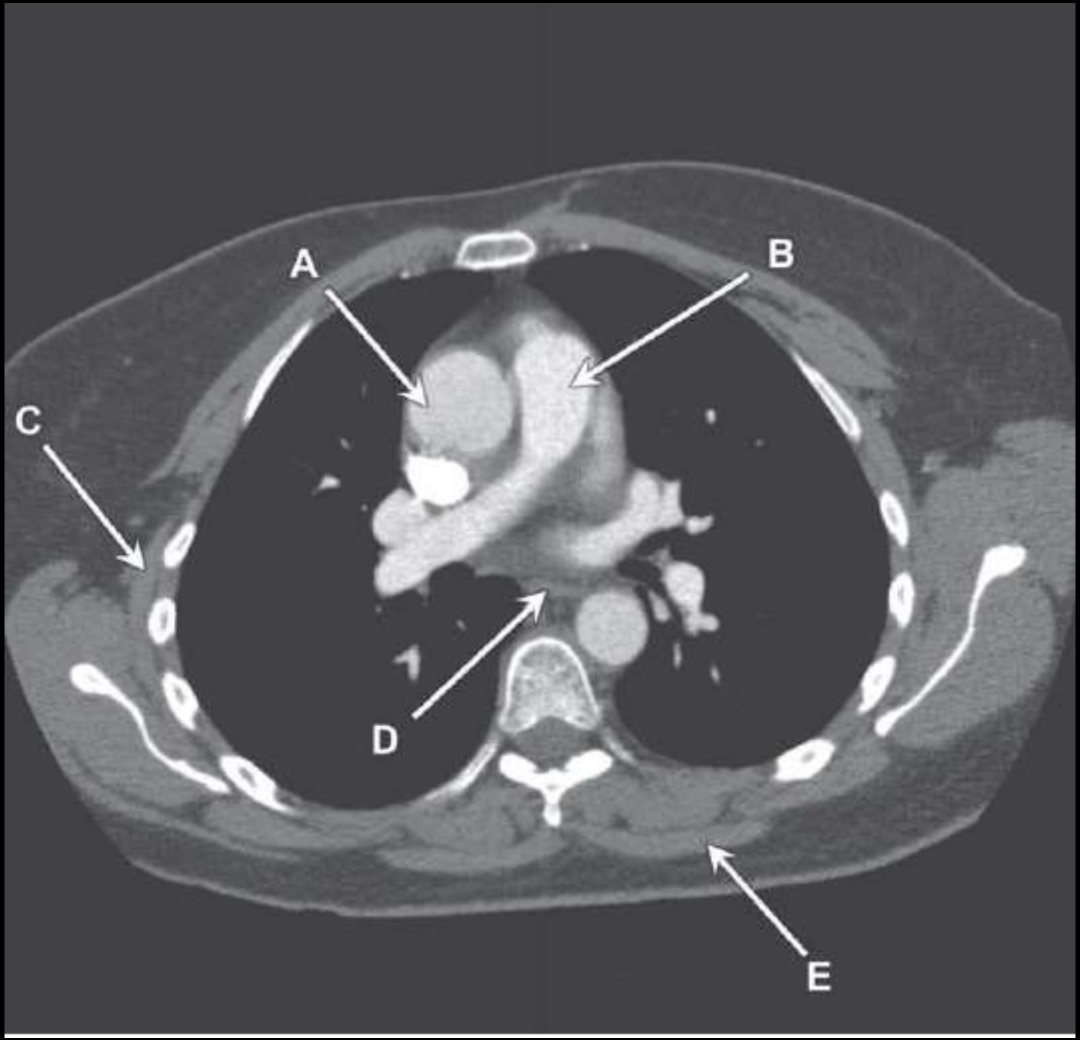
2. Name the segment of the liver labelled B.



Case 4

CT chest/ abdomen. Axial section.

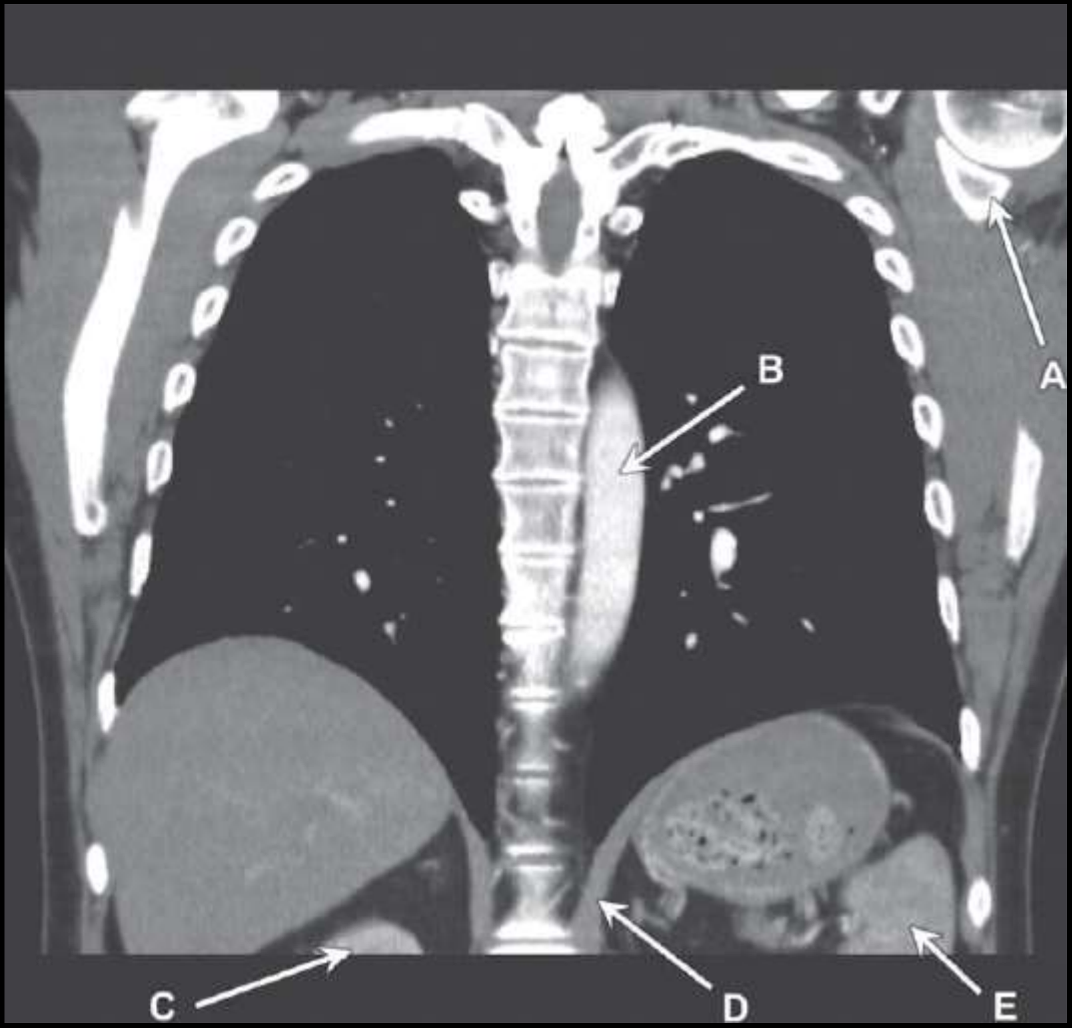
1. Right latissimus dorsi muscle
2. Segment 4(A)
3. Inferior vena cava
4. Oesophagus
5. Xiphoid process of sternum (xiphisternum)


A
B
C
D
E

Case 8

CT chest. Axial section.

1. Ascending aorta
2. Pulmonary trunk
3. Right serratus anterior muscle
4. Oesophagus
5. Left trapezius muscle

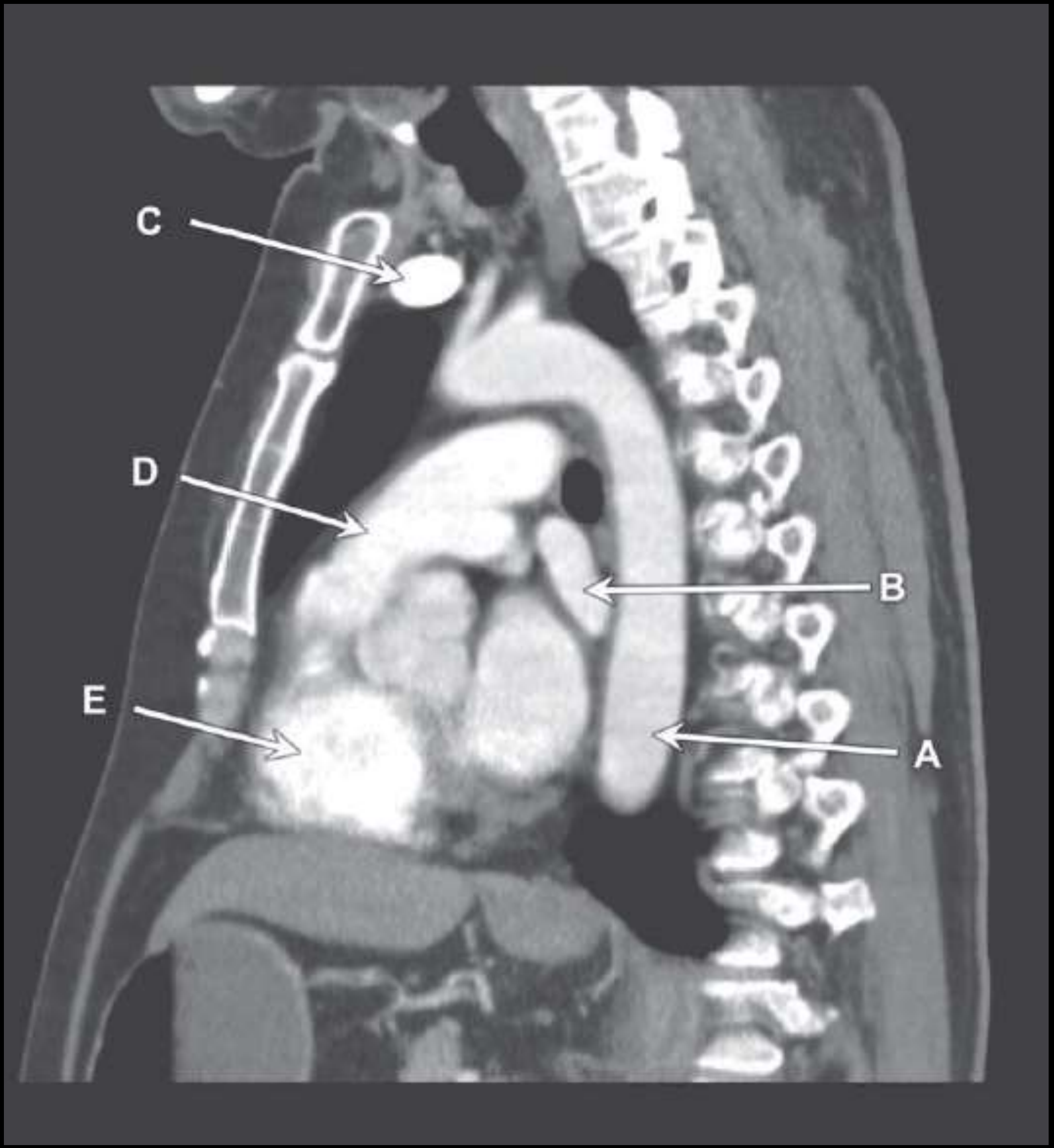

A
B
C
D
E

Case 11

CT chest. Coronal section.

1. Left glenoid
2. Descending thoracic aorta
3. Right kidney (upper pole)
4. Left diaphragmatic crus
5. Spleen

This might look tricky at first but these should all be familiar structures, just seen in an unfamiliar way.



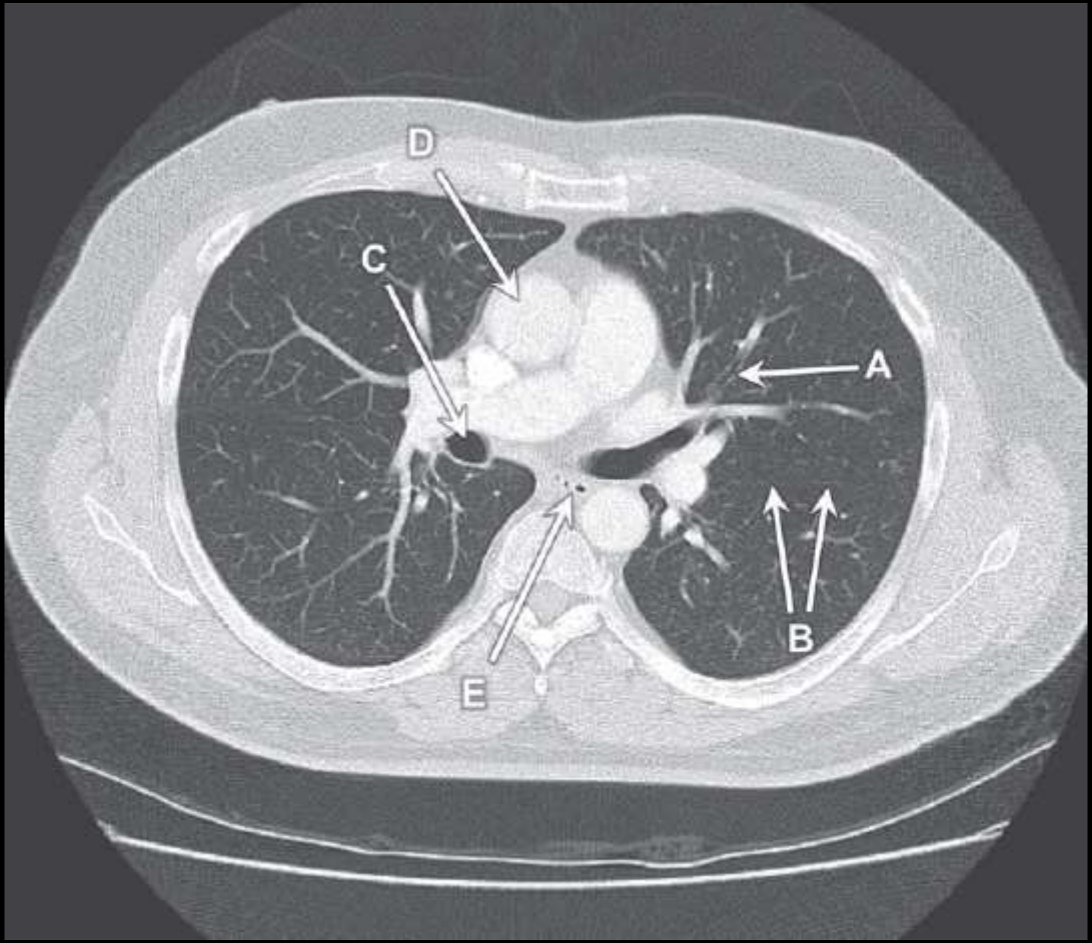
C
D
B
E
A

Case 15

CT chest. Parasagittal section.

1. Descending thoracic aorta
2. Left pulmonary vein
3. Left brachiocephalic vein
4. Pulmonary trunk
5. Right ventricle

B is difficult. It is straightforward to work out if not immediately obvious: a structure travelling horizontally behind the heart; we are left of the midline as we can see the descending aorta; it is not connected to the pulmonary arterial tree.... it must be the left pulmonary vein!

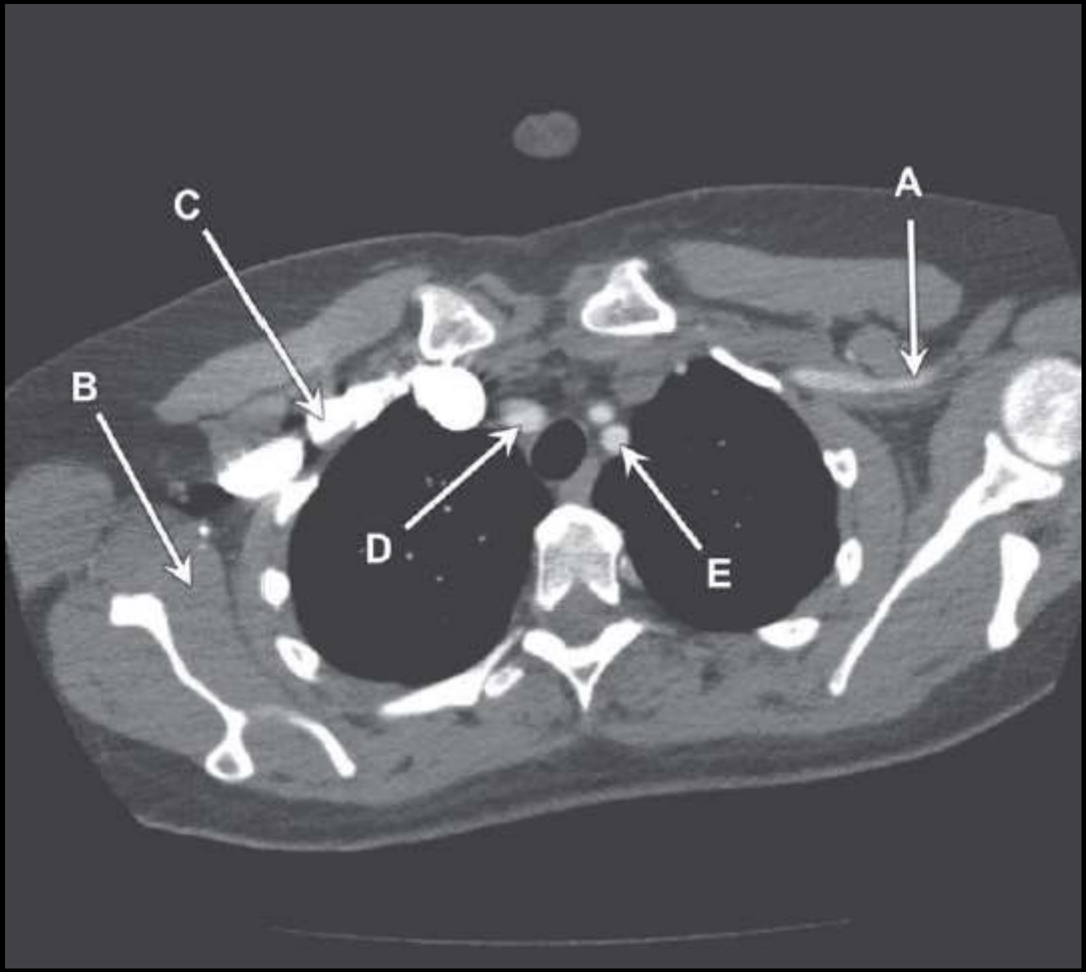

D
C
A
B
E

Case 17

CT chest (lung windows). Axial section.

1. Lingular bronchus
2. Left oblique fissure
3. Right main bronchus
4. Ascending aorta
5. Oesophagus

Note that 'A' is hollow so is an airway, not a vessel.


A
B
C
D
E

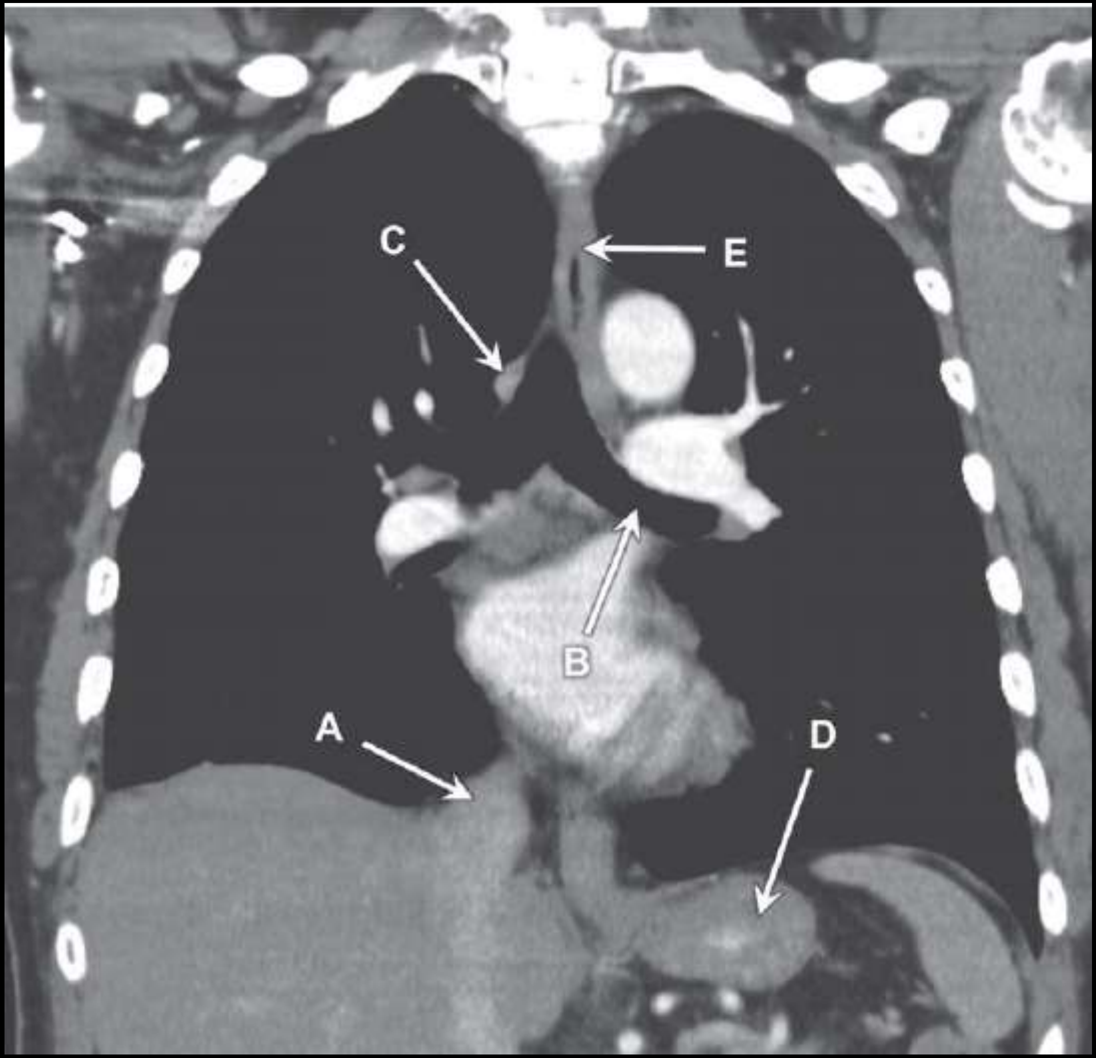
Case 20

CT chest. Axial section.

1. Left axillary artery
2. Right subscapularis muscle
3. Right subclavian vein
4. Brachiocephalic trunk
5. Left subclavian artery

The right subclavian vein is filled with dense contrast giving the streak artefact seen.

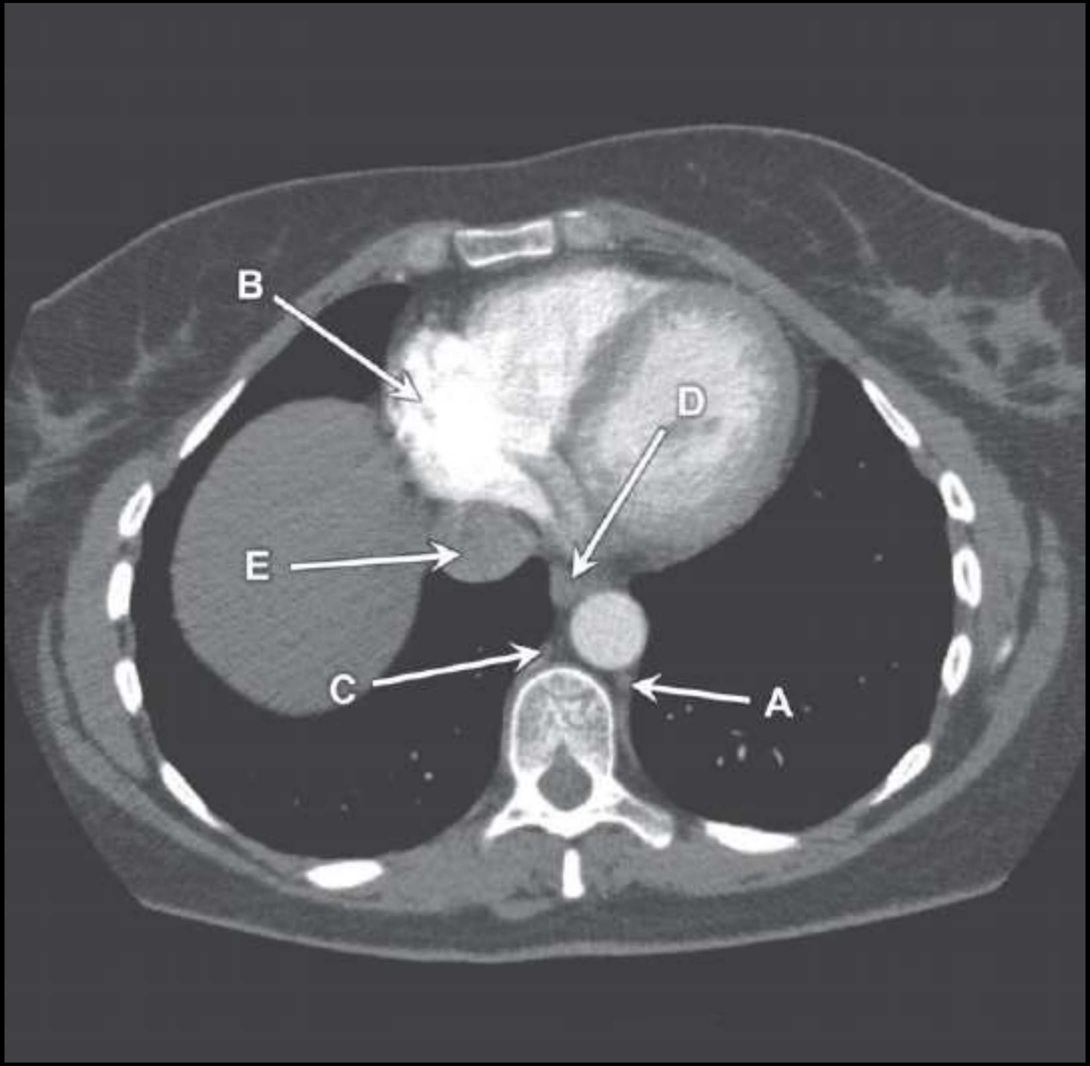
Of the two vessels in the left axilla, one would expect there to be contrast in the artery, not the vein, at this phase of the scan.


C
E
B
A
D

Case 14

CT chest. Coronal section.

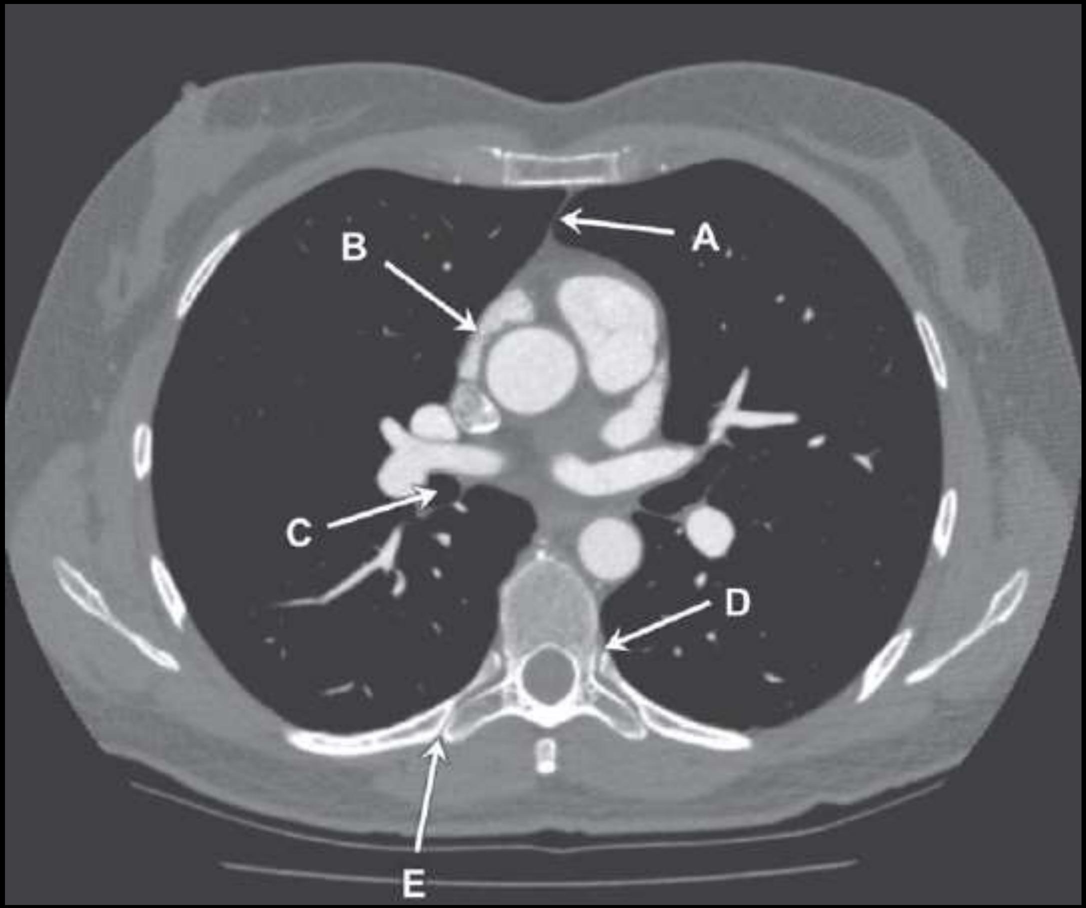
1. Inferior vena cava
2. Left main bronchus
3. Azygos vein
4. Stomach
5. Oesophagus


B
D
E
C
A

Case 19

CT chest. Axial section.

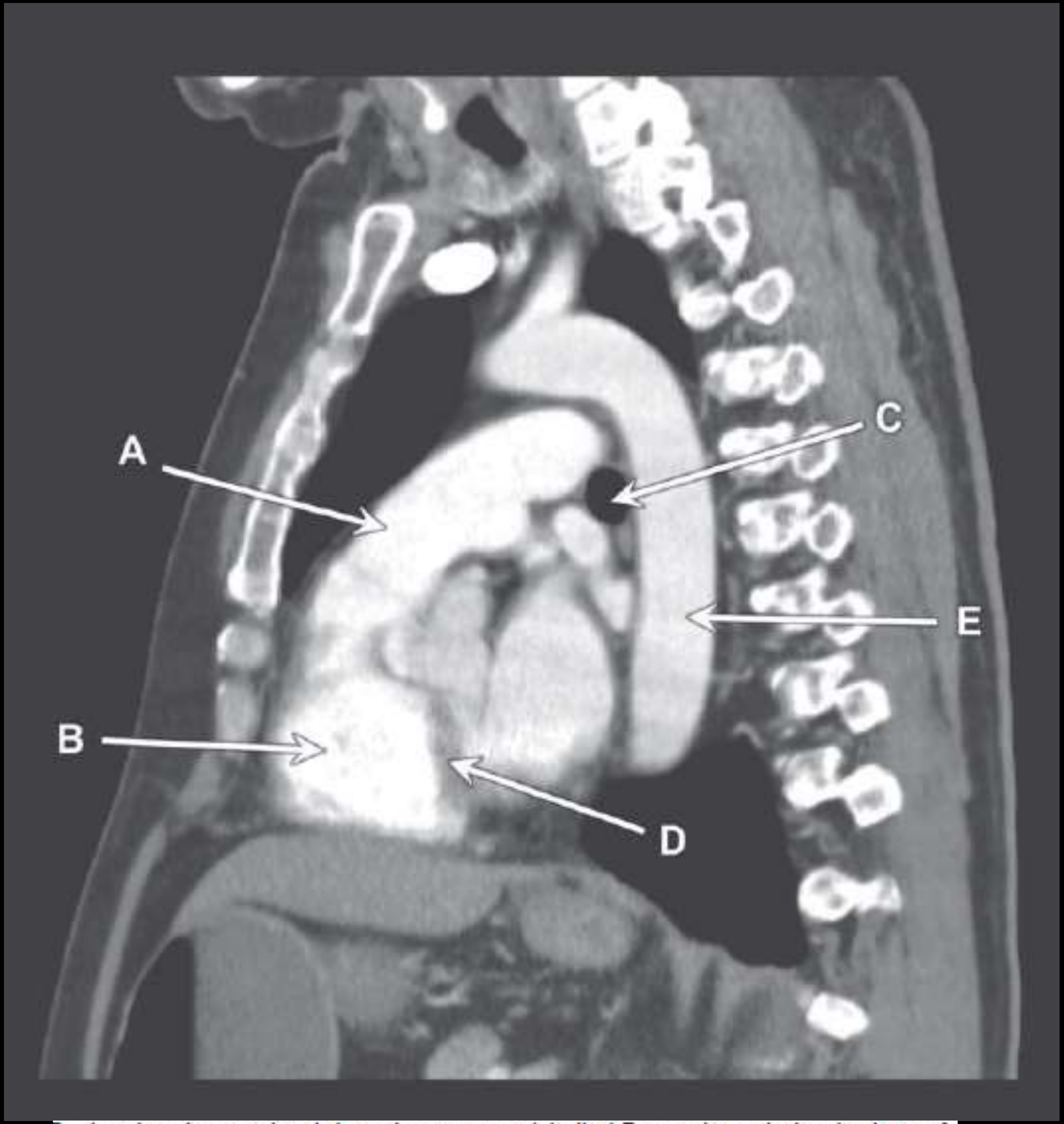
1. Hemiazygos vein
2. Right atrium
3. Azygos vein
4. Oesophagus
5. Inferior vena cava


A
B
C
D
E

Case 8

CT thorax with intravenous contrast. Axial section.

1. Anterior junction line
2. Right atrium
3. Bronchus intermedius
4. Left costovertebral joint
5. Right costotransverse joint

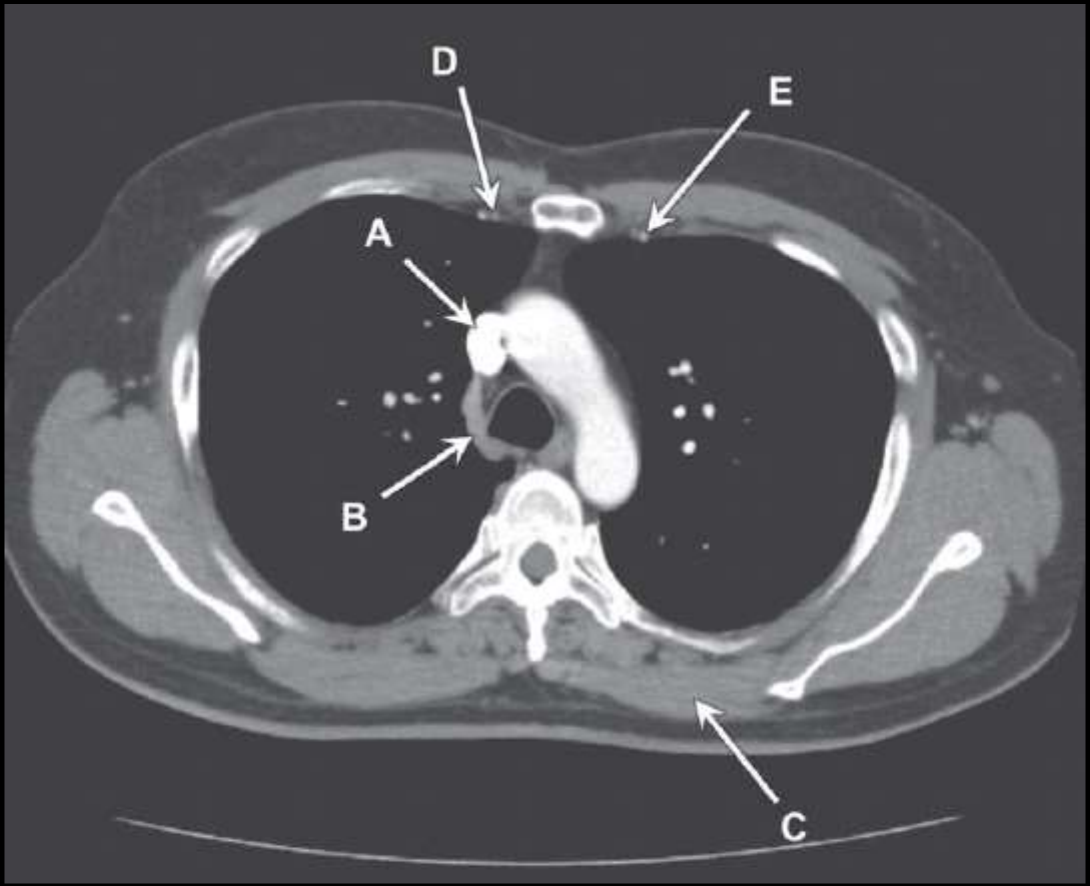


5. At what thoracic level does the structure labelled E pass through the diaphragm?

Case 15

CT thorax with intravenous contrast. Sagittal reconstruction.

1. Pulmonary trunk
2. Right ventricle
3. Left main bronchus
4. Interventricular septum
5. T12

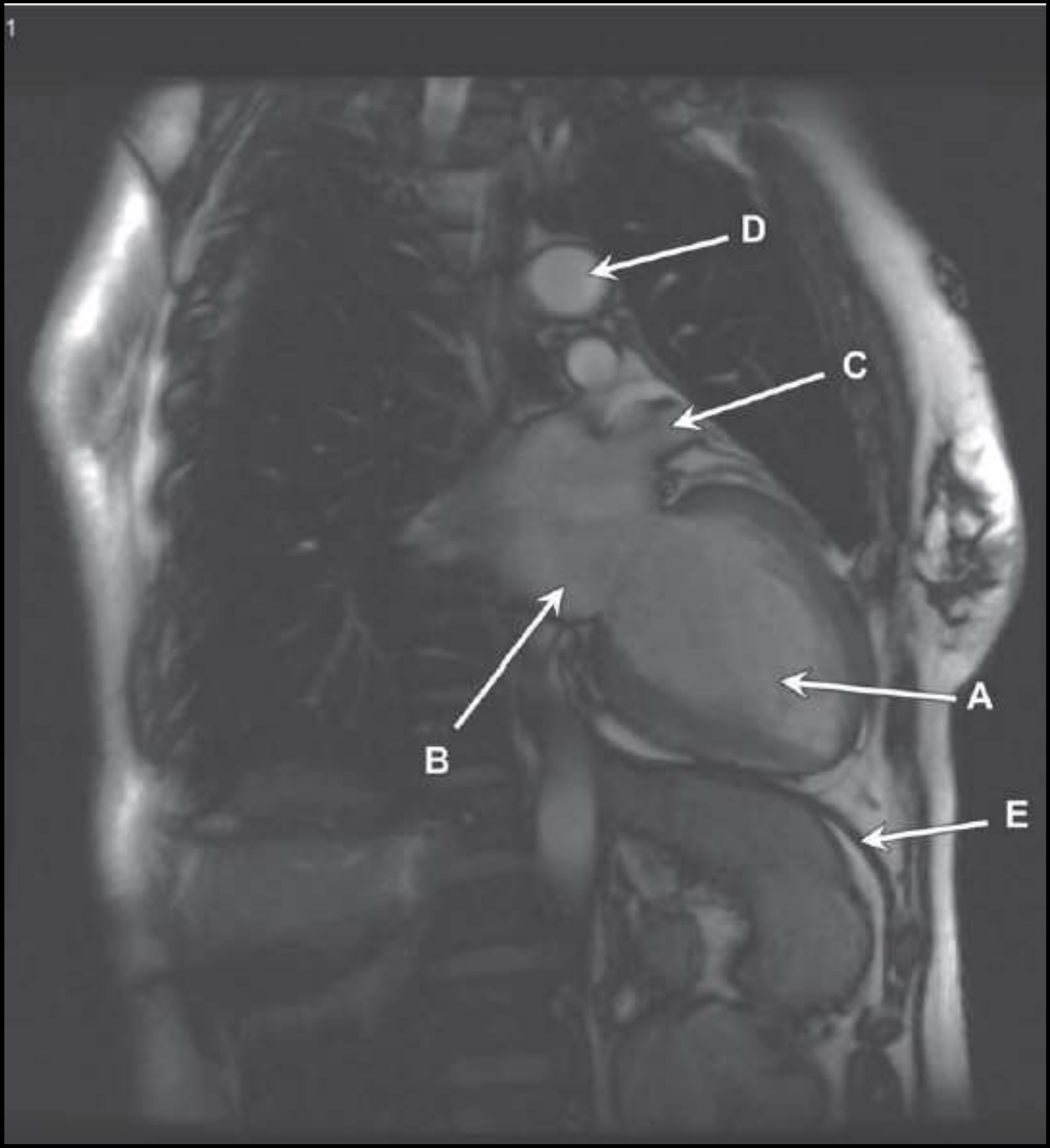

D
E
A
B
C

Case 19

CT thorax with intravenous contrast. Axial section.

1. Superior vena cava
2. Azygos vein
3. Trapezius muscle
4. Right internal mammary vein
5. Left internal mammary artery

As the azygos arch courses anteriorly, oblique sections may make it appear as an ovoid structure on some images. This risks being mistaken for a lymph node by some but the radiologist knows better!

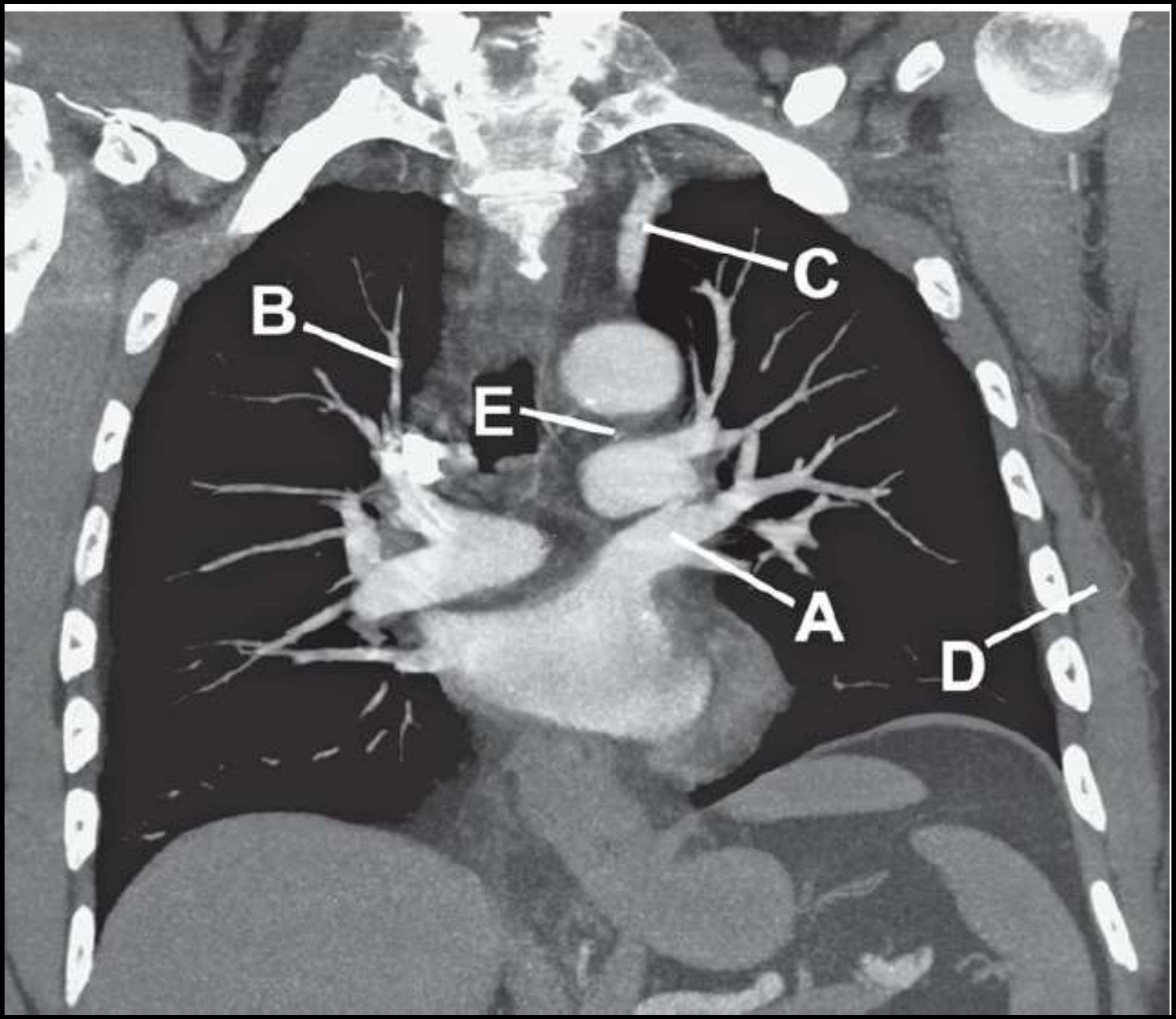

1
D
C
B
A
E

Case 18

Cardiac MR. T2W long-axis.

1. Left ventricle
2. Left atrium
3. Left pulmonary vein
4. Aortic arch
5. Left hemidiaphragm

Cardiac MRI images are obtained at oblique angles, in line with the axes of the heart and tend to be named as 'long axis' and 'short axis' to match the terminology used in echocardiography.


B
C
E
A
D

Q16 Answers

a Left superior pulmonary vein
b Right superior apical pulmonary artery
c Left subclavian artery (first part)
d Serratus anterior muscle
e Ligamentum arteriosum

CT pulmonary angiogram (CTPA), oblique coronal section

The pulmonary artery (PA) bifurcates soon after exiting the fibrous pericardium. The right PA is the longer branch and crosses the midline below the carina ending anterior to the right main bronchus at the hilum. Here it bifurcates into the right upper lobe branch and the interlobar branch, which supplies the middle and lower lobes. Thereafter pulmonary arteries are named in accordance with the segments supplied. Internationally standardized nomenclature of bronchopulmonary segmental anatomy was published by the British Thoracic Society in 1950 and can be seen below. Variations are common and there remains debate over what comprises a 'normal' configuration of segmental bronchopulmonary anatomy, as is described in the footnote.

Q16

Bronchopulmonary Segments:

RIGHT LUNG	LEFT LUNG
UPPER LOBE: apical, posterior, anterior	UPPER LOBE: apical, posterior, anterior, superior lingular, inferior lingular
MIDDLE LOBE: medial, lateral	
LOWER LOBE: apical (superior), anterior basal, lateral basal, posterior basal, medial basal	LOWER LOBE: apical (superior), anterior basal, lateral basal, posterior basal
TOTAL = 10	TOTAL = 9*

*Gray's Anatomy (40th Ed, 2008) and Applied Radiological Anatomy (2006) describe a combined apico-posterior segment of the left upper lobe. The latter text also does not list the medial basal segment of the left lower lobe as being a separate segment.

The shorter left pulmonary artery passes superior to the left main bronchus and runs within the concavity of the aortic arch. Here, the left PA and aorta are attached via the ligamentum arteriosum, the fibrous remnant of the foetal ductus arteriosus.

The subclavian artery arises on the left from the aortic arch, and on the right from the brachiocephalic artery (trunk). It is anatomically divided into three parts by the scalenus anterior muscle, to which the first part lies medially, second part lies posteriorly and third part lies laterally.

Pulmonary veins do not follow a segmental distribution, but travel in the intersegmental septae alongside lymphatic vessels. Usually two veins drain into each side of the left atrium, carrying blood from above and below the oblique fissures on both sides and entering the hilum slightly anterior to the PA. There are normal variations seen in the number of pulmonary veins (PV) draining into the atrium, for example three PV on the right or a single PV on the left.

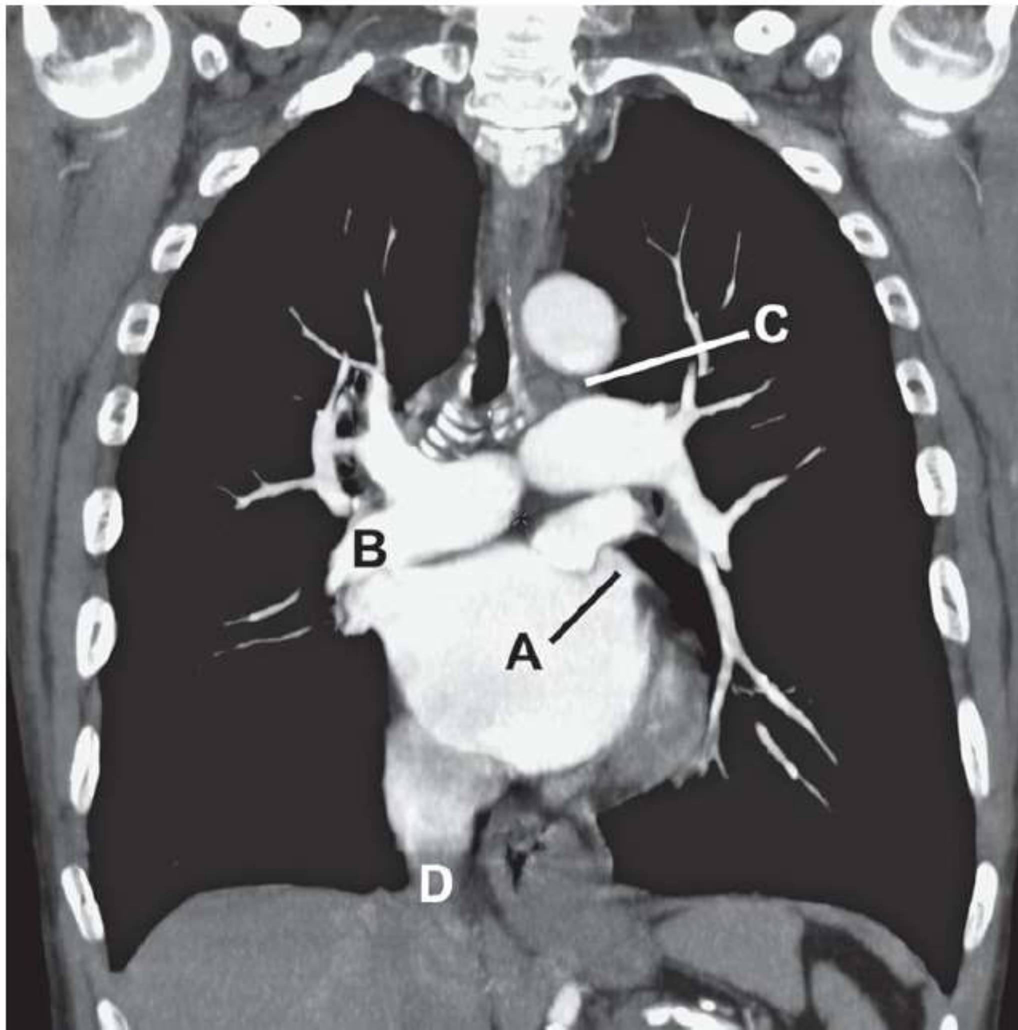
Brock RC. The Nomenclature of Broncho-pulmonary Anatomy – An International Nomenclature Accepted by the Thoracic Society. *Thorax* 1950; 5:222–228.

Lee KS, Bae WK, Lee BH, Kim IY, Choi EW, Lee BH. Bronchovascular anatomy of the upper lobes: evaluation with thin section CT. *Radiology* 1991; 181:765–772.

Jardin M, Remy J. Segmental bronchovascular anatomy of the lower lobes: CT analysis. *Am J Roentgenol* 1986; 147:457–468.

Q17

a Name the structure labelled A
b Define the upper limit of normal diameter of the structure labelled B
c Name the nerve located at the site labelled C
d Name the vertebral level of the corresponding diaphragmatic opening for the structure labelled D
e Name the additional structure(s) that cross the diaphragm through the same opening as structure D



Q17 Answers

a Left atrial appendage
b 2cm
c Left recurrent laryngeal nerve (branch of CN X)
d T8 (caval opening)
e Right phrenic nerve

CT pulmonary angiogram, coronal section

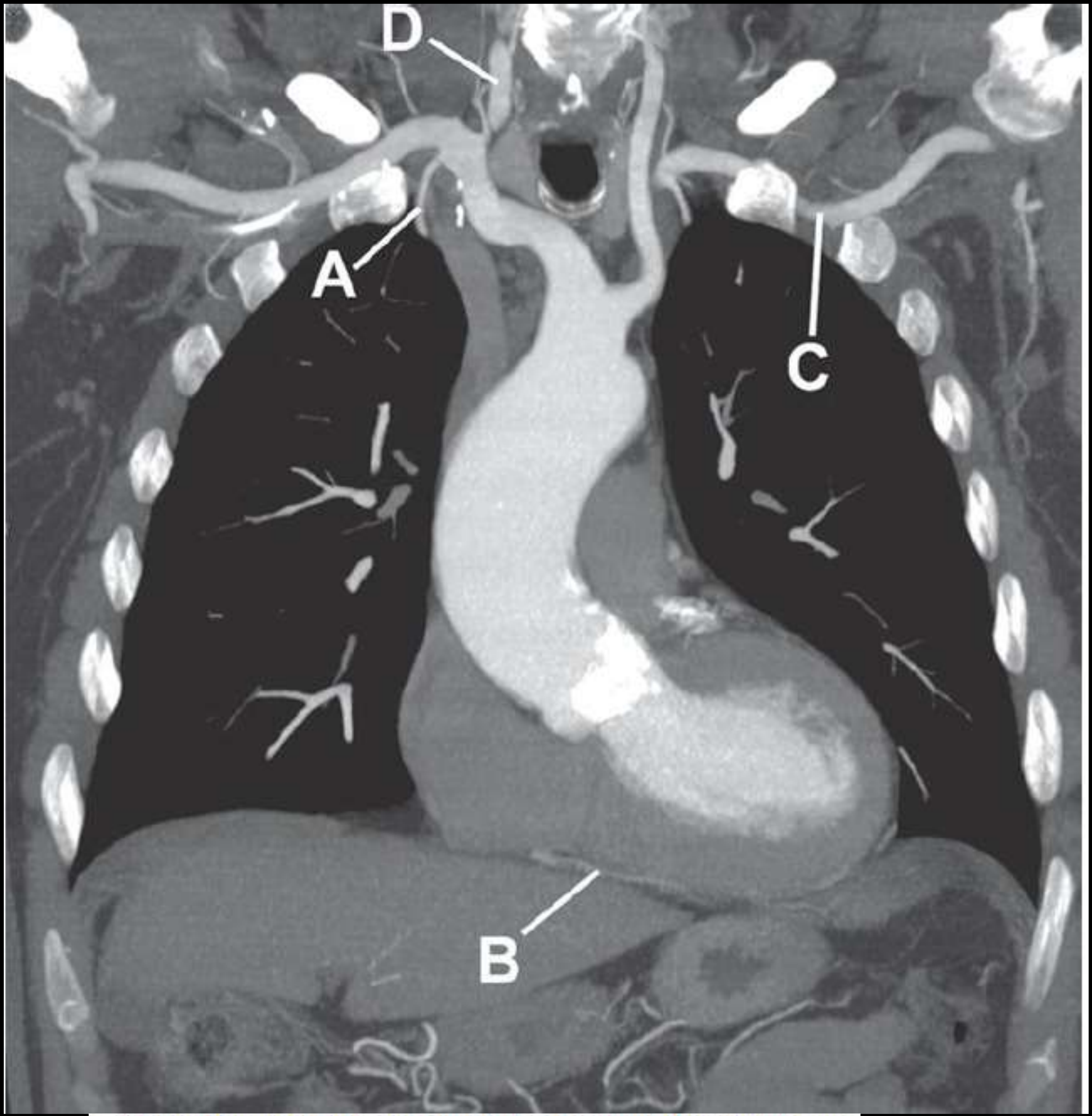
The left atrial appendage is a blind-ending recess positioned in the upper postero-lateral left atrium. This can be a site of mural thrombus formation, especially in patients with atrial fibrillation secondary to mitral valve disease.

The right interlobar artery can be seen on the PA chest radiograph running out lateral to the right cardiac border with bronchus intermedius in between. The diameter of the artery should not exceed 2cm (mean 1.4cm).

The recurrent laryngeal nerves supply the cervical trachea and oesophagus and the larynx. They are branches of the vagus (CN X) nerves which arise at the base of the neck on the right and down in the thorax on the left. On the right, the recurrent laryngeal nerve loops around the subclavian artery before heading cranially; on the left it passes under the arch of the aorta posterior to the ligamentum arteriosum, which runs between the aorta and left PA.

The caval opening in the diaphragm is at the level of the T8 vertebral body; the right phrenic nerve also crosses the diaphragm through this opening.

Bush A. Diagnosis of pulmonary hypertension from radiographic estimates of pulmonary arterial size. *Thorax* 1988; 43:127–131.



e Name the anatomical variant demonstrated in this image

Q18 Answers

a Right internal mammary (internal thoracic) artery
b Posterior descending (interventricular) artery
c First part of the left axillary artery
d Right carotid artery
e 'Bovine arch'

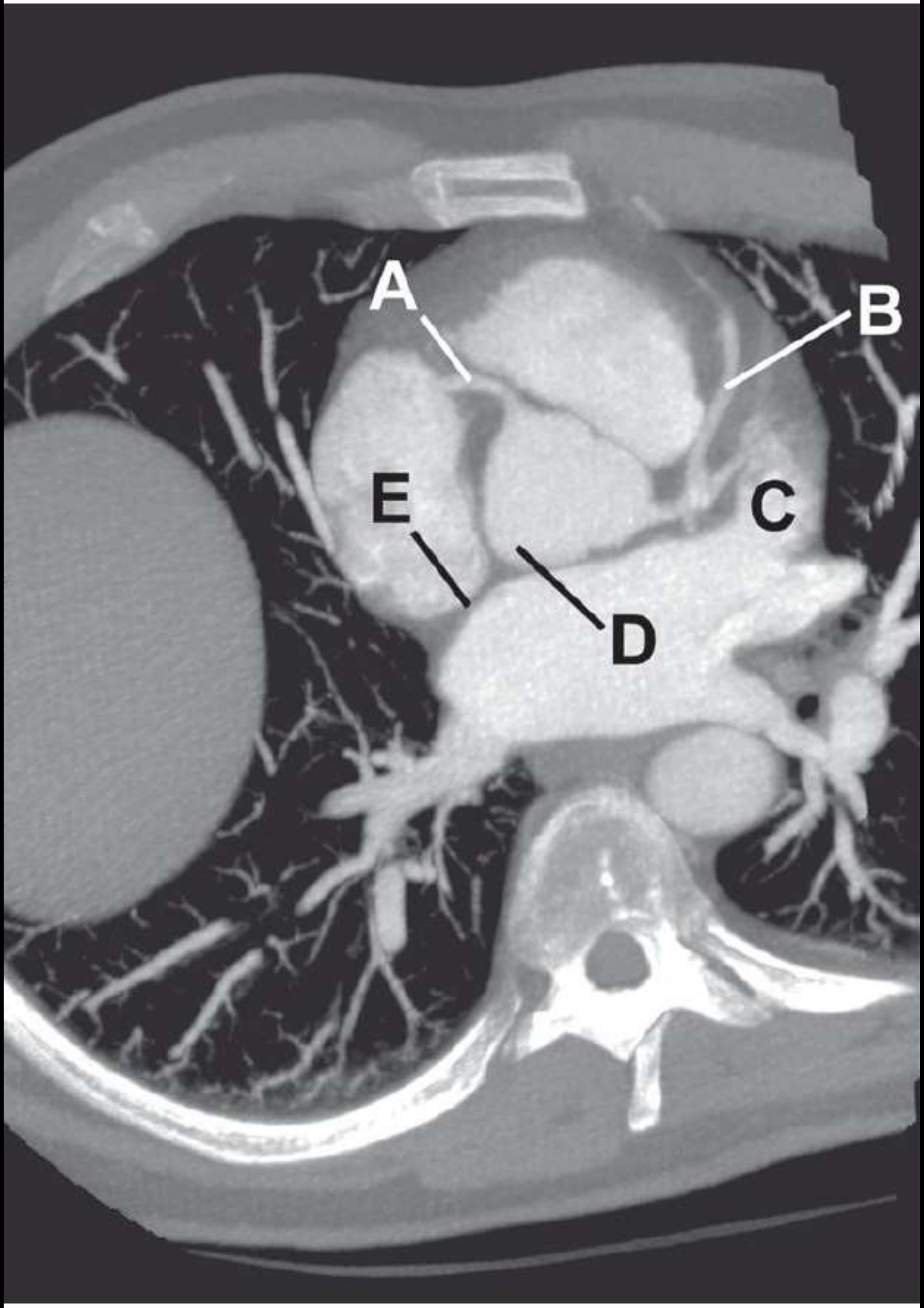
CT aortic angiogram, maximum intensity projection, coronal section

The Bovine arch configuration of vessels shown in this image is the most common arch anomaly and is said to be present in 13% of the population. It is when the left common carotid artery arises from the right brachiocephalic trunk rather than the arch and results in there being only two arch branches. Despite its name, this arch vessel configuration is not the same as is found in cows and other ruminant animals. The actual 'bovine' aortic arch has a single large branch from which bilateral carotid and subclavian arteries arise. Despite this discrepancy, the term is widely used and understood in human medicine.

The first part of the subclavian artery is the section lying medial to scalenus anterior and gives rise to three branches. From proximal to distal these are the vertebral artery, thyrocervical trunk and internal mammary (or internal thoracic) artery. The last of these travels inferiorly in the chest wall alongside the lateral sternal edge.

Lateral to the first rib, the subclavian becomes the axillary artery. This is anatomically divided into three parts depending on the position relative to pectoralis minor, to which the first part is medial, the second part posterior and third part lateral.

Layton KF, Kallmes DF, Cloft HJ, Lindell IP, Cox CV. Bovine Aortic Arch Variant in Humans: Clarification of a Common Misnomer. *Am J Neuroradiol* 2006; 27:1541–1542.


A
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E

Q19 Answers

a Right coronary artery (RCA)
b Left anterior descending (LAD) artery
c Left atrial appendage
d Non-coronary (or posterior coronary) sinus
e Interatrial septum

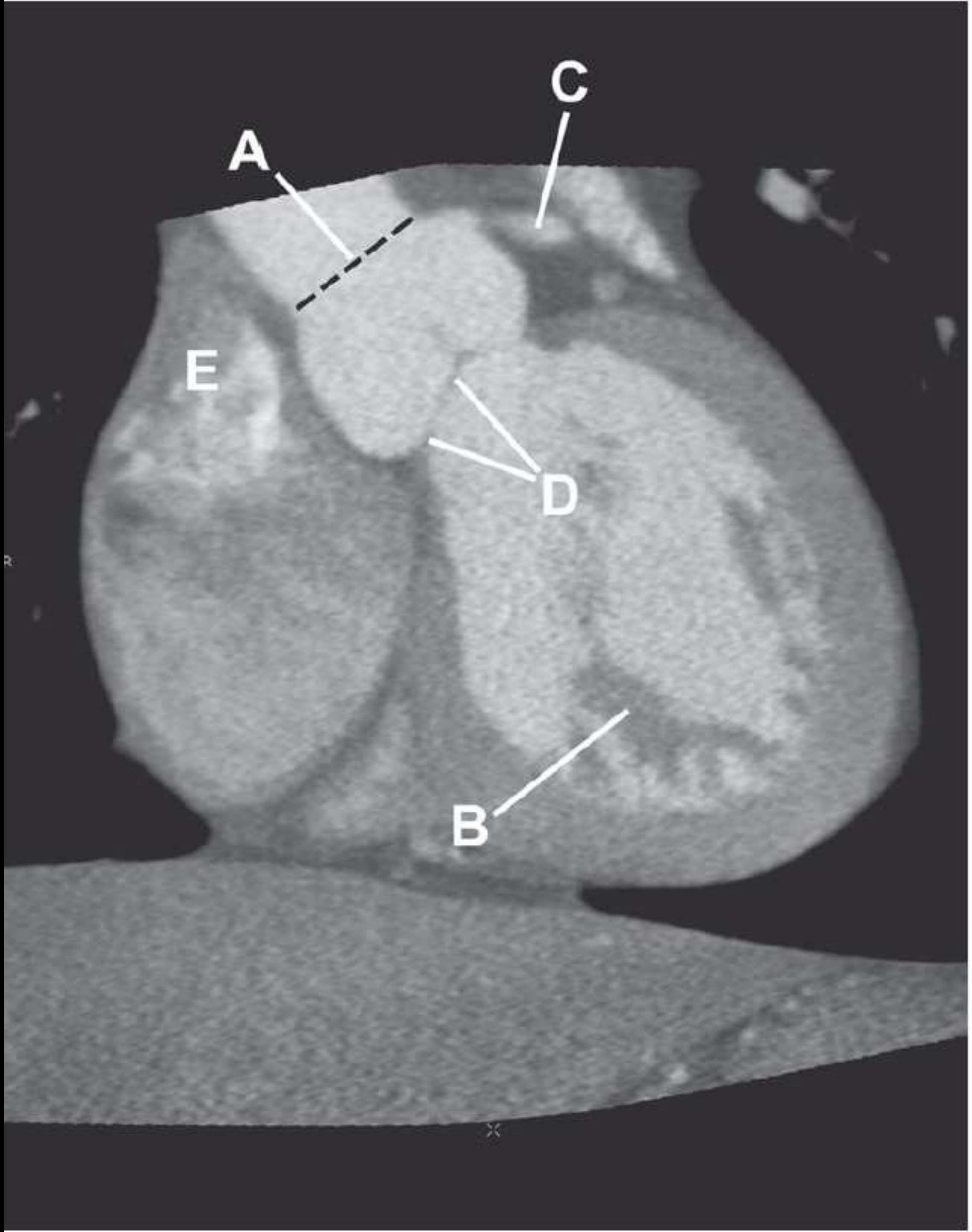
CT chest with intravenous contrast, maximum intensity projection, axial section

The right and left main coronary arteries originate from their respective coronary sinuses. The third sinus of Valsalva lies right posterior and is called the non-coronary sinus.

The RCA originates anteriorly and travels between the right auricle and infundibulum of the right ventricle. It then follows the atrio-ventricular groove down to the inferior cardiac margin giving off the sino-atrial (SA) nodal and conus branches. The nodal branch is variable in its origin arising from the RCA in 60% of individuals and from the left coronary artery (LCA), circumflex branch, in the remaining 40%. The posterior descending artery (PDA) travels along the base of the heart. In 85% of people, the RCA supplies the PDA in a 'right dominant system'.

The left main stem originates postero-laterally and travels between the left auricle and the pulmonary trunk. The circumflex continues on this same course, travelling over the left side of the heart along the atrio-ventricular groove. It gives off the obtuse marginal branches and in approximately 40% of people the sino-atrial (SA) nodal branch. The LAD courses along the interventricular groove on the anterior surface of the heart. It supplies diagonal branches to the left and right ventricles and also perforating branches to the interventricular septum.

The left atrial cavity is smooth-walled, indicating that it developed from the incorporation of the pulmonary veins into the wall of the developing heart. The roughened wall of the left auricle indicates that it is the remnant of what was once an embryological cardiac chamber. The atrio-ventricular (AV) node cannot be seen on diagnostic imaging; however its position is reasonably constant within the right atrium. It lies in the interatrial septum, above the insertion of the septal tricuspid valve leaflet and left of the opening to the coronary sinus.


A
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D
B

Q20 Answers

a Sino-tubular junction
b Papillary muscle in the left ventricle
c Left main stem coronary artery
d Non-coronary (right posterior) aortic valve cusp
e Right atrial appendage (auricle)

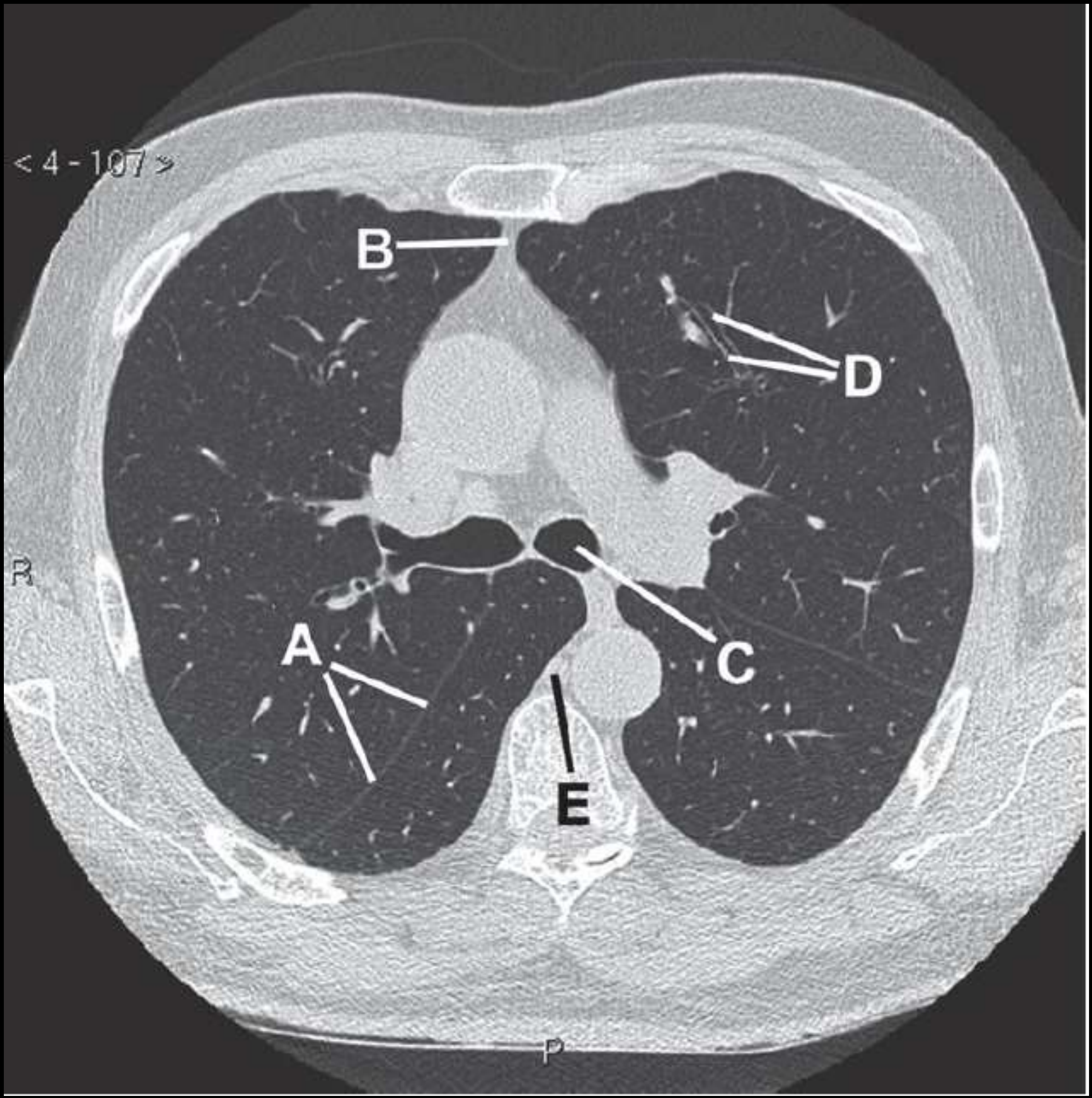
CT coronary angiogram, coronal section

Distal to the aortic orifice the wall of the ascending aorta bulges into the three sinuses of Valsalva. The RCA originates from anterior (right coronary) sinus and the LCA from the left posterior (left coronary) sinus. They are positioned in accordance with the three cusps of the valve which allows for a wider opening and therefore reduction in the resistance of flow. Its transition to the ascending aorta is called the sino-tubular junction.

The atrioventricular valve cusps of both the tricuspid and bicuspid (mitral) valves are attached by means of chordae tendinae to papillary muscles. These arise from the wall of each ventricle and contract in systole pulling tightly on the valve leaflets and hence preventing retrograde flow. Rupture of a papillary muscle, a rare complication of myocardial infarction, results in an acute regurgitation through the mitral valve often leading to heart failure. In these cases, the postero-medial papillary muscle is twice as likely to be affected as the antero-medial papillary muscle. This is thought to be due to the postero-medial muscle being supplied by the LAD system alone while the antero-medial usually receiving blood supply from both the circumflex and LAD systems.

Above and to the left of the SVC opening is the right auricle, a large triangular muscular out-pouch of the right atrium. It sits adjacent to the aorta and the AV groove.

Minami H. Papillary muscle rupture following acute myocardial infarction. *Jpn J Thorac Cardiovasc Surg* 2004; 52(8):367–371.



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C
E
P

Q22 Answers

- a Right oblique fissure
- b Anterior pleural junction
- c Left main bronchus
- d Superior lingular segmental bronchus
- e Azygos vein

High resolution CT chest, axial section

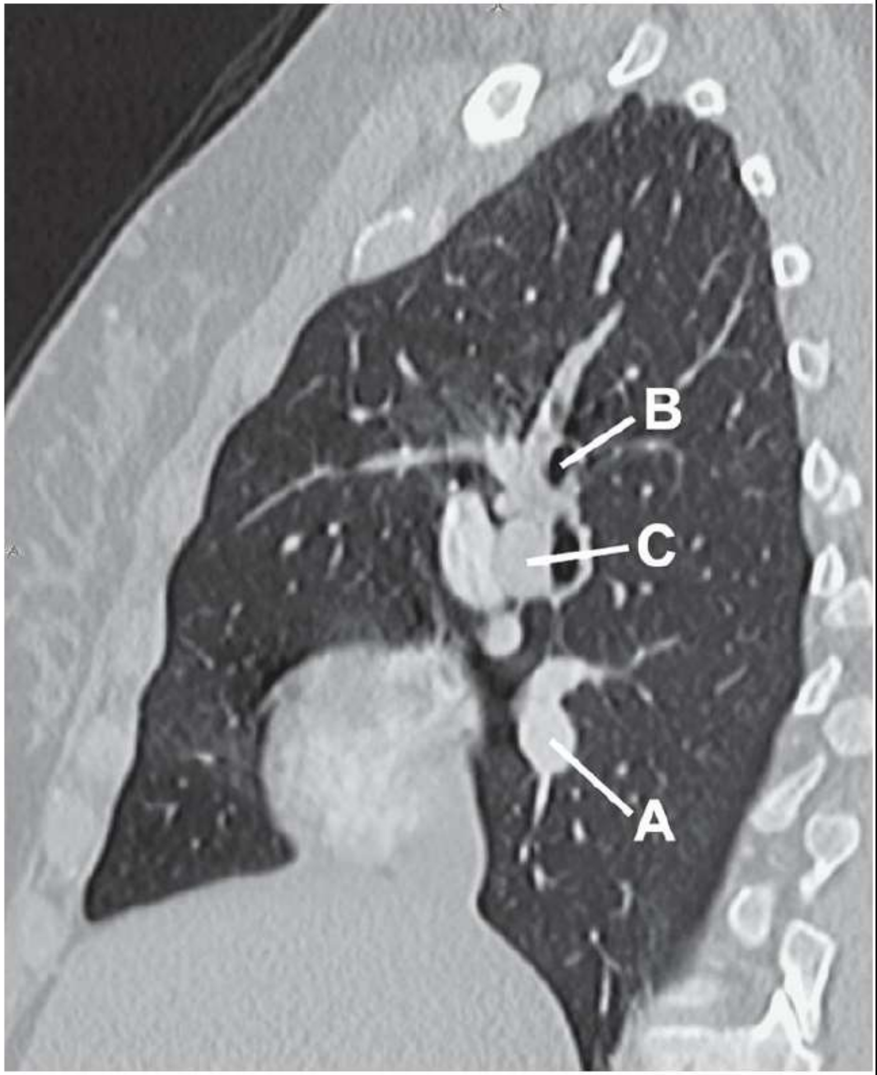
The oblique or major fissure separates the lower lobe from the remainder of the lung on both sides. The degree to which the fissures are developed is variable, with the transverse (horizontal) fissure being fully developed in only a third of people and absent in 10%. Underdevelopment can be difficult to determine radiologically. The line seen on plain radiographs is due to the composite layering of visceral pleura from both lobes surrounded by air and is only seen when viewing the fissure in profile (i.e. oblique fissure seen on lateral chest x-ray (CXR), transverse fissure seen on PA CXR). CT imaging normally displays the fissures as a clear line, but with underdevelopment of the fissure the position is indicated by a thin, dark linear strip which is devoid of traversing lung markings or vessels. The anterior junction of the pleura is responsible for the anterior junctional line that is seen on CXR and is the location of the sternopericardial ligaments.

Azygos means 'unpaired' and the azygos vein travels up the right paraspinal region, draining the posterior intercostal veins from the right side of the chest. It drains into the posterior aspect of the SVC, after having passed over the top of the right main bronchus. On the left are the hemiazygos (inferiorly) and accessory hemi-azygos (superiorly) veins. They provide drainage of the left inferior and superior posterior intercostal veins respectively and the two veins are occasionally in continuity. The hemiazygos veins usually cross the midline from left to right at the level of T9 to drain into the azygos vein.

Bronchi are named according to the lung segments which they supply. Juxta-cardiac lung is predominantly middle lobe on the right and lingula on the left. Both are divided into two segments with medial/lateral segments of the right middle lobe and superior/inferior segments of the lingula on the left.

Q23

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structure that courses cranio-caudally anterior to the structure labelled C
e Name the structure that courses cranio-caudally posterior to the structure labelled C



Q23 Answers

a Inferior right pulmonary vein
b Right upper lobe bronchus
c Right pulmonary artery
d Right phrenic nerve
e Right vagus nerve

CT chest with intravenous (IV) contrast and lung windowing, sagittal section

The position of the pulmonary artery in relation to the bronchus can allow determination of whether it is right or left in the absence of other indicators. The right main bronchus is 'epi-arterial' (at the same level as the right pulmonary artery). The left main bronchus is 'hypo-arterial' (below the left pulmonary artery).

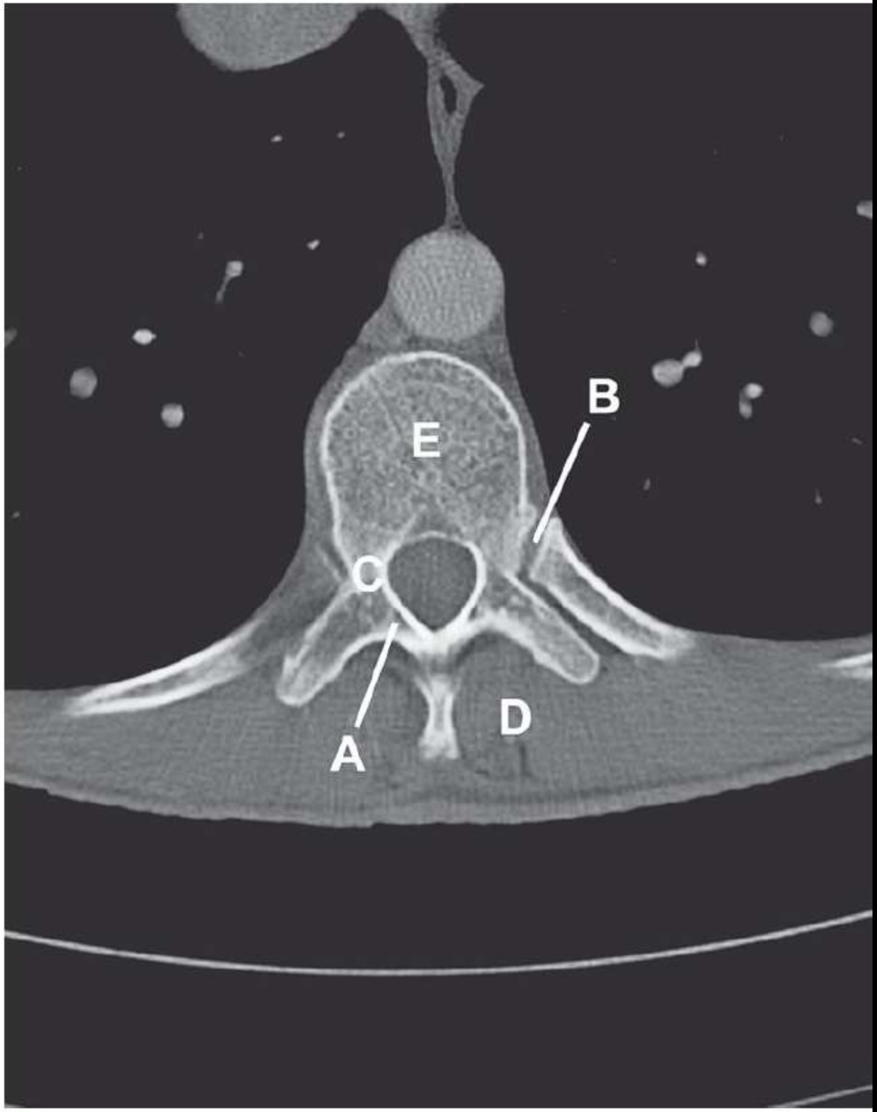
The superior pulmonary vein travels down through the hilum to reach the left atrium whilst the inferior vein approaches on a straighter course from the back.

The right main bronchus gives rise to the upper lobe branch soon after the carina and then continues as bronchus intermedius.

The vagus nerves pass posterior to the lung roots and cross the diaphragm alongside the oesophagus (vagal trunks). The phrenic nerves travel anterior to the lung root and down the antero-lateral surface of the pericardium to supply motor innervation to the diaphragm.

Q24

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the muscle group labelled D
e Name the substance which is seen in greater abundance with increasing age at the site labelled E



Q24 Answers

a Lamina
b Costovertebral joint
c Pedicle
d Erector spinae muscles
e Fat (yellow marrow)

CT thoracic spine, bone windows, axial section

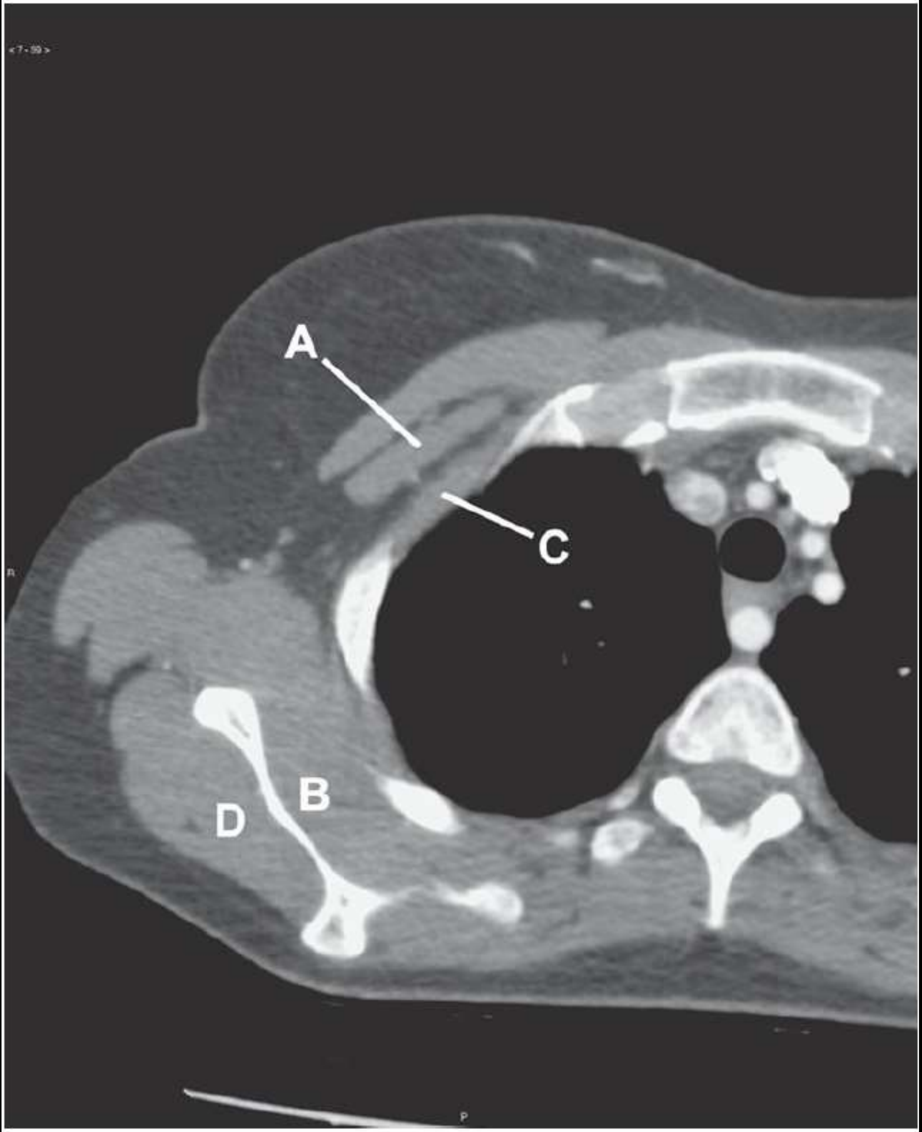
The thoracic vertebrae are recognized in the axial plane by the presence of articulation with ribs. A synovial articulation occurs between the vertebral body and the head of the rib. Another articulation occurs between the tubercles of the rib and the anterior surface of the transverse process, known as the costotransverse joint. The vertebral bodies are slightly wedge-shaped in sagittal plane, which contributes to the kyphotic shape of the thoracic vertebral column. The pedicles pass back from the superior half of each vertebral body.

Extensor paraspinal muscles run the length of the spine lying in the vertebral grooves on either side of the spinous processes. The largest and most powerful of these is erector spinae, the component parts of which form the intermediate layer o the intrinsic back muscles.

In childhood the cancellous bone of the vertebral bodies contains red (haematopoetic) marrow, but this usually converts to yellow (fatty) marrow throughout adult life. At age 30 years, there will have been approximately 30% conversion and this continues over time. The appearance of vertebral bodies on MRI varies depending on the constituency of marrow. Red marrow shows greater contrast enhancement where as yellow marrow shows as higher signal on non-contrast T1W.

Q25

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the anatomical variant shown in this image



Q25 Answers

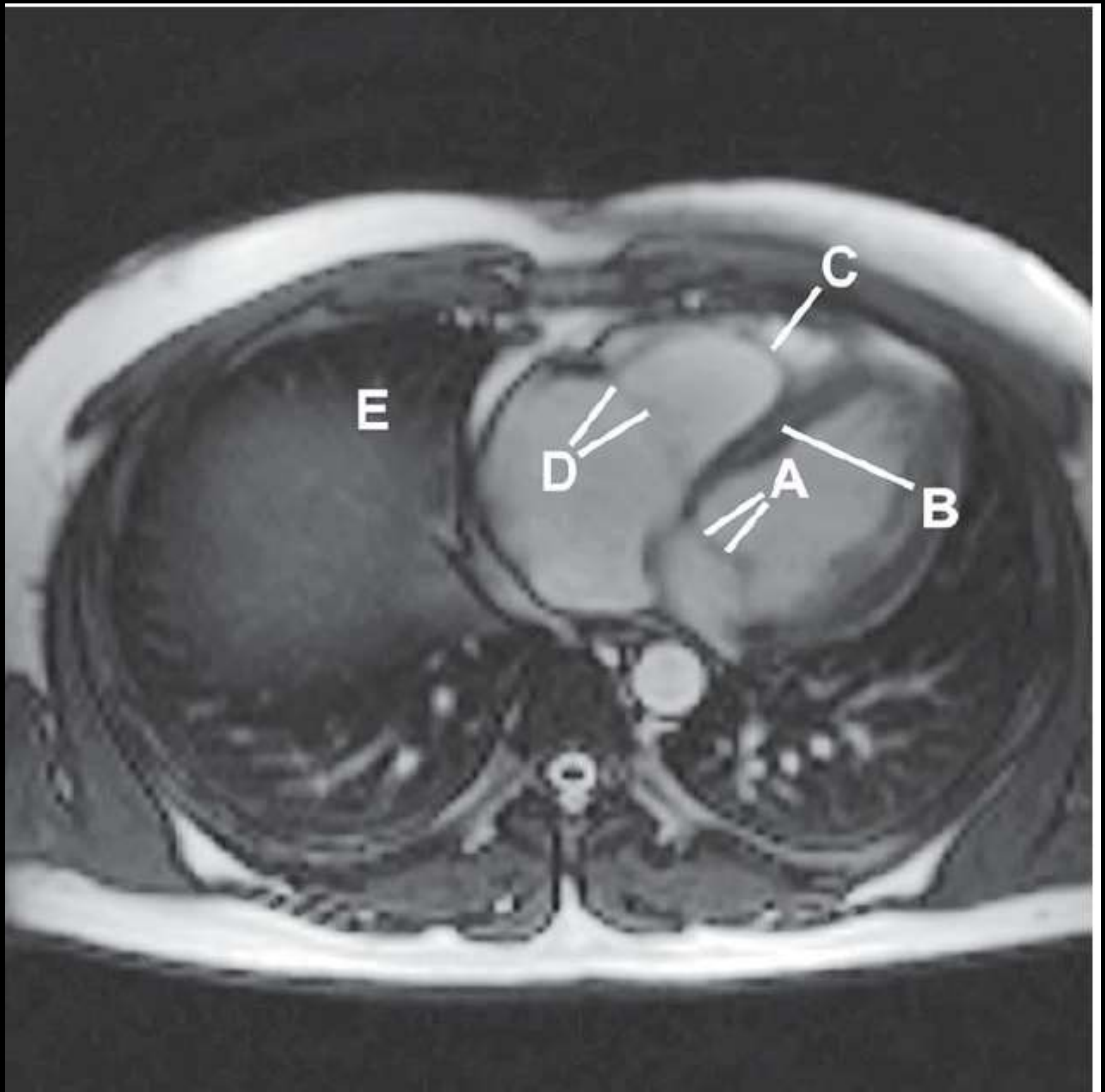
- **a** Pectoralis minor
- **b** Subscapularis
- **c** Intercostal muscles
- **d** Infraspinatus
- **e** Aberrant right subclavian artery

CT upper chest with contrast, in arterial phase, axial section

The superficial muscles of the chest wall consist of pectoralis major and minor anteriorly; serratus anterior laterally; muscles of the shoulder girdle postero-laterally; trapezius and erector spinae posteriorly. The muscles which lie between the ribs (intercostals) are found in three layers: external, internal and innermost. The fibres of these muscles are orientated perpendicular to each other in a similar (though unrelated) fashion to the three muscles of the anterior abdominal wall. The intercostal neurovascular bundles run in the subcostal groove and are located between the internal and innermost muscle layers.

The four muscles that are principally responsible for stability and movement of the shoulder girdle are subscapularis, supraspinatus, infraspinatus and teres minor. Collectively they are known as the rotator cuff muscles.

An aberrant right subclavian artery takes its origin as the last branch from a left-sided aortic arch. It then crosses from left to right, passing behind the oesophagus in doing so. This can be a cause of posterior indentation seen in the oesophageal contour during barium swallow examinations and can occasionally be symptomatic (dysphagia lusoria).



C
E
D
A
B

Q26 Answers

a Mitral valve anterior leaflet
b Muscular interventricular septum
c Moderator band of the right ventricle
d Tricuspid valve anterior leaflet
e Right middle lobe of lung

Cardiac MRI, axial section

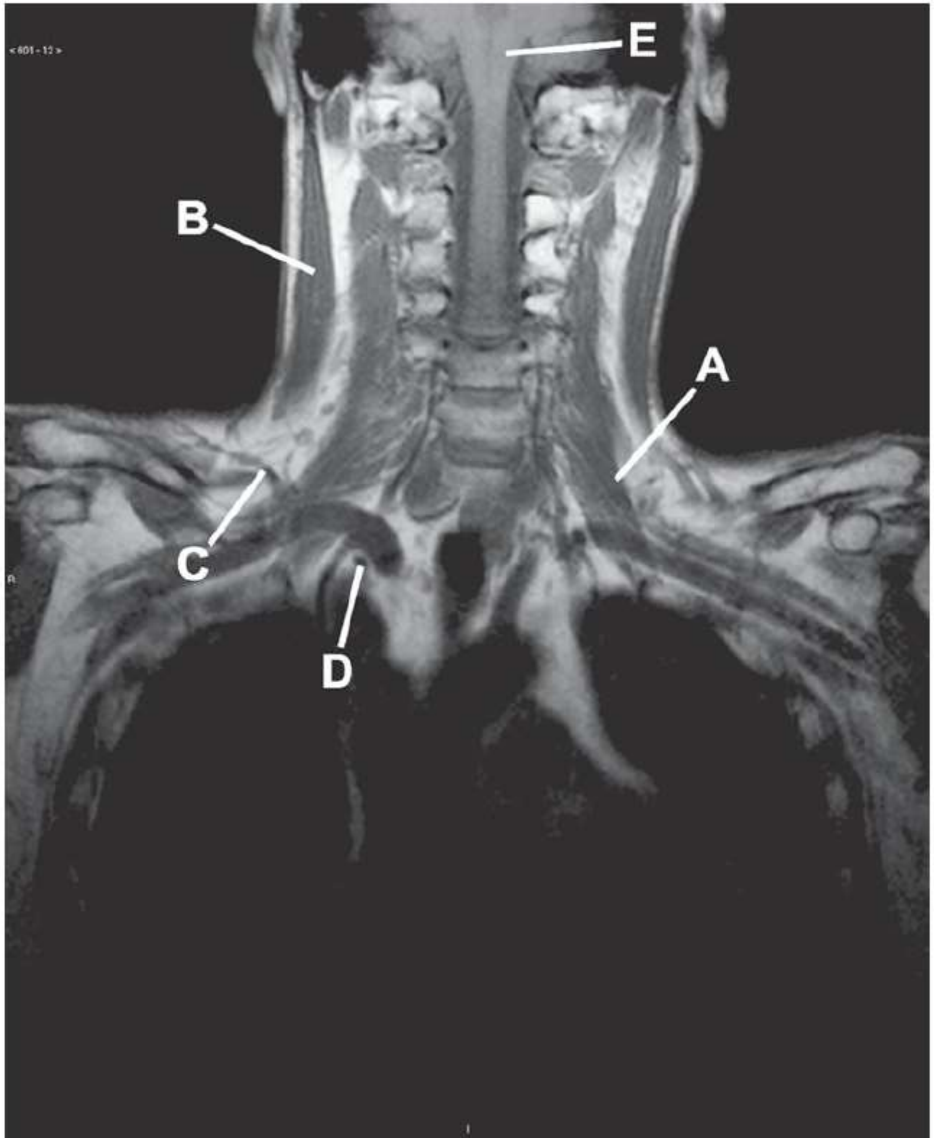
The atrioventricular valve cusps are tethered to the papillary muscles of the ventricular wall by chordae tendinae and act to prevent reflux of blood from the ventricle into the atrium. The bi-leaflet mitral valve is in the left heart; the anterior leaflet is the larger of the two and forms a division between the left ventricular inflow and outflow tracts. On the right side is the tricuspid valve, with leaflets sited in the anterior, posterior and septal positions.

The moderator band is a muscular bundle that crosses the right ventricular cavity, running from the lower interventricular septum to the anterior wall. It attaches at the level of the anterior papillary muscle and carries the right bundle branch fibres of the conducting system.

The interventricular septum is supplied via the septal branches of the left anterior descending (anterior interventricular) artery which runs the length of the anterior interventricular groove.

Q27

a Name the structure labelled A
b Name the motor nerve supplying the structure labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the structure labelled E



Q27 Answers

a Scalenus anterior muscle
b Right spinal accessory nerve (CN XI)
c Dorsal scapular artery
d Right recurrent laryngeal nerve
e Inferior cerebellar peduncle

T1W MRI base of neck, oblique coronal section

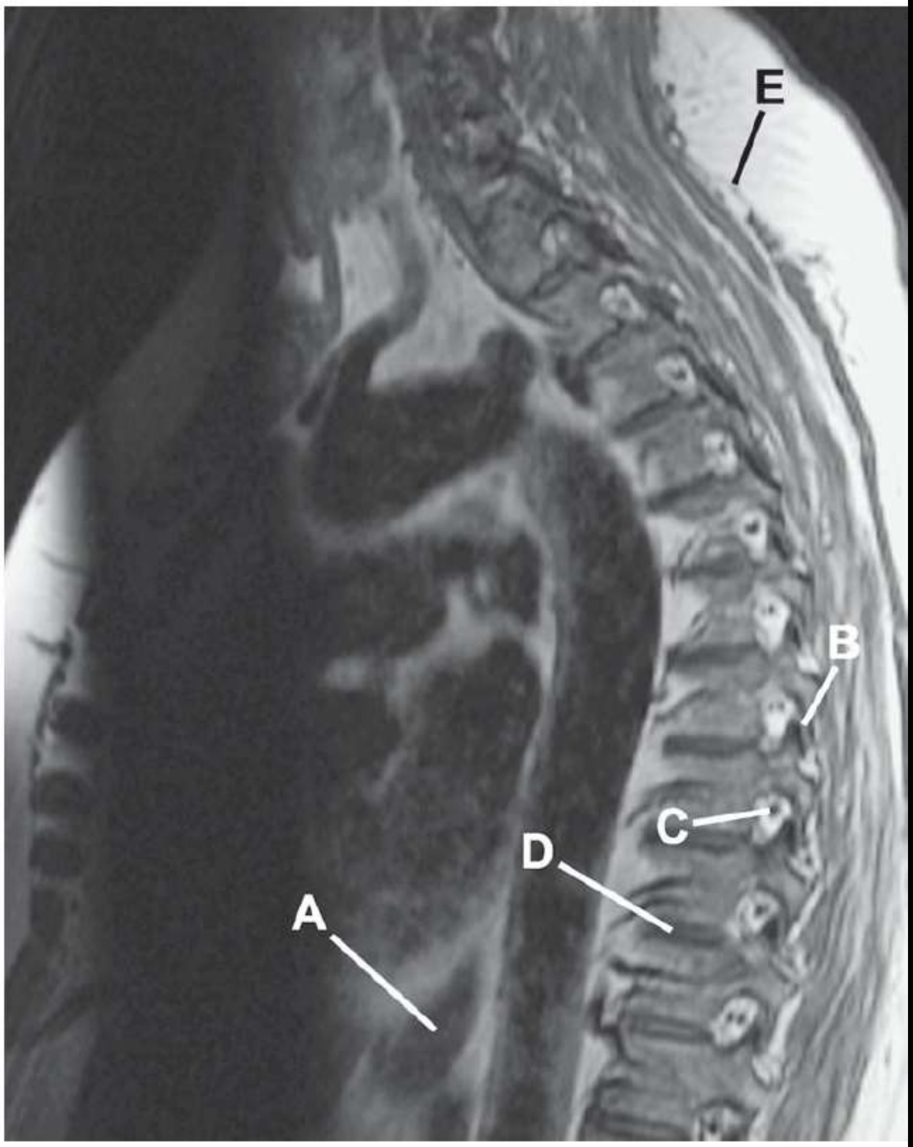
The scalenus anterior muscle and its relations are central to the anatomy of the root of the neck. It arises from the anterior tubercles of C3–6 in the form of four tendinous origins, passing infero-laterally and attaching to the upper surface of the first rib:

Anterior relations:	Phrenic and vagus nerves (the right recurrent laryngeal branch loops beneath the 1st part of the right subclavian artery) Ascending cervical, transverse cervical and suprascapular arteries Internal jugular vein Deep cervical lymph nodes
Medial relations:	Inferior thyroid, vertebral, thyrocervical, internal mammary and subclavian (1st part) arteries Vertebral veins Ansa subclavia Thoracic duct
Posterior relations:	Costocervical, superior intercostal, deep cervical and subclavian (2nd part) arteries
Lateral relations:	Dorsal scapular and subclavian (3rd part) arteries Trunks of brachial plexus

The trapezius muscle is a large flat muscle which is the most superficial major muscle on the upper back. It arises posteriorly in the midline, from the skull to lower thorax, and converges to insert onto the inner aspect of the pectoral girdle at the clavicle, acromion and scapular spine. Motor nerve supply is from the spinal part of the accessory nerve which is the eleventh cranial nerve.

Q28

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the structure labelled E



Q28 Answers

- **a** Oesophagus
- **b** Zygapophyseal (facet) joint
- **c** Dorsal root ganglia within the intervertebral canal
- **d** Intervertebral disc
- **e** Ligamentum nuchae

T1W MRI cervical and thoracic spine, sagittal section

The distal oesophagus courses left and anterior, passing in front of the aorta before traversing the diaphragm at the T10 level.

Thoracic vertebral bodies articulate together through zygapophyseal (facet) joints. Positioned either side of the midline they are small synovial joints between the inferior articular processes of the vertebra above and the superior articular processes of the vertebra below. On the side of the vertebral bodies are costal demi-facets for articulation with the ribs. The first rib and lower two ribs have a slightly different configuration. T1 has a complete facet superiorly for articulation with the first rib, and a demi-facet inferiorly for articulation with the 2nd rib. Both T11 and T12 have only a single complete facet for articulation with their corresponding ribs.

Additional support to the vertebral column is given by the anterior and posterior longitudinal ligaments running anterior and posterior to the vertebral bodies and associated discs; the ligamentum flavum running between adjacent laminae; interspinous ligaments running between adjacent vertebral spinous processes and the supraspinous ligament (known as the ligamentum nuchae above C7) running along the tips of the spinous processes.

Intervertebral discs consist of a cartilaginous endplate, the annulus fibrosis and the nucleus pulposis. As a result of being firmly attached to the anterior longitudinal ligament the annulus has greater strength anteriorly. Degeneration of the nucleus pulposis results in dehydration which changes the MRI signal characteristics (darker on T2W images).

The intervertebral foramina lie between adjacent vertebrae with the pedicle of the vertebra above forming the roof and the pedicle of the vertebra below forming the floor. In the thoracic, lumbar and sacral regions they transmit the corresponding spinal nerve and its respective dorsal root ganglion as well as the smaller spinal artery and vein. (In the cervical region spinal nerves emerge above their corresponding vertebra with the 8th cervical spinal nerve emerging below the 7th cervical vertebra).

Q29

a Name the structures labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the insertion point(s) of the structure labelled C
e Name the structure labelled E

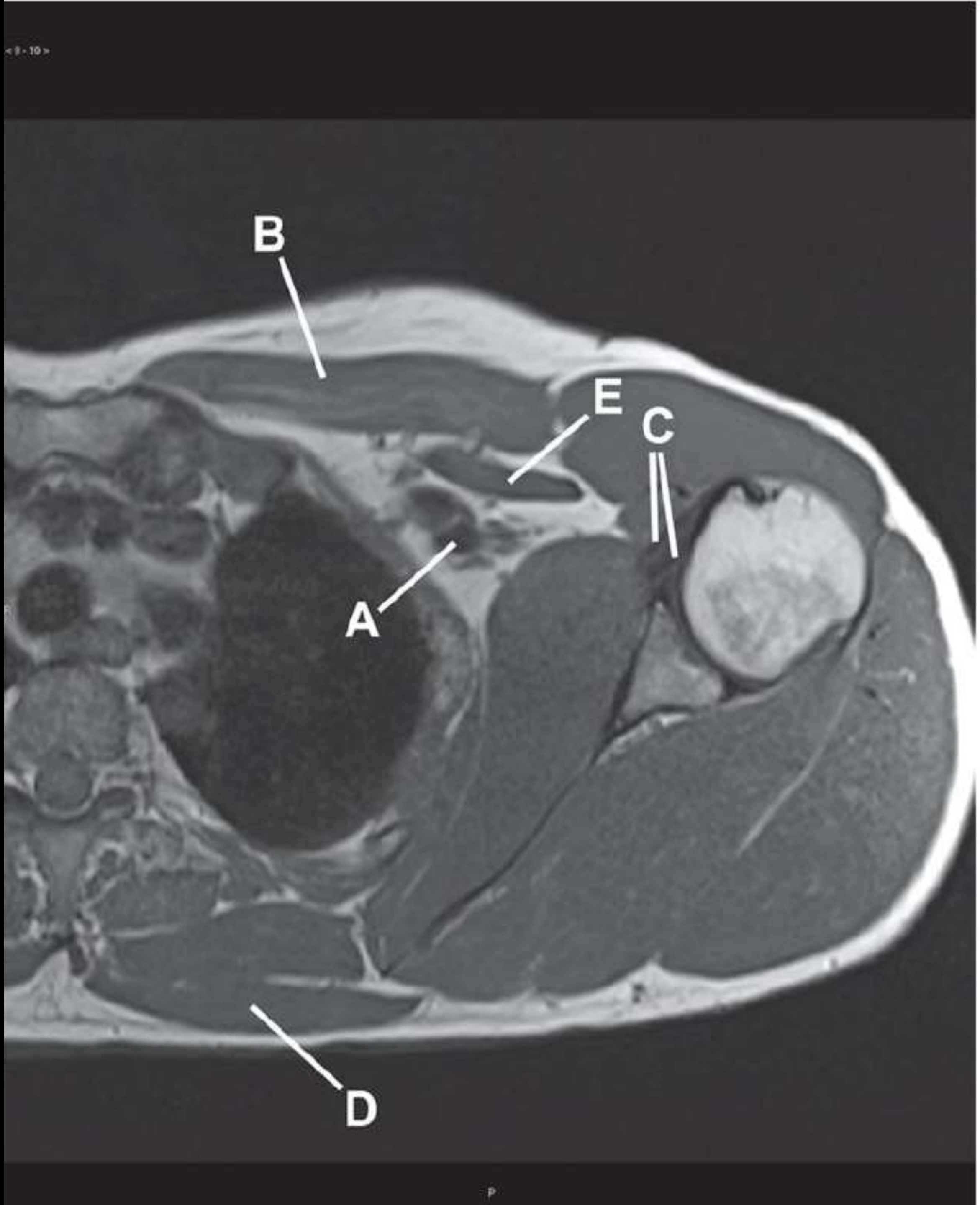
Q29 Answers

a The three trunks of the brachial plexus
b Scalenus anterior
c Sternocleidomastoid
d Manubrium and clavicle
e Pectoralis major

T1W MRI root of neck, sagittal section

The attachment of the scalenus anterior is onto the upper surface of the first rib. It passes between the subclavian artery and subclavian vein, with the artery lying deep to the muscle and running alongside the three cords of the brachial plexus. The anatomy of the brachial plexus is complex, and a full description is beyond the scope of this text. For simplicity it can be divided into sections which are (proximal to distal) the roots, trunks, divisions, cords and terminal branches. The roots refer to the anterior rami of the C5–T1 spinal nerve roots which come together to form three trunks in the neck. These divide into six divisions posterior to the clavicle (three anterior and three posterior) before reorganizing themselves again into three cords posterior to pectoralis minor. The cords surround the axillary artery and are named medial, lateral and posterior according to their position in relation to the artery as they enter the axilla before finally dividing into the terminal branches.

Sternocleidomastoid muscle arises from the mastoid process and occipital bone and passes obliquely downwards and forwards to insert medially into the manubrium ('sternal head') and clavicle ('clavicular head'). As an anatomical landmark, it forms the division of the anterior and posterior triangles of the lateral neck.


B
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Q30 Answers

- **a** Second part of Axillary artery
- **b** Pectoralis major
- **c** Tendon of subscapularis
- **d** Trapezius
- **e** Pectoralis minor

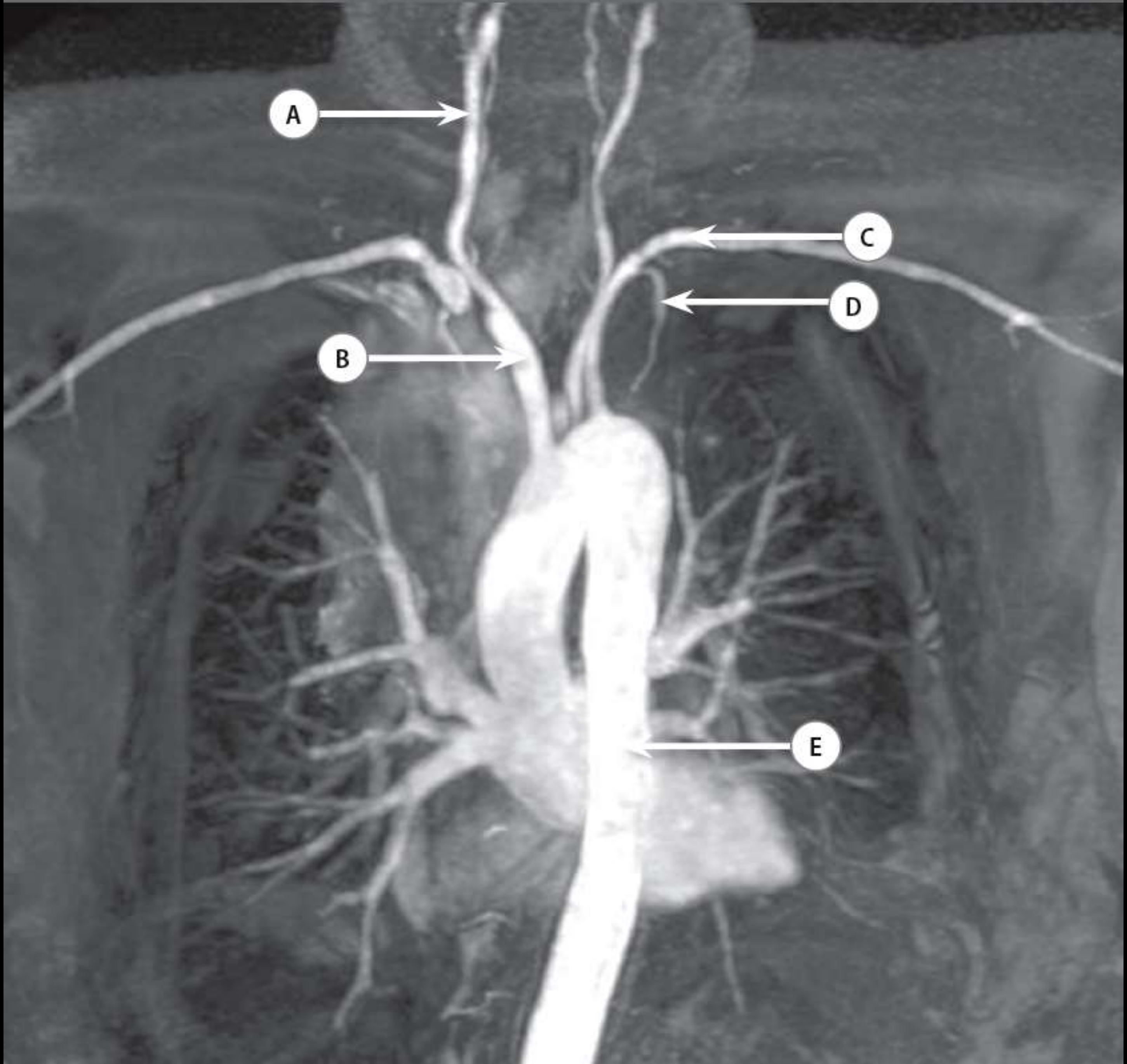
T1W MRI of upper chest and shoulder, axial section

The axillary artery is divided into three parts. The first part lies medial, the second part posterior and the third part lateral to pectoralis minor muscle. The axillary artery lies postero-lateral to the axillary vein.

As well as descriptively dividing the axillary artery into its three parts, pectoralis minor is the landmark used in delineating the three levels of axillary lymph nodes – level I are lateral to pectoralis minor, level II are posterior to pectoralis minor and level III are medial to pectoralis minor. The levels are utilized in the staging of breast cancer, for which nodal involvement is the single most important factor in determining prognosis. Involvement of level III nodes (N3a) carries a poorer prognosis than involvement of level I or II.

Singletary SE. Revision of the American Joint Committee on Cancer Staging System for Breast Cancer. *Journal of Clinical Oncology* 2002; 20:3628–3636.

Case 2.2



Case 2.2

A Right common carotid artery

B Brachiocephalic trunk

C Left subclavian artery

D Left internal thoracic artery/left internal mammary artery

E Descending thoracic aorta

MRI aortic angiogram.

The aortic arch begins at the origin of the brachiocephalic trunk. The branch vessels that arise from the aortic arch are, in order:

- brachiocephalic trunk
- left common carotid artery
- left subclavian artery

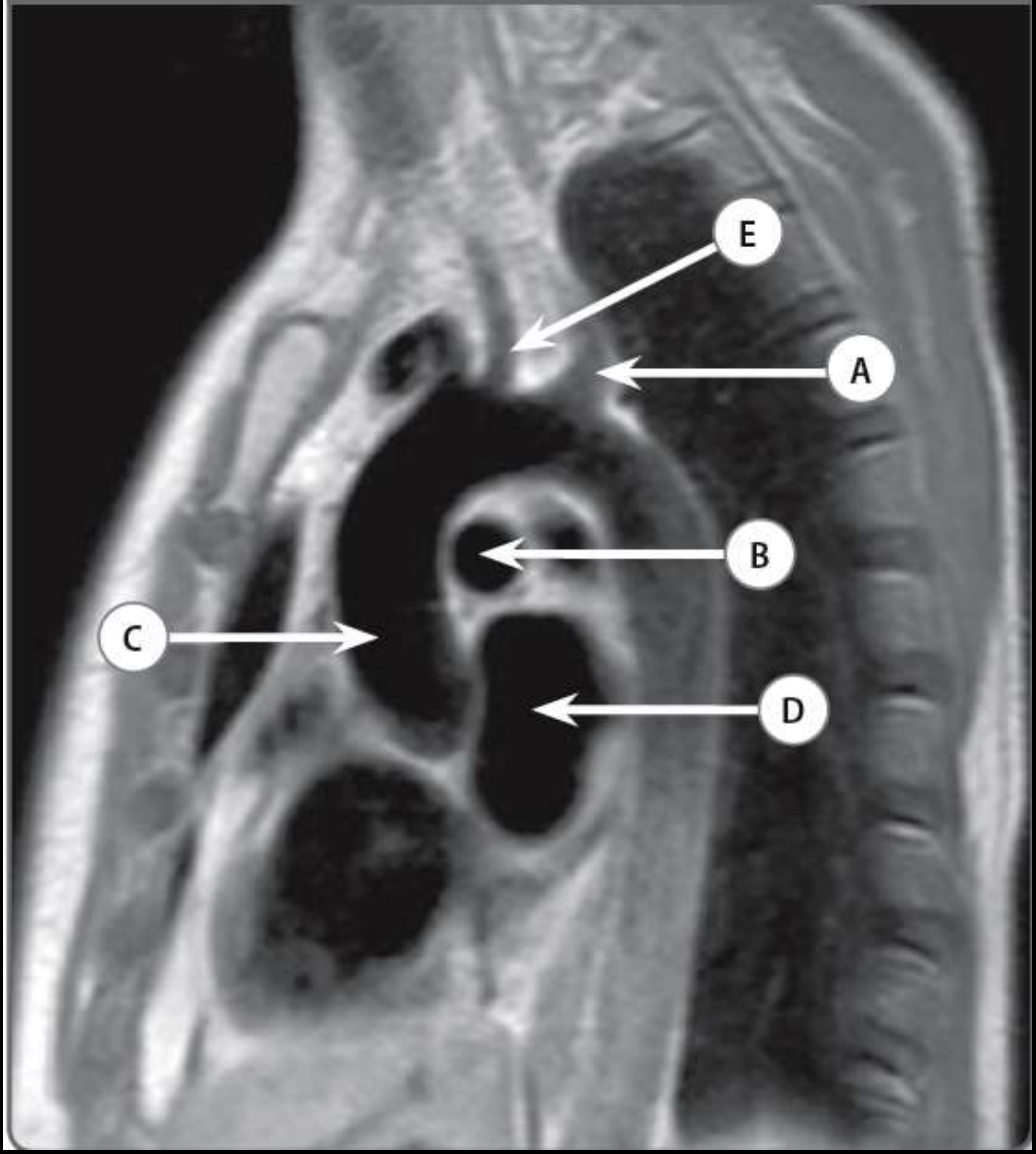
The brachiocephalic trunk bifurcates into the right subclavian and right common carotid arteries. From the subclavian arteries arise the internal thoracic or internal mammary arteries.

The most common variation in the anatomy of the aortic arch vessels is a common origin of the brachiocephalic trunk and the left common carotid, or so-called bovine arch (20%). In 6%, the left vertebral artery arises directly from the arch, instead of the left subclavian. An anomalous right subclavian artery is another variant, whereby the right subclavian originates as the last of the arch vessels, and takes a retro-oesophageal course as it traverses from left to right. This can cause symptoms of dysphagia, and can be seen on a barium swallow as a persistent indentation posteriorly.

The aortic arch ends, and the descending thoracic aorta begins immediately distal to the left subclavian artery. At this point, the ligamentum venosum (remnant of the ductus arteriosus) joins the lower border of the arch to the main pulmonary artery. The aorta is fixed at this point.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 101–103.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 142.
Layton KF. Bovine aortic arch variant in humans: clarification of a common misnomer. American Journal of Neuroradiology 2006; 27:1541–1542.

Case 2.3



Case 2.3

A Left subclavian artery

B Left pulmonary artery

C Ascending thoracic aorta

D Left atrium

E Left common carotid artery

Sagittal thoracic MRI.

Blood can appear 'black' or 'bright' on MRI, depending on which sequence is used. Standard gradient echo sequences will give a 'bright blood' picture. This is a parasagittal section, on a spin echo MRI sequence, on which blood appears 'black' Spin echo sequences show 'black blood' because of high velocity signal loss. This occurs due to the 180° pulse. Blood which receives the 90° pulse moves out of the slice before the 180° pulse is applied. This means that the blood produces no sign

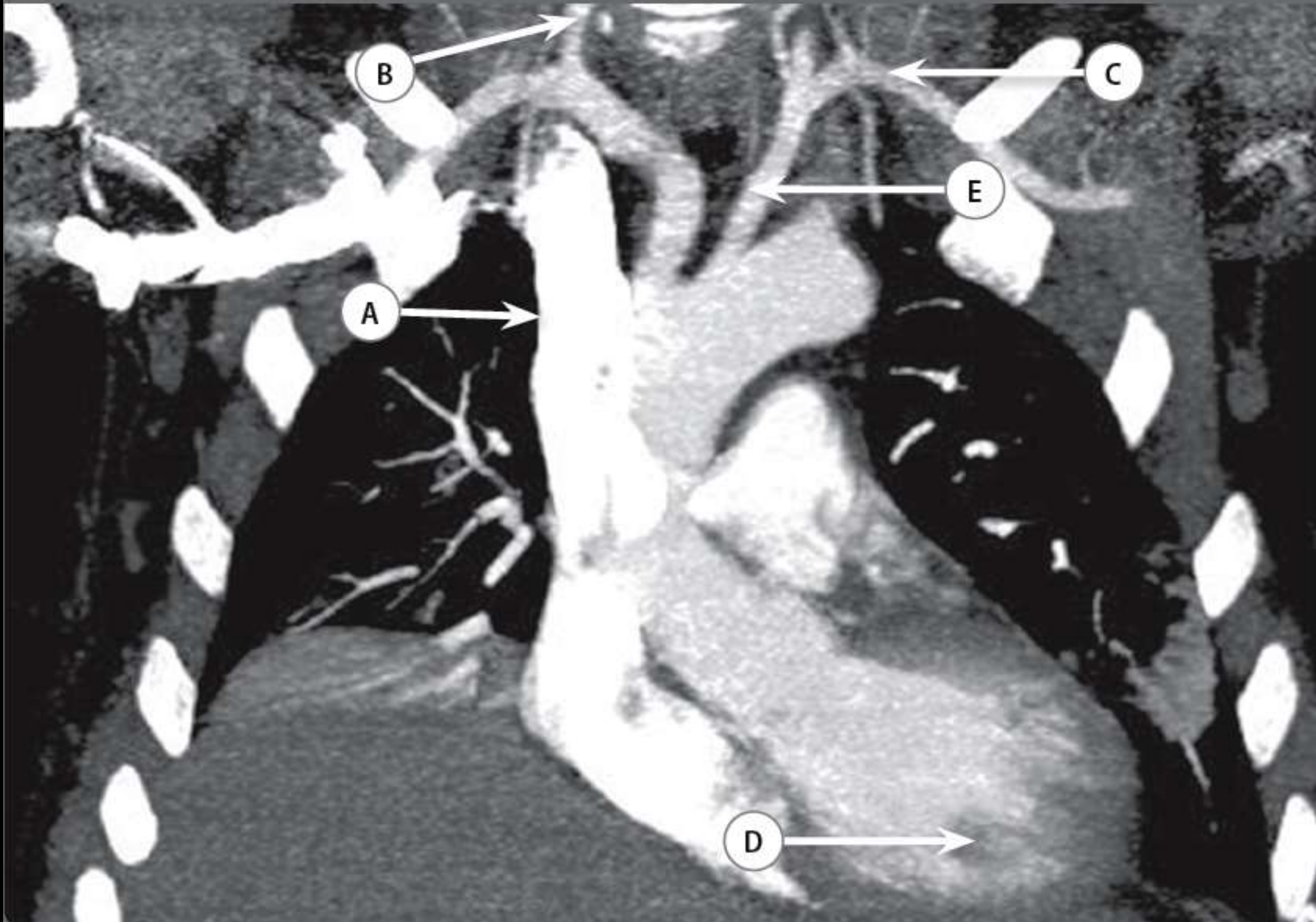
The three main branch vessels can be seen arising from the aortic arch as it passes from anterior to posterior. The brachiocephalic trunk arises first, anteriorly, and the left subclavian last, the most posterior. The descending aorta is located in the posterior mediastinum, to the left of midline.

Posterior to the left main pulmonary artery on this section, is the left main bronchus (which also appears dark, as it is filled with air). As the left main pulmonary artery courses laterally, it comes to lie on top of the left main bronchus, which is why the left hilum is higher than the right on a frontal chest radiograph.

The left atrium is the most posterior of the cardiac chambers, as seen on this parasagittal section.

http://www.revisemri.com/questions/pulse_sequences/black_blood_bright_blood. Last accessed September 2011.

Case 2.4



Case 2.4

A Superior vena cava

B Right common carotid artery

C Left subclavian artery

D Papillary muscle

E Left brachiocephalic trunk (normal variant)

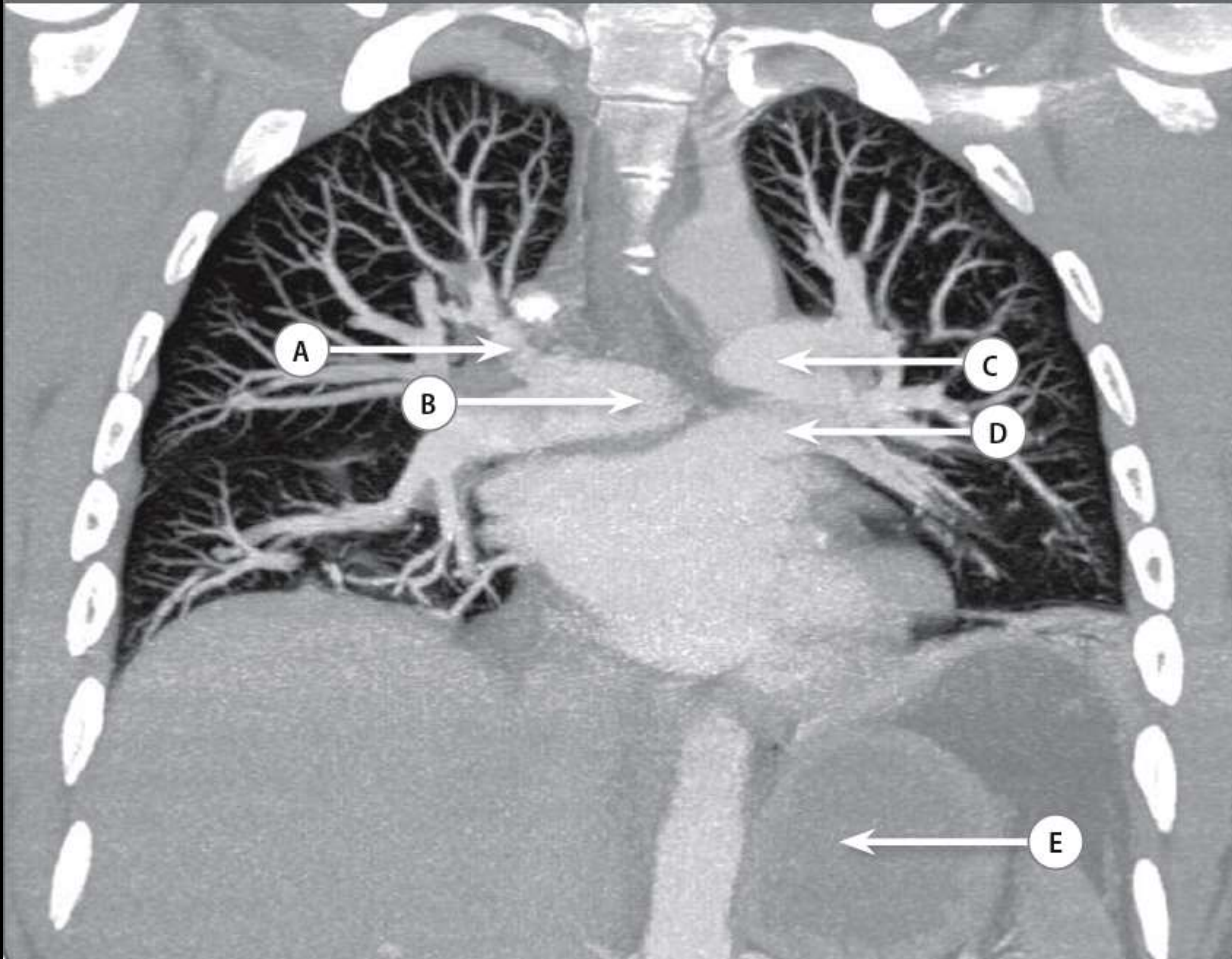
Coronal maximum intensity projection of a CT pulmonary angiogram.

Variations in the pattern of branching of the aortic arch are common, such that only 65% of people have a 'normal' branching pattern. 2.7% of people have a common origin of the left subclavian and common carotid arteries, to form a left sided brachiocephalic trunk. This gives a symmetrical appearance to the aortic branches. The right common carotid is seen to arise in its normal position from a standard right sided brachiocephalic trunk.

The papillary muscles of the heart can be appreciated on CT, particularly on a cardiac gated image. These muscles are located in the ventricles, and act to tether the atrioventricular valves by the chordae tendinae. The chordae are attached to the valve cusps, and prevent them prolapsing during systole. In the left ventricle, there are two papillary muscles, an anterior and a posterior one. The right ventricle contains three papillary muscles: the anterior, posterior and septal.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 140–144.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 117.

Case 2.5



Case 2.5

A Right upper lobe pulmonary artery

B Right main pulmonary artery

C Left main pulmonary artery

D Left superior pulmonary vein

E Gastric fundus

Coronal maximum intensity projection from a thorax CT.

The main pulmonary artery arises from the right ventricle, and travels superiorly and posteriorly. It starts off anterior to the aorta, before coming to lie to its left. At the level of T5, it bifurcates into the left and right main pulmonary arteries.

The left main pulmonary artery runs superoposteriorly, and arches over the left main bronchus before entering the hilum. At this point, it branches into its lobar branches.

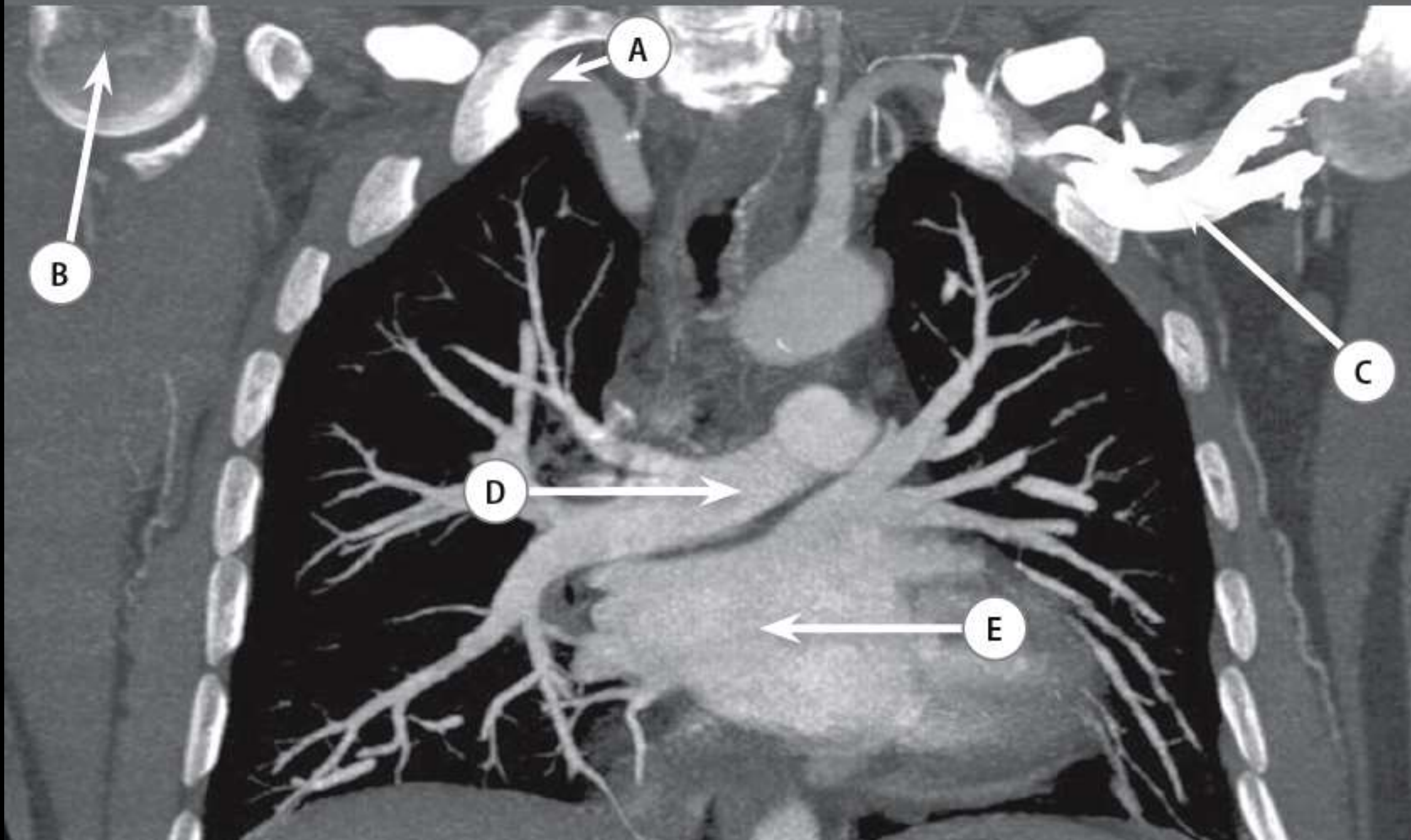
The right pulmonary artery branches from the main pulmonary trunk at 90°, and passes behind the superior vena cava and ascending aorta, anterior to the right main bronchus. The right main pulmonary artery divides into upper lobe and interlobar branches.

There are four main pulmonary veins which drain into the left atrium; the right and left, superior and inferior pulmonary veins. In the upper zones, the veins lie inferolateral to the arteries, and in the lower zones the veins have quite a horizontal course, compared to the arteries which are much more vertical.

The pulmonary vasculature makes up the hilar point, which can be seen on a frontal chest radiograph. Remember, the hilar point is where the superior pulmonary vein crosses the interlobar pulmonary artery.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 110–111.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 128–130.

Case 2.6



Case 2.6

A Right subclavian artery

B Right head of humerus

C Left subclavian vein

D Right pulmonary artery

E Left atrium

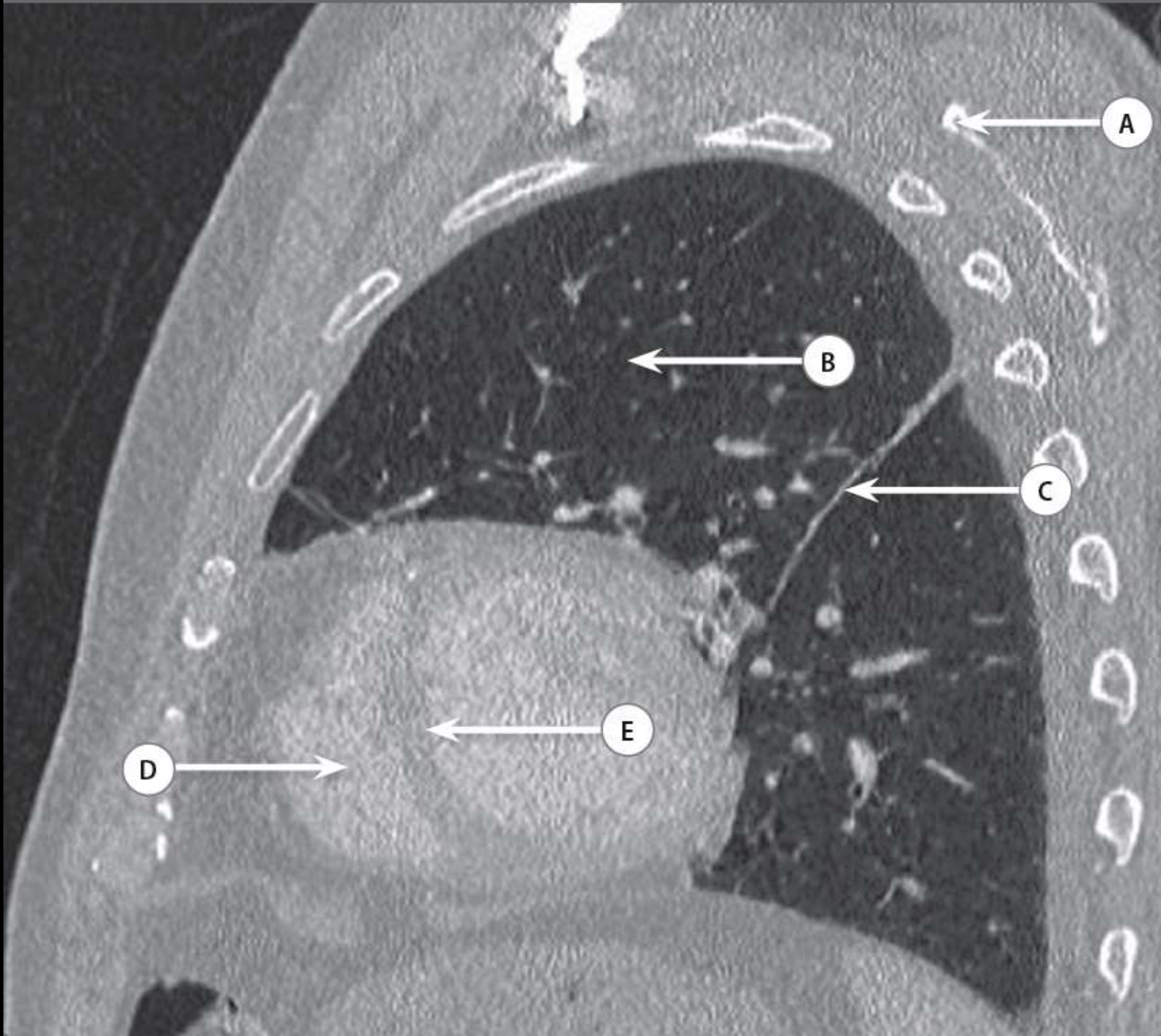
Coronal CT pulmonary angiogram (CTPA) of the thorax through the heart.

This image is from a CTPA and therefore the pulmonary arteries are of higher attenuation than the aorta and the subclavian artery. The vascular structure with the highest attenuation, labelled 'C' is the left subclavian vein, which contains high concentrations of contrast when a vein in the left upper limb is injected. The cephalic and the axillary veins unite to form the subclavian vein.

The right pulmonary artery can be easily identified as it arises from the pulmonary trunk. It passes in front of the right main bronchus and behind the ascending aorta (not seen here). After the origin of the right upper lobe pulmonary artery it becomes the interlobar artery from which the middle and lower lobe branches arise. The arterial branching follows the segmental branching pattern of the airways.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 100–103.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 122–125.
Weber E, Netter FH, Vilensky JA, Carmichael SW. Netter's Concise Radiologic Anatomy. Philadelphia: Saunders/Elsevier, 2009:177.

Case 2.7



Case 2.7

A Left spine of scapula

B Left upper lobe

C Left oblique fissure

D Right ventricle

E Interventricular septum

A left parasagittal CT of the thorax through the right and left ventricles of the heart.

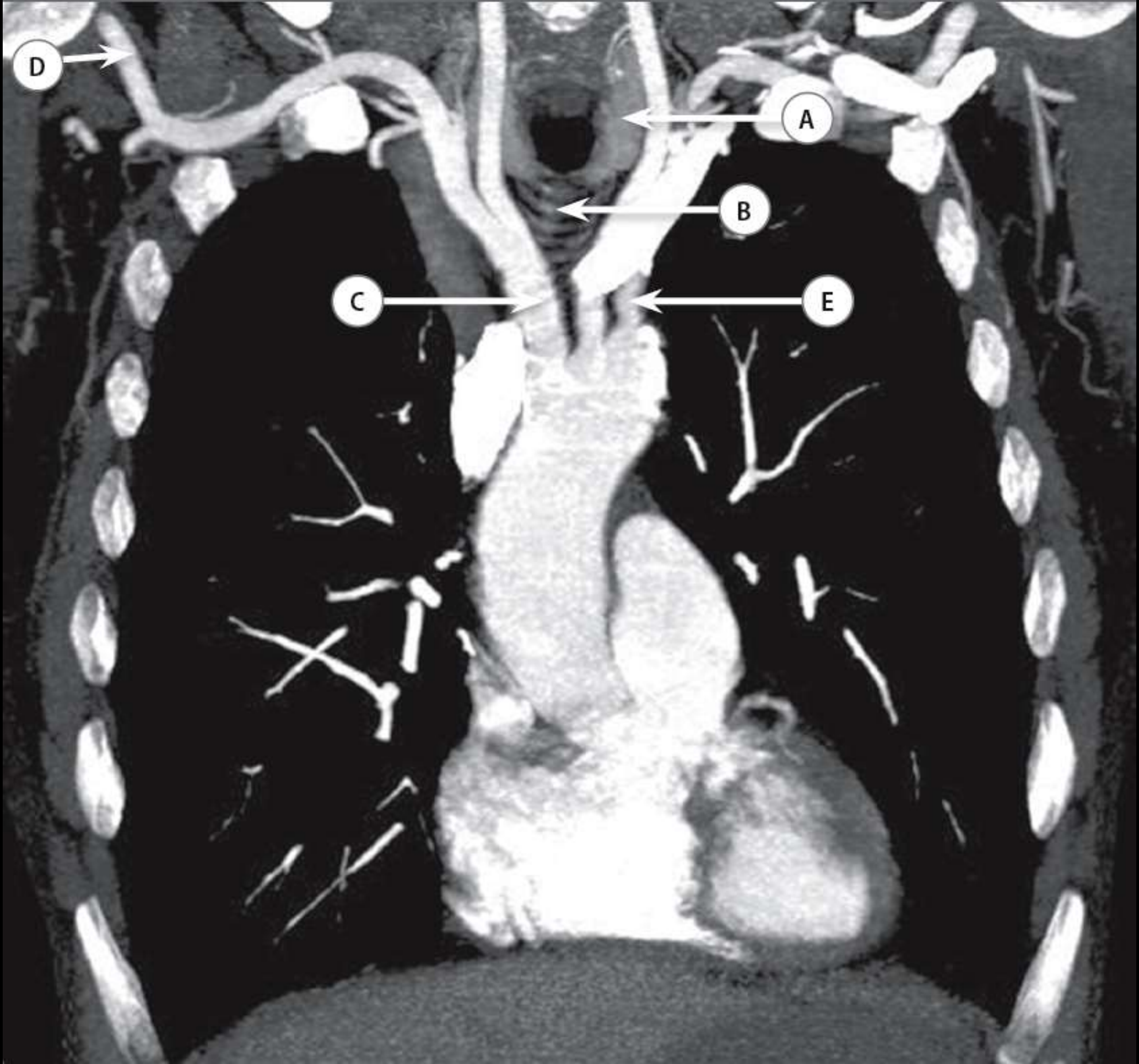
The left oblique fissure extends from about T4/T5 posteriorly to the diaphragm anteriorly. This is similar in both left and right lungs.

The right ventricle is the most anterior chamber of the heart. It is crescent shaped, and has a thinner wall than the larger, more muscular left ventricle. The left ventricle large and under higher pressure, therefore producing a bulge into the right ventricle, giving it this crescent shape. Inflow is from the right atrium via the tricuspid valve (three leaflets). Outflow is into the pulmonary artery via the pulmonary valve.

The muscular interventricular septum lies between the two ventricles and bulges into the right ventricle, giving the right ventricle its crescent shape and the left ventricle its circular shape.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 104–107.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 134.

Case 2.8



Case 2.8

A Left lobe of the thyroid

B Trachea

C Branchiocephalic trunk

D Right axillary artery

E Left subclavian artery

Coronal CT of the thorax through the arch of the aorta.

The ascending aorta begins at the aortic valve which lies at the level of the 2nd costal cartilage. The arch of the aorta passes posteriorly and from right to left.

The subclavian artery becomes the axillary artery at the lateral margin of the 1st rib. It becomes the brachial artery at the lower aspect of teres major. It provides branches to the lateral thorax and upper limb.

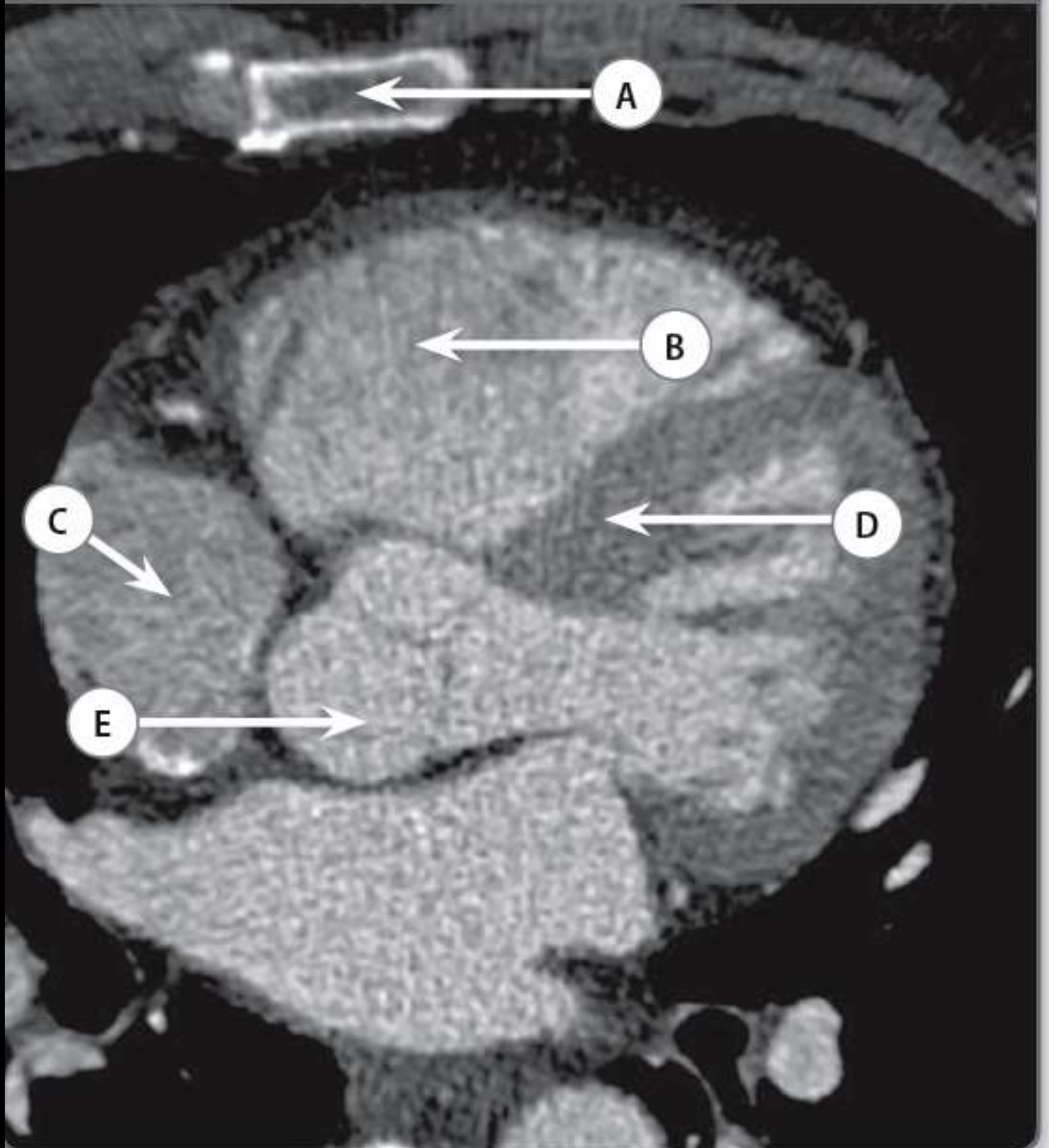
This configuration is only seen in 65% of people as variation is common:

- In 5% the vertebral artery arises directly from the arch of the aorta, between the left common carotid and left subclavian artery. This leads to four vessels arising from the aorta instead of three
- In 2.7% there is a common origin of the left common carotid and subclavian arteries (left branchiocephalic artery)
- In 2.5% the left common carotid artery arises from the branchiocephalic artery
- In 0.5% there is an aberrant right subclavian artery which arises distal to the left subclavian. It passes to the right passing behind the oesophagus

You should make sure you have seen images of these variants prior to the exam.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 117.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 140–144.
Weber E, Netter FH, Vilensky JA, Carmichael SW. Netter's Concise Radiologic Anatomy. Philadelphia: Saunders/Elsevier, 2008: 183.

Case 2.9



Case 2.9

A Sternum

B Right ventricle

C Right atrium

D Interventricular septum.

E Non-coronary (or right posterior) sinus of the aorta

Axial CT through the heart and aortic valve.

It is important to be able to identify the chambers of the heart both on coronal and axial images.

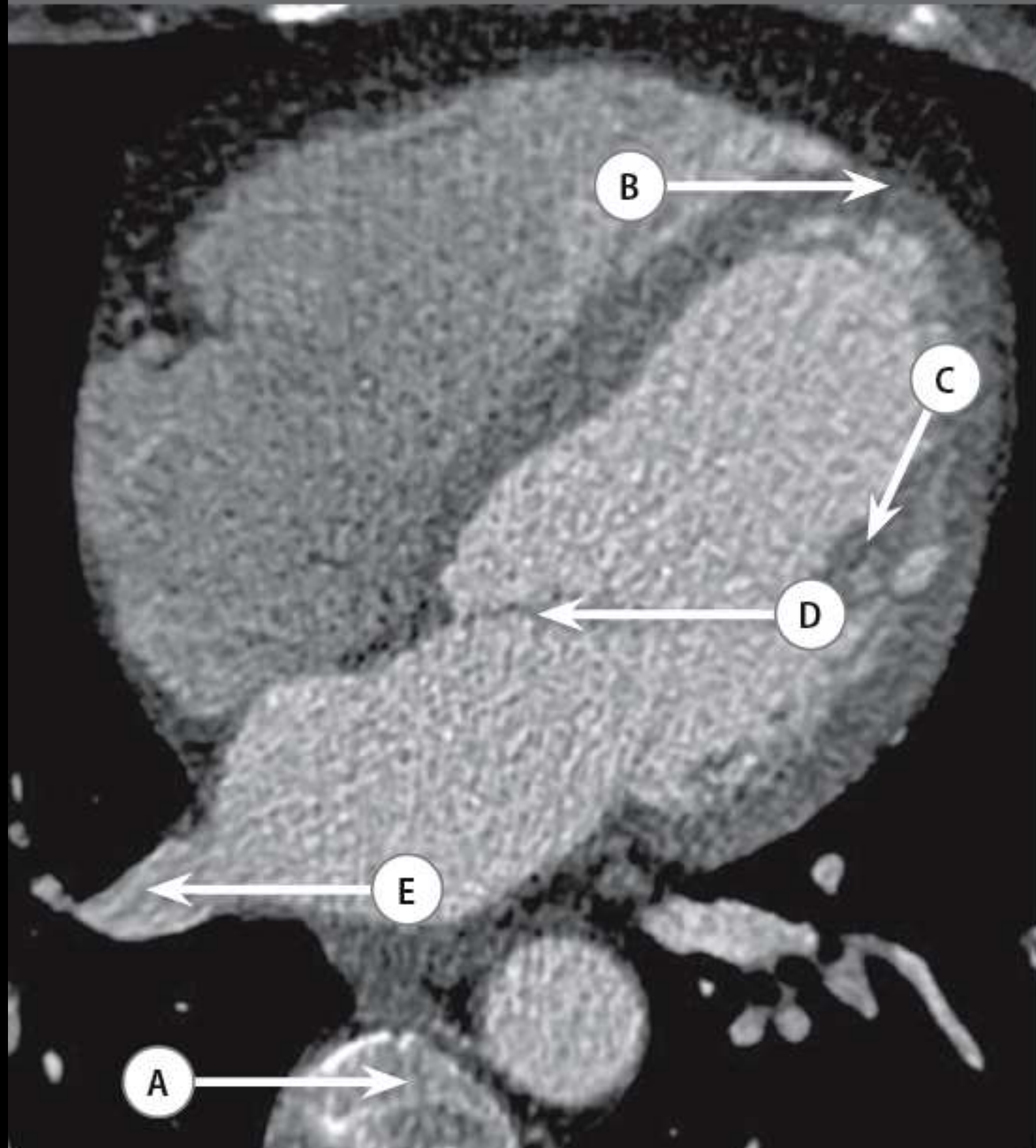
The right ventricle forms most of the sternocostal surface of the heart. The cavities of the right and left ventricles are separated by the interventricular septum. The cavity of the right ventricle is crescentic in cross-section because the interventricular septum bulges into it.

The aortic valve has three cusps. Above each cusp is a localised dilatation or sinus (sinuses of Valsalva). The right coronary artery arises from the anterior sinus (also known as the right coronary sinus). The left coronary artery arises from the left posterior sinus (also known as the left coronary sinus). No artery arises from the right posterior sinus (also known as the non-coronary sinus).

The interventricular septum is a thick muscular septum separating the left and right ventricles. It bulges into the right ventricle due to the increased pressure in the left ventricle.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 99.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 139.

Case 2.10



Case 2.10

A Thoracic vertebral body

B Apex of heart/left ventricular apex

C Papillary muscle

D Anterior cusp of mitral/bicuspid valve

E Right inferior pulmonary vein

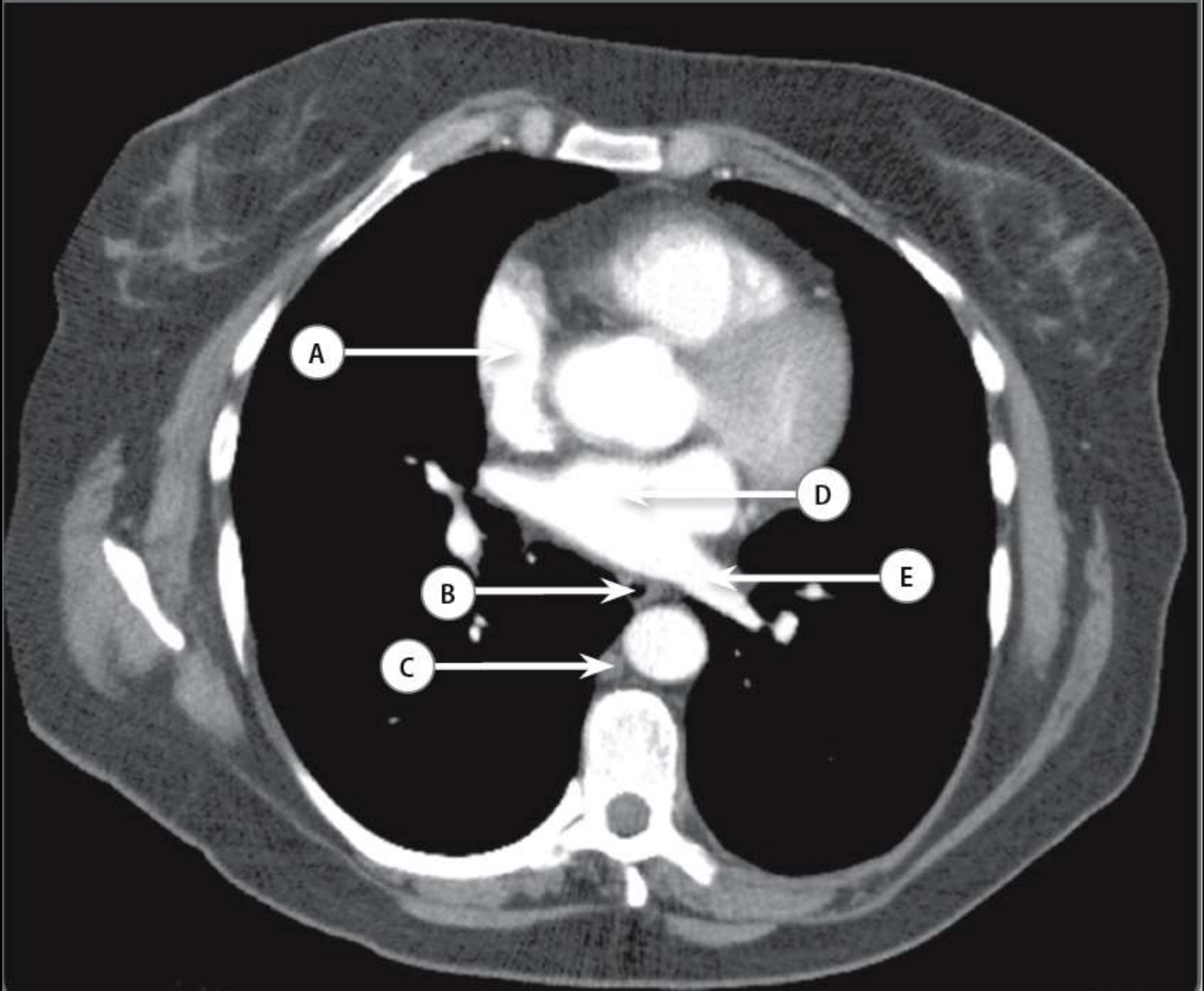
Axial CT of the heart.

Papillary muscle contraction prevents regurgitation of blood into the atrium by maintaining the position of the valve cusps during systole.

The bicuspid mitral valve separates the left atrium and left ventricle. The right pulmonary vein drains oxygenated blood from the lungs into the left atrium.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 99.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 139.
Weber E, Netter FH, Vilensky JA, Carmichael SW. Netter's Concise Radiologic Anatomy. Philadelphia: Saunders/Elsevier, 2009: 191.

Case 2.11



Case 2.11

A Right atrium

B Oesophagus

C Azygous vein

D Left atrium

E Left superior pulmonary vein

Axial CT pulmonary angiogram.

The right atrium receives deoxygenated blood from the superior vena cava (SVC), inferior vena cava (IVC) and coronary sinus through its smooth posterior wall. The SVC drains superiorly at the level of the right 3rd costal cartilage. The IVC drains at the level of the right 5th costal cartilage. The coronary sinus opens in between the right atrioventricular orifice and the IVC opening.

The anterior wall is rough and composed of pectinate muscular ridges. These ridges are continuous with the right atrial appendage/auricle which overlies the aorta and serves to increase the capacity of the right atrium. The interatrial septum has a depression, the fossa ovalis, the remnant of the foramen ovale which allows a right to left shunt during fetal circulation.

The azygos system of veins lies on either side of the vertebral column in the posterior mediastinum and drains the mediastinal organs, thoracic and abdominal walls, and the back. Its course and anatomy are variable.

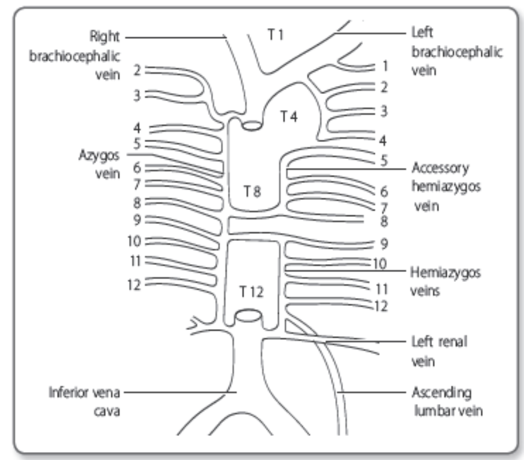


Figure 2.1 The azygos system.

The azygos begins at the level of L2 as a branch of the IVC, or as a confluence of lumbar and subcostal veins. It enters the thorax behind the right crus of the diaphragm, and lies to the right of the aorta and thoracic duct. The azygos enters the SVC by arching over the right hilum from the posterior mediastinum.

The azygos receives blood from most of the intercostal veins on the right, as displayed in the diagram above. The hemiazygos and accessory hemiazygos receive blood from most of the intercostal veins on the left, and drain into the azygos at the midthoracic level.

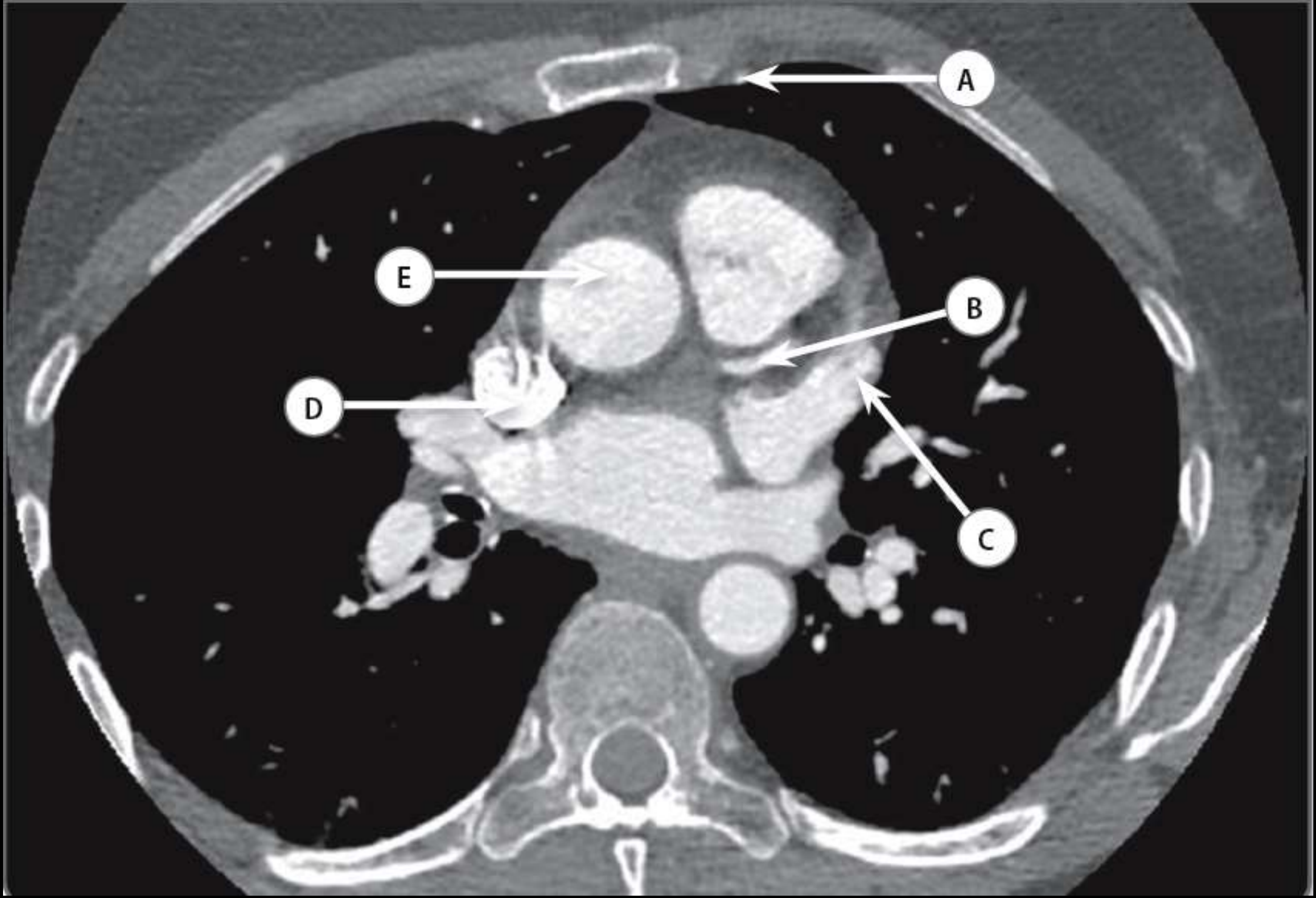
The hemiazygos often begins at the left renal vein, and ascends into the thorax on the left side of the aorta. These structures are shown in **Figure 2.1**.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 135–165.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 99.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 132–135.

Case 2.15



Case 2.15

A Left internal mammary/thoracic artery

B Left anterior descending artery

C Left atrial appendage

D Superior vena cava

E Ascending aorta

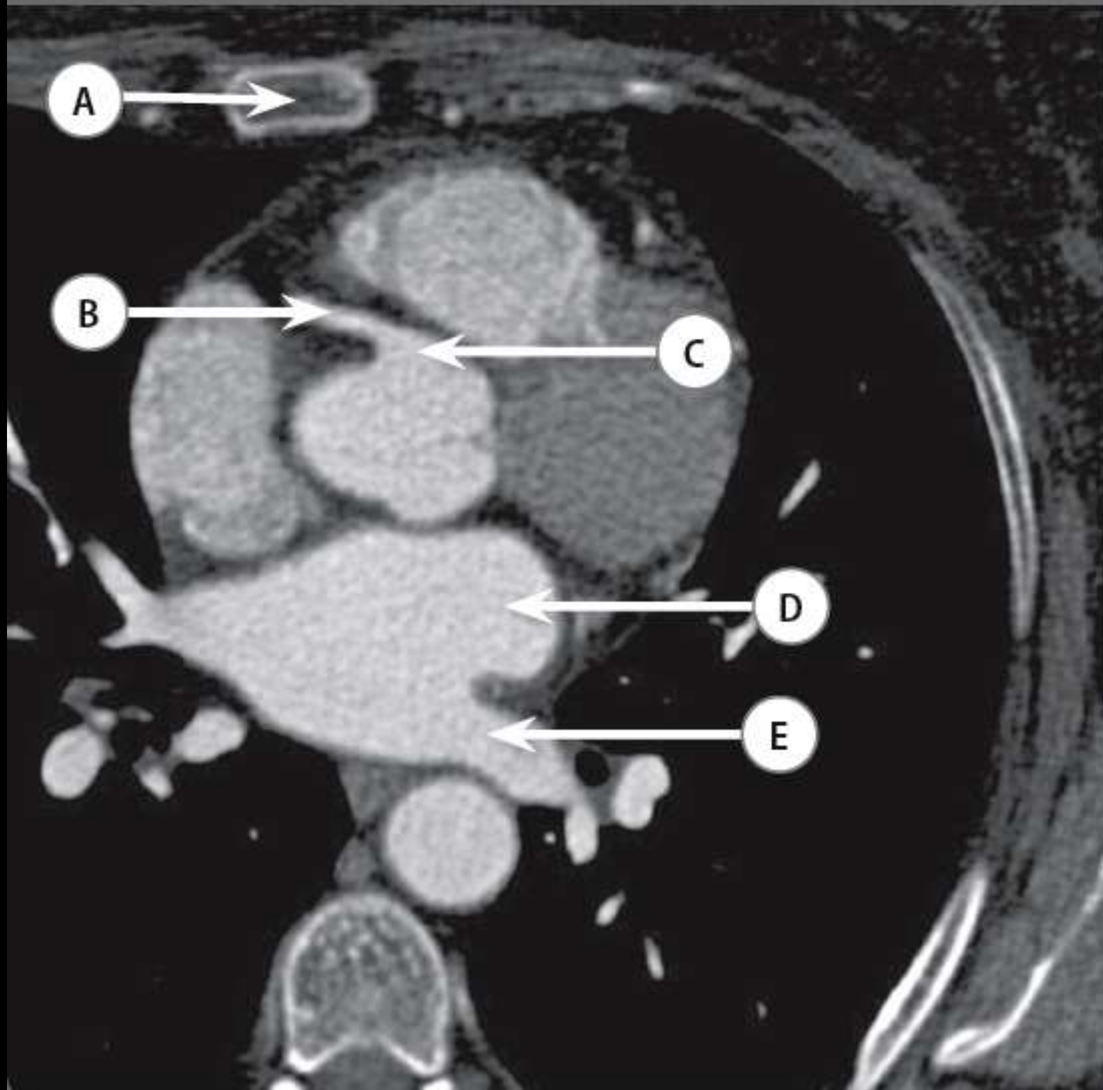
Axial cardiac CT.

The internal mammary/thoracic arteries originate from the subclavian arteries, and enter the thorax behind the clavicle and 1st costal cartilage. They run along the inside of the thoracic wall just lateral to the sternum, to the 6th intercostal space where they divide into the superior epigastric and musculophrenic arteries.

The left atrial appendage serves to increase the capacity of the left atrium, and may be the source of emboli in atrial fibrillation.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 135–165.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 99.

Case 2.18



Case 2.18

A Sternum

B Right coronary artery

C Anterior sinus of Valsalva/right aortic sinus

D Left atrium

E Left inferior pulmonary artery

Axial CT of the chest.

The sternum consists of three fused bones: manubrium, body of sternum and xiphoid process. Superiorly, the junction of the manubrium with the body of sternum is called the 'Angle of Louis'. This is at the level of T4/T5, where the 2nd rib articulates. This is the same level as the aortic arch and the carina.

The right coronary artery (RCA) arises from the anterior sinus of Valsalva/right aortic sinus and travels between the right atrium and pulmonary trunk in the right atrioventricular groove. The RCA supplies:

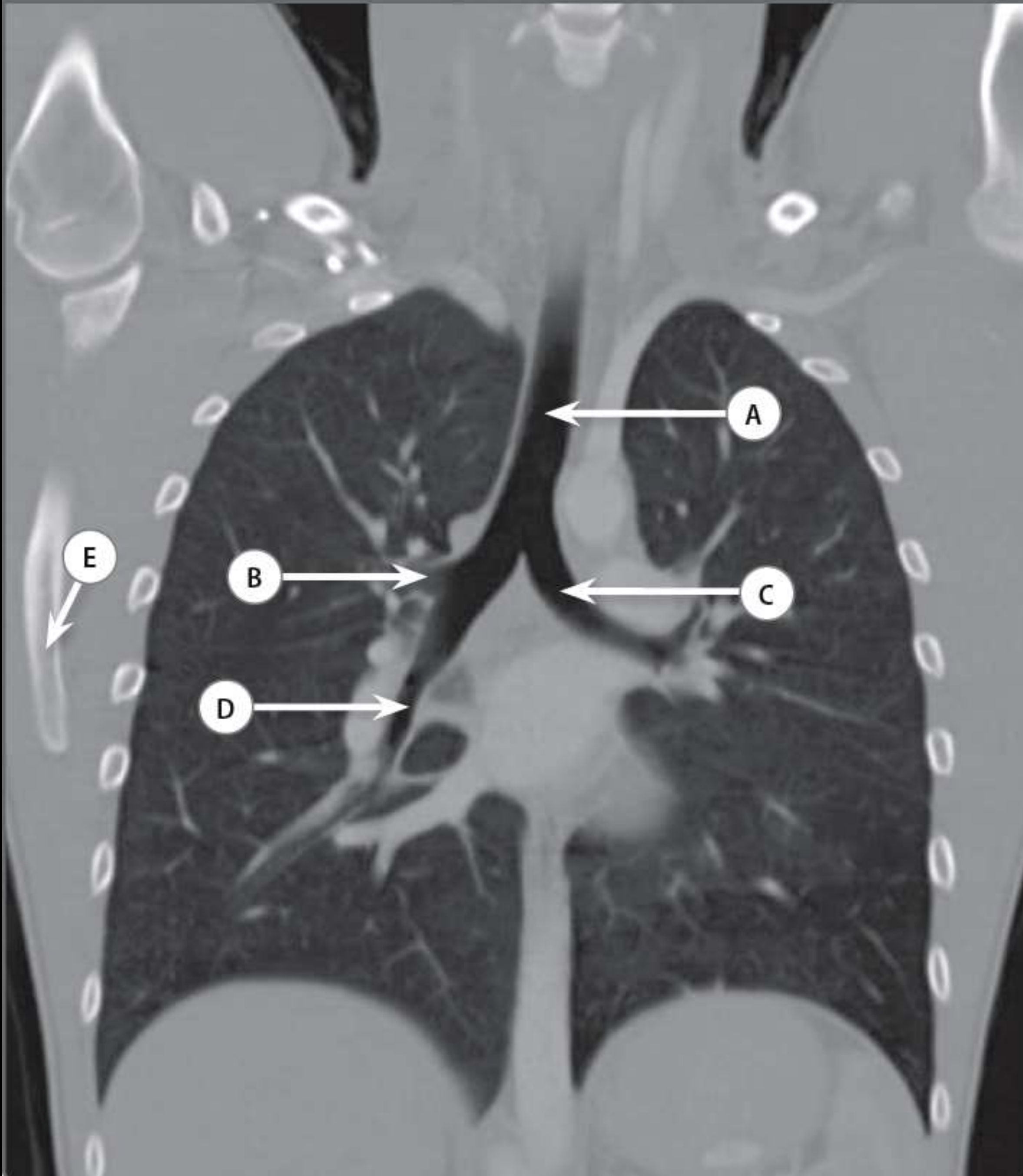
- the right atrium
- most of the right ventricle

- the diaphragmatic surface of the left ventricle
- part of the atrioventricular septum
- the sinoatrial node (in 60% of people)
- the atrioventricular node (in 80% of people).

The left main pulmonary artery runs superoposteriorly, and arches over the left main bronchus before entering the hilum. At this point, it branches into its lobar branches.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 135–165.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 99.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 139.

Case 2.19



Case 2.19

A Trachea

B Right upper lobe bronchus

C Left main bronchus

D Bronchus intermedius

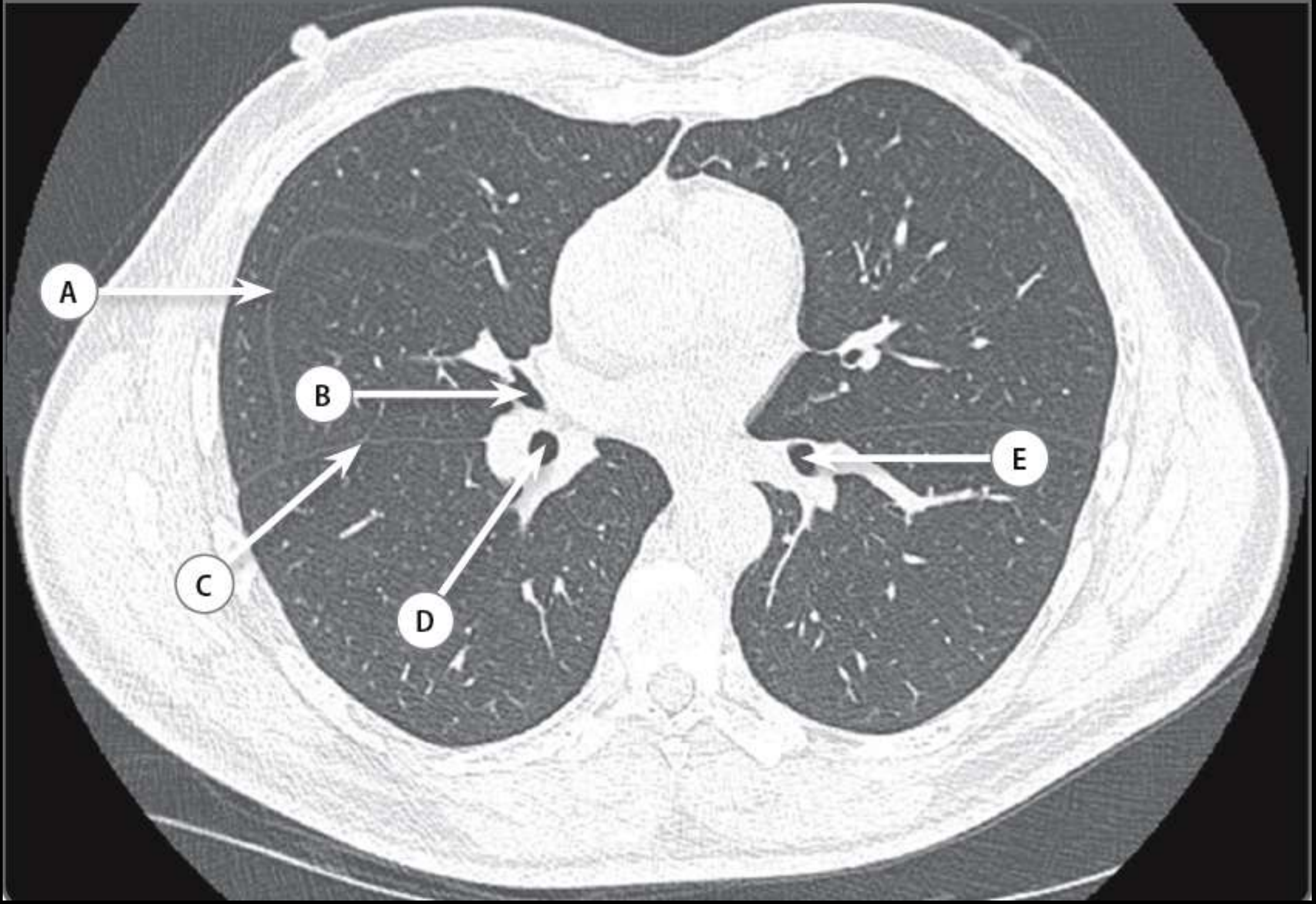
E Right scapula

Coronal reformatted CT of the thorax.

The trachea begins at C6 level at the lower border of the cricoid cartilage. The trachea is lined by ciliated columnar epithelium, is approximately 15 cm long, 2 cm in diameter, and made of 15–20 incomplete rings of cartilage which are completed posteriorly by the trachealis muscle. On paediatric plain radiographs, the trachea may be quite substantially deviated to the right – this is normal. The lower trachea is supplied by branches of the bronchial artery. The upper trachea is supplied by the inferior thyroid artery. The arch of the aorta may indent the left side of the trachea just above the carina.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 102.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 122–125.

Case 2.20



Case 2.20

A Horizontal fissure

B Middle lobe bronchus

C Oblique fissure

D Right lower lobe bronchus

E Left lower lobe bronchus

High-resolution CT (HRCT).

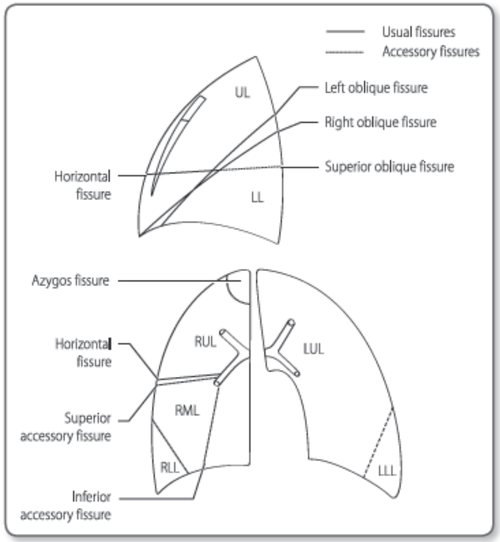


Figure 2.6 The pulmonary lobes and fissures. UL, upper lobe; ML, middle lobe; LL, lower lobe; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; LUL, left upper lobe; LLL, left lower lobe.

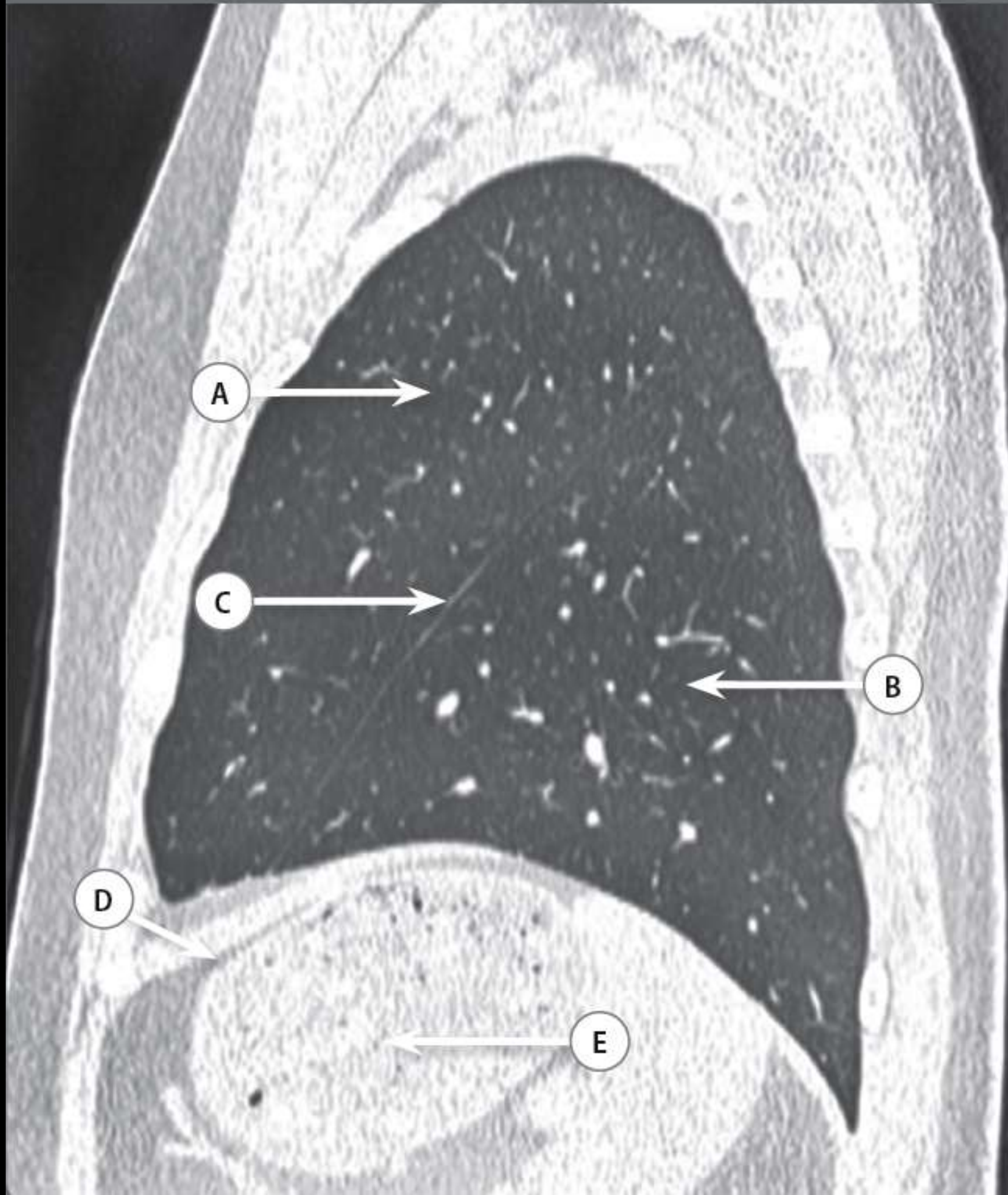
The fissures are well demonstrated on HRCT. The oblique fissures appear as:

- thin curvilinear lines which are concaved anteriorly in the upper thorax
- flat lines in the midthorax
- convex anterior lines in the lower chest

The horizontal fissure is seen as an avascular zone in the midthorax (**Figure 2.6**).

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 122.

Case 2.22



Case 2.22

A Left upper lobe

B Left lower lobe

C Left oblique fissure

D Left anterior hemidiaphragm

E Stomach with gastric contents

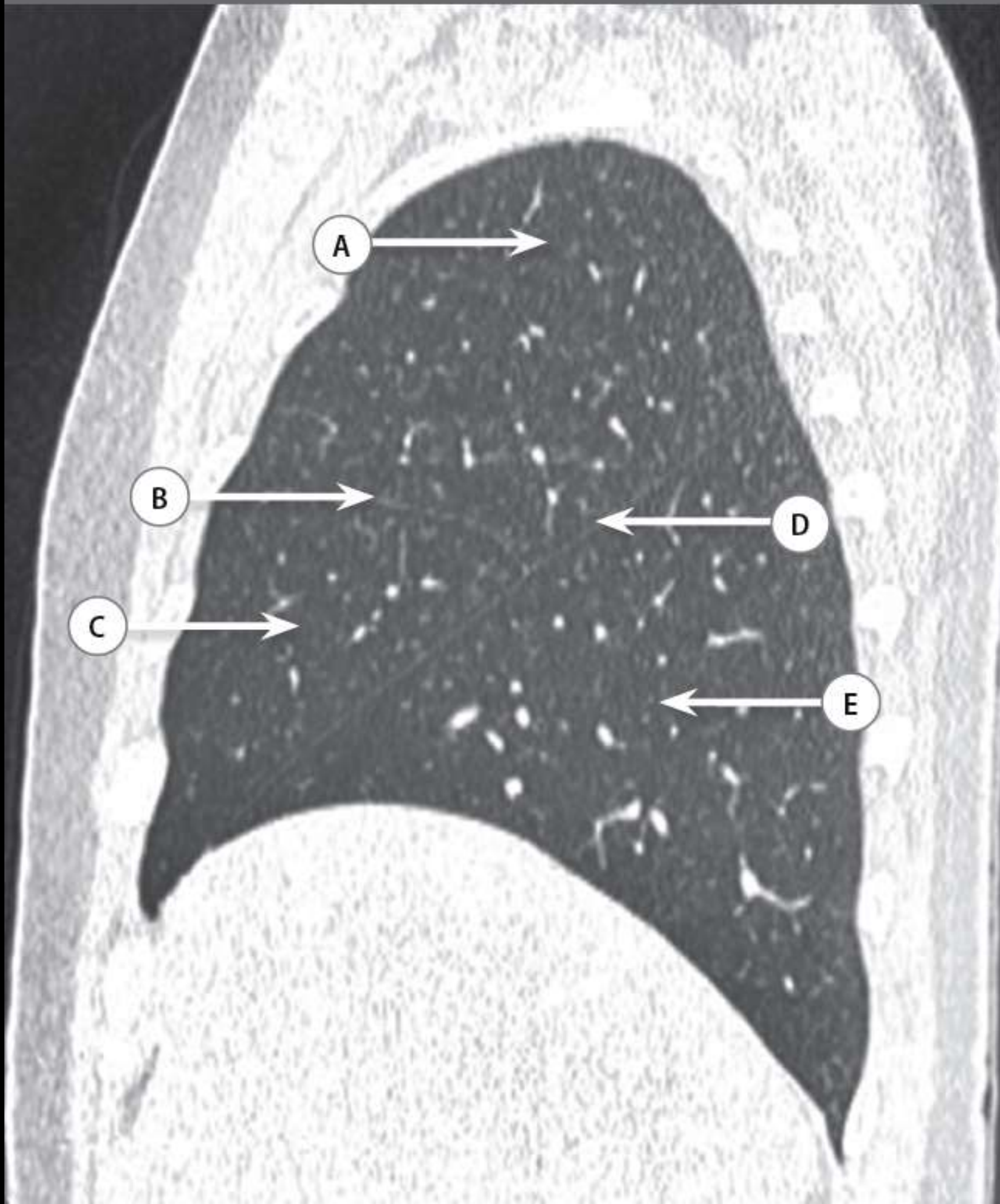
Sagittal reformatted high-resolution CT.

The left upper lobe is anterior and superior to the left lower lobe. The left oblique fissure separates the two lobes, and travels from T4/T5 posteriorly to the diaphragm anteroinferiorly.

The stomach is situated just inferior to the left hemidiaphragm, which is demonstrated well here.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 125–126.

Case 2.23



Case 2.23

A Right upper lobe

B Horizontal fissure

C Middle lobe

D Right oblique fissure

E Right lower lobe

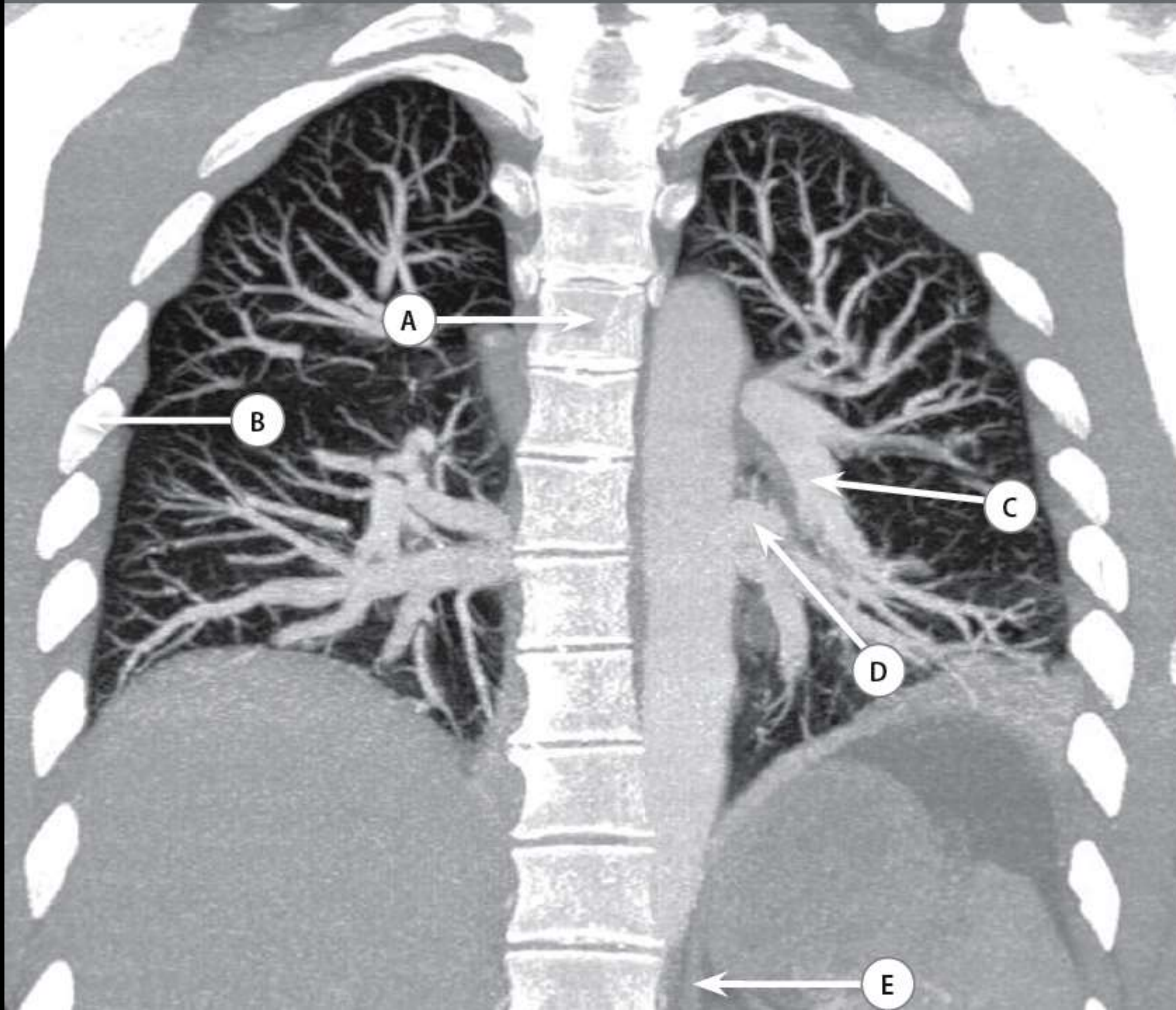
Sagittal reformatted high-resolution CT.

The right upper lobe is superior and anterior. The middle lobe sits anterior and inferior, and the right lower lobe sites posterior and inferior. The right oblique fissure follows a similar course to the left oblique fissure.

The horizontal fissure travels from the hilum laterally at the level of the 4th costal cartilage. It meets the oblique fissure posteriorly in the midaxillary line at the level of the 6th rib. It is absent in 10% of people and complete in only 30%.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 125–126.

Case 2.28



Case 2.28

A T4 vertebral body

B Right 5th rib

C Left lower lobe pulmonary artery

D Left lower lobe pulmonary vein

E Left crus of the diaphragm

Coronal CT pulmonary angiogram of the thorax.

This is a posterior section as the vertebral bodies and the aorta can be seen. There is contrast in the pulmonary arteries and thus they are of higher attenuation than the aorta.

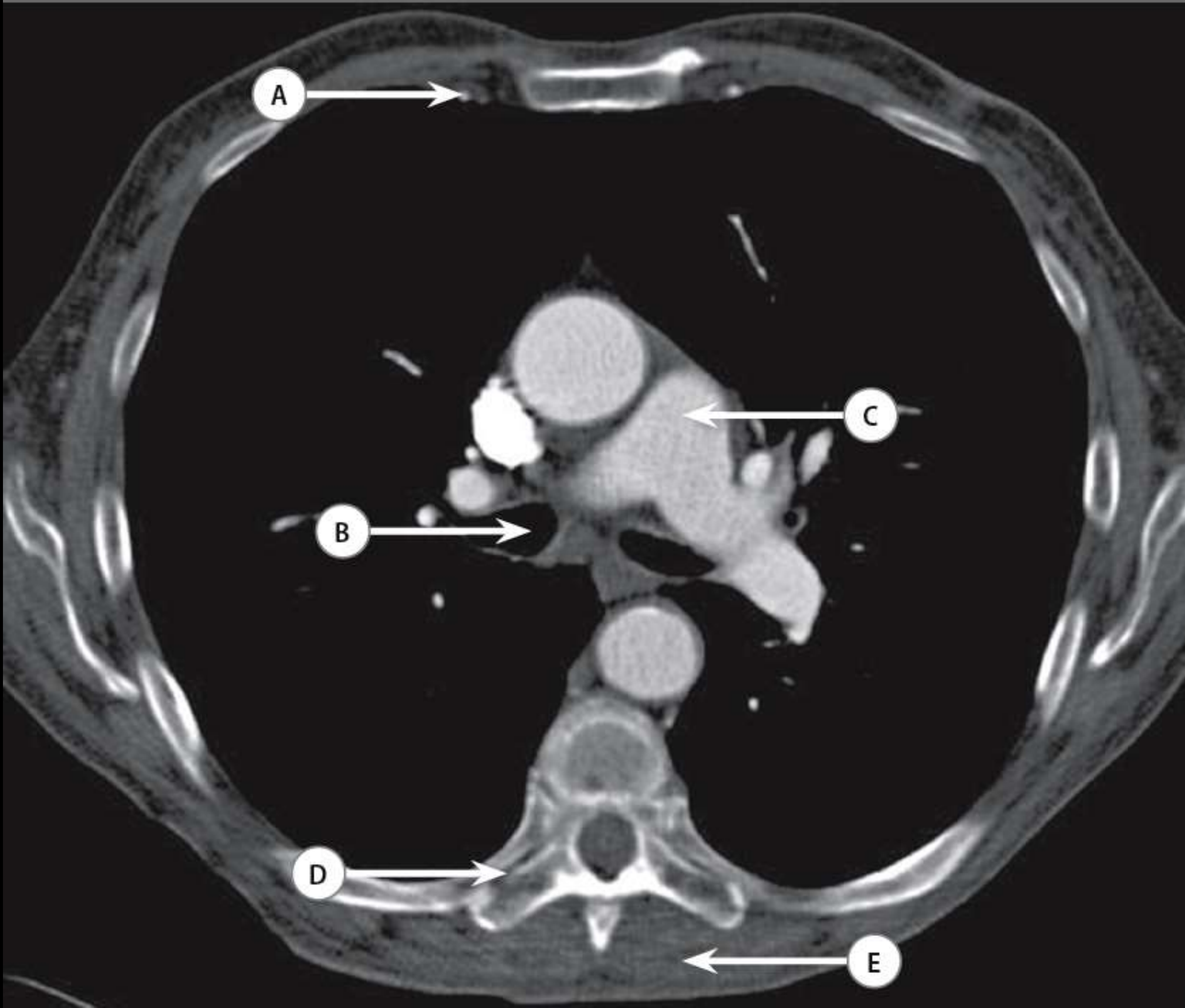
Bony structures A and B are easily recognised as a vertebral body and a rib. It is of paramount importance not to rush into writing these answers down; the number and laterality of the ribs must be given. Forgetting to include these details will cost precious points. In this case, the 1st rib can be seen and the numbers of the labelled structures can be determined by counting down. If you cannot find anything that helps to determine the number of a labelled vertebral body, simply indicate whether it is cervical, thoracic or lumbar.

The branching of the pulmonary arteries closely follows the branching of the airways; this is not the case with the branching of the pulmonary veins. Remembering this fact will prevent mistaking pulmonary arteries for veins.

The main divisions of the pulmonary trunk are the right and left pulmonary arteries. At the left hilum, the left pulmonary artery divides into the upper and lower lobe branches.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 110–111.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 126–127.
Weber E, Netter FH, Vilensky JA, Carmichael SW. Netter's Concise Radiologic Anatomy. Philadelphia: Saunders/Elsevier, 2009: 205.

Case 2.29



Case 2.29

A Right internal thoracic artery/mammary artery

B Right main bronchus

C Pulmonary trunk/main pulmonary artery

D Costotransverse joint on the right

E Left erector spinae

Axial CT of the chest.

This is an axial section through the thorax at the level of the pulmonary trunk division. The pulmonary trunk begins at the pulmonary valve inferior to the level seen here. At first it lies anterior to the aorta and then passes to its left to lie in the concavity of the arch where it divides.

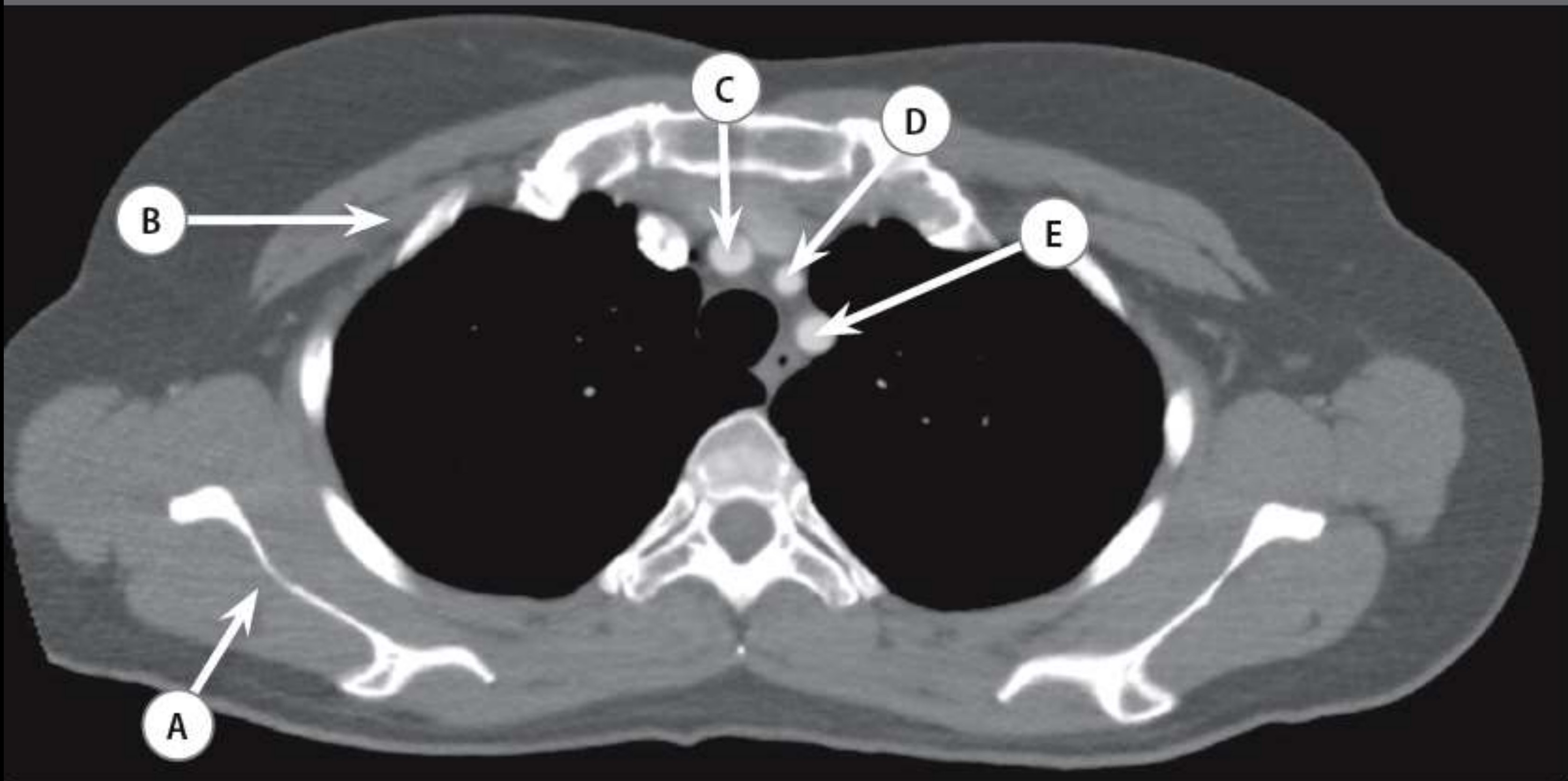
The internal thoracic/internal mammary artery arises from the subclavian artery near its origin. It is a paired artery that supplies the anterior chest wall and the breast. It divides into the superior epigastric and musculophrenic arteries.

The facet of the tubercle of the rib forms an articulation with the transverse process of the vertebra. This is called the costotransverse joint. It is not possible to assign a number to the costotransverse joint in this image as there are no solid landmarks to count from. Therefore only laterality can be indicated.

The erector spinae is a large muscular and tendinous mass which acts as an extensor of the spine. Its superior part attaches to the transverse processes of the lumbar vertebra and the 11th and 12th rib.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 93.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 133.

Case 2.30



Case 2.30

A Right infraspinatus

B Right pectoralis minor

C Brachiocephalic trunk

D Left common carotid artery

E Left subclavian artery

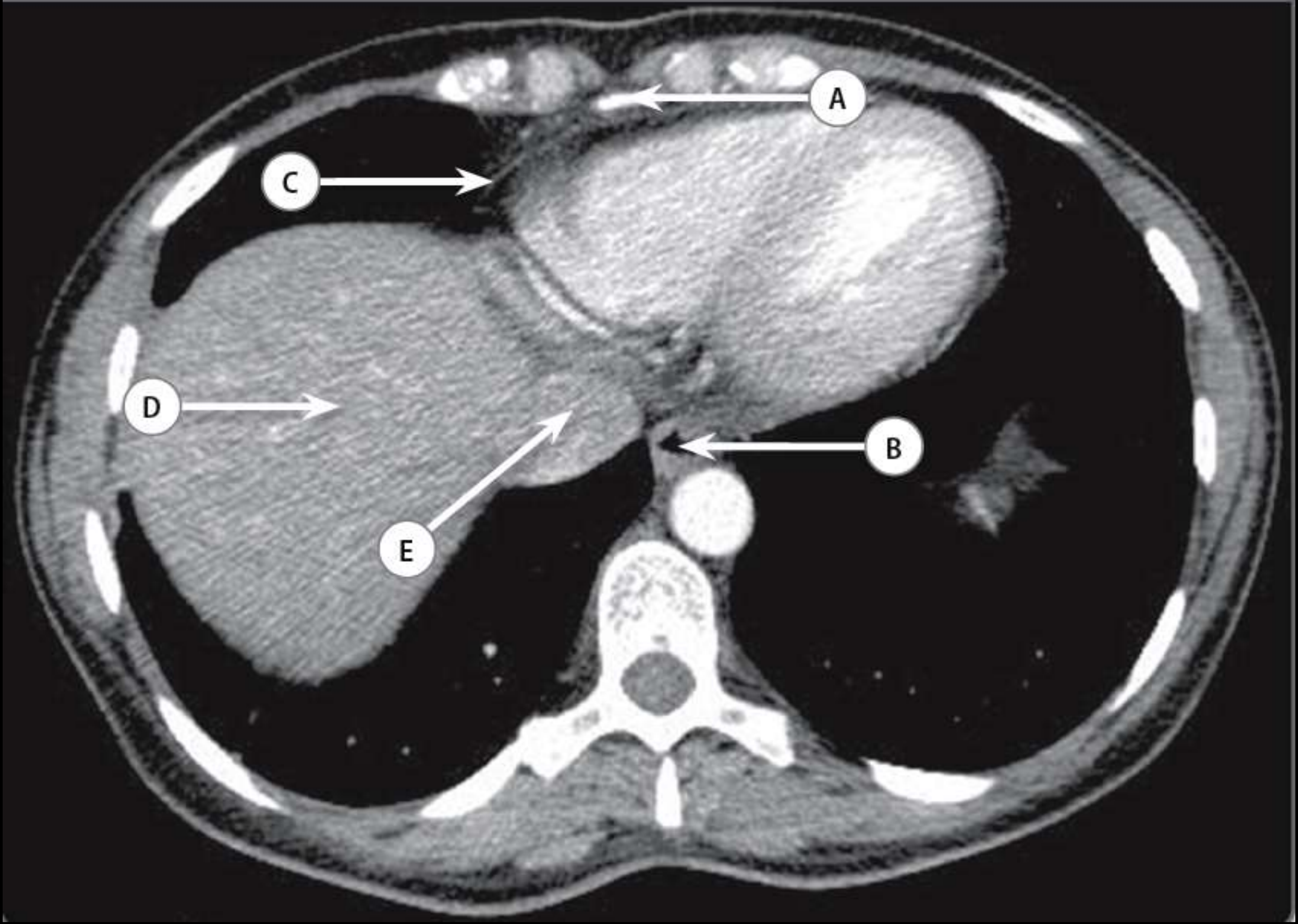
Axial CT of the thorax.

The infraspinatus comprises one of the four rotator cuff muscles (the others being supraspinatus, teres minor and subscapularis). It is a stabiliser and lateral rotator of the humerus, and lies in the infraspinous fossa where it is partially covered by the trapezius and deltoid. It is supplied by the suprascapular nerve.

The pectoralis minor lies beneath the larger pectoralis major. Its attachments are the anterior 3rd to 5th ribs and the coracoid process of the scapula. It lies in the anterior wall of the axilla, and nerves and vessels travel under it to enter the arm. Its functions are to draw the scapula anteriorly and inferiorly to stabilise it against the chest wall, and to elevate the ribs in deep inspiration. It is innervated by the medial pectoral nerve.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 709.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 96.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 153.

Case 2.31



Case 2.31

A Xiphisternum

B Oesophagus

C Pericardium

D Right lobe liver

E Inferior vena cava

Axial CT of the thorax.

The pericardium is a double walled sac which is draped over the heart and great vessels and has a visceral and parietal layer. The visceral layer is attached to the myocardium. The parietal layer is loose except superiorly where it is attached to the great vessels, and inferiorly where it is attached to the central tendon of the diaphragm by the pericardiophrenic ligament.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 132.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 107.

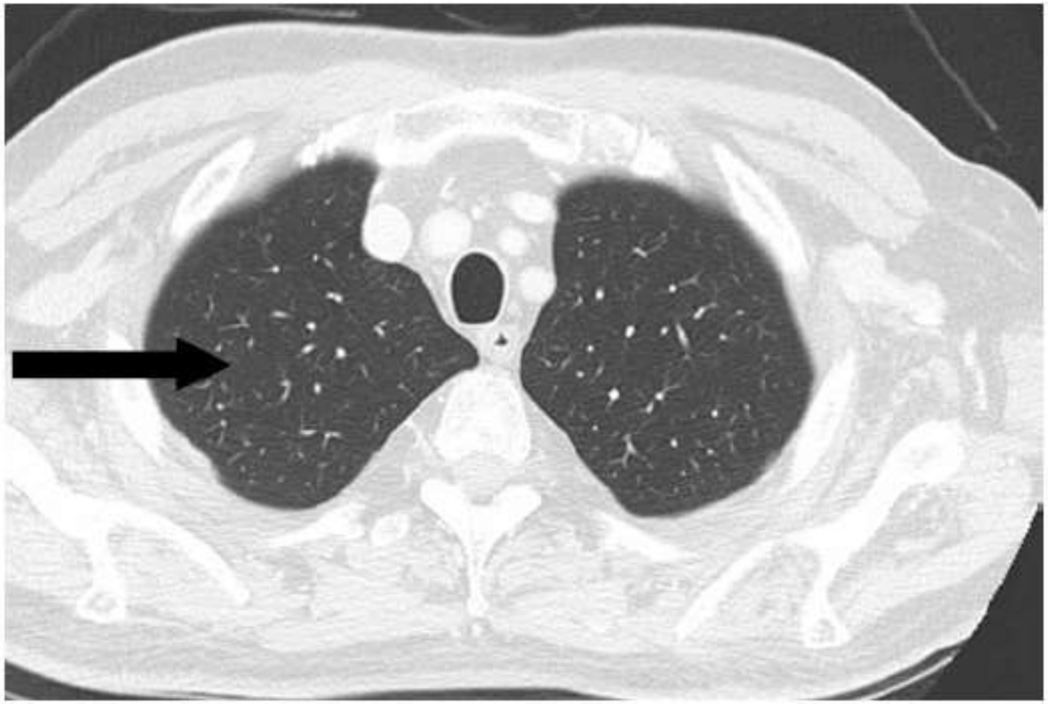
Question 1:

Question 1: PA chest radiograph

Answer: Trachea

- The trachea is a rigid, tubular structure responsible for the passage of air from the pharynx to the lungs and is reinforced by C-shaped cartilaginous rings. The flat band of muscle and connective tissue posterior to it is called the posterior tracheal membrane, which can appear convex during expiratory views on CT.
- It is 12 to 15 cm long in adults.
- On a PA chest radiograph, it is seen as a midline transradiant cylindrical structure beginning at the level of the lower part of the cricoid cartilage and extending to the carina (from C6 to approximately T5).
- A slight deviation to the right is normal, particularly in children.

■ Question 2:

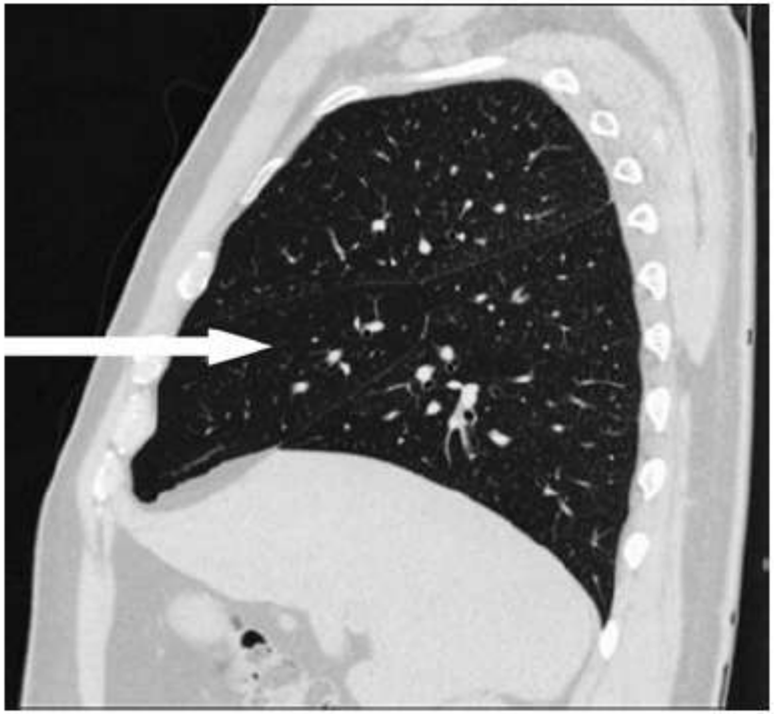


Question 2: Axial CT of the chest

Answer: Right upper lobe

- The right upper lobe is separated from the middle lobe by the horizontal fissure.
- It is divided into three segments: anterior, apical, and posterior.
- The interface between the right upper lobe medial pleural surface and right lateral tracheal border, when seen on a chest radiograph, is termed right paratracheal stripe.

- **Question 3:**

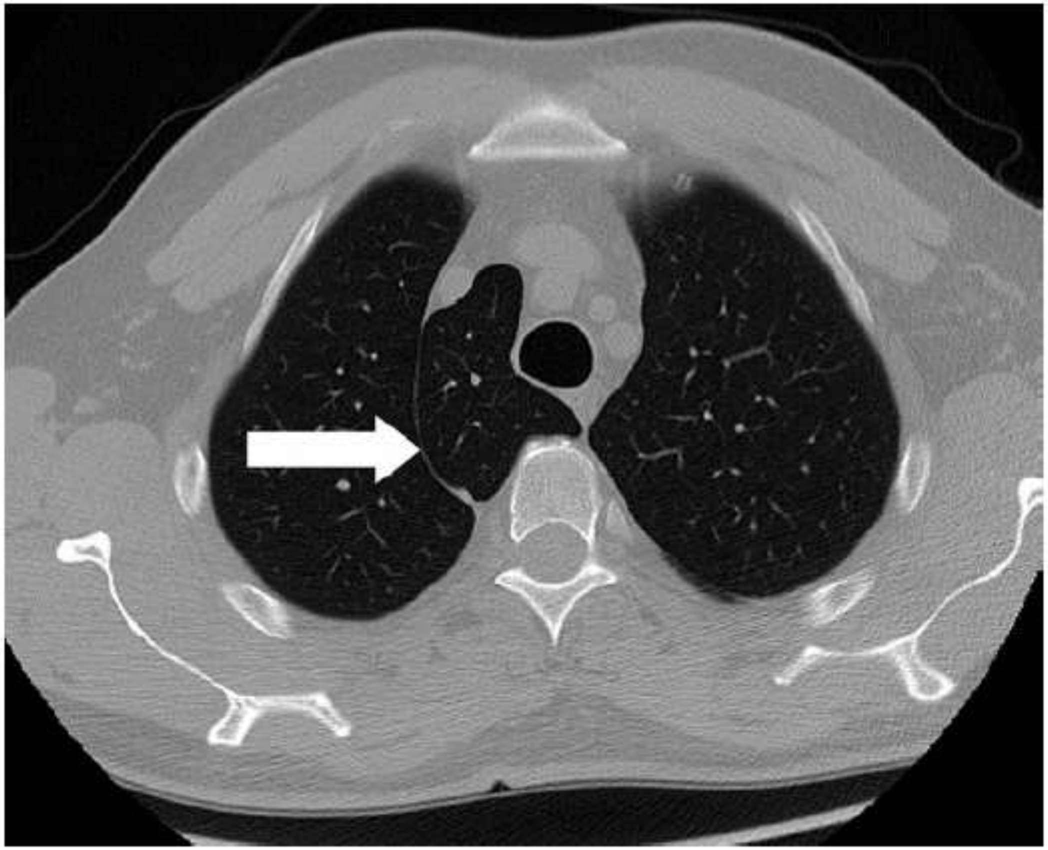


Question 3: Sagittal CT of the chest

Answer: Middle lobe

- The middle lobe is divided into two segments: medial and lateral.
- It is separated from the upper lobe by the horizontal fissure superiorly and from the lower lobe by the oblique fissure inferiorly.

- **Question 4:**

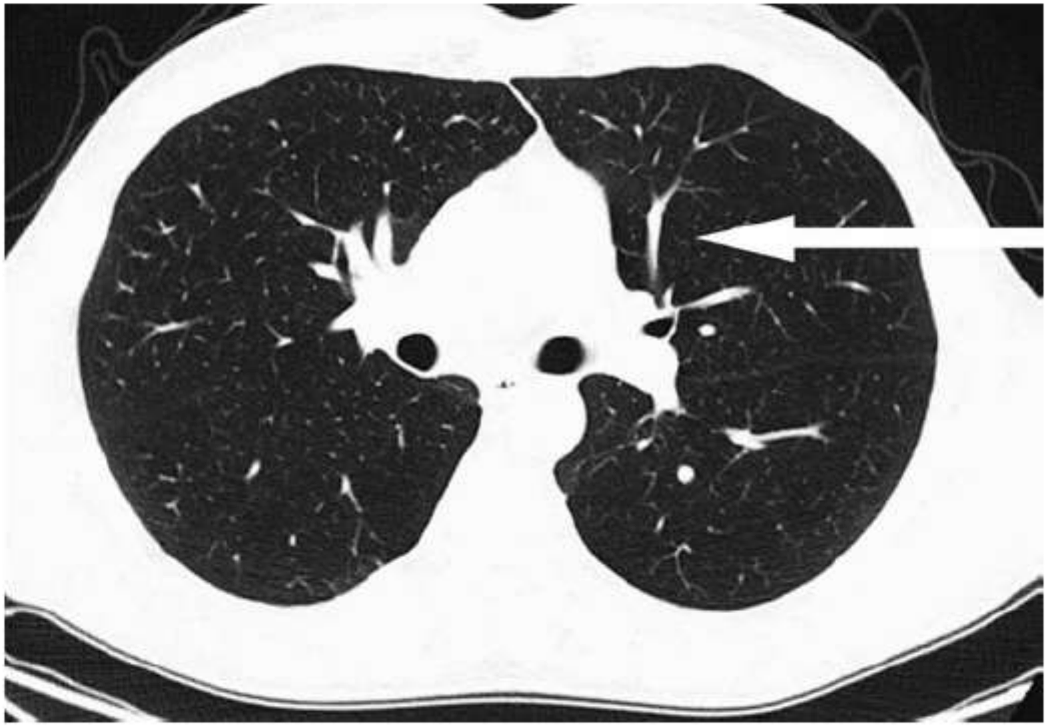


Question 4: Axial CT of the chest

Answer: Azygos fissure

- An azygos fissure is the most common accessory fissure and is a common examination question.
- An azygos fissure is seen in approximately 1% of the population.
- It occurs because of failure of normal migration of the azygos vein, which leads to invagination of the parietal and visceral pleura along its course. Sometimes the section of lung medial to the fissure is termed the azygos lobe.
- If complete, it has clinical relevance because it acts as a barrier to apical consolidation extending inferiorly to the rest of the upper lobe.

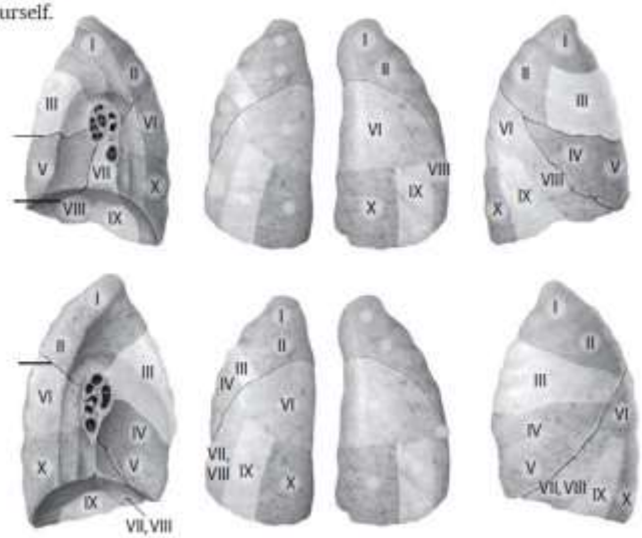
- **Question 5:**



Question 5: Axial CT of the chest

Answer: Left upper lobe

- The left upper lobe is analogous to a combined right upper and middle lobe.
- It is separated from the left lower lobe by the left oblique fissure.
- It is divided into four segments: anterior, apicoposterior, and the superior and inferior lingular segments.
- The figure below illustrates the different lung segments within the lung lobes with which you should familiarise yourself.



From Atlas of Anatomy, © Thieme 2008, illustrations by Markus Voll.

Segmental architecture of the lungs

Each segment is supplied by a segmental bronchus of the same name (e.g., the apical segmental bronchus supplies the apical segment).

Right lung		Left lung	
Superior lobe			
I	Apical segment	Apicoposterior segment	I
II	Posterior segment		II
III	Anterior segment		III
Middle lobe		**Lingula**	
IV	Lateral segment	Superior lingular segment	IV
V	Medial segment	Inferior lingular segment	V
Inferior lobe			
VI	Superior segment		VI
VII	Medial basal segment		VII
VIII	Anterior basal segment		VIII
IX	Lateral basal segment		IX
X	Posterior basal segment		X

Note: In the left lower lobe, the anterior basal and medial basal segments are conjoined to form the anteromedial basal segment.

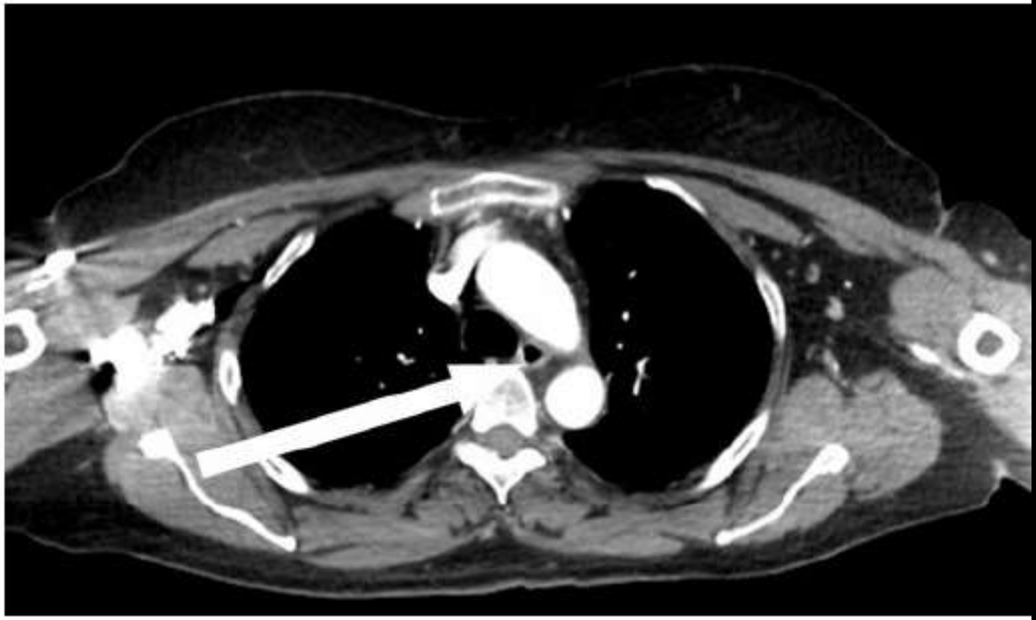
- **Question 7:**

Question 7: Axial CT of the chest

Answer: Right main bronchus

- The right main bronchus arises from the trachea at the carina.
- It forms a more obtuse angle with the trachea compared to the left (lies at 25° to the median plane).
- It is considerably shorter than the left (about half the length) with a mean length of 2.2 cm.

Question 8:

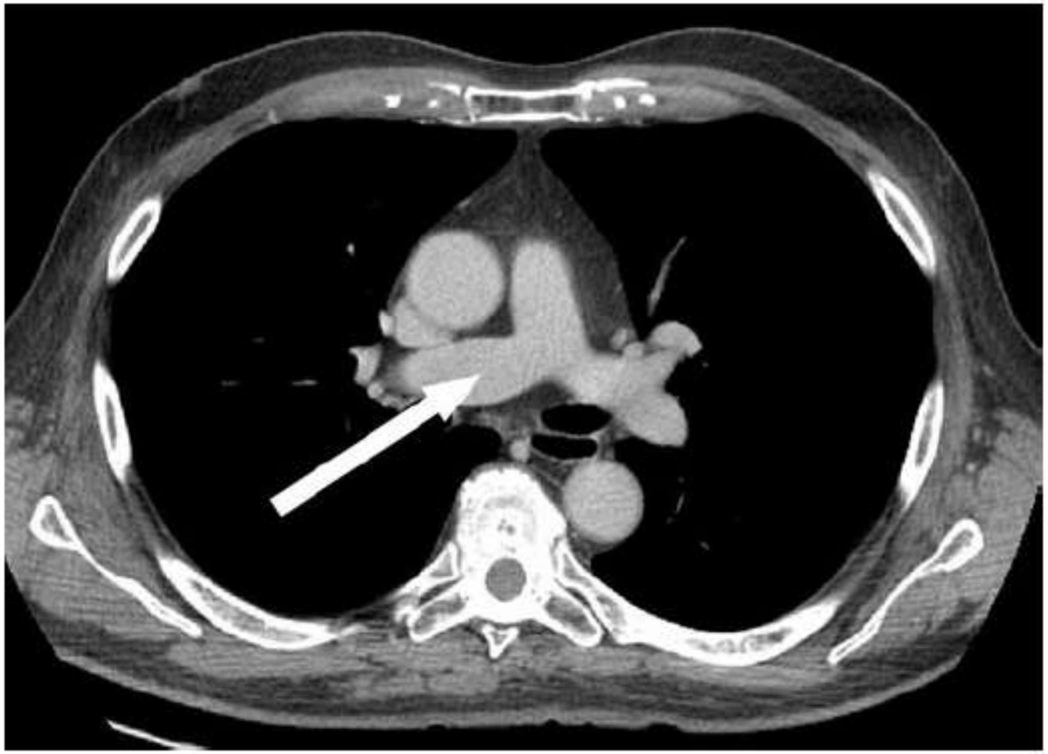


Question 8: Axial CT of the chest

Answer: Oesophagus

- The oesophagus is the muscular tubular structure that is responsible for conducting food from the mouth to the stomach. It begins at the level of the cricopharyngeus and terminates at the gastro-oesophageal junction and measures approximately 25 cm in length.
- The examination aims to test the candidate on common anatomical structures, but in somewhat unusual modalities or planes such as an axial CT in this instance, or a sagittal CT demonstrating a longitudinal 'slip' of air posterior to the trachea that may project in and out of plane.

Question 10:

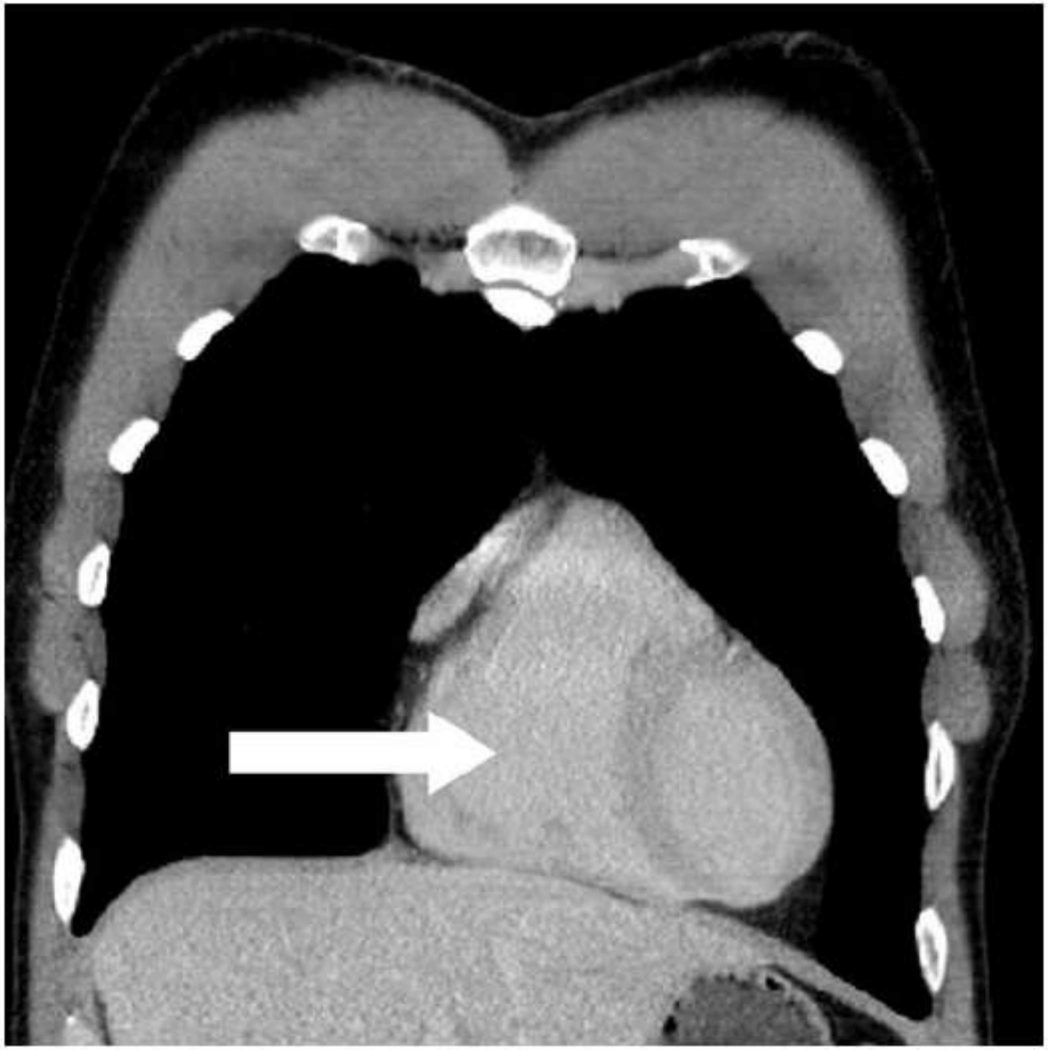


Question 10: Axial CT of the chest

Answer: Right main pulmonary artery

- The right main pulmonary artery arises at a right angle from the pulmonary trunk and passes behind the ascending aorta and the superior vena cava. It passes anterior to the right main bronchus.
- It is longer than the left main pulmonary artery.
- The left main pulmonary artery arches superiorly over the left bronchus making it much shorter. This is why the left hilar point is higher than the right on a PA chest radiograph.

Question 11:



Question 11: Coronal CT of the chest

Answer: Right ventricle

- The right ventricle is an anterior structure and, when anatomically normal, is not visible on a PA radiograph. It is border-forming on a lateral projection.
- Being the second largest chamber in a normal heart, it is readily identifiable.
- Sometimes the right ventricle will be shown in alternative projections, such as sagittal views where its inferior border usually comes into contact with the sternum, or a coronal view (as in this case) to show its anterior position.

Question 12:

Question 12: Axial CT of the chest

Answer: Right pectoralis major muscle

- The pectoralis major muscle is a fan-shaped muscle that covers the anterior superior aspect of the thorax and is the most superficial muscle.
- It has two components that are capable of acting independently: a sternal component and a clavicular component. These converge to cross below the shoulder joint to insert at the bicipital groove.
- The pectoralis major muscle is a strong adductor of the arm and also acts as an internal rotator of the humerus.

Question 13:

Question 13: Axial CT of the chest

Answer: Interventricular septum

- The interventricular septum is a strong, thick structure composed of muscular and membranous components that separate the ventricles. It bows to the right due to the higher left ventricular pressure.
- Assessment of the interventricular septum is important because it is a marker of many cardiopulmonary diseases such as pulmonary hypertension, ventricular septal defects, and interventricular aneurysms.

- **Question 15:**

Question 15: Axial CT of the chest

Answer: Right costovertebral joint

- A costovertebral joint, as the name implies, is the articulation between the head of a rib and the vertebral column.
- A typical rib articulates at two points with the spine: the head of the rib articulates with the vertebral body (costovertebral) and the tubercle of the rib articulates with the transverse process (costotransverse).
- Atypical ribs such as the 11th and 12th ribs do not articulate with the corresponding transverse processes of the vertebral body.
- The costovertebral joint is a synovial joint and, as such, is prone to synovial disease processes such as rheumatoid arthritis.

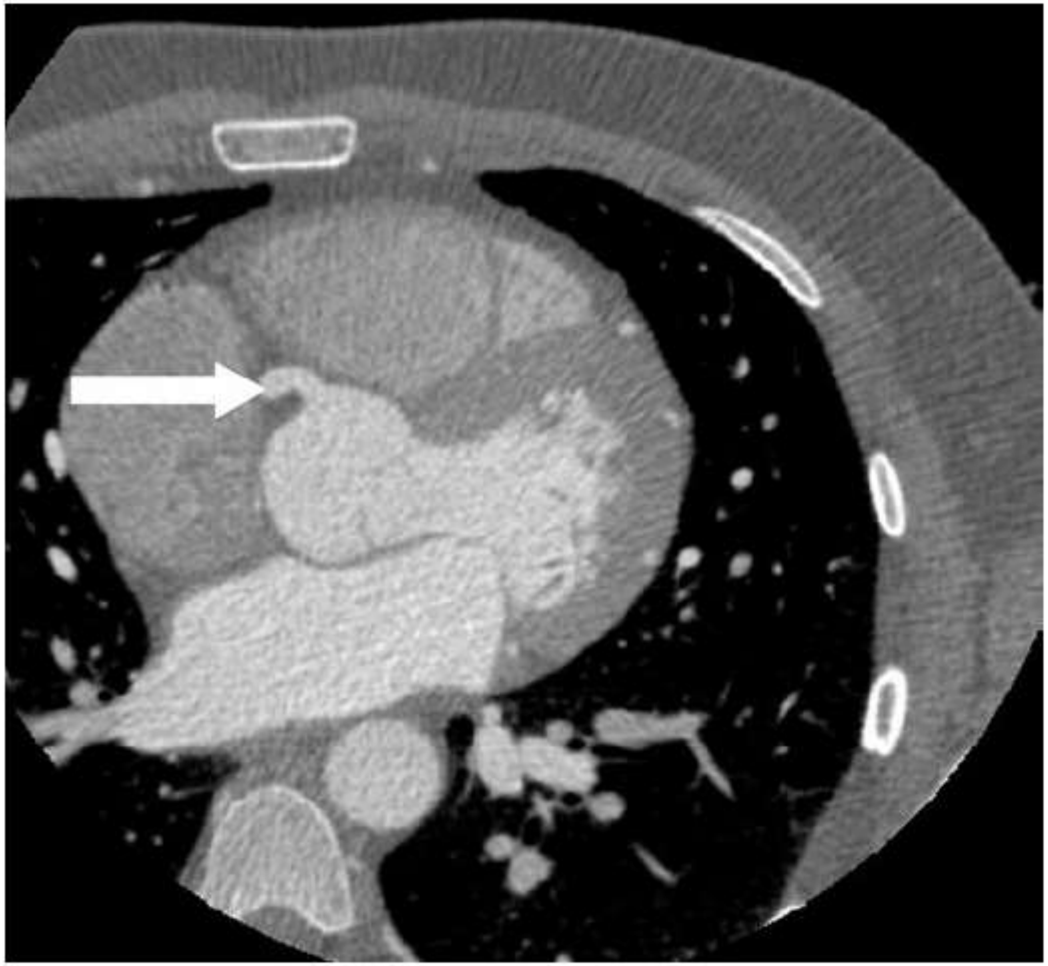
- **Question 16:**

Question 16: Axial CT of the chest

Answer: Anterior junctional line

- The anterior junctional line is formed by the visceral and parietal pleura lining the left and right upper lobes.

Question 17:



Question 17: Axial CT of the heart

Answer: Right coronary artery

- The right coronary artery arises from the right coronary sinus (also known as the anterior sinus) and descends in the anterior atrioventricular groove.
- It has two major branches: the right marginal artery and, in about 60% of the population, the posterior descending artery (PDA).
- When the right coronary artery gives rise to the PDA, this is known as right dominance because the PDA supplies the posterior and lateral wall of the left ventricle.
- The right coronary artery supplies the right atrium, most of the right ventricle, and the inferior part of the left ventricle.
- It also supplies the sinoatrial node in approximately 60% of people and the atrioventricular node in approximately 80% of the population.

Question 19:

Question 19: Axial CT of the chest

Answer: Aberrant right subclavian artery

- The aberrant right subclavian artery is the most common of the arch vessel anomalies with an incidence of 0.5%.
- It usually arises distal to the left subclavian artery and passes posterior to the oesophagus before traveling to the right upper limb.
- Normally, no vessels pass posterior to the oesophagus.

Question 20:

Question 20: Axial CT of the chest

Answer: Left common carotid artery

- The left common carotid artery is the second vessel to arise from the aortic arch.
- In the image, the left brachiocephalic vein is also filled with contrast medium because it has been injected via the left arm. It is important not to confuse it with one of the branches of the aorta. The brachiocephalic veins lie lateral to the three branches of the aortic arch.

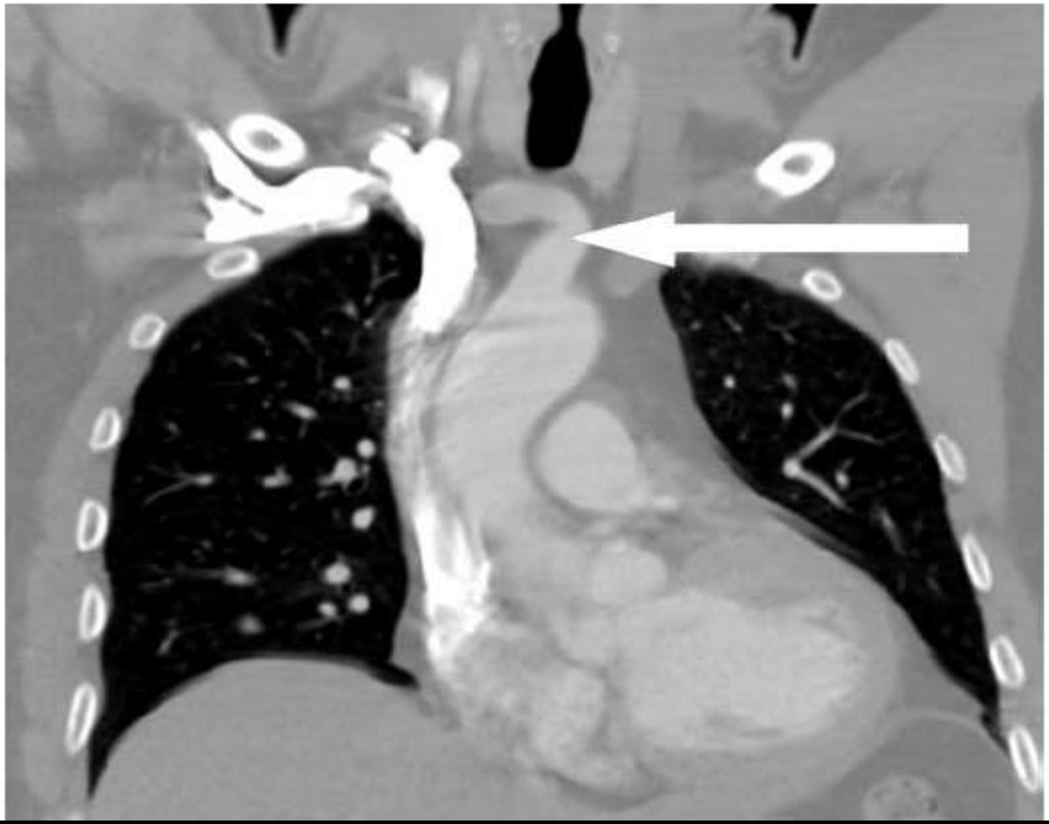
- **Question 22:**

Question 22: Coronal CT of the chest (MIP image)

Answer: Arch of the aorta

- The arch of the aorta is the most superior aspect of the aorta.
- You can tell that this is the arch because within the thorax the only part of the aorta to have large vessels arising from it is the arch. These vessels supply the head, neck, and arms.

Question 23:

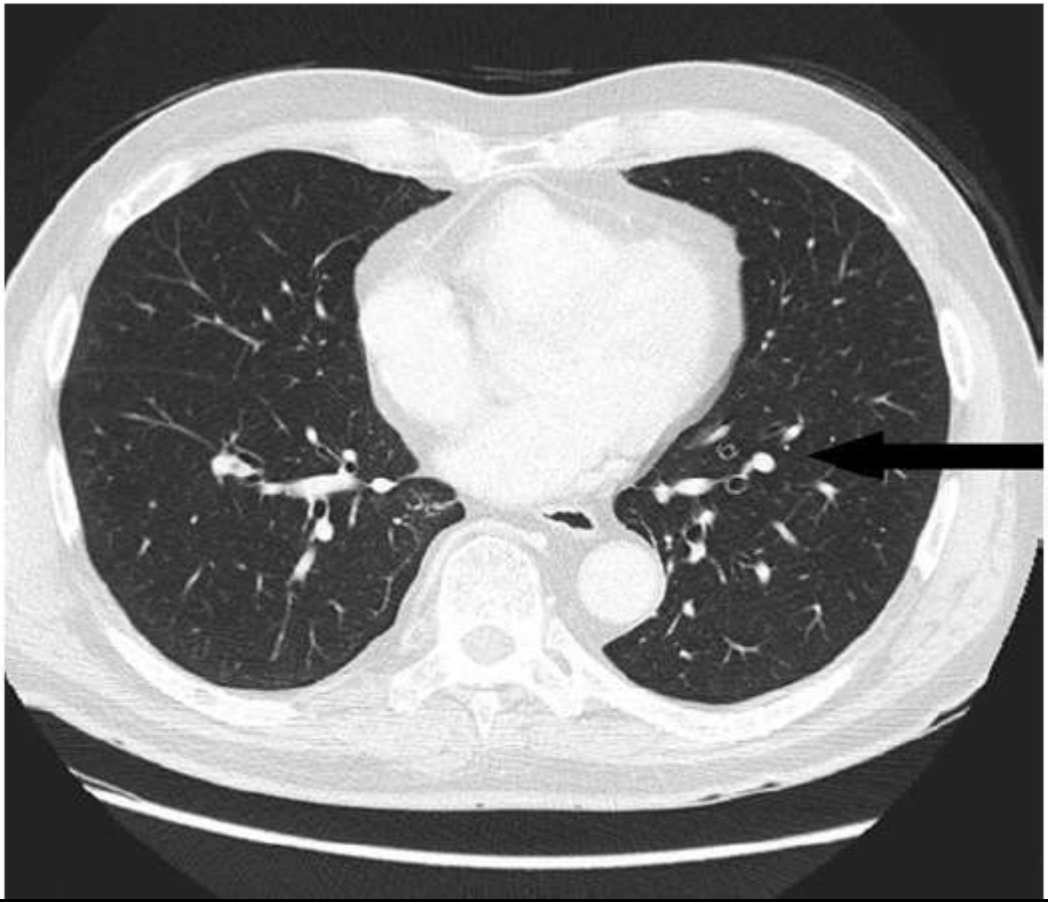


Question 23: Coronal CT of the chest

Answer: The innominate artery (brachiocephalic artery)

- The innominate artery is the first branch of the aortic arch and shortly divides into the right common carotid and right subclavian arteries posterior to the right sternoclavicular joint.
- It is the largest and shortest of the arch vessels.

- **Question 25:**

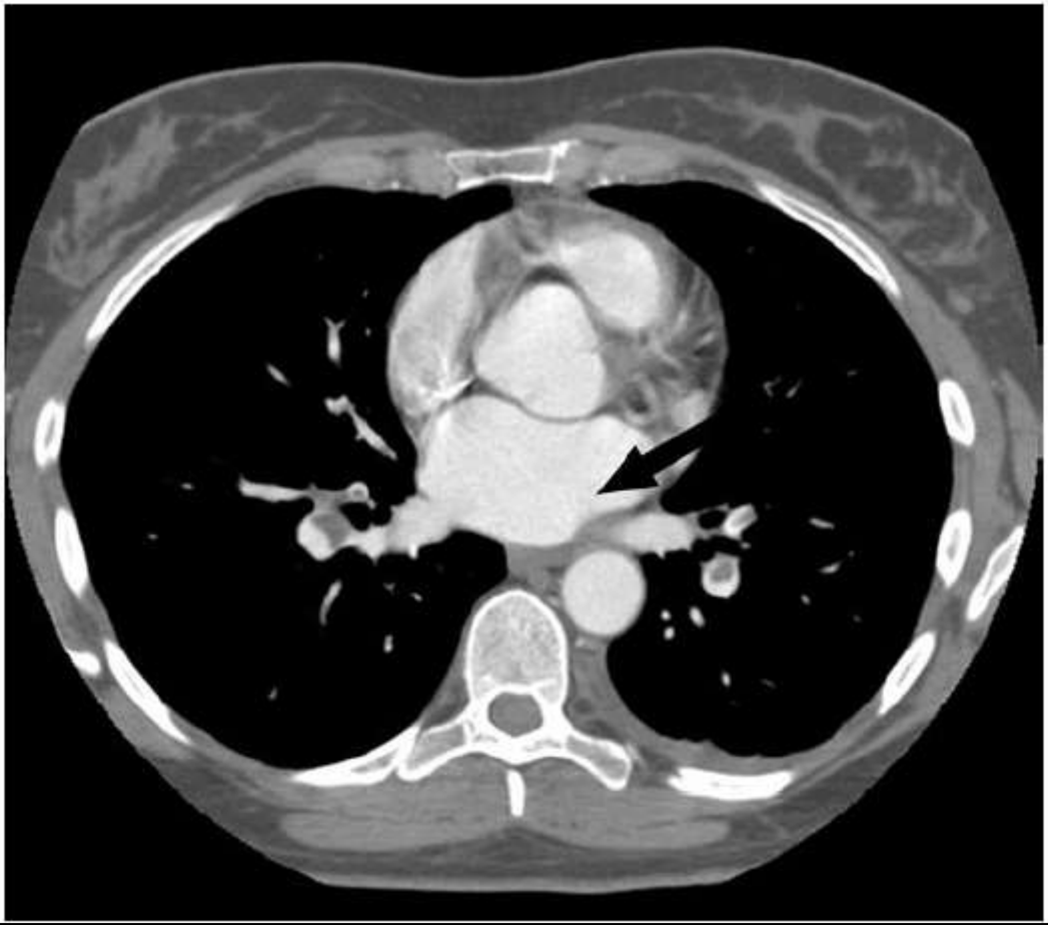


Question 25: Axial CT of the chest

Answer: Left lower lobe

- The left lower lobe has four segments: apical, anteromedial basal, lateral basal, and posterior basal segments.
- It is separated from the left upper lobe by the oblique fissure.

- Question 26:



Question 26: Axial CT of the chest

Answer: Left atrium

- The left atrium is the most posterior of the four cardiac chambers and lies close to the bodies of the thoracic vertebrae.
- The four pulmonary veins bring oxygenated blood to this chamber.
- The oesophagus is related to the posterior left atrial margin, which explains the incidence of dysphagia with left atrial enlargement.
- It may be of interest to note that there are bilateral pulmonary emboli in the image. However, you will not be shown any abnormalities in the examination.

Question 27:

Question 27: Axial CT of the abdomen

Answer: Right erector spinae muscle

- Erector spinae are a longitudinal set of three muscle fibres acting together as extensors of the spine.
- They arise from the crest of the sacrum and insert at various levels of the thoracic spine, cervical spine, and the base of the skull.
- On axial images, it is closely related to the vertebral column.

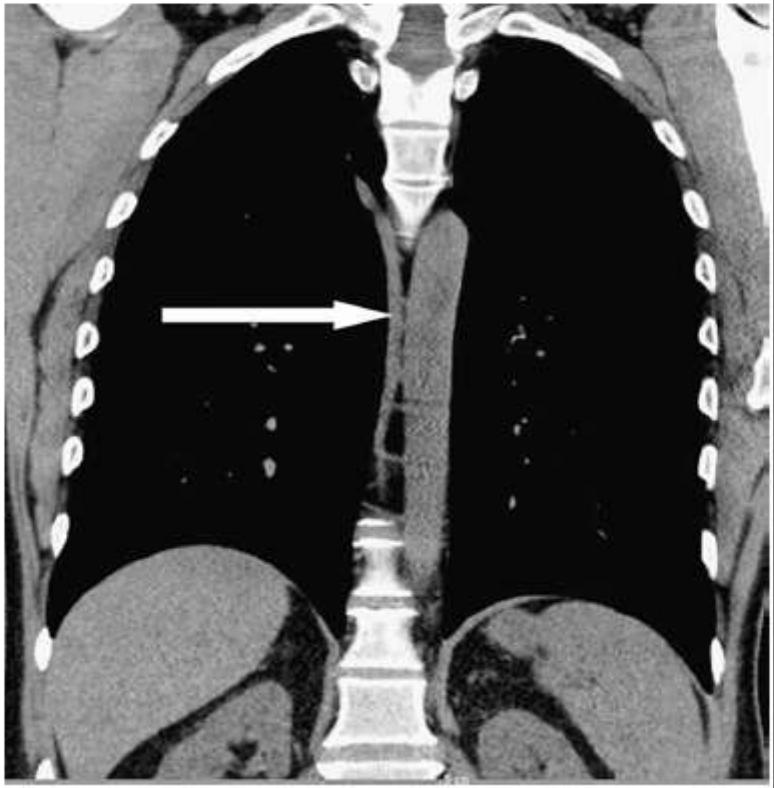
- Question 30:

Question 30: Axial CT of the chest

Answer: Right subscapularis muscle

- The rotator cuff muscles are a favourite amongst examiners due to their clinical significance and their ability to discriminate candidates' anatomical knowledge.
- The subscapularis muscle—as the name implies—lines the subscapular fossa.
- On an axial reformat, it demonstrates an intimate anteromedial relation to the scapula.
- Unlike the other rotator cuff muscles, it inserts onto the lesser tubercle of the humerus anteriorly.

Question 31:



■ Question 31: Coronal CT of the chest

Answer: The azygos vein

- The azygos vein is a small calibre vein that ascends from the level of T12 and arches over the right main bronchus to drain into the superior vena cava.
- It ascends just to the right of the vertebral column—as opposed to the hemiazygos and accessory hemiazygos veins, which ascend to the left of the vertebral column.
- The azygos vein drains the posterior chest and abdominal walls.
- The azygos and hemiazygos veins may be very large if there is congenital atresia or obstruction of the inferior vena cava.

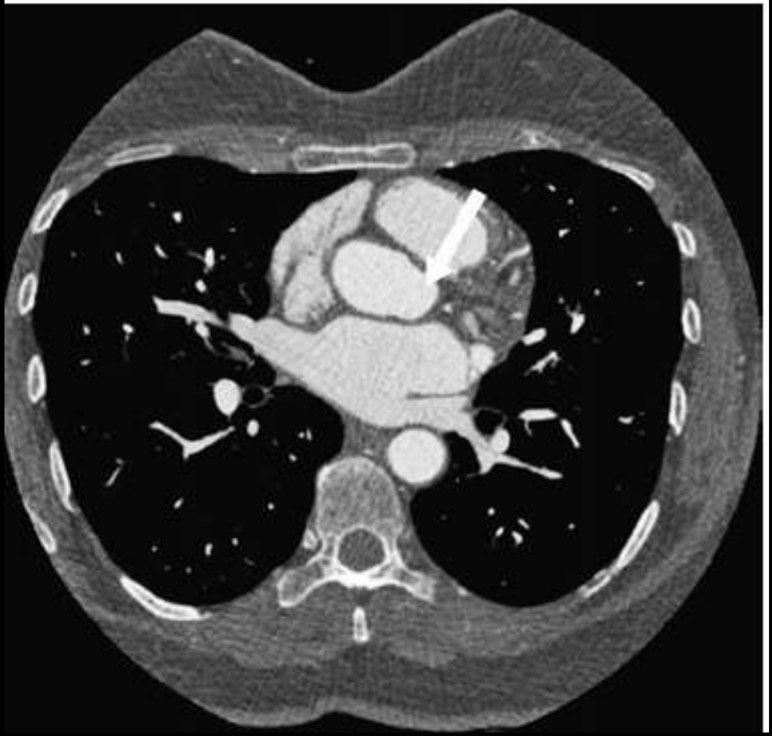
- Question 33:

Question 33: Sagittal CT of the chest

Answer: Left oblique fissure

- The left oblique fissure separates the left upper lobe from the left lower lobe and extends from T4/T5 posteriorly in an anteroinferior direction to make contact with the diaphragm; as such, it is not seen on the frontal chest X-ray.
- The left oblique fissure is more vertically oriented than the right.
- If you are struggling to determine whether this is the left hemithorax or the right, count the number of lobes visible. On the right, there will be three lobes, and on the left, as in this case, there will be two.

- Question 35:



Question 35: Axial contrast-enhanced CT of the chest

Answer: Left posterior sinus of Valsalva or left coronary sinus

- There are three sinuses of Valsalva:
  - Anterior or right coronary sinus
  - Left posterior or left coronary sinus
  - Right posterior or noncoronary sinus
- The sinuses are areas of focal dilation directly above the cusp of each valve.
- The right and left main coronary arteries arise from the right and left coronary sinuses, respectively. As the name suggests, no coronary artery arises from the noncoronary sinus.

- **Question 36:**

Question 36: Axial CT of the chest

Answer: Right scapular spine

- The scapular spine is a bony plate arising obliquely from the posterior aspect of the scapula that separates the supraspinatus fossa from the infraspinatus fossa.
- The scapular spine extends superolaterally to end in a bony process, the acromion.

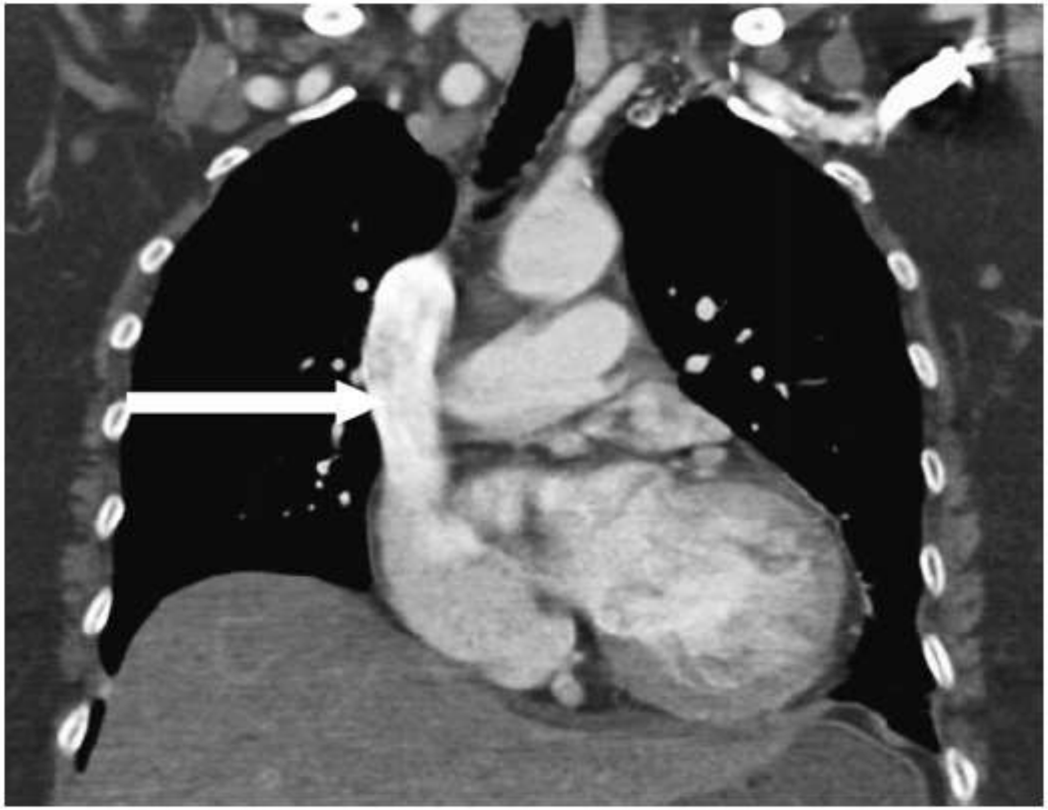
- **Question 37:**

■ Question 37: Axial CT of the chest

Answer: Right infraspinatus muscle

- The infraspinatus muscle is another member of the rotator cuff. As the name implies, the infraspinatus muscle occupies the infraspinatus fossa and inserts onto the greater tuberosity of the humerus.
- On axial CT, the infraspinatus muscle is separated from the supraspinatus by the spine of the scapula. The infraspinatus is lateral to the spine.
- The infraspinatus is also larger than the supraspinatus, which is another distinguishing feature.

- **Question 38:**



Question 38: Coronal CT of the chest

Answer: Superior vena cava

- The superior vena cava (SVC) begins at the confluence of the right and left brachiocephalic veins. The latter usually runs obliquely from the left acromioclavicular joint to the right sternomanubrial junction.
- The SVC enters the right atrium at approximately the level of T3. Knowledge of this level is important to gauge whether central venous catheters are appropriately sited.

- **Question 40:**

Question 40: Coronal CT of the chest

Answer: Right diaphragmatic crus

- The diaphragmatic crura are strong tendinous structures that attach the diaphragm to the lumbar spine.
- They extend from the diaphragm in an inferomedial direction to attach to the vertebral column.
- The right crus is longer and extends to L3, whereas the left crus extends to L2.

Question 41:

Question 41: Sagittal CT of the chest

Answer: Left ventricle

- You can tell that the image shows the left side of the chest because the spleen can be seen on the same slice.
- You can also tell that it is the ventricle rather than the atrium because of its anterior location within the thorax.
- Incidentally, there is a pulmonary nodule anterior to the 5th rib on this image that was found to be a metastasis.

■ **Question 42:**

Question 42: Axial CT of the chest

Answer: Right pectoralis minor muscle

- The pectoralis minor muscle is a small, triangular anterior chest wall muscle that lies deep to the pectoralis major muscle.
- It has an insertion point (the apex of the triangle) at the coracoid process and attachments (the base) at 3rd, 4th, and 5th ribs with variation in the site of attachment.
- It acts as a scapular stabiliser and an accessory respiratory muscle by elevating the ribs during deep respiratory efforts.

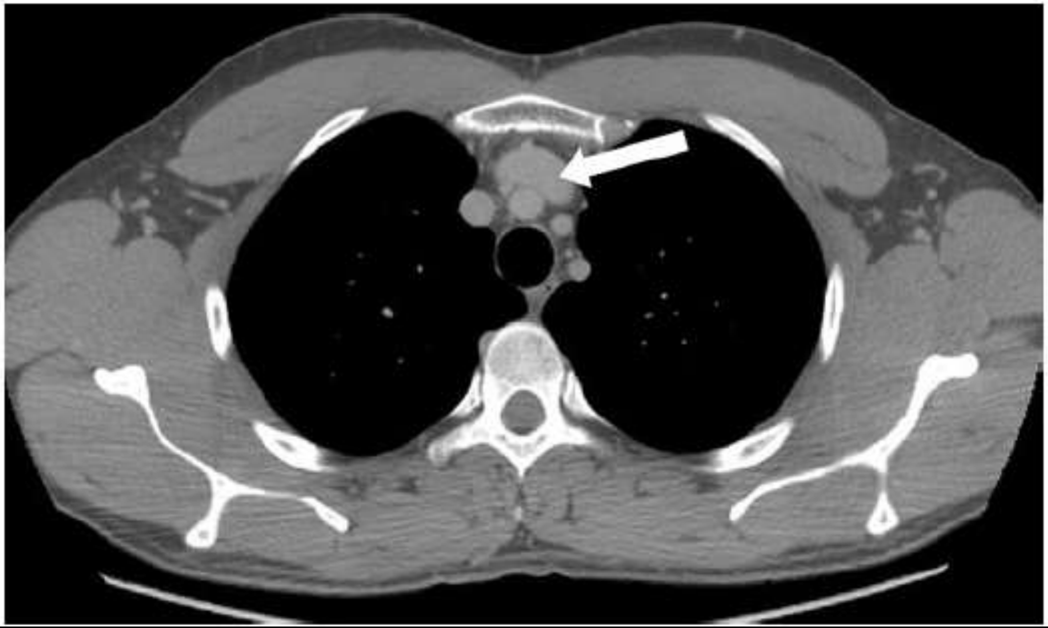
- **Question 44:**

Question 44: Axial CT of the chest

Answer: Left serratus anterior muscle

- Serratus anterior forms the medial wall of the axilla and overlies the lateral thoracic wall.
- It inserts at the lateral wall of the scapula and is derived from broad muscular slips that arise from the first eight or nine ribs. This allows the muscle to act as a strong protractor of the scapula. It also assists in normal respiratory efforts (when the scapula is fixed).

- **Question 45:**



Question 45: Axial CT of the chest

Answer: Left brachiocephalic vein

- The left brachiocephalic vein has its origin from the union of the left internal jugular vein and the left subclavian vein.
- It is responsible for draining the head and neck and the left upper limb to the right atrium.
- It has a longer course than the right brachiocephalic vein and can be seen on axial CT slices coursing obliquely behind the sternum and anterior to the aortic arch branches to drain into the superior vena cava.

- Question 46:

Question 46: Axial CT of the chest

Answer: Azygos vein

- Following its vertical ascent lateral to the right side of the vertebral bodies, the azygos vein rises over the root of the right lung to join the superior vena cava as seen here.

- **Question 47:**

■ Question 47: Axial CT of the chest

Answer: Left trapezius muscle

- The trapezius muscle, so named for its trapezoidal shape, is a large superficial muscle of the back that has upper, middle, and lower fibres.
- The upper fibres attach to the vertebral column and the skull, whereas the middle and lower fibres attach to the spinous processes of C7 to T12.
- It inserts at the lateral aspects of the clavicle and scapula. It is the most superficial muscle of the back on axial slices.

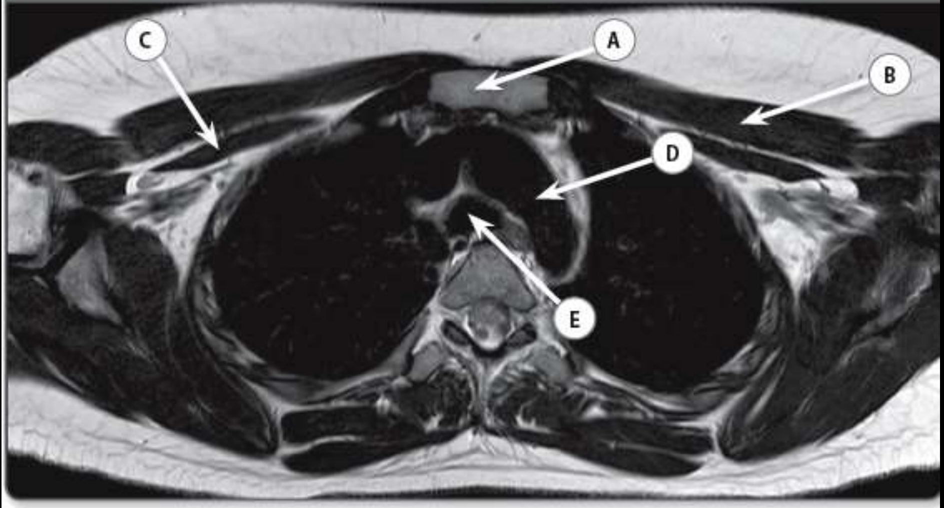
Question 50:

Question 50: Axial contrast-enhanced CT of the chest

Answer: Left anterior descending artery

- Cardiac structures are much easier to identify and interpret on modern 64-slice CT scanners especially with the aid of electrocardiographic gating; therefore, it would be fair to ask a question about the coronary arteries.
- The left anterior descending artery (LAD) is one of two main branches of the left coronary artery, the other being the circumflex artery (the origin of which is visible on this image).
- The LAD descends in the anterior interventricular groove to the apex of the heart.
- It supplies blood to the left ventricle, interventricular groove, and occasionally to the right ventricle.

Case 3.17



Case 3.17

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 3.17

A Sternum

B Left pectoralis major muscle

C Right pectoralis minor muscle

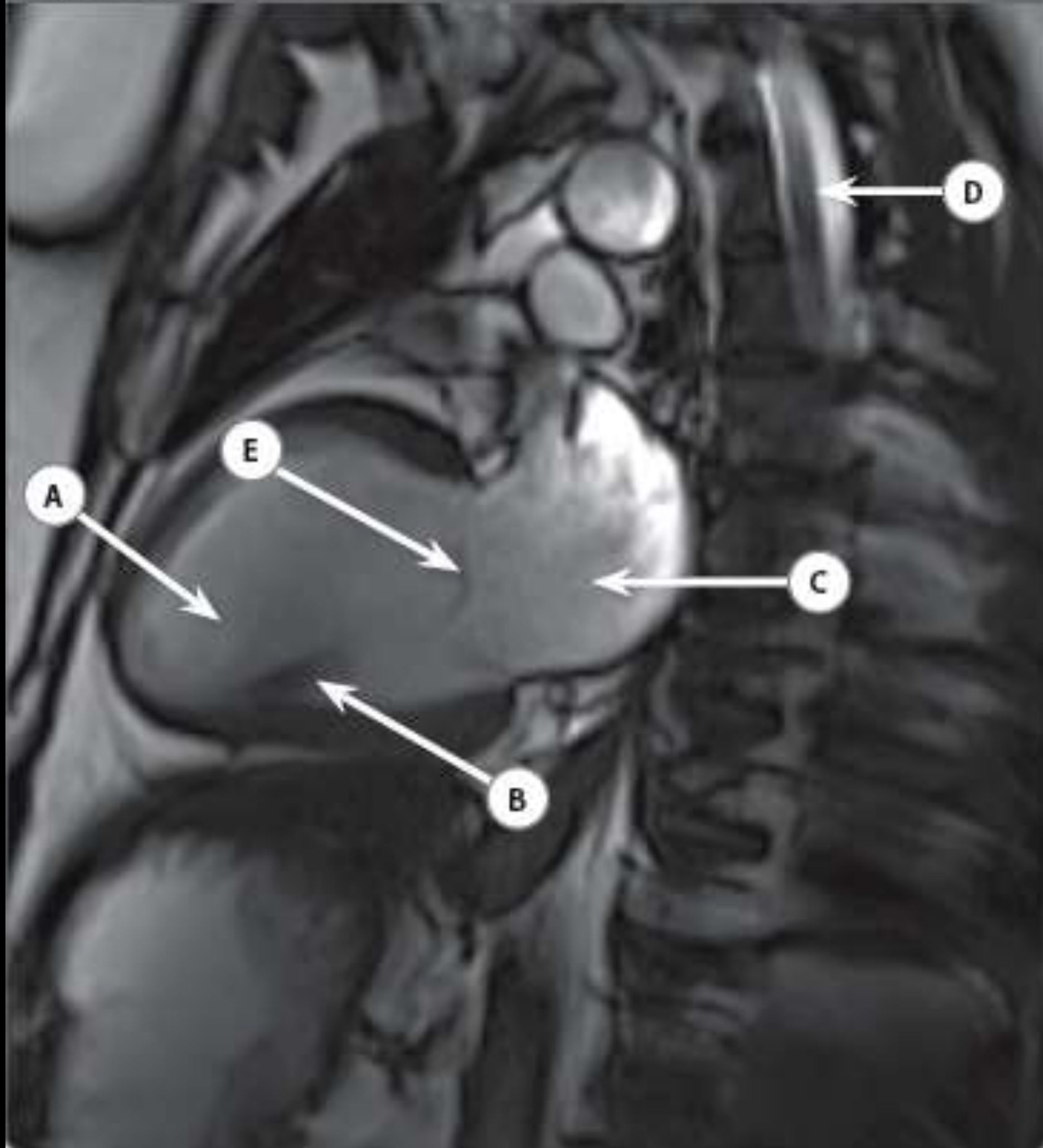
D Aortic arch

E Trachea

Although the vessel lumina demonstrate flow voids, it should be possible to identify them based on location and relative anatomy. Occasionally, artefacts or pathologies lead to high signal within the blood vessels.

Remember, the airways will also return no signal as they are filled with air.

Case 8.13



Case 8.13

A Left ventricle

B Papillary muscle

C Left atrium

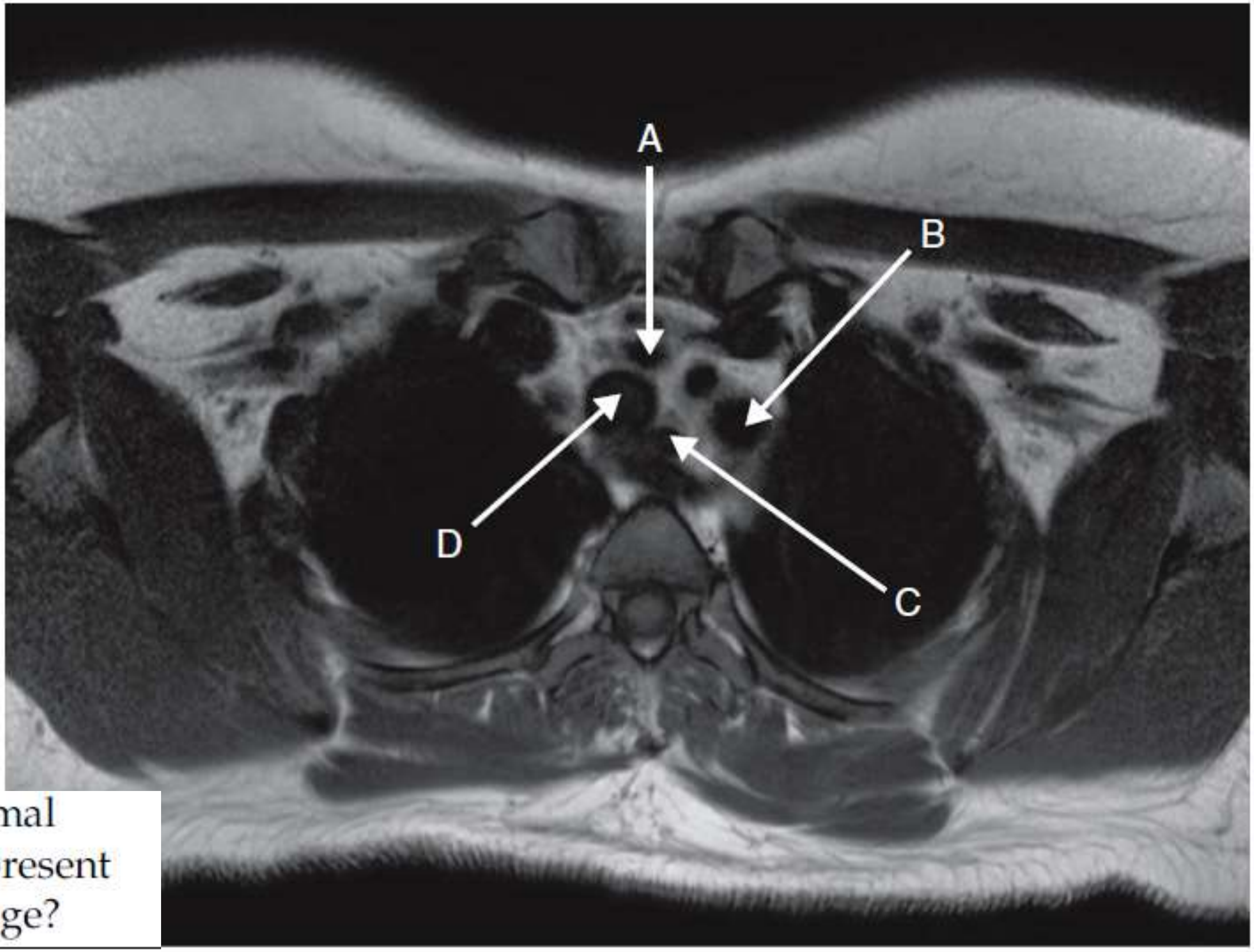
D Spinal cord (thoracic)

E Anterior leaflet of mitral valve

This is an oblique coronal view of the left ventricle in which the mitral valve, left atrium and ventricle are seen in profile. The thoracic spinal cord is seen, surrounded by CSF.

Orientation on an oblique view can be difficult and in this image, it is worth appreciating that the left atrium is the most posterior chamber, adjacent to the spine. This helps identify the left ventricle and the mitral valve. It is also worth noting that the blood returns high signal (bright blood sequence) unlike standard sequences in which a flow void is noted.

Case 2.15



(e)	Which normal variant is present on this image?

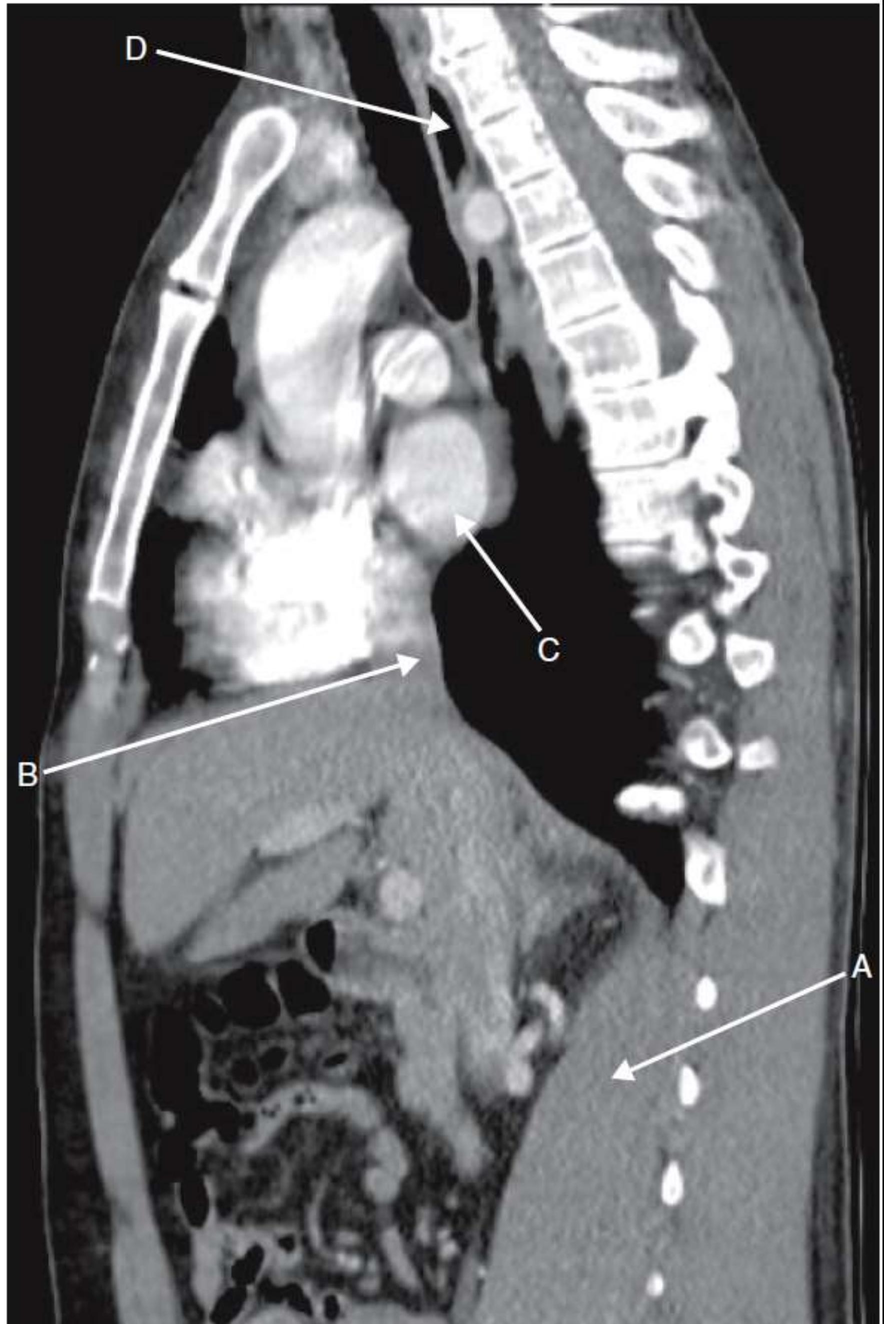
2.15 Axial T1-weighted MR of the thorax

(a) Right common carotid artery.
(b) Left subclavian artery.
(c) Oesophagus.
(d) Trachea.
(e) Aberrant right subclavian artery (ARSCA). In approximately 0.5–1% of individuals the right subclavian artery arises from the aortic arch distal to the origin of the left subclavian artery. It courses posterior to the oesophagus as it crosses obliquely to the right side. When the origin is aneurysmal (Kommerell diverticulum) it may cause dysphagia (dysphagia lusoria).

Note: in patients with a normal right subclavian artery position the brachiocephalic trunk (BCT) usually has a larger diameter than both the left common carotid and left subclavian arteries. This is because it carries arterial blood to the right common carotid and right subclavian arteries. However, in the case of an ARSCA, the artery to the right of the left common carotid artery is the right common carotid artery. This has a diameter equal to the other great vessels, unlike the BCT.

An ARSCA will cause posterior indentation of the barium column in the oesophagus during a barium swallow.

Case 7.14

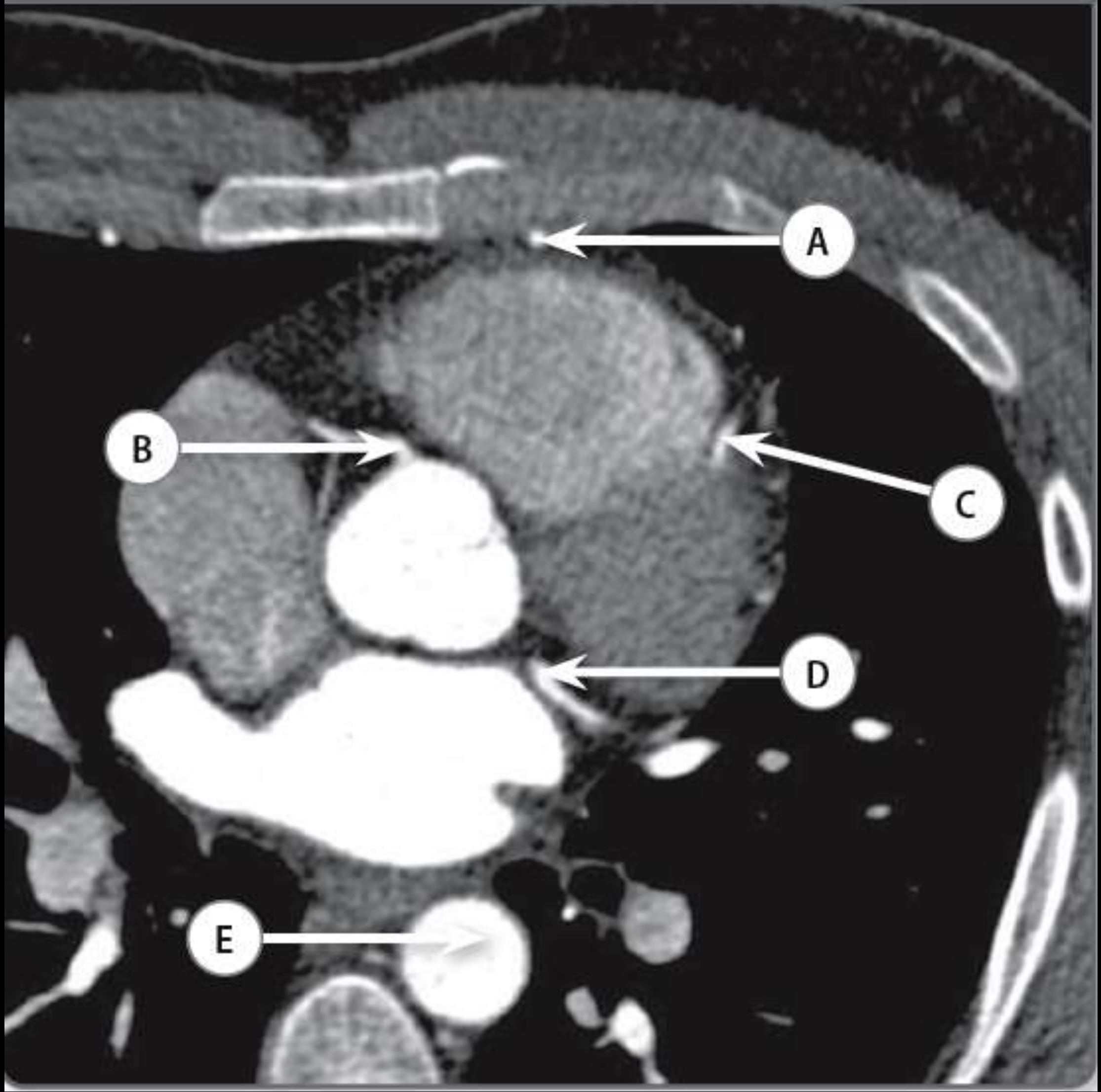


(e)	Which normal variant is present on this image?

7.14 Sagittal enhanced CT thorax and abdomen

(a) Right psoas muscle. (Right side because the aortic root can be seen. Plus see answer (e).)
(b) Inferior vena cava.
(c) Left atrium.
(d) Oesophagus.
(e) Aberrant right subclavian artery. The aberrant right subclavian artery arises from the aorta distal to the left subclavian artery, traverses behind the oesophagus to supply the right arm. It will produce a posterior impression on the oesophagus at barium swallow.

Case 5.19



Case 5.19

A Left internal mammary artery

B Right coronary artery

C Left anterior descending artery

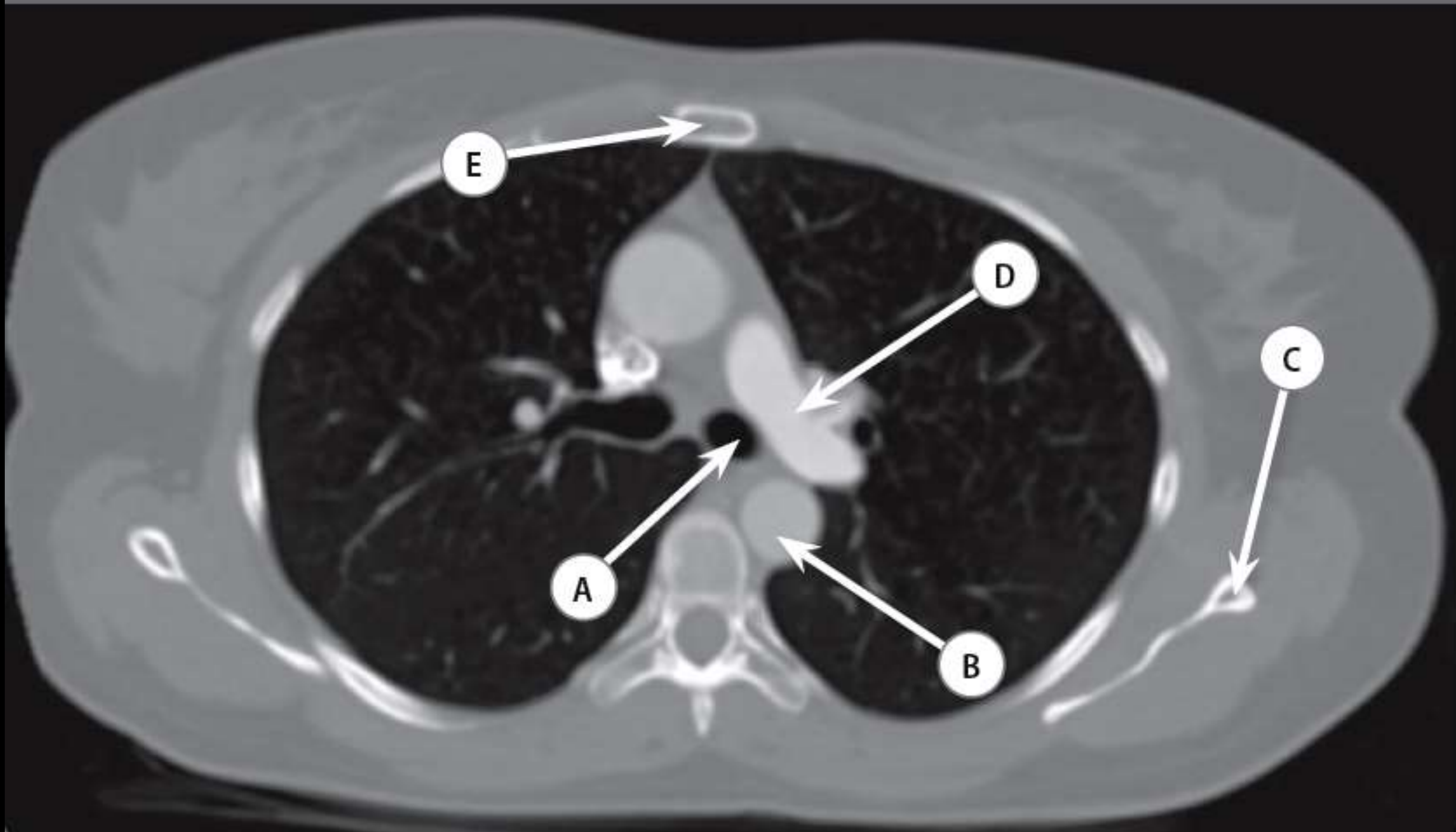
D Circumflex artery

E Descending thoracic aorta

Axial CT of the chest.

For further discussion see Chapter 2, Cases 2.1–2.18.

Case 6.5



Case 6.5

A Left main bronchus

B Descending aorta

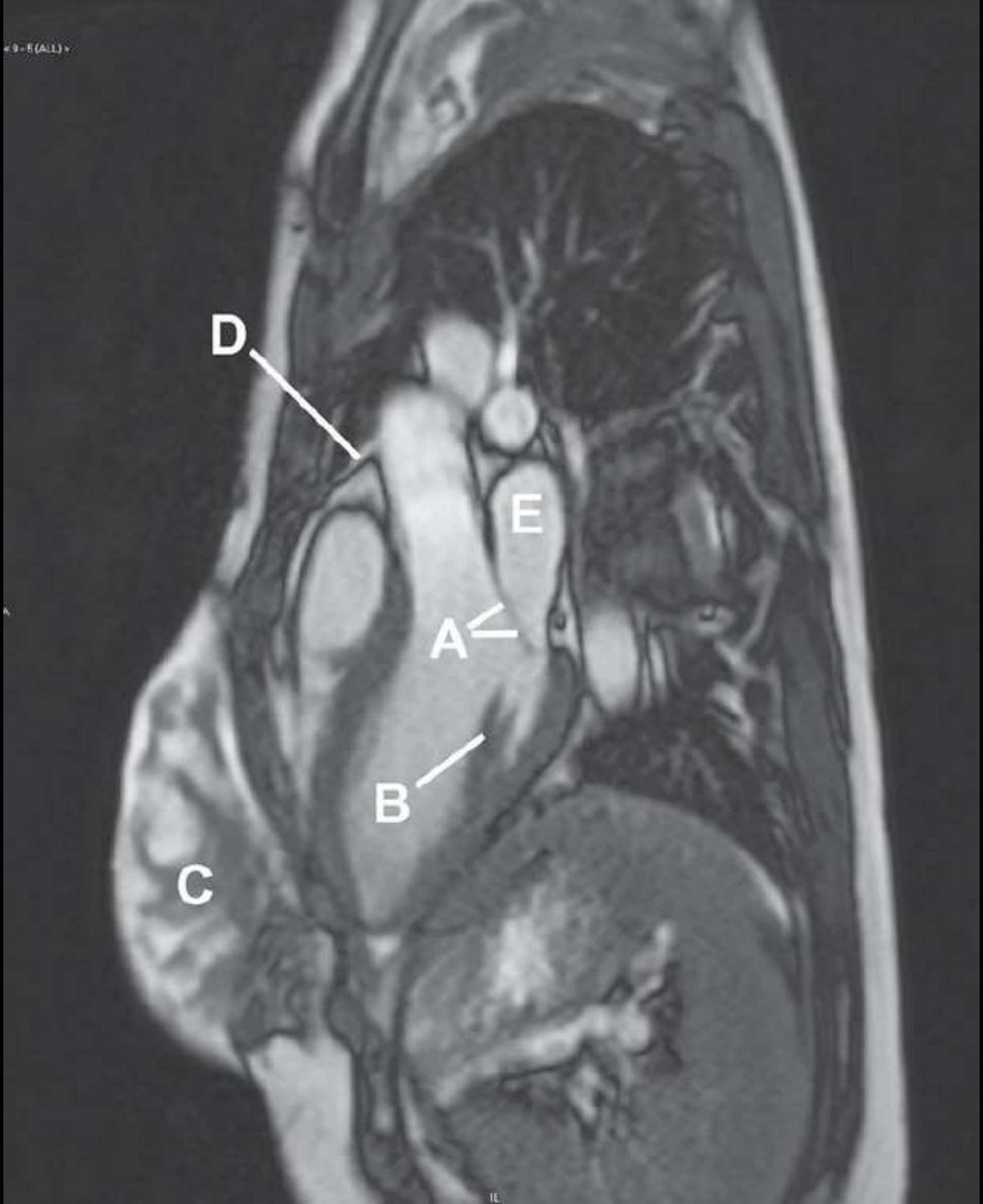
C Left scapula

D Left main pulmonary artery

E Body of sternum

Axial CT of the chest.

For further discussion, see Chapter 2, Cases 2.19–2.25.


D
E
A
B
C

Q16 Answers

a Anterior leaflet (cusp) of the mitral valve
b Papillary muscle
c Left breast
d Left coronary artery
e Left atrium

Cardiac MRI (Gradient Echo/True fast imaging with steady state precession (True FISP)), long-axis vertical plane

This long axis vertical plane view demonstrates the left atrium and ventricle. Horizontal long axis (or 4-chamber view) and short-axis plane can also be used specifically for cardiac MRI.

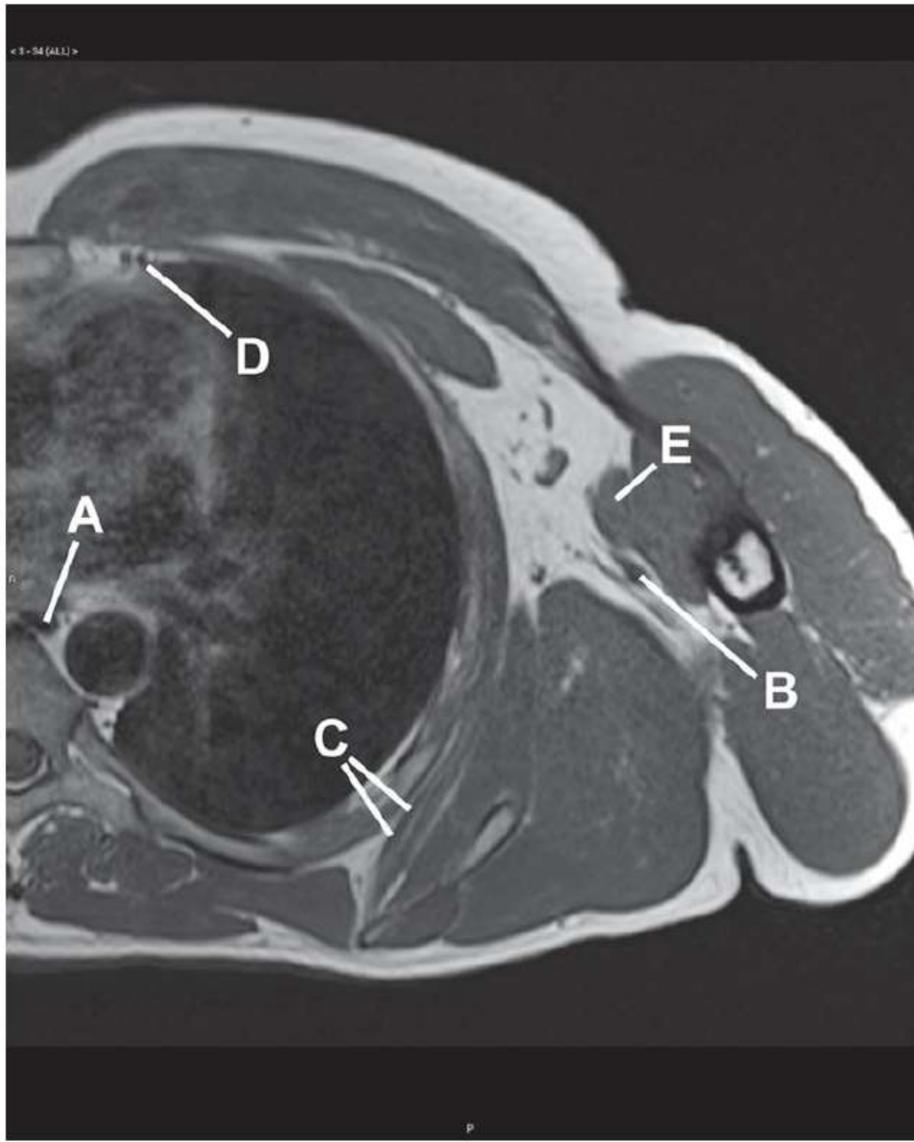
The orientation of the heart means that there is significant obliquity in the projection of the extra-cardiac structures. The lower part of the image is significantly further left than the upper part.

This image is taken in early systole, shortly after closure of the mitral valve.

Lee VS. Cardiac MRI: Technical Aspects and Primer. *Radiology* 2002; eMedicine: www.emedicine.medscape.com

Q20

a Name the structure labelled A
b Name the structure labelled B
c Name the motor nerve supplying the structure labelled C
d Name the structure labelled D
e Name the structure labelled E



Q20 Answers

- **a** Azygous vein
- **b** Axillary artery/brachial artery
- **c** Long thoracic nerve
- **d** Internal mammary artery
- **e** Teres major

T1W MRI of the thorax at the level of the left axilla, axial section

The axillary artery passes through the axilla alongside the axillary vein, which lies medial to the cords of the brachial plexus; these surround the artery and are named according to their position relative to it.

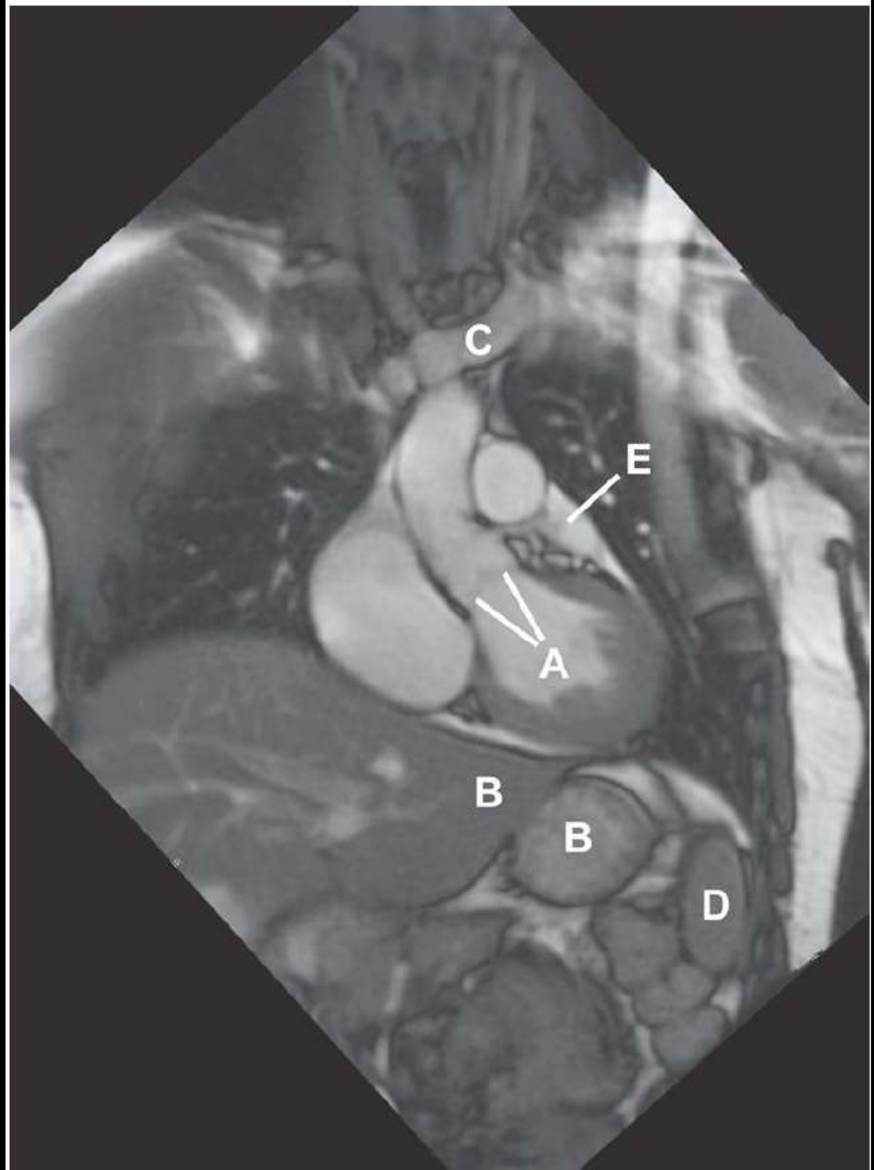
As the axillary artery crosses the inferior border of teres major it is renamed the brachial artery.

The long thoracic nerve is a branch of the upper roots of the brachial plexus, arising from the posterior aspects of C5/6/7. It travels inferiorly along the superficial fascia of serratus anterior. The action of serratus anterior is that of a powerful lateral rotator (lower half) and protractor of the scapula.

The internal mammary artery, which is a branch of the subclavian artery, passes down behind the first six costal cartilages on the inner anterior thoracic wall. The artery is located lateral to the vein.

Q9

a Name the structure labelled A
b Name the structure that connects the two structures labelled B
c Name the structure labelled C
d Name the structure labelled D
e Name the structure labelled E



Q9 Answers

a Aortic valve
b Lesser omentum
c Left brachiocephalic vein
d Spleen
e Left atrium/auricle

MRI of the aortic root, oblique coronal section

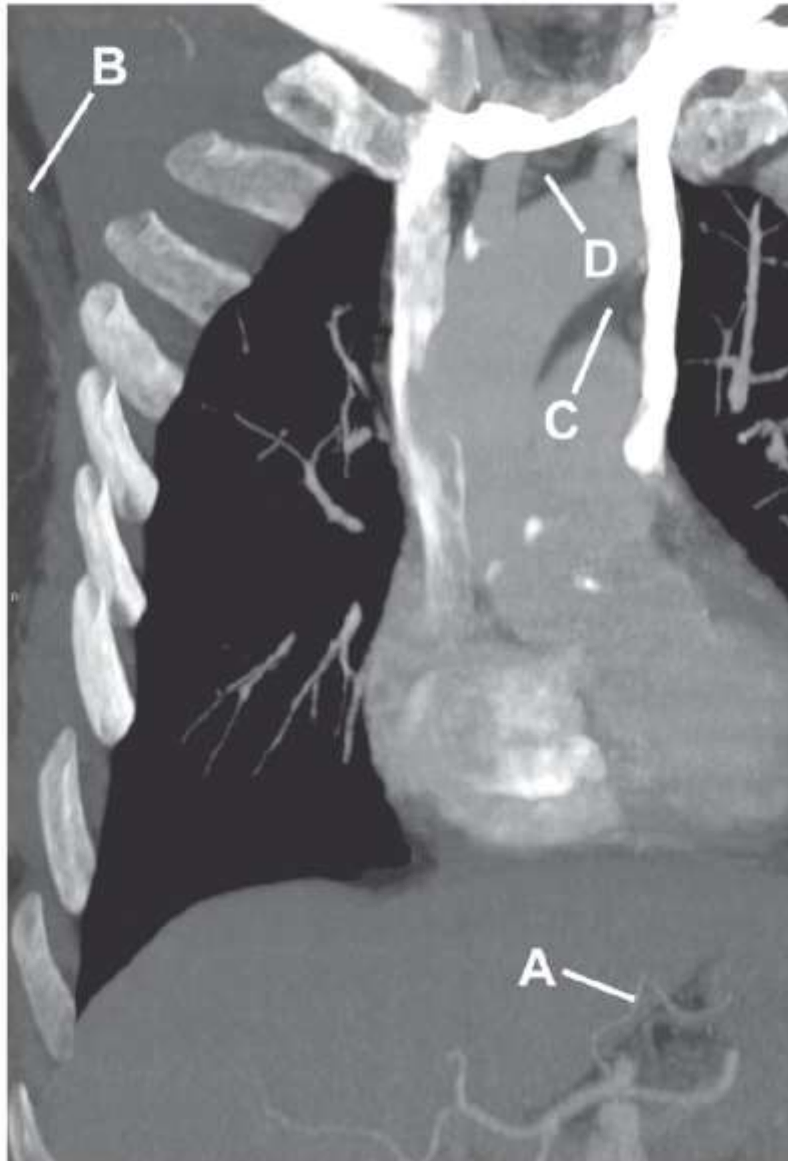
The lesser omentum consists of two layers of peritoneum which extends between the posterior aspect of the liver and the lesser curvature of the stomach. The hepatic connection is 'L'-shaped as it joins into the fissure for the ligamentum venosum and porta hepatis. The lesser omentum runs from the right side of the intrathoracic oesophagus, along the lesser curvature of the stomach and includes the first two centimetres of duodenum. The free edge at this point forms the anterior margin of the foramen of Winslow (epiploic foramen) and the lesser omentum is the anterior boundary of the lesser sac.

The thyroid is supplied by paired inferior thyroid arteries (from the thyrocervical trunk) and paired superior thyroid arteries (from the external carotid artery). In a small percentage of people there is a further artery supplying the thyroid – thyroidea ima – which arises directly either from the brachiocephalic trunk or the arch of the aorta.

Summers JE. Surgical anatomy of the thyroid gland. *Am Joint Surg* 1950; 80:35–43.

Q4

a Name the structure labelled A
b Name the structure labelled B
c Name the area labelled C
d Name the structure labelled D
e Name the anatomical variant demonstrated in this image



Q4 Answers

a Left gastric artery
b Latissimus dorsi
c Aorto-pulmonary window
d Trachea
e Double SVC

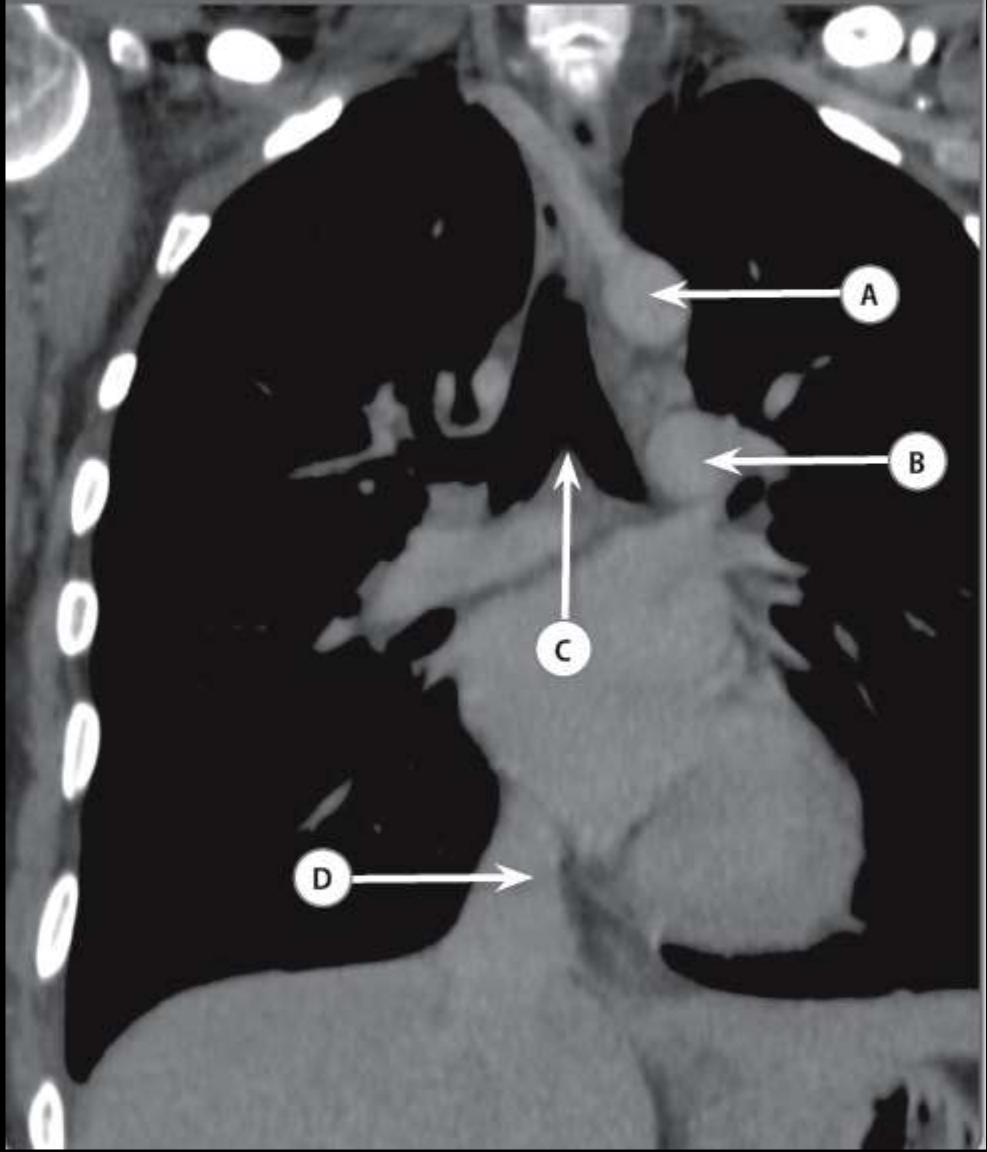
CT thorax with contrast, maximum intensity projection, coronal section

In the developing venous system, paired superior cardinal veins drain into the two horns of the sinus venosus. The left horn develops into the coronary sinus and the right horn is incorporated into the right atrium. The upper cardinal veins interconnect via an oblique vein which becomes the left brachiocephalic vein. The inferior aspect of the left-sided cardinal vein usually involutes leaving a single, right-sided superior vena cava draining into the heart.

Failure to form an oblique vein results in a double SVC without communication. Involution of the right cardinal vein rather than the left results in a left SVC, and formation of an oblique vein but with no involution results in a double SVC with communication (as in this case). In most cases, a left SVC will drain into the coronary sinus.

Davies M, Guest PJ. Developmental abnormalities of the great vessels of the thorax and their embryological basis. *British Journal of Radiology* 2003; 76:491–502.

Case 15.9



E	Which anatomical variant is present on this image?

Case 15.9

A Arch of aorta

B Pulmonary trunk

C Carina

D Inferior vena cava

E Aberrant right subclavian artery

An aberrant right subclavian artery is a common anatomical variant of the aortic arch. The aberrant artery usually arises distal to the left subclavian artery from a dilated segment of aorta called the 'diverticulum of Kommerell'. It usually courses posterior to the oesophagus and can lead to oesophageal compression, thus causing dysphagia (otherwise known as 'dysphagia lusoria').