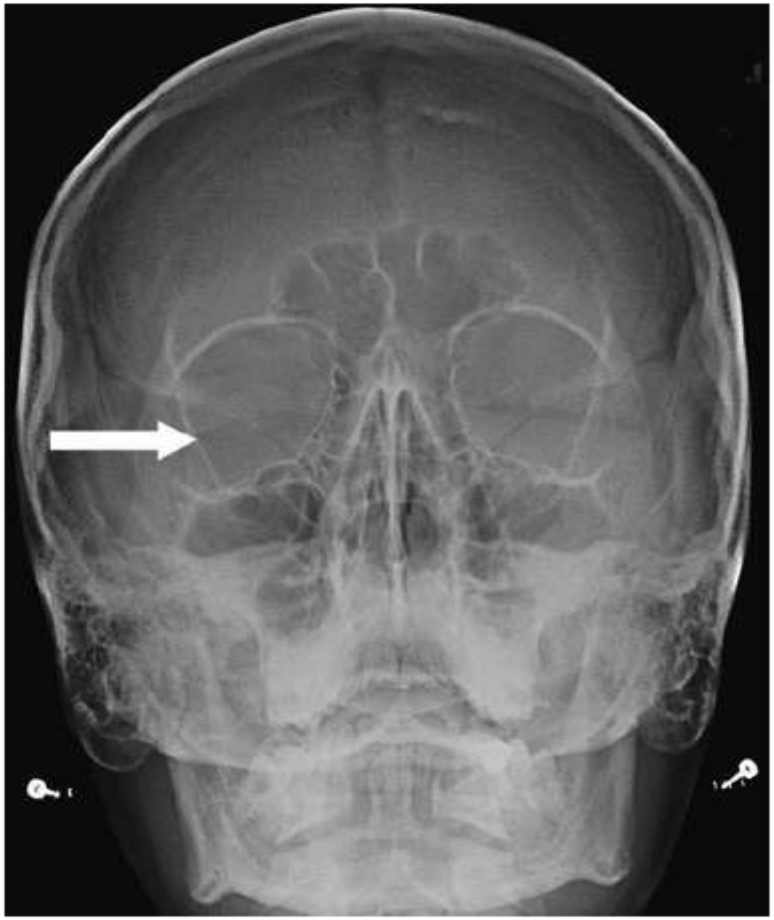
HEAD & NECK

CONTENTS

PLAIN FILM

- **Question 29:**



■ Question 29: Frontal radiograph of the facial bones

Answer: Greater wing of the right sphenoid bone (innominate line)

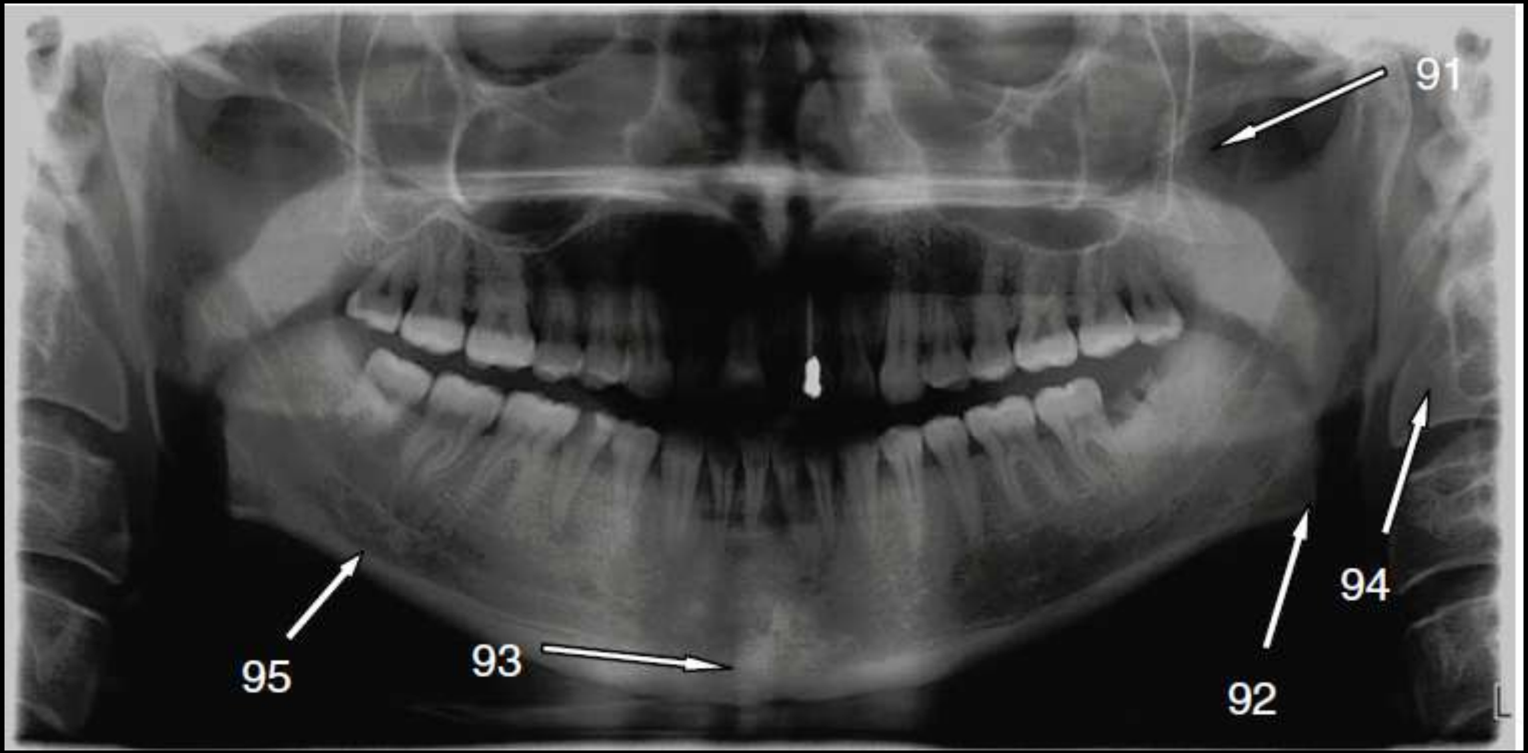
- There are many different facial and temporal bones; they can be difficult to remember.
- The sphenoid bone consists of a body, greater and lesser wings, and forms part of the skull base.
- The greater wing appears as a high density line due to the tangential projection.

- **Question 30:**

Question 30: Orthopantomogram

Answer: Right mental foramen

- The mental foramina are best seen, but are not always visible, on the orthopantomogram.
- The orthopantomogram is a panoramic projection that converts a curved 3D structure into a 2D image.
- The mental foramina are seen as small, round, transradiant structures because each contains fat and the mental nerve, not bone.
- They lie inferior to the roots of the teeth and lateral to the mental symphysis.


91
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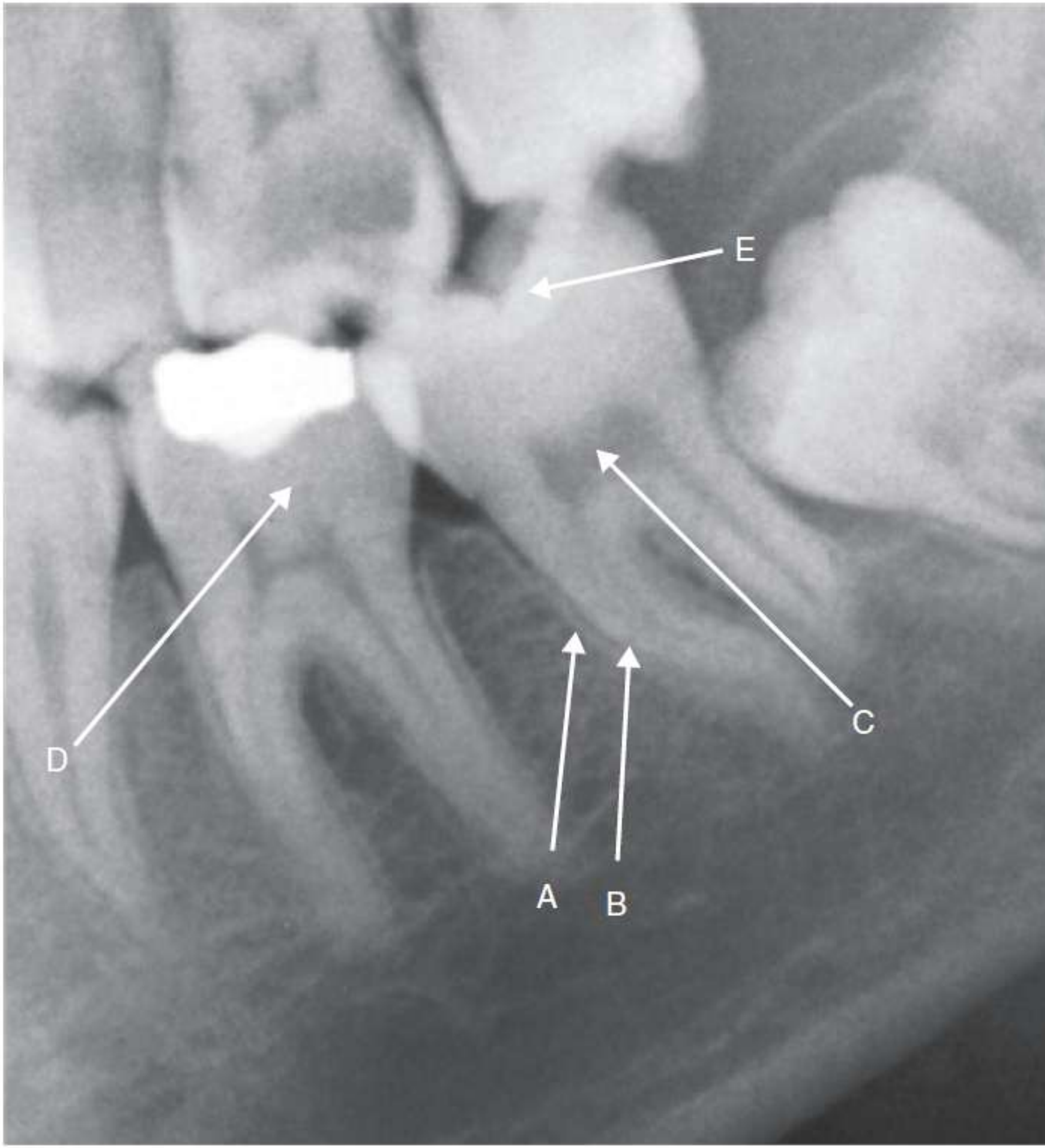
Orthopantomogram

91. Left coronoid process of mandible
92. Left angle of mandible
93. Symphysis menti
94. C2 vertebral body
95. Right body of mandible

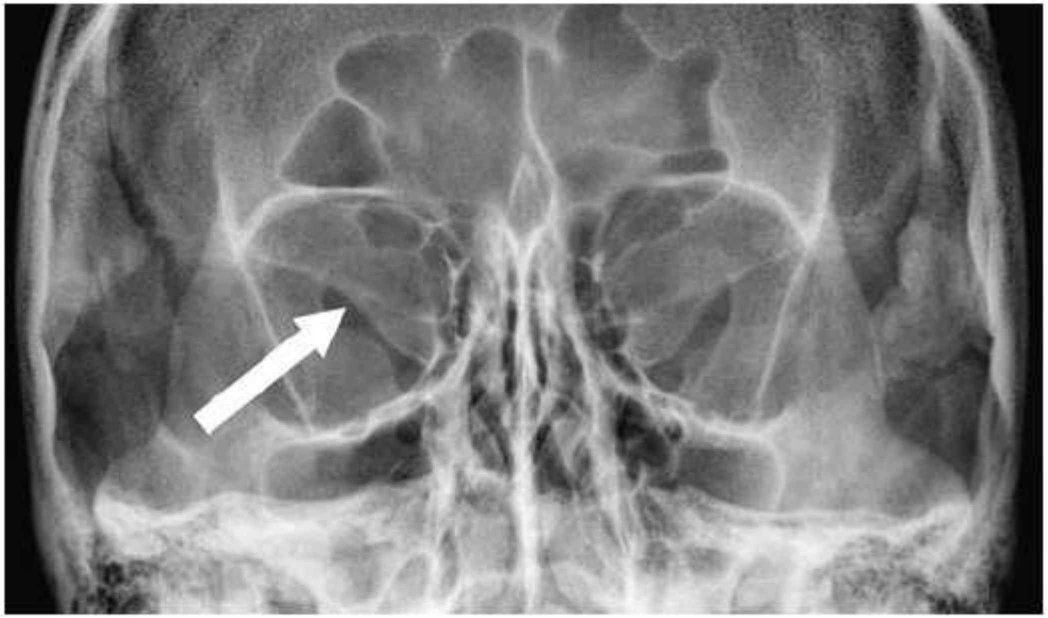
Case 7.13



7.13 Bitewing x-ray

(a) Lamina dura. This is a dense white line of bone surrounding the root of each tooth.
(b) Periodontal ligament. This is the radiolucent line around the neck and root of the tooth.
(c) Pulp chamber. The pulp canals extend inferiorly from this and transmit nerves and vessels from the supporting bone.
(d) Dentine.
(e) Enamel. This is the densest material in the body.

Question 31:



Question 31: Orbital radiograph

Answer: Right superior orbital fissure

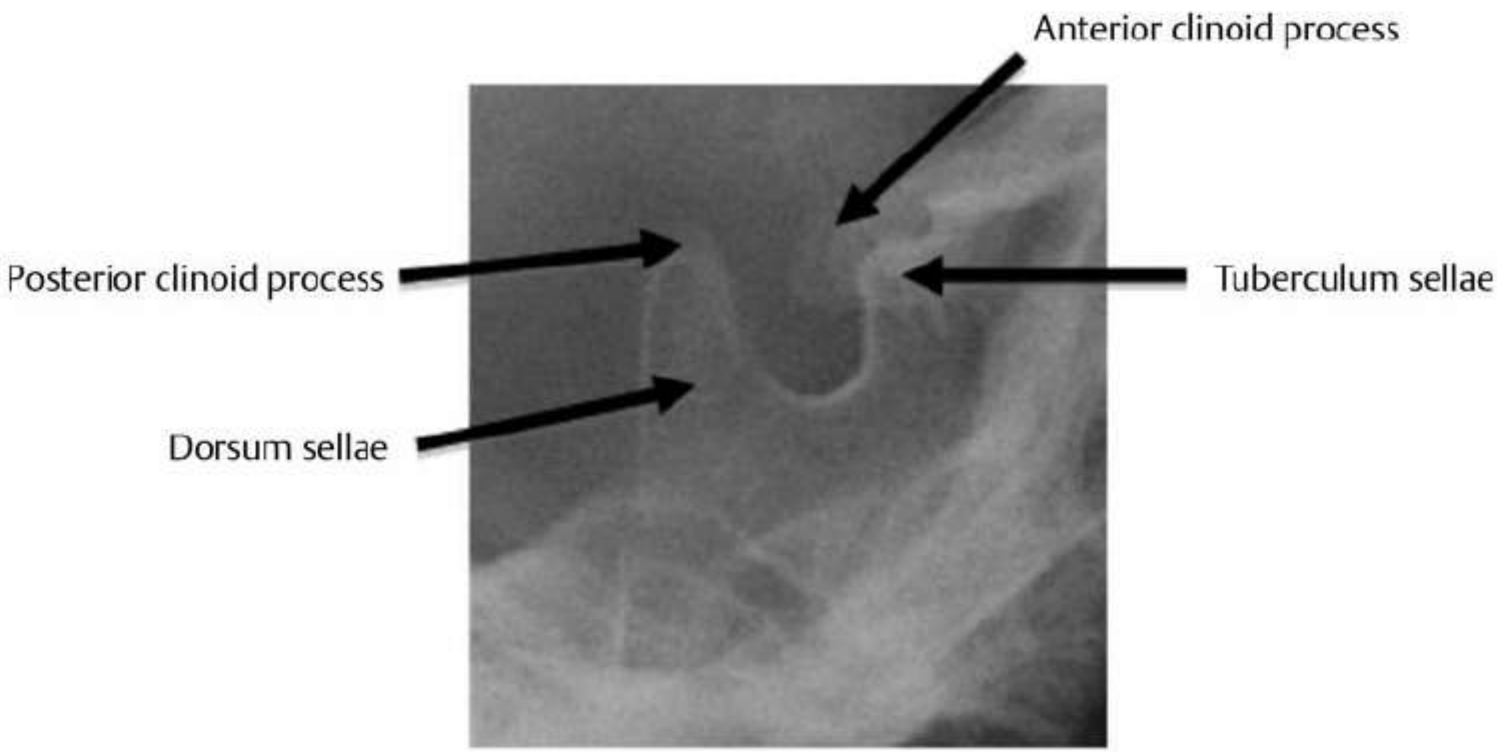
- The superior orbital fissure contains cranial nerves III, IV, V_1, and VI; superior orbital vein; and a branch of the middle meningeal artery.
- It is a triangular space between the greater and lesser wings of the sphenoid.

- **Question 40:**

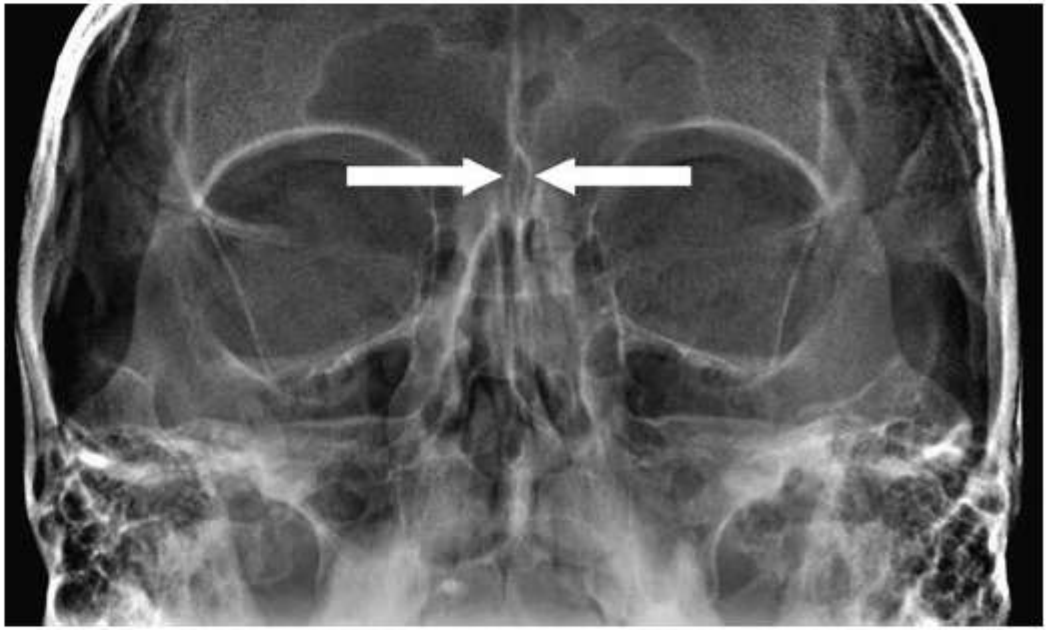
Question 40: Lateral skull radiograph

Answer: Sella turcica or pituitary fossa

- The sella turcica is a deep fossa within the sphenoid bone that contains the pituitary gland.
- The anterior part of the sella turcica is the tuberculum sellae, and the posterior part is the dorsum sellae. The clinoid processes—two posterior and two anterior—are bony projections that surround the sella turcica.



- **Question 6:**

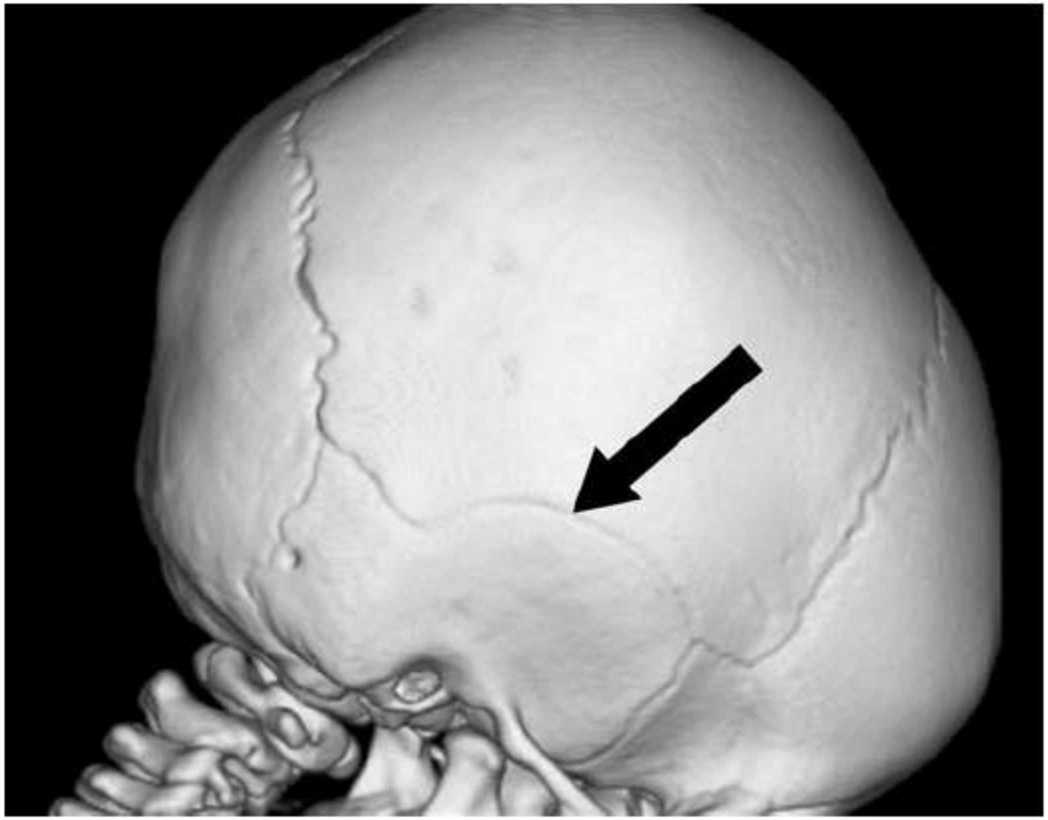


■ Question 6: Orbital radiograph

Answer: Crista galli

- *Crista galli* is Latin for 'crest of the cock'.
- On a frontal radiograph, the crista galli appears as a diamond-shaped bone in the midline at the level of the superior orbits.
- It arises from the cribriform plate of the ethmoid bone.
- It is the anterior attachment for the falx cerebri.

- **Question 9:**

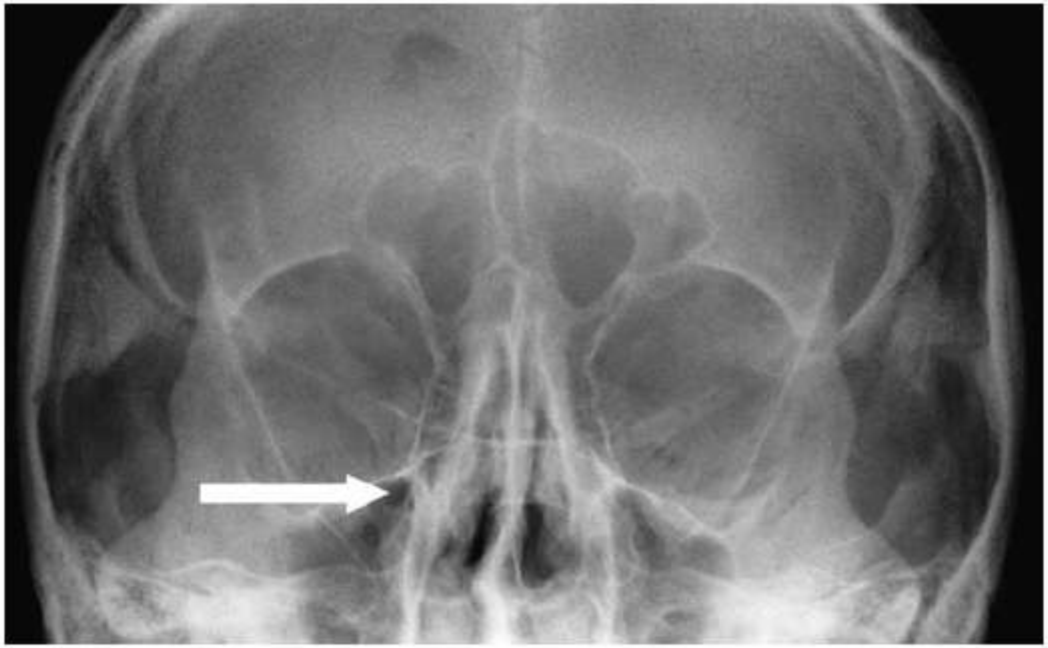


Question 9: Surface rendered 3D reconstruction of a paediatric skull

Answer: Right temporoparietal (squamosal) suture

- There are three main sutures in the skull: the sagittal suture, the paired lambdoid, and paired coronal sutures.
- Other sutures that may be visible depending on the age of the child are the temporoparietal suture, sphenotemporal suture, and metopic suture.
- The pterion is where the sphenoparietal suture joins the coronal suture.
- The asterion is where the temporoparietal suture joins the lambdoid suture.

Question 10:



Question 10: Orbital radiograph

Answer: Right foramen rotundum

- The foramen rotundum runs from the middle cranial fossa to the pterygopalatine fossa in the sphenoid bone.
- It transmits the maxillary division of the trigeminal nerve (V_2).
- The table below summarises the structures that pass through the skull base and various facial foramina. Questions on this area are common.

Facial/Skull Foramina	Contents
Optic canal	Optic nerve ophthalmic artery
Superior orbital fissure	Cranial nerves III, IV, ophthalmic nerve (V_1), VI Superior orbital vein, branch of middle meningeal artery
Inferior orbital fissure	Infraorbital nerve and artery, inferior ophthalmic veins
Foramen rotundum	Maxillary nerve (V_2)
Foramen ovale	Mandibular nerve (V_3), accessory meningeal artery
Foramen spinosum	Middle meningeal artery
Foramen lacerum	Internal carotid artery
Internal auditory meatus	Cranial nerves VII and VIII
Jugular foramen	Cranial nerves IX, X and XI, internal jugular vein, inferior petrosal and sigmoid sinuses
Hypoglossal canal	Cranial nerve XII

Middle cranial fossa

Posterior cranial fossa

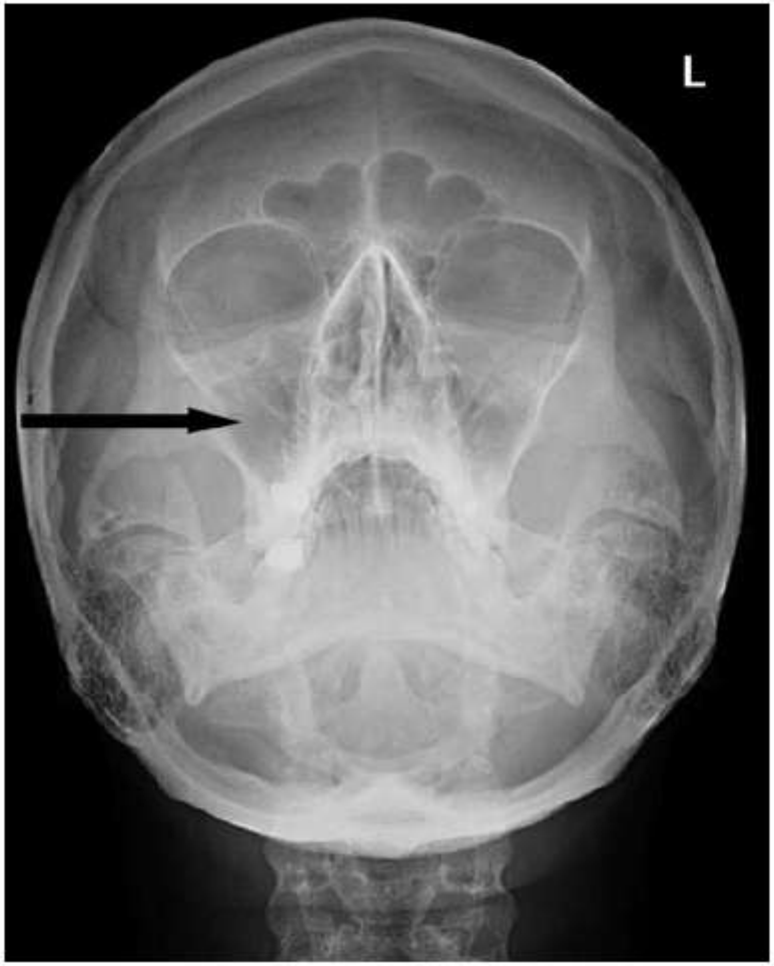
- **Question 46:**

Question 46: Lateral radiograph of the cervical spine

Answer: Epiglottis

- The epiglottis is a leaf-shaped cartilage.
- On a lateral radiograph, it can be recognised as a structure of soft tissue density arising from the laryngeal part of the pharynx, extending cranially into the oropharynx, posterior to the base of the tongue.
- During swallowing, it directs food boluses into the pyriform sinuses to protect the larynx.

- Question 32:

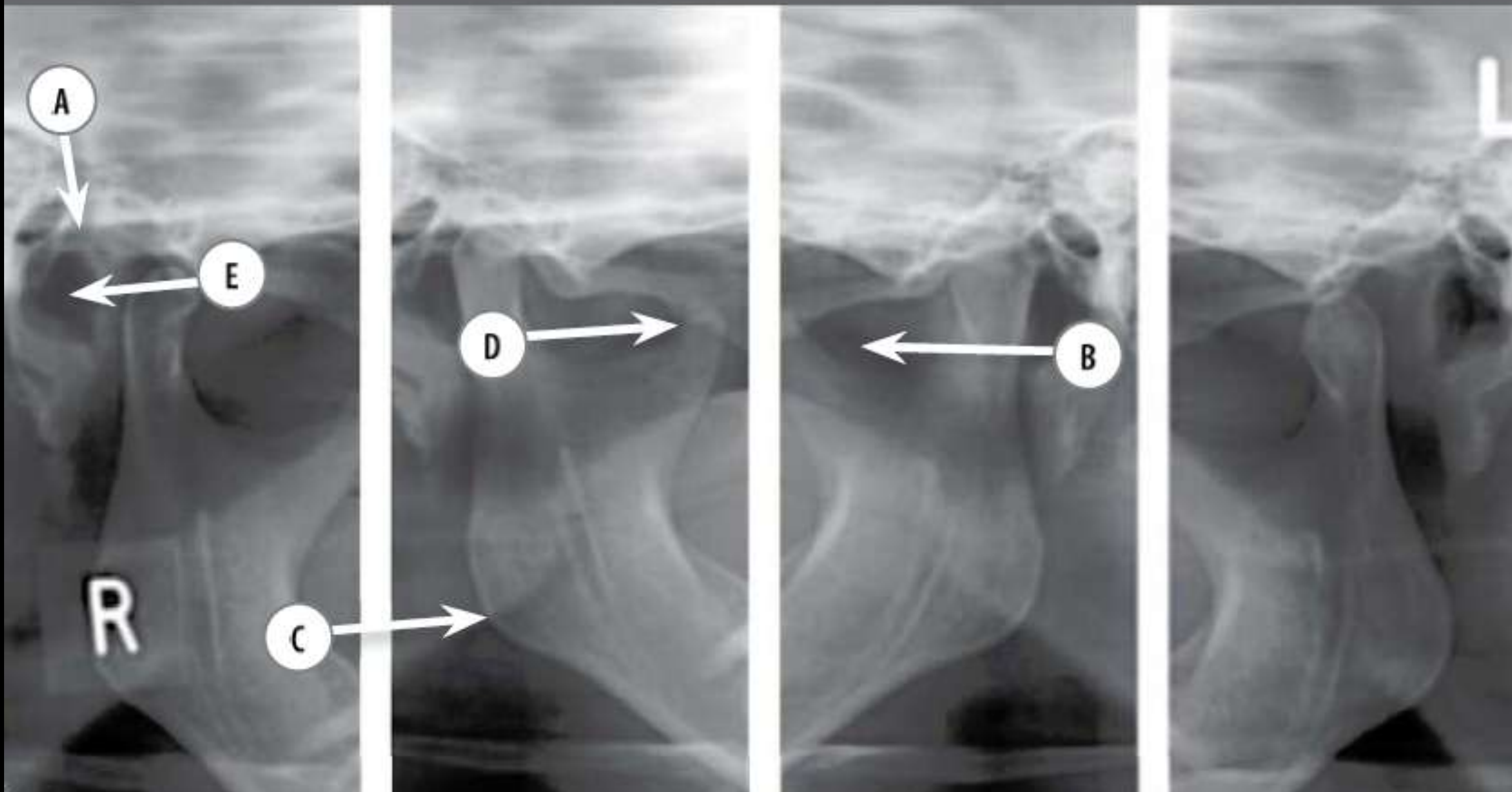


Question 32: Radiograph of the face (occipitomental 30° projection)

Answer: Right maxillary sinus

- The maxillary sinus, or antrum, is a pyramidal mucosa-lined air space in the body of the maxilla.
- It is inferior to the orbits and lateral to the nasal cavity.
- It is the largest of the paranasal sinuses.
- It drains into the middle meatus of the nose.

Case 1.23



Case 1.23

A Right temporomandibular fossa

B Left mandibular notch

C Right angle of mandible

D Right coronoid process

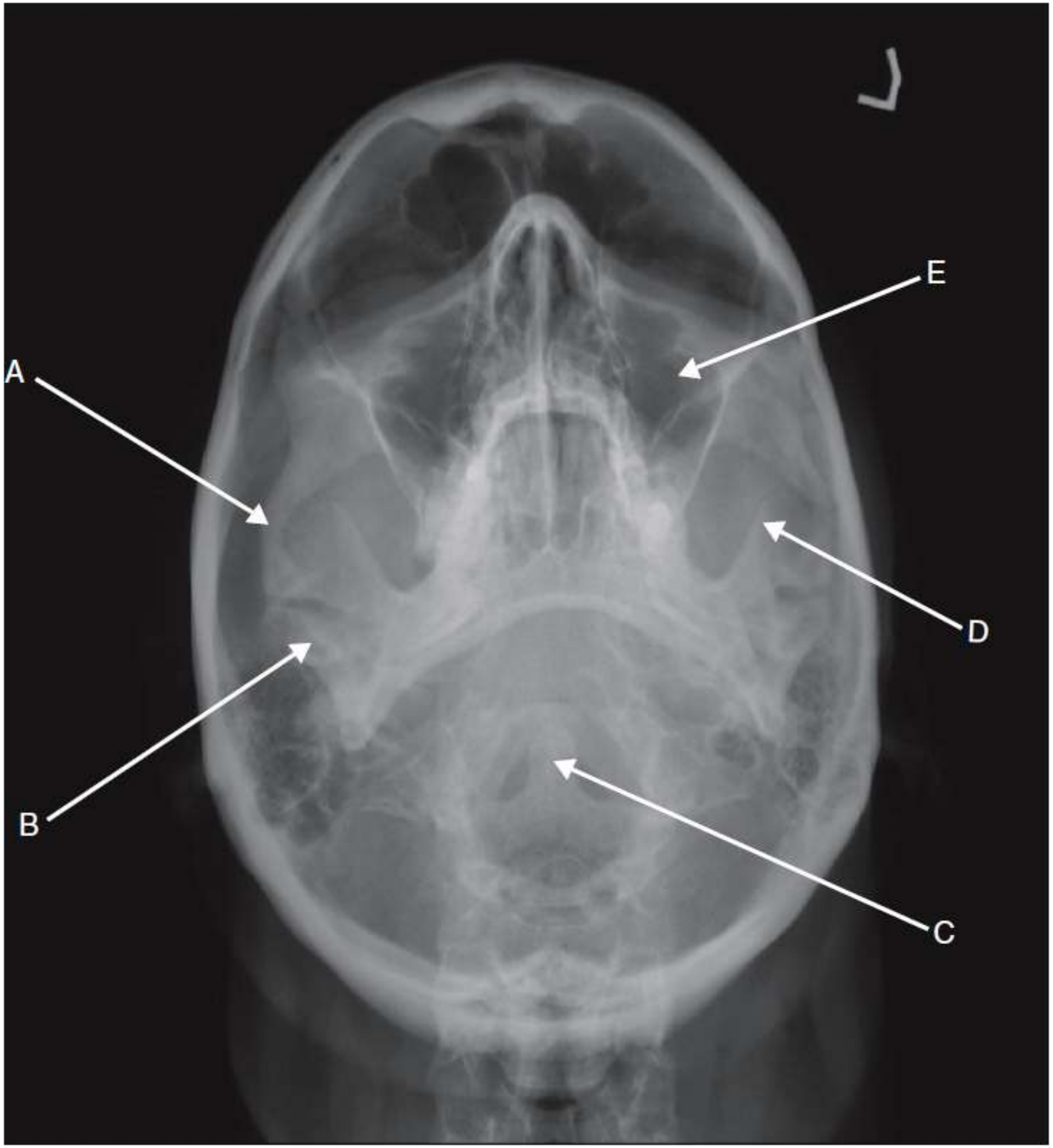
E Right external acoustic meatus

Radiographs of both temporomandibular joints.

These are closed and open mouth plain radiographs of the temporomandibular joints.

On opening the mouth the mandibular condyle translates anteriorly. The next question explains the temporomandibular joints in more detail.

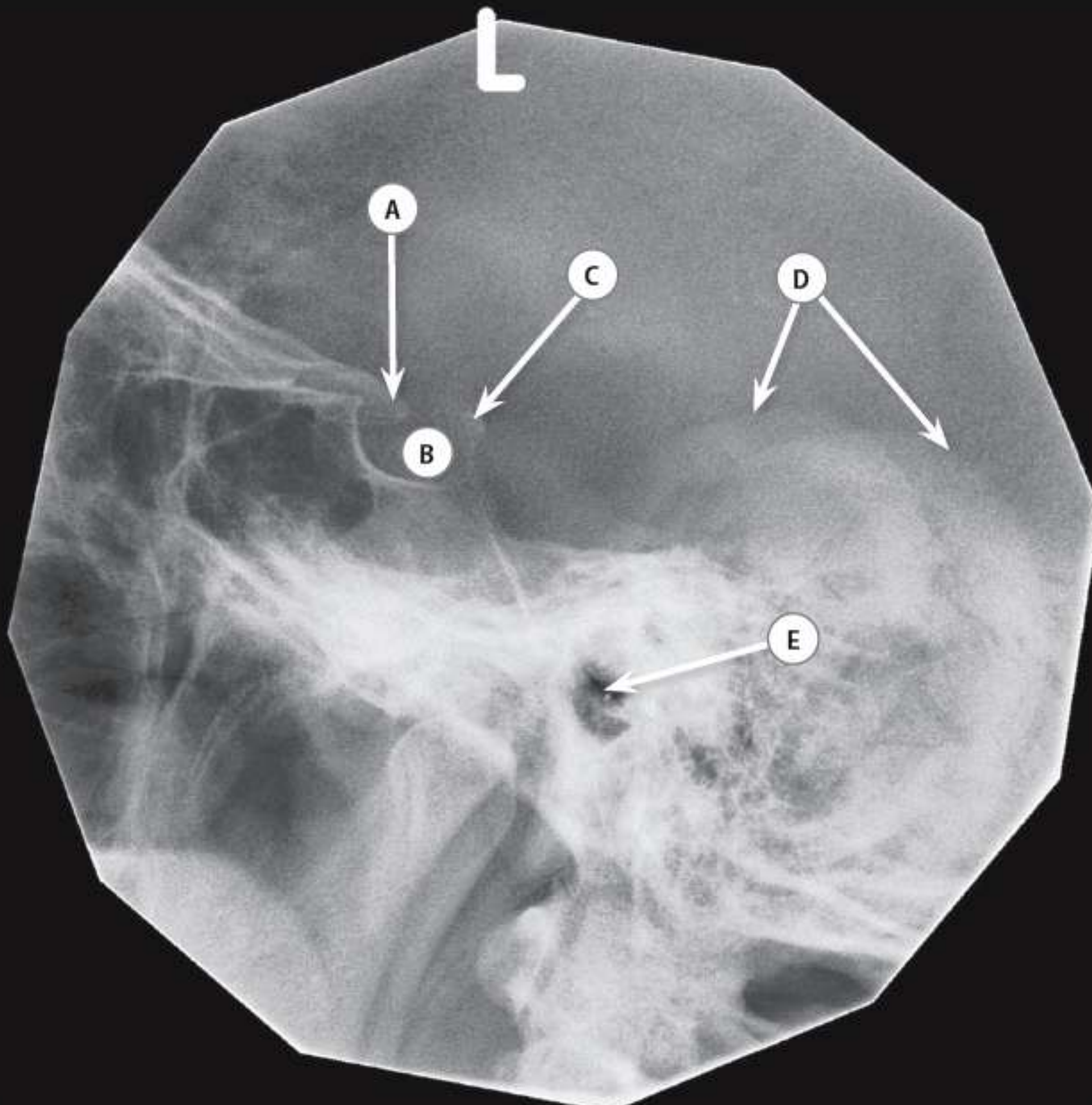
Case 1.11



1.11 Facial bones: OM30 view (occipitomental projection with 30 degrees angulation)

(a) Temporal process of the right zygomatic bone. This meets the zygomatic process of the temporal bone to form the zygomatic arch or cheek bone. Temporalis muscle passes medial to the arch to attach at the coronoid process of the mandible.
(b) Right head of mandible. This is best seen on orthopantomogram (OPG) views or dedicated mandibular views. It articulates with the mandibular fossa of the temporal bone to form the temporomandibular joint (TMJ). These are best visualized with MR. This joint lies immediately anterior to the external auditory meatus; therefore trauma to the mandible often results with haemorrhage into the meatus which can be confused with intracerebral trauma.
(c) Odontoid peg or dens. This is part of C2 (atlas) and articulates with C1 (axis) at the atlanto-axial joint.
(d) Left coronoid process of the mandible.
(e) Left maxillary sinus. The anatomy on facial films is complex and symmetry is often useful to facilitate evaluation.

Case 15.4

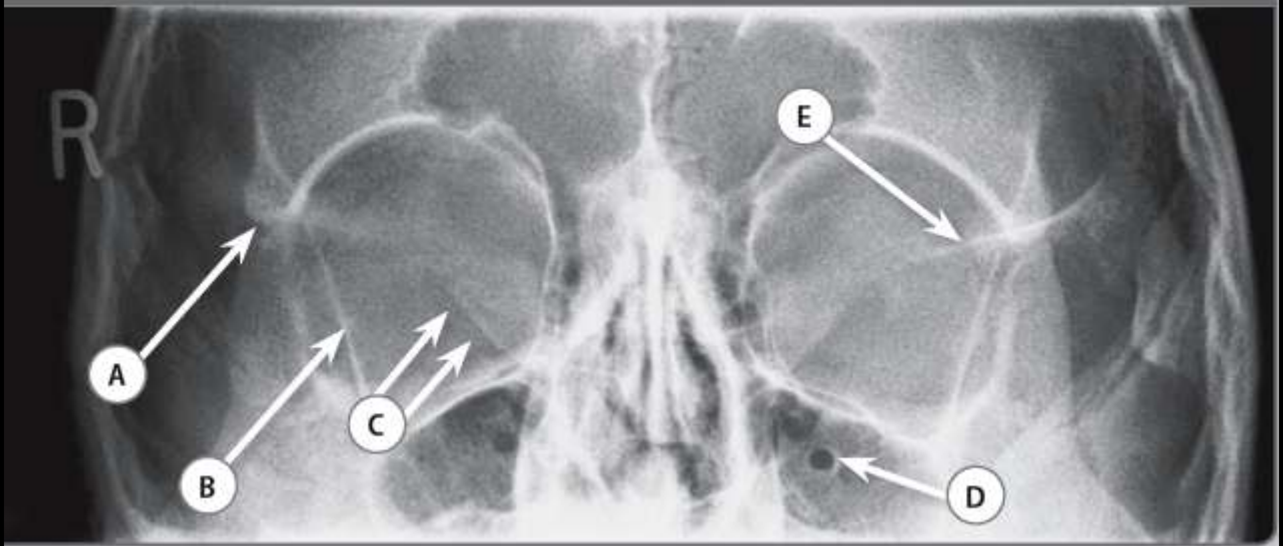


Case 15.4

- **A** Anterior clinoid process
- **B** Pituitary fossa
- **C** Posterior clinoid process
- **D** Pinnae of ears
- **E** Left external auditory canal

The pituitary fossa (sella turcica, meaning Turkish saddle) is a saddle-shaped depression in the superior portion of the sphenoid bone in the middle cranial fossa. The saddle of the sella, in which the pituitary gland sits, is called the hypophyseal fossa. The tuberculum sellae is a small bony bulge situated anterior to the hypophyseal fossa. The dorsum sellae forms the posterior boundary of the saddle, terminating laterally as the posterior clinoid processes. The anterior clinoid processes are frontal continuations of the sella.

Case 13.13



Case 13.13

A Right frontozygomatic suture

B Right greater wing of sphenoid

C Right superior orbital fissure

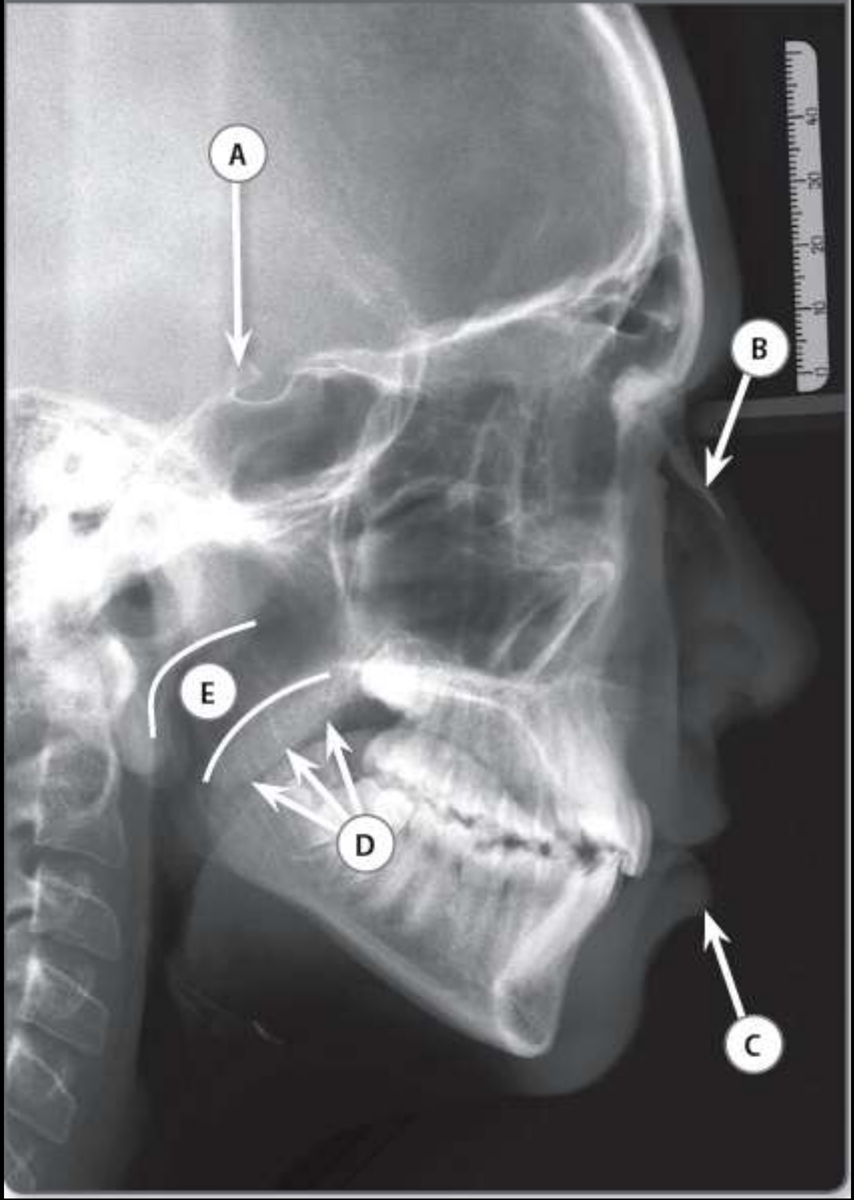
D Left foramen rotundum

E Left lesser wing of sphenoid

You should be able to recognise the fissures and foramina of the skull base, including the:

- **Greater and lesser wings of the sphenoid bone** – visible as two thin dense lines which cross each other in the superolateral aspect of the orbit
- **Superior orbital fissure** – evident as a tubular lucency in the medial aspect of the orbit
- **Foramen rotundum** – a well-defined rounded lucency with dense borders, projected over the maxillary antrum just below the inferior orbital rim. The maxillary division (V3) of the trigeminal (CN V) nerve passes through it.

Case 12.17



Case 12.17

A Posterior clinoid process

B Nasal bone

C Lower lip

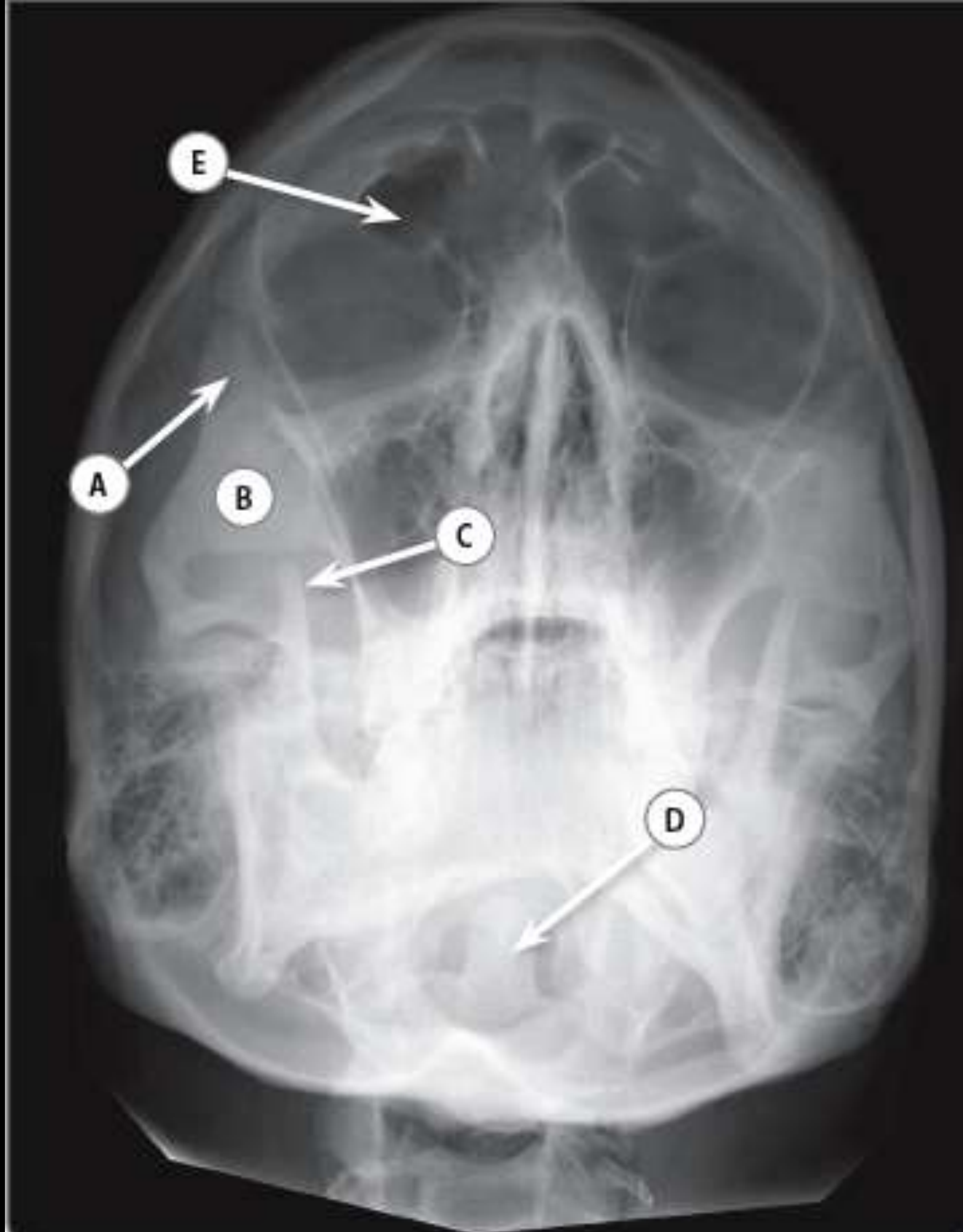
D Soft palate

E Nasopharynx

Lateral views of the facial bones are taken for two main reasons: for cephalometric measurements in dentistry prior to orthodontic treatment; and in paediatric radiology for assessment of upper airways patency.

It is important to be able to recognise the soft tissue structures visible on the plain radiograph, outlined by air in the upper respiratory tract, such as the soft palate, prevertebral soft tissues and the tongue. The air-filled parts of the aerodigestive tract are also clearly demonstrated, including the oral and nasal cavities, paranasal sinuses, oropharynx, nasopharynx and larynx.

Case 11.8



Case 11.8

A Frontal process of right zygoma

B Body of right zygoma

C Coronoid process of right mandible

D Odontoid process (dens) of axis (C2)

E Right frontal sinus

Water's projection is useful for assessing for facial fractures. On this view, the zygoma, orbit and maxilla form the outline of an elephant's head, (**Figure 11.2**). The frontal process of zygoma forms the elephant's forehead, the orbit its ear, the body of zygoma its face and the temporal process of zygoma its trunk.

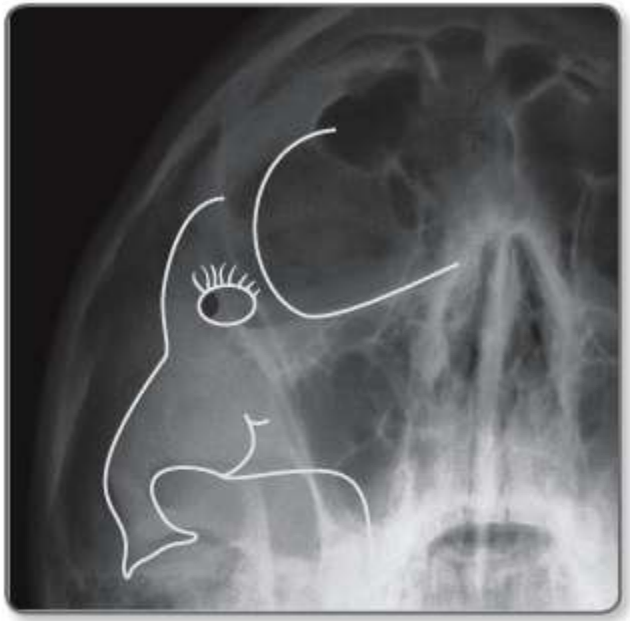
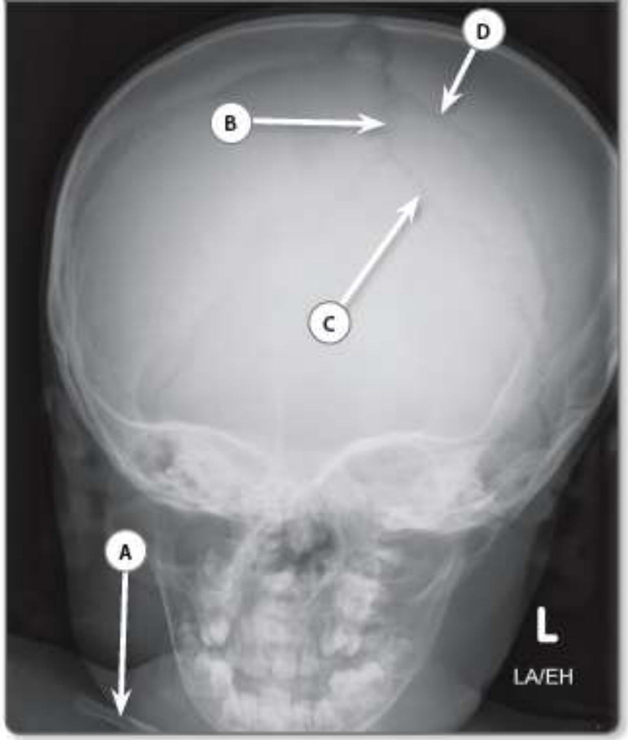


Figure 11.2 'Elephant's head'. A schematic illustration of facial bone relationships on the Water's projection.

Case 10.19



Case 10.19

	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 labelled D.	
E	What is the point at which suture B meets suture D (along with its contralateral counterpart) called?	

Case 10.19

A Right clavicle

B Sagittal suture

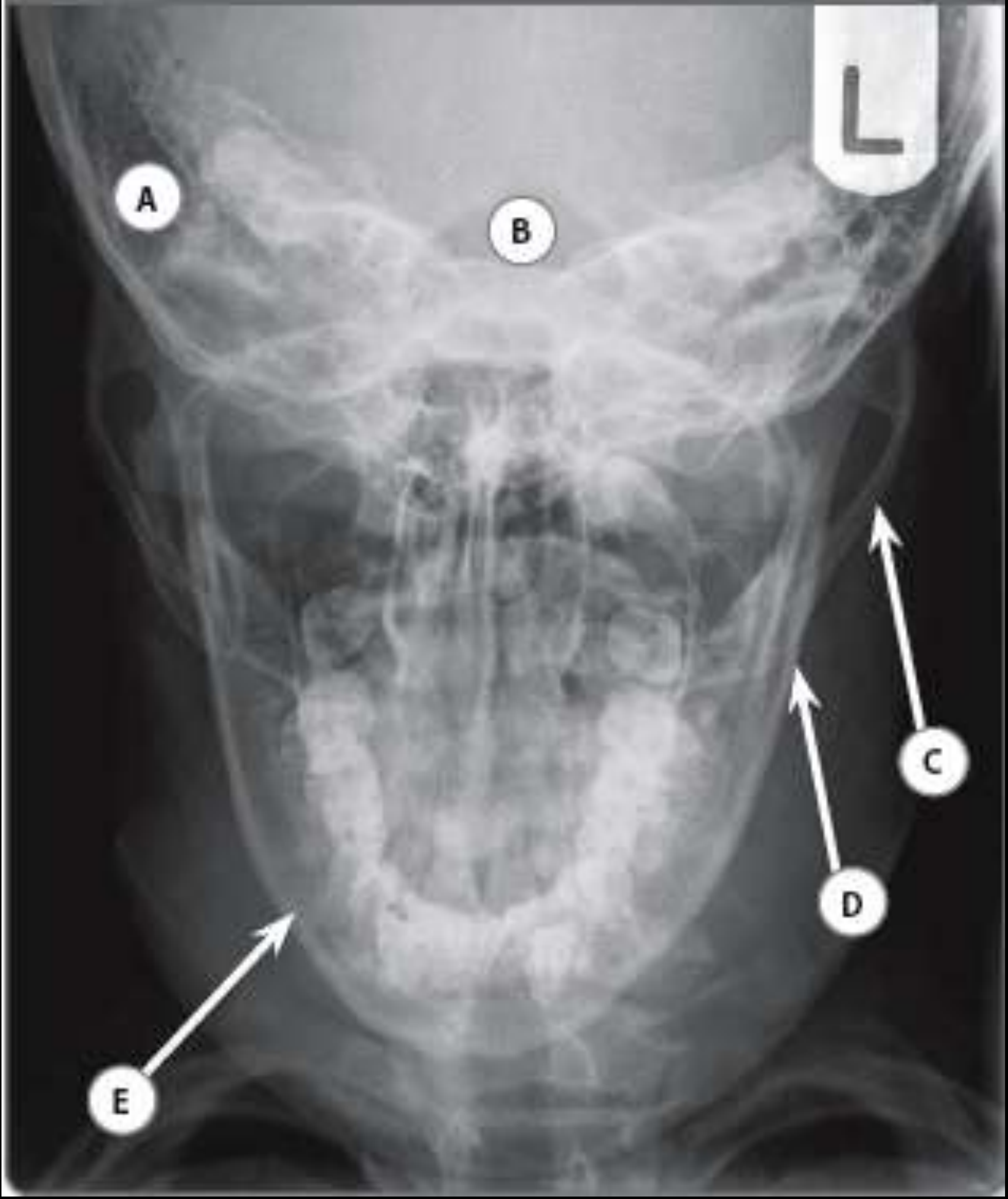
C Left lambdoid suture

D Left coronal suture

E Bregma

The sagittal and lambdoid sutures meet posteriorly at the lambda – accordingly, the point at which the paired parietal bones meet the occipital bone. This corresponds to the site of the posterior fontanelle in the fetus or neonate. The sagittal and coronal sutures meet anteriorly at the bregma, as would the anteriorly placed metopic (or frontal) suture, if present. This is therefore where the paired parietal bones meet the frontal bone and corresponds to the site of the anterior fontanelle. This is an important anatomical landmark in neonatal cranial ultrasound. A wormian bone (usually a normal variant) can be seen in the left coronal suture in this case.

Case 8.14



Case 8.14

A Right mastoid air cells

B Foramen magnum

C Left zygomatic arch

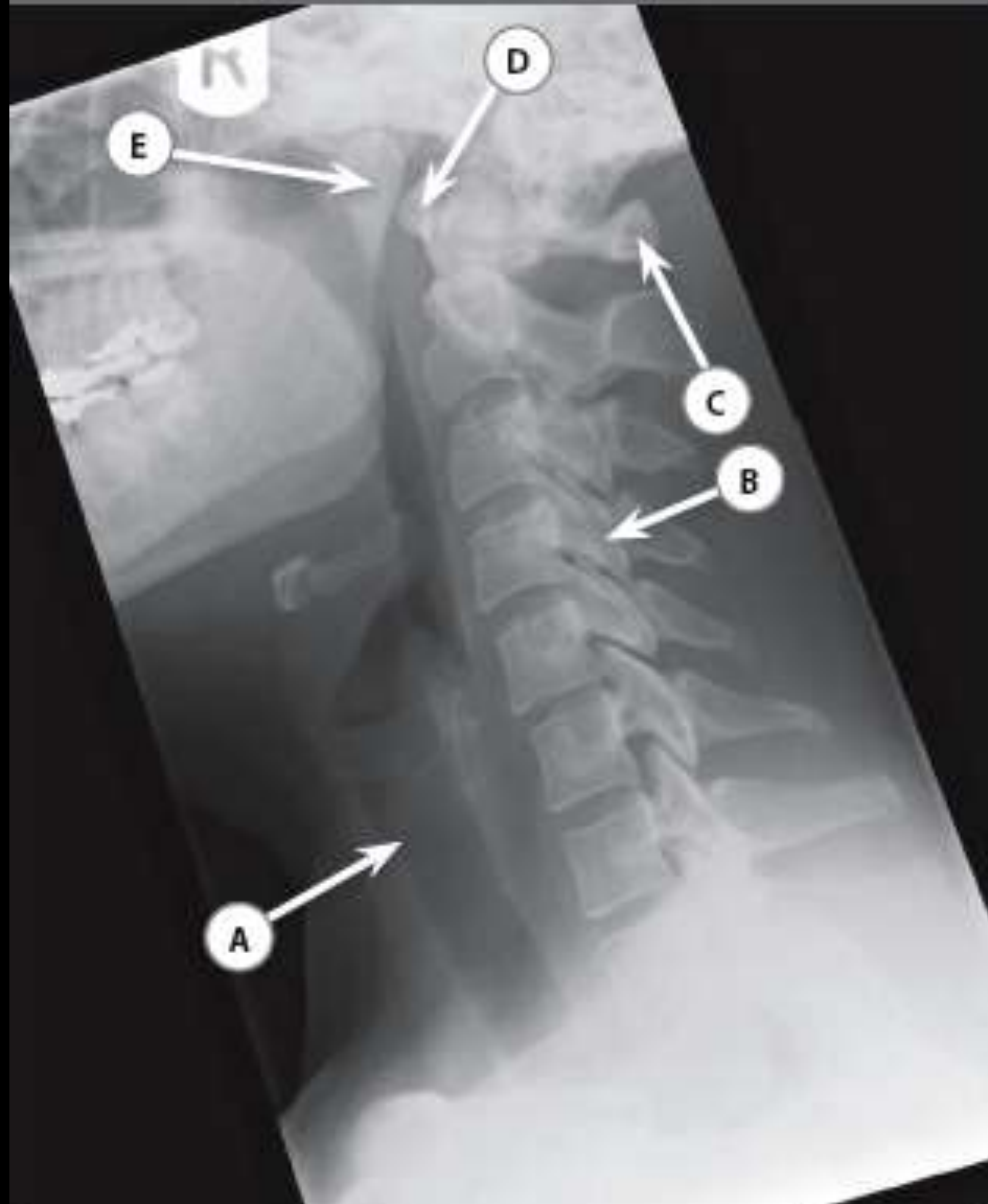
D Left mandibular ramus

E Right mandibular body

The mandible is the strongest of all the facial bones. It consists of two hemimandibles which are fused anteriorly in the midline at the mental symphysis. Each hemimandible contains the following portions:

- The horizontally curved body
- The vertically orientated ramus, which unites with the ipsilateral body to form a right angle (*angle of mandible*)
- Three processes:
  - **Condylar process** – superoposterior projection of the ramus, part of the temporomandibular joint
  - **Coronoid process** – superoanterior projection of the ramus, insertion of the temporalis muscle
  - **Alveolar process** – tooth-bearing area of the mandible.

Case 7.20



Case 7.20

A Trachea

B Inferior articular process of C4

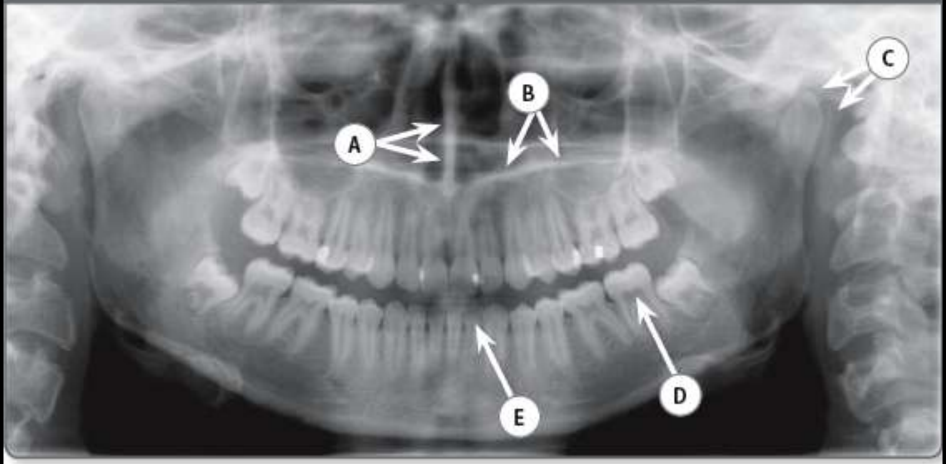
C Posterior tubercle of C1

D Anterior arch of C1

E Right mandibular condyle

An adequate lateral cervical spine radiograph will visualise the C7/T1 junction (as in this case). The inferior and superior articular processes articulate at the facet joints, which slope posteroinferiorly and should overlap (or lie closely parallel) in a normal, non-rotated radiograph.

Case 4.6



Case 4.6

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

Case 4.6

A Nasal septum

B Hard palate

C Left temporomandibular joint

D Pulp cavity of second left lower molar tooth

E Crown of left lower lateral incisor

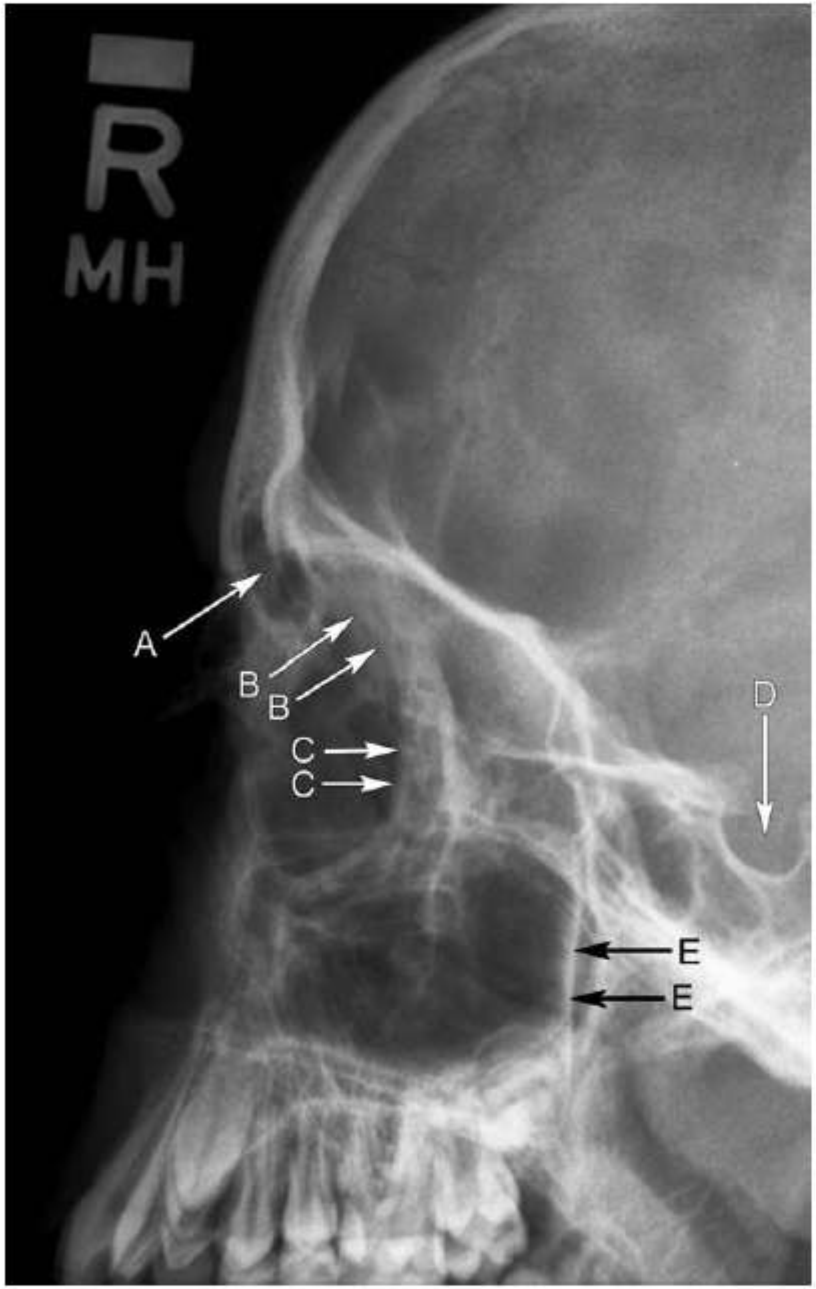
The dental orthopantomogram (OPG) is acquired by synchronous rotation of the X-ray tube and X-ray detector around the patient's head and is a two-dimensional view of the whole mandible and maxilla. The appearances may be a bit confusing – note that the cervical spine is on each side of the mandible.

There are 32 permanent teeth occupying alveoli in the mandible and maxilla. On each side of the upper and lower jaw there are eight teeth, as illustrated in **Table 4.1**.

Table 4.1 Permanent dentition in the right upper jaw

Molars			Pre-molars		Canine	Incisors	
3rd	2nd	1st	2nd	1st	Solitary	Lateral	Medial

Question 9.18



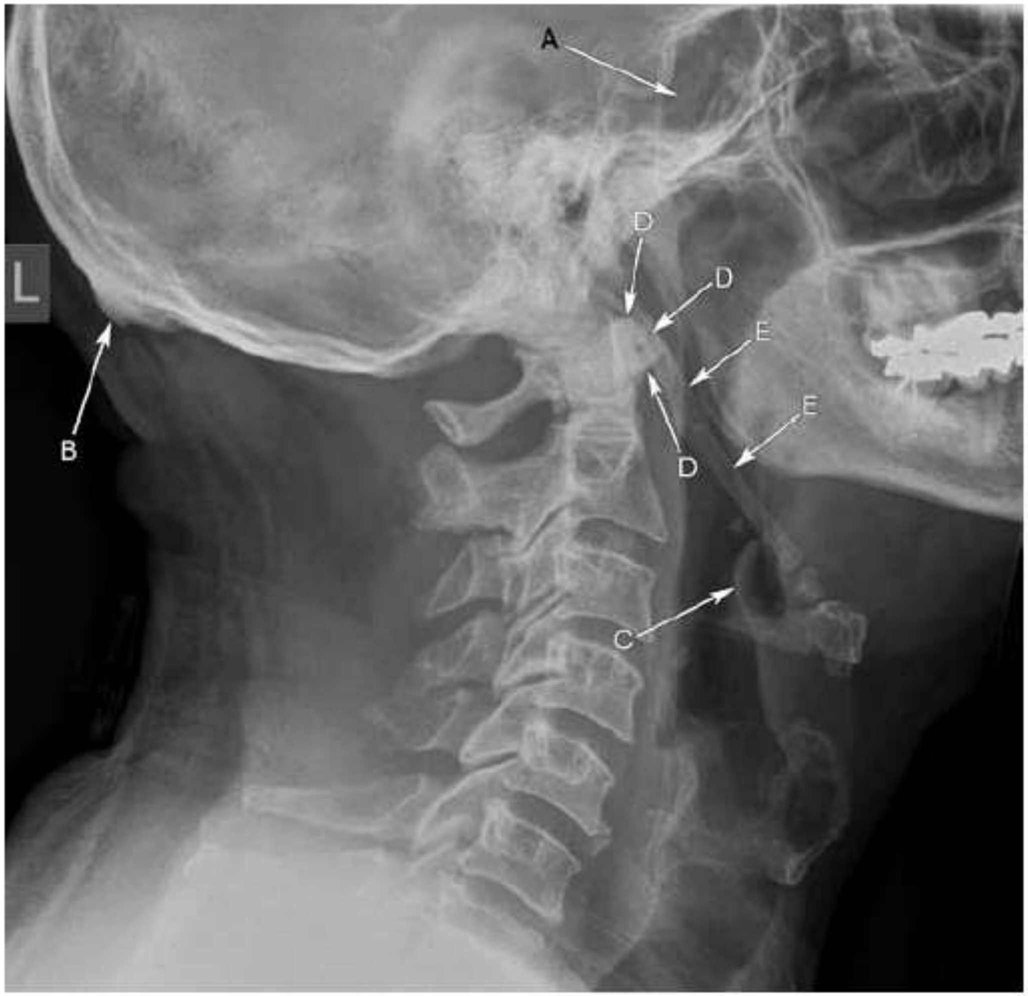
Name the structures labelled **A** to **E**.

9.18 Lateral X-ray of the facial bones

A Frontal sinus.
B Zygomatic process of the frontal bone.
C Frontal process of the zygomatic bone.
D Pituitary fossa.
E Posterior wall of the maxillary sinus.

The frontozygomatic suture lies in the region of the superolateral orbital margin. It is the point where the zygomatic process of the frontal bone meets the frontal process of the zygomatic bone.

Question 8.18



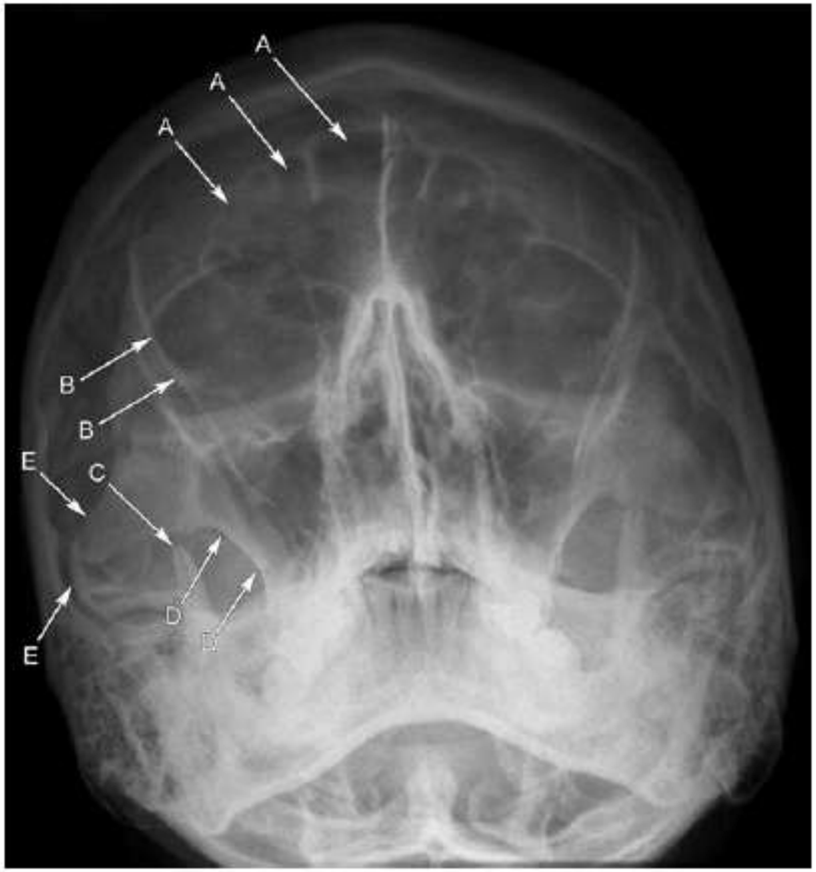
Name the structures labelled A to D.
E What normal variant is present?

8.18 Lateral X-ray of the cervical spine

A Sphenoid sinus.
B External occipital protuberance.
C Epiglottis.
D Anterior arch of C1.
E Calcified stylohyoid ligament.

The stylohyoid ligament is at the superior end of the stylohyoid muscle and connects to the styloid process of the temporal bone. It is not uncommon for this ligament to be partially ossified, as is seen on this image. This can lead to the formation of an elongated styloid process, which is seen in approximately 4% of the population. In a small percentage of these people (5–10%) this elongation is believed to be the cause of a cluster of symptoms including throat pain, globus, dysphagia, tinnitus and facial pain. This is known as Eagle's syndrome, described by Watt Weems Eagle in 1937. Stylohyoid calcification (with or without styloid process elongation) has also been described in the literature as a potential cause of difficult intubation, so if present it is well worth noting the finding in the report.

Question 7.4



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

7.4 X-ray of the face (Water's view)

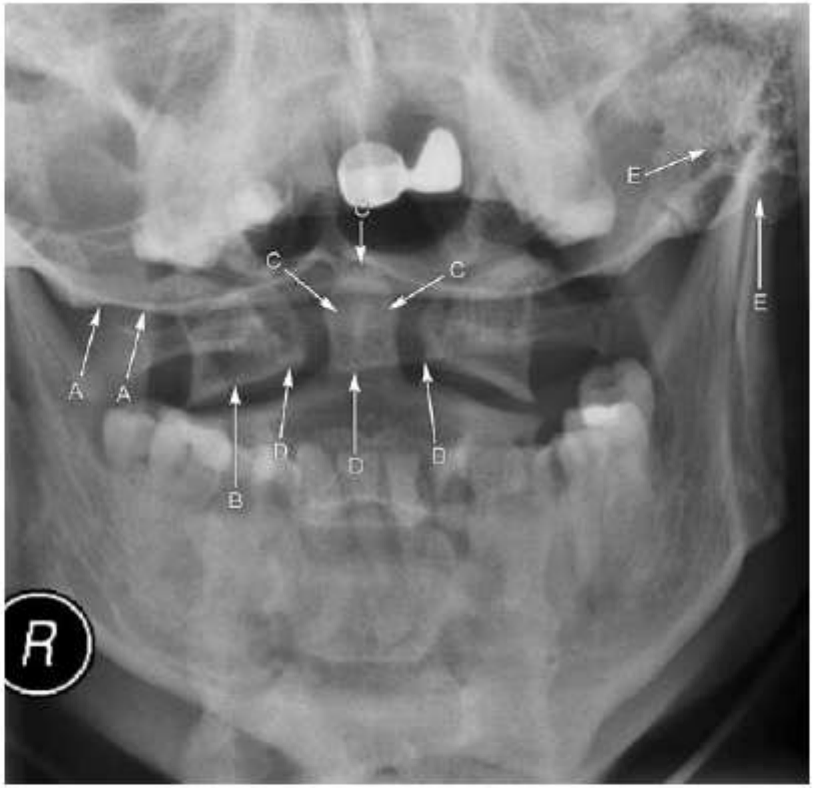
A Frontal sinus.
B Greater wing of the right sphenoid bone (innominate line).
C Right coronoid process of the mandible.
D Lateral wall of the right maxillary sinus.
E Right zygomatic arch.

The frontal sinuses are absent at birth and generally only reach their full size at puberty. About 5% of people do not have a frontal sinus. The frontal sinuses connect to the middle meatus via the frontonasal duct. Their mucosal outline is innervated by the supraorbital nerve.

The maxilla forms the upper jaw, with the maxillary arch holding the upper teeth. It attaches laterally to the zygomatic bone. It helps form the roof of the mouth, the wall of the orbit and the lateral wall of the maxillary sinus.

The innominate line represents the tangentially viewed superior surface of the greater wing of the sphenoid bone (the squamo-zygomatic surface).

Question 6.9



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

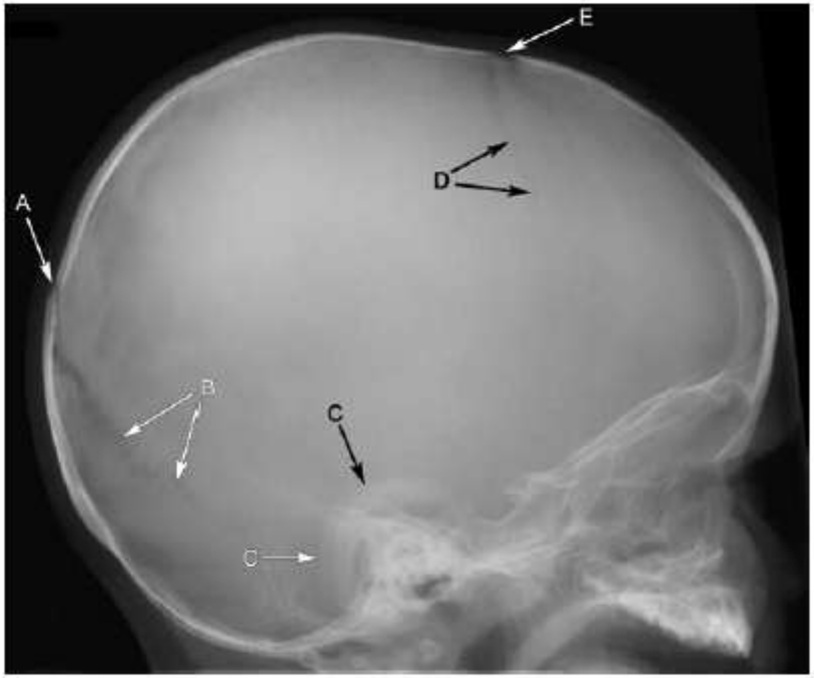
6.9 X-ray of the odontoid peg

A Occipital bone.
B Right lateral mass of C1.
C Odontoid peg.
D Anterior arch of C1.
E Left mastoid air cells.

The odontoid peg (dens) is a bony projection from the body of C2 (axis). The peg articulates with the posterior surface of the anterior arch of the atlas and has ligamentous attachments to the atlas and occipital bone. Fractures of the peg are classified into three different types:

Type I	Fracture through the tip
Type II	Fracture through the base (most common)
Type III	Fracture through the body of C2

Question 5.10



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

5.10 Lateral X-ray of an infant's skull

A Posterior fontanelle.
B Lambdoid suture.
C Pinna.
D Coronal suture.
E Anterior fontanelle.

The coronal suture separates the parietal and frontal bones and can be recognized by its orientation in the coronal plane. The lambdoid suture derives its name from the shape of the Greek letter lambda (Λ). It is a posterior suture that separates the parietal, temporal and occipital bones. Knowledge of the sutures of the skull is essential for a radiologist, to help in differentiating between sutures and fractures on skull radiographs. Skull fractures usually appear as dark linear lines and are not usually located in anatomical areas, whereas skull sutures are located in anatomical areas and do not run in straight lines (as can be seen on this image).

The anterior fontanelle is located at the junction of the coronal and sagittal sutures and can take up to two years to close. The posterior fontanelle is located at the junction of the lambdoid and sagittal sutures and usually closes by the age of six months.

Question 3.9

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

3.9 Lateral X-ray of the cervical spine

A Anterior arch of C1.
B Spinous process of C2.
C Pedicle of C6.
D Facet joint C4/C5.
E Harris' ring.

C1, C2 and C7 are 'special' vertebrae because each differs from the normal structure of the remaining cervical vertebrae.

- C1 (the atlas) has no vertebral body.
- C2 (the axis) has an odontoid peg.
- C7 (vertebra prominens) has a prominent longer spinous process than the other cervical vertebrae, which is why it is called the vertebra prominens.

Question 3.1

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

E What nerve passes through D?

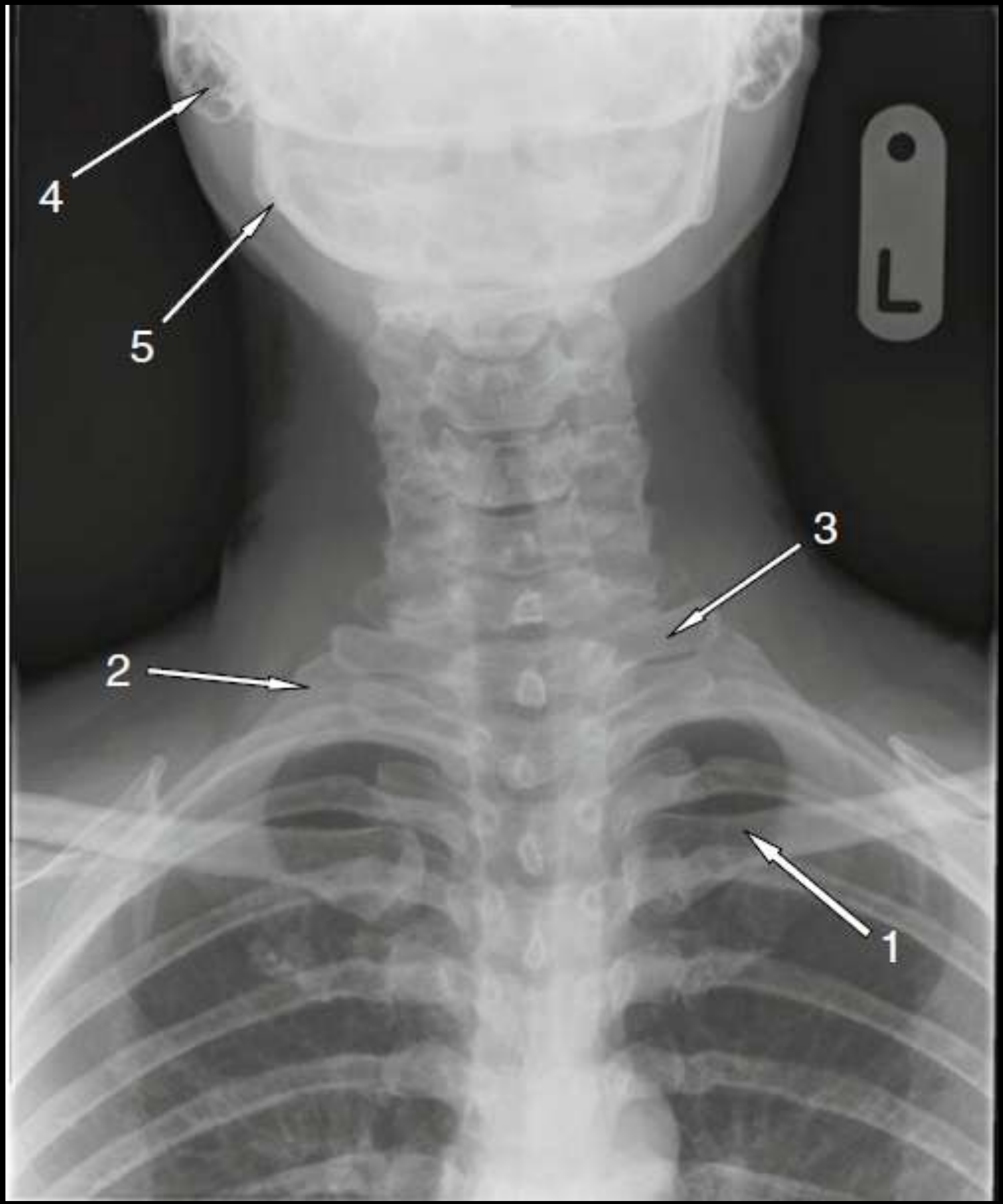
3.1 PA X-ray of the skull

A Frontal process of the right zygomatic bone.
B Right maxillary antrum.
C Crista galli.
D Left foramen rotundum.
E Maxillary branch of the trigeminal nerve.

The trigeminal nerve arises from the lateral surface of the pons and within millimetres enters the trigeminal ganglion, from which three major branches arise and exit the cranium through different foramina. The table below outlines the three divisions:

Division	Exit foramina of the skull	Sensory innervation
Ophthalmic division (V^1)	Superior orbital fissure	Skin of the forehead and superior to the eye
Maxillary division (V^2)	Foramen rotundum, followed by infraorbital foramen	Skin inferior to the eye and superior to the mouth
Mandibular division (V^3)	Foramen ovale	Lower lip, teeth and gums, chin and jaw (also has motor innervation to the muscles of mastication)

The foramen rotundum is projected below the inferior rim of the orbit on facial radiographs and connects the middle cranial fossa with the pterygopalatine fossa. The crista galli is a ridge of bone that extends superiorly from the cribriform plate. It forms the anterior attachment for the falx cerebri. The anterior margin of the lateral orbital wall seen on facial bone radiographs is formed inferiorly by the orbital process of the zygomatic bone and the zygomatic process of the frontal bone superiorly. The junction of these two bones forms the zygomaticofrontal suture.


4
5
L
3
2
1

Cervical Spine Radiograph

1. Head of left clavicle
2. Right first rib
3. Left transverse process of T1
4. Right mastoid air cells
5. Left angle of mandible

C7 vertebra is found as it has downward-pointing transverse processes, unlike the thoracic vertebrae, which have upward pointing transverse processes.


15
L
HBL
13
12
14
11

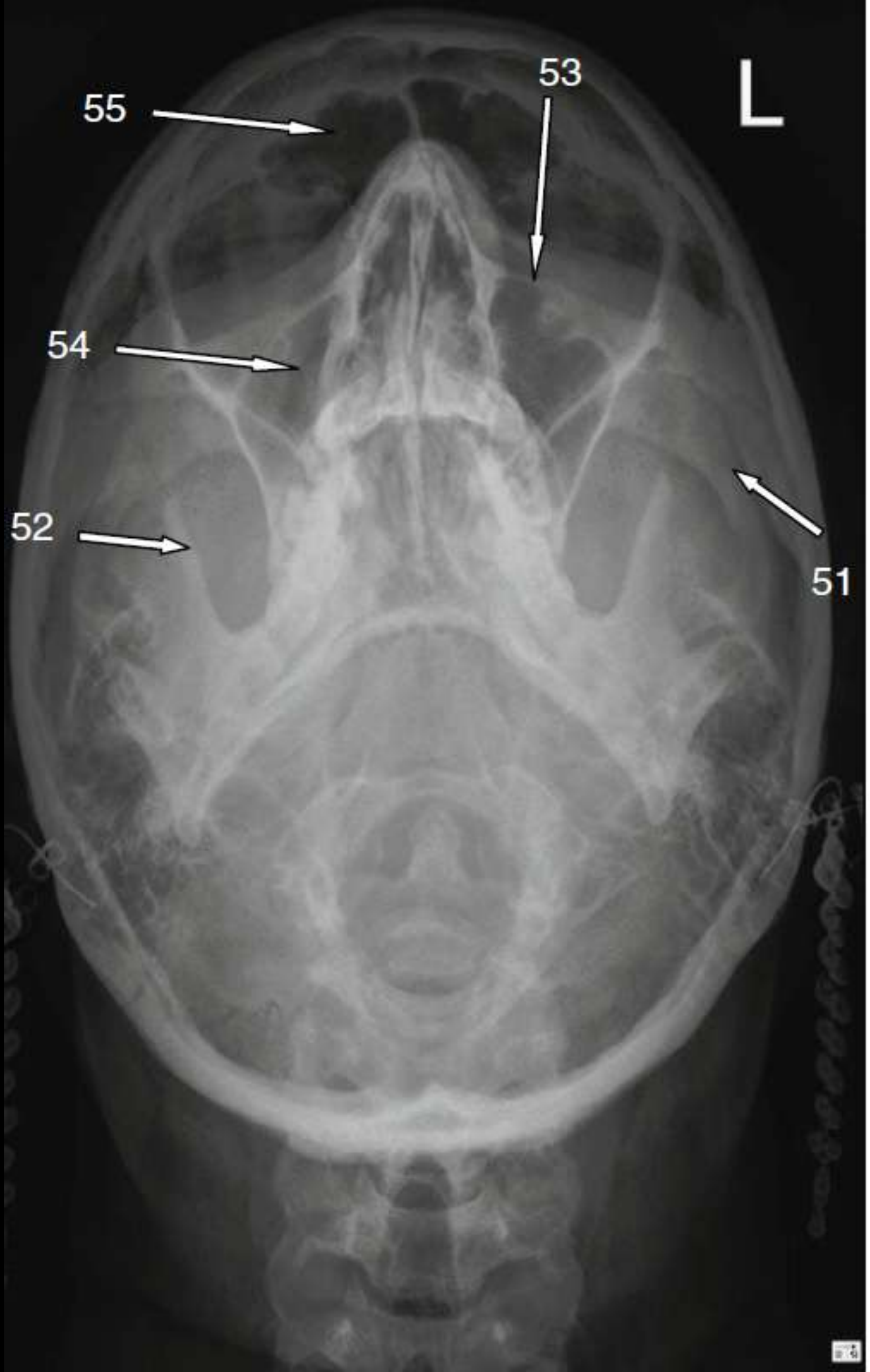
Cervical Spine Radiograph

11. Body of hyoid bone
12. Epiglottis
13. Vallecula
14. Spinous process of C5 vertebra
15. Anterior arch of C1 vertebra (Atlas)


81
83
L
84
82
85

Cervical Spine Radiograph

81. Mandibular condyle
82. Trachea
83. Dens
84. C3/C4 facet joint
85. C7/T1 intervertebral disc space

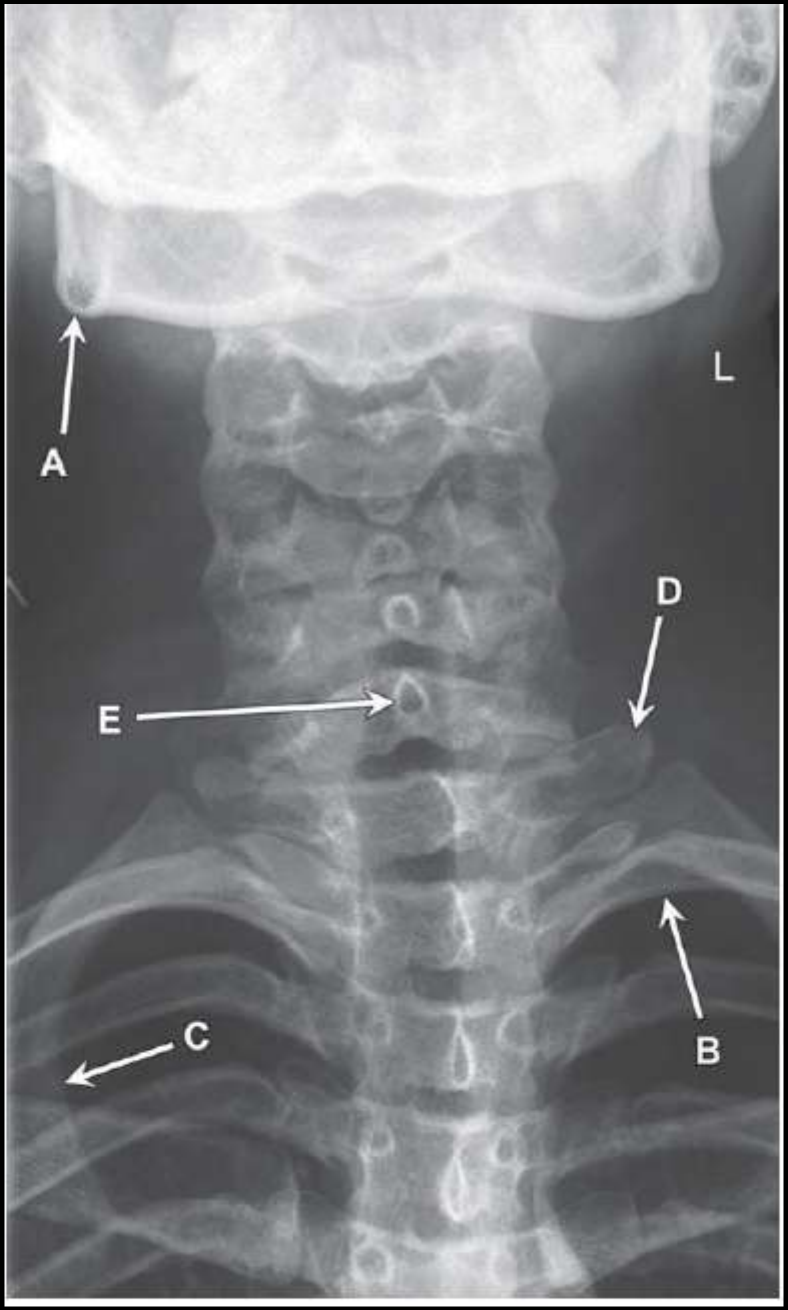


55
53
L
54
52
51

Skull Radiograph

51. Left zygomatic arch
52. Right coronoid process of mandible
53. Left orbital floor
54. Right maxillary sinus/antrum
55. Right frontal sinus

The zygomatic arch on this view looks like an elephant's trunk.


L
A
D
E
B
C

Case 6

AP radiograph. Cervical spine.

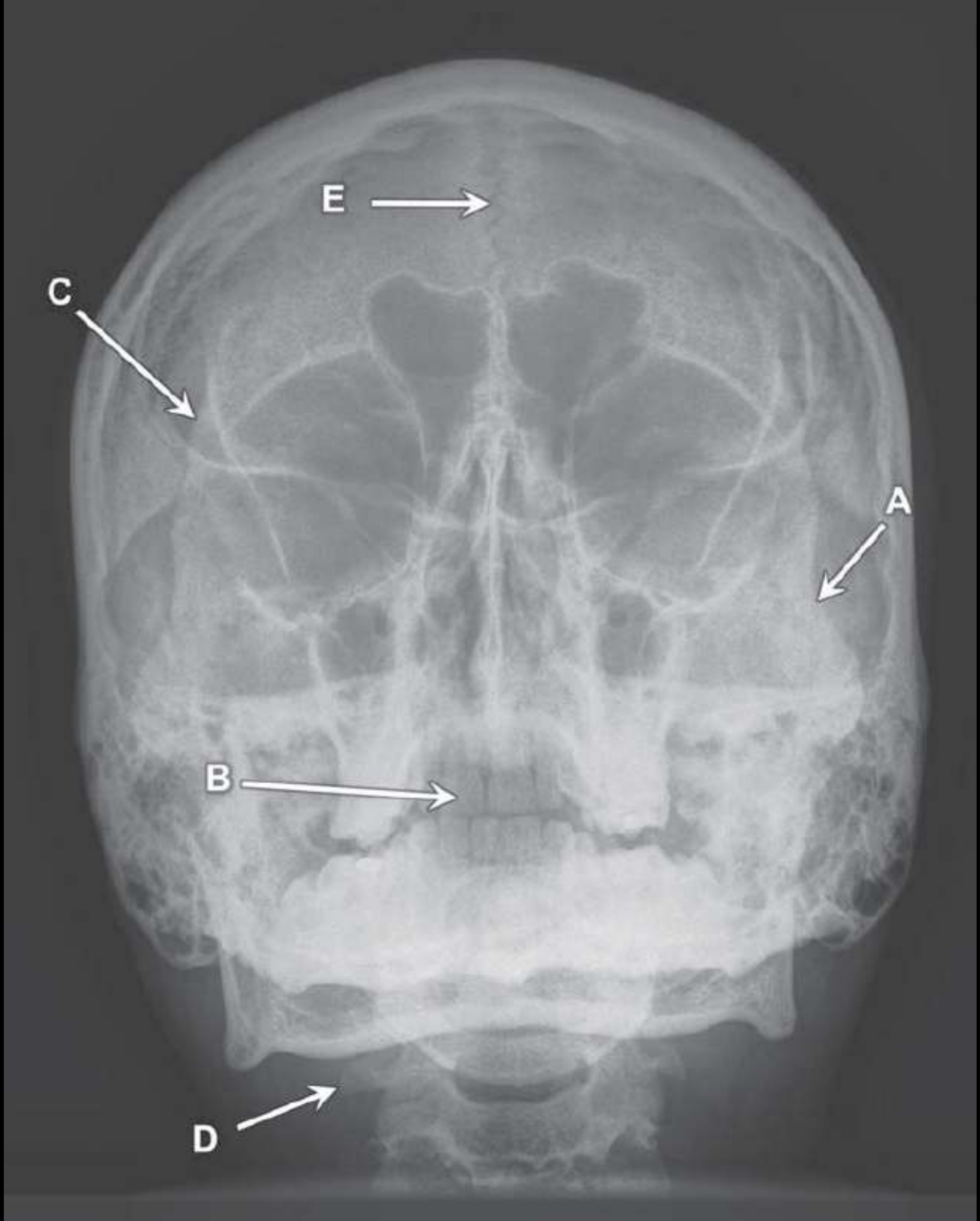
1. Right angle of the mandible
2. Left second rib
3. Right first rib
4. Left transverse process of T1
5. Spinous process of C7


L
E
A
D
B
C

Case 11

Occipitomental skull radiograph.

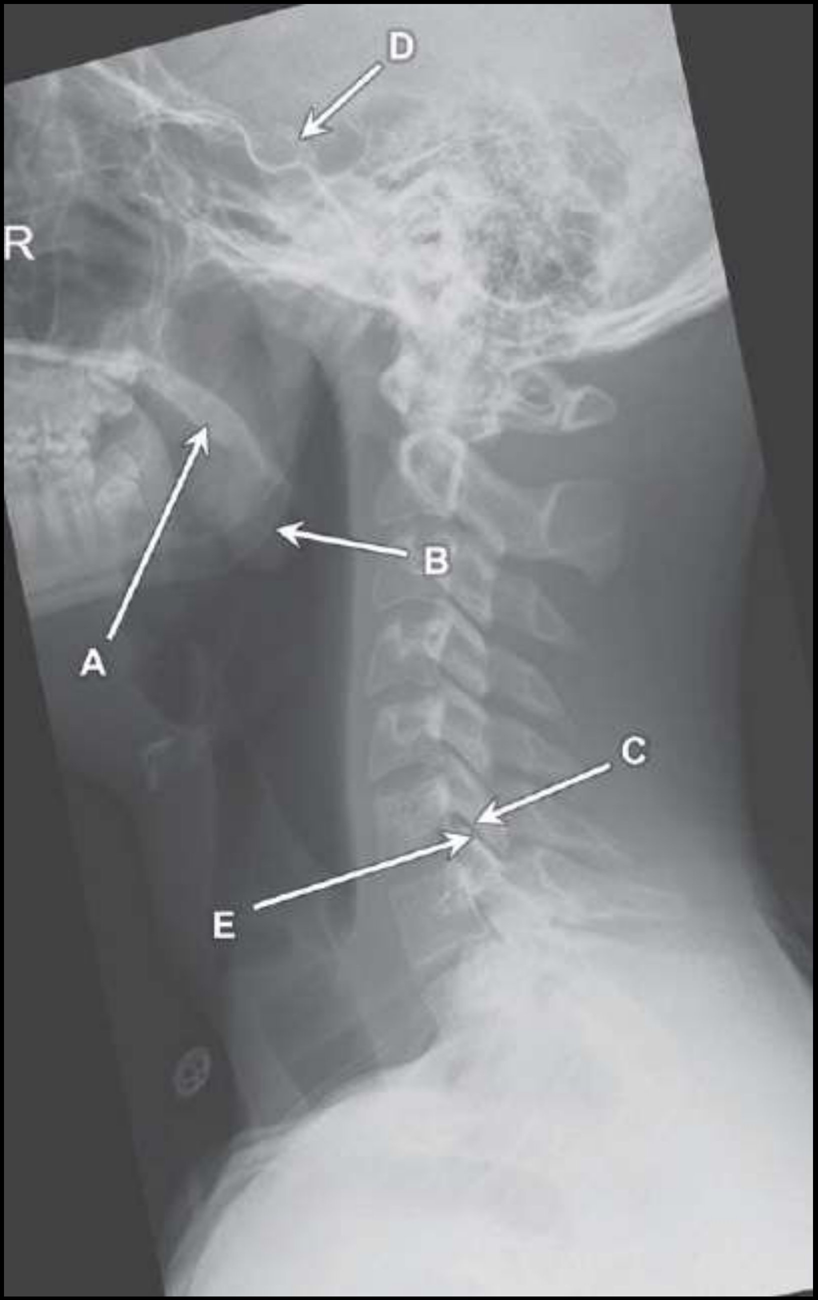
1. Right foramen rotundum
2. Right mastoid air cells
3. Right transverse foramen of C1
4. Left infraorbital foramen
5. Left innominate line/ greater wing of sphenoid


E
C
A
B
D

Case 19

AP skull radiograph.

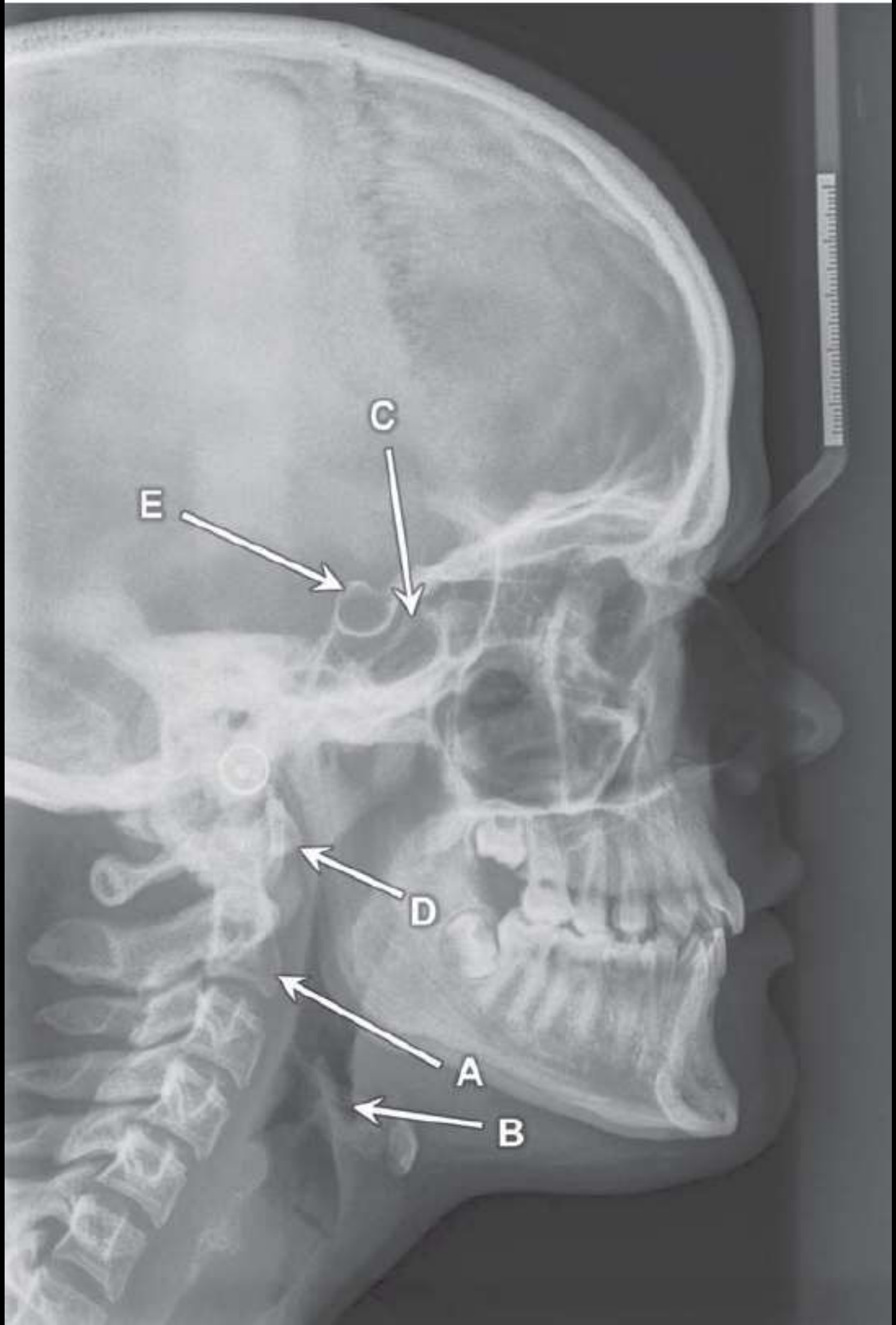
1. Left zygoma
2. Right first upper incisor
3. Zygomatic process of the right frontal bone
4. Right lateral process of the C2 vertebra
5. Sagittal suture


R
D
A
B
C
E

Case 5

Plain radiograph, lateral cervical spine.

1. Soft palate
2. Angle of the mandible (not possible to say which side)
3. Inferior articular process of C6 vertebra
4. Posterior clinoid process
5. Superior articular process of C7 vertebra

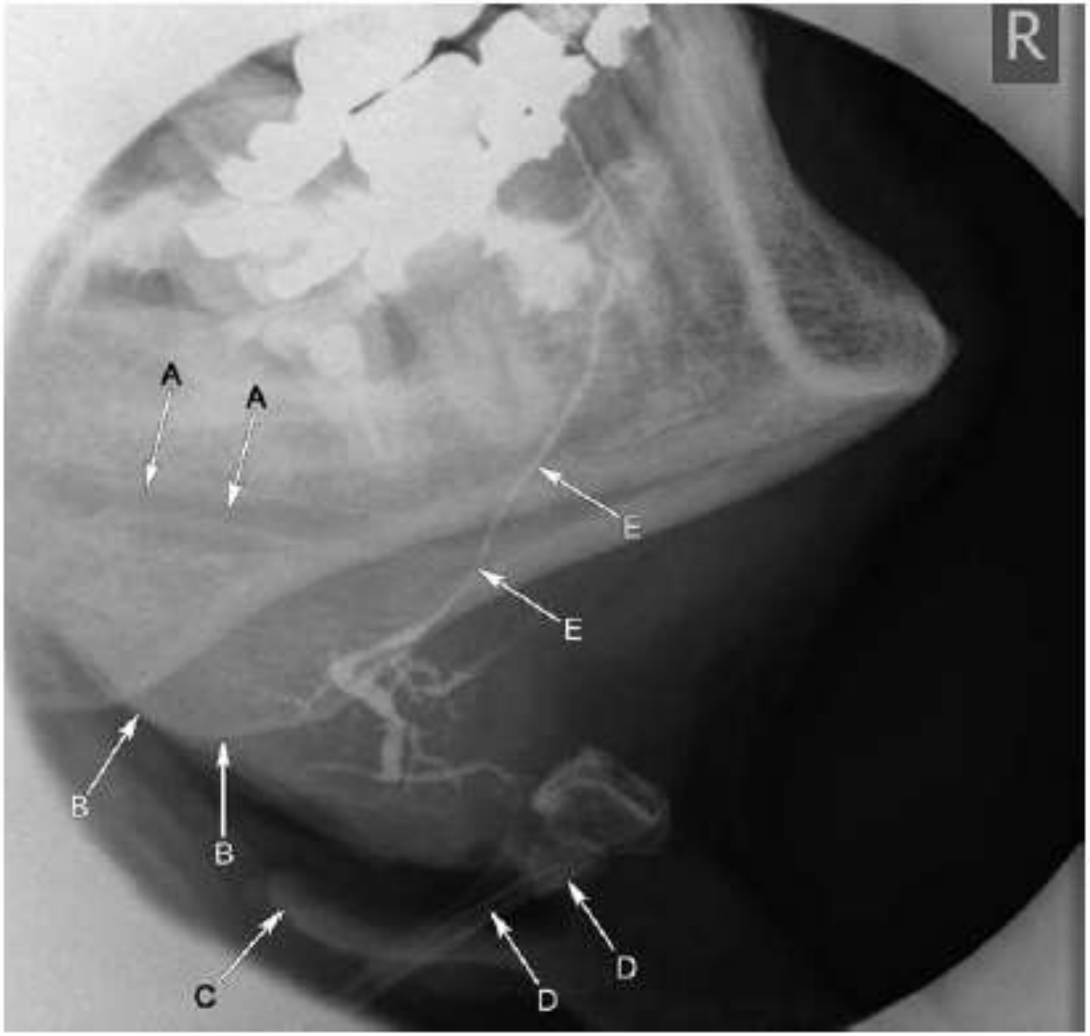

C
E
D
A
B

Case 6

Cephalogram

1. Body of the C2 vertebra
2. Vallecula
3. Sphenoid sinus
4. Body of the C1 vertebra (anterior arch)
5. Posterior clinoid process of the sphenoid bone

Question 1.19



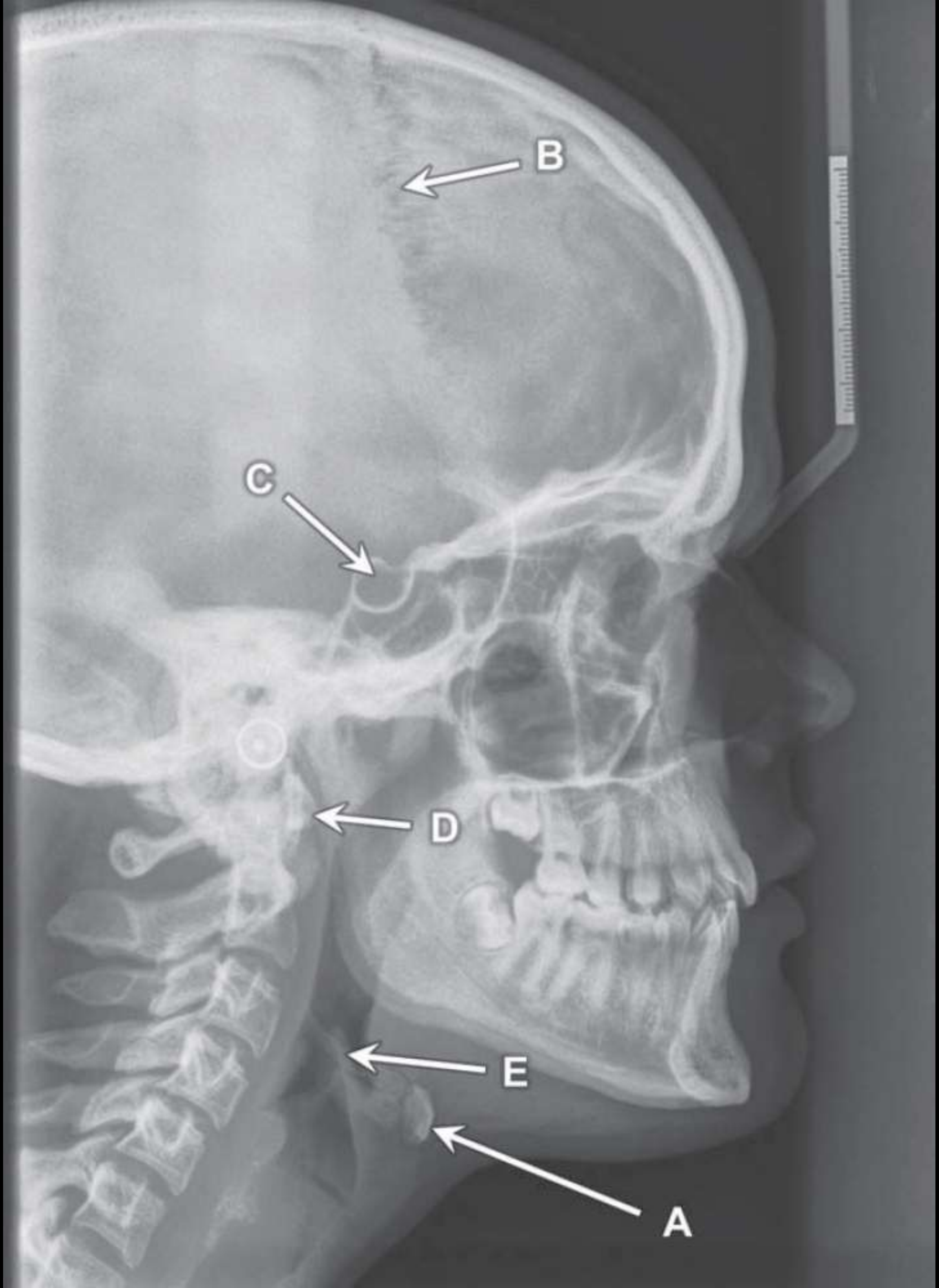
Name the structures labelled **A** to **E**.

1.19 Submandibular sialogram

A Right inferior alveolar canal.
B Angle of the right mandible.
C Epiglottis.
D Hyoid bone.
E Right Wharton's duct (submandibular duct).

Sialograms of the salivary glands are performed to assess the salivary ducts for flow, obstruction and filling defects (e.g., calculi). A cannula is inserted into the relevant duct opening within the mouth, contrast is injected and radiographs taken. Standard views are an AP view and a lateral oblique view of the examined side. A right lateral oblique X-ray is therefore performed for imaging the right submandibular gland.

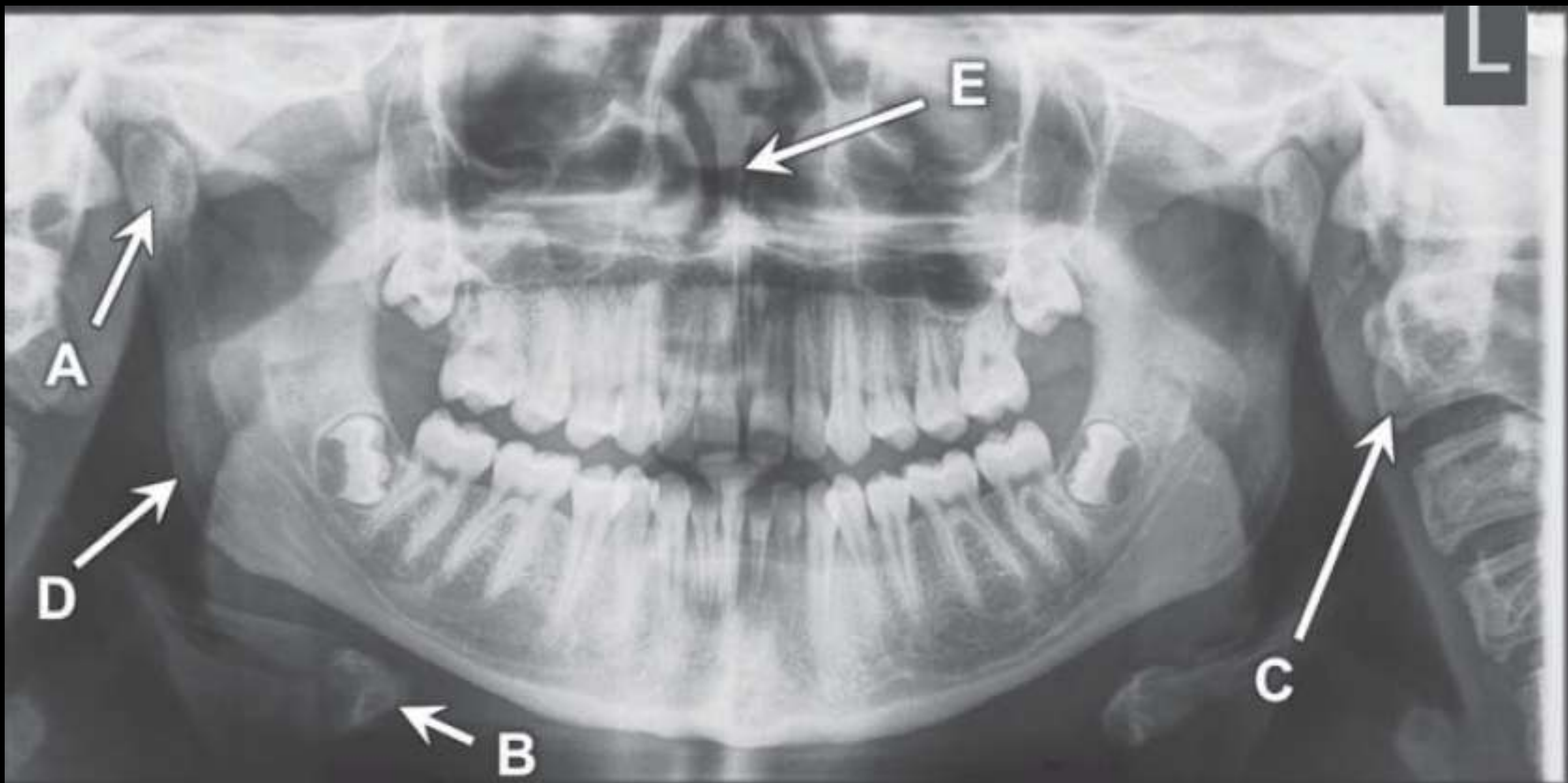
The submandibular ducts (Wharton's ducts) open into the anterior floor of the mouth, under the tongue and on either side of the frenulum linguae. The parotid ducts (Stenson's ducts) open into the rear of the mouth opposite the upper second molar tooth. The inferior alveolar canal transmits the inferior alveolar nerve (a terminal branch of the mandibular division of the trigeminal nerve (CN V^3)) and exits the mandible via the mental foramen, where it supplies the sensation to the chin and lower lip. It is at risk of injury during the removal of wisdom teeth.


B
C
D
E
A

Case 17

Encephalogram.

1. Hyoid bone
2. Coronal suture
3. Pituitary fossa
4. Anterior arch of C1 vertebra
5. Epiglottis



L
E
A
D
B
C

Case 2

Orthopantomogram.

1. Right mandibular condyle
2. Hyoid bone
3. C2 vertebral body
4. Angle of the mandible (right)
5. Nasal septum


C
A
E
B
D

Case 4

Occipitomental radiograph of skull.

1. Coronoid process of the mandible
2. Dens/ odontoid peg
3. Right frontal sinus
4. Left mastoid air cells
5. Right zygomatic arch

Question 1.4

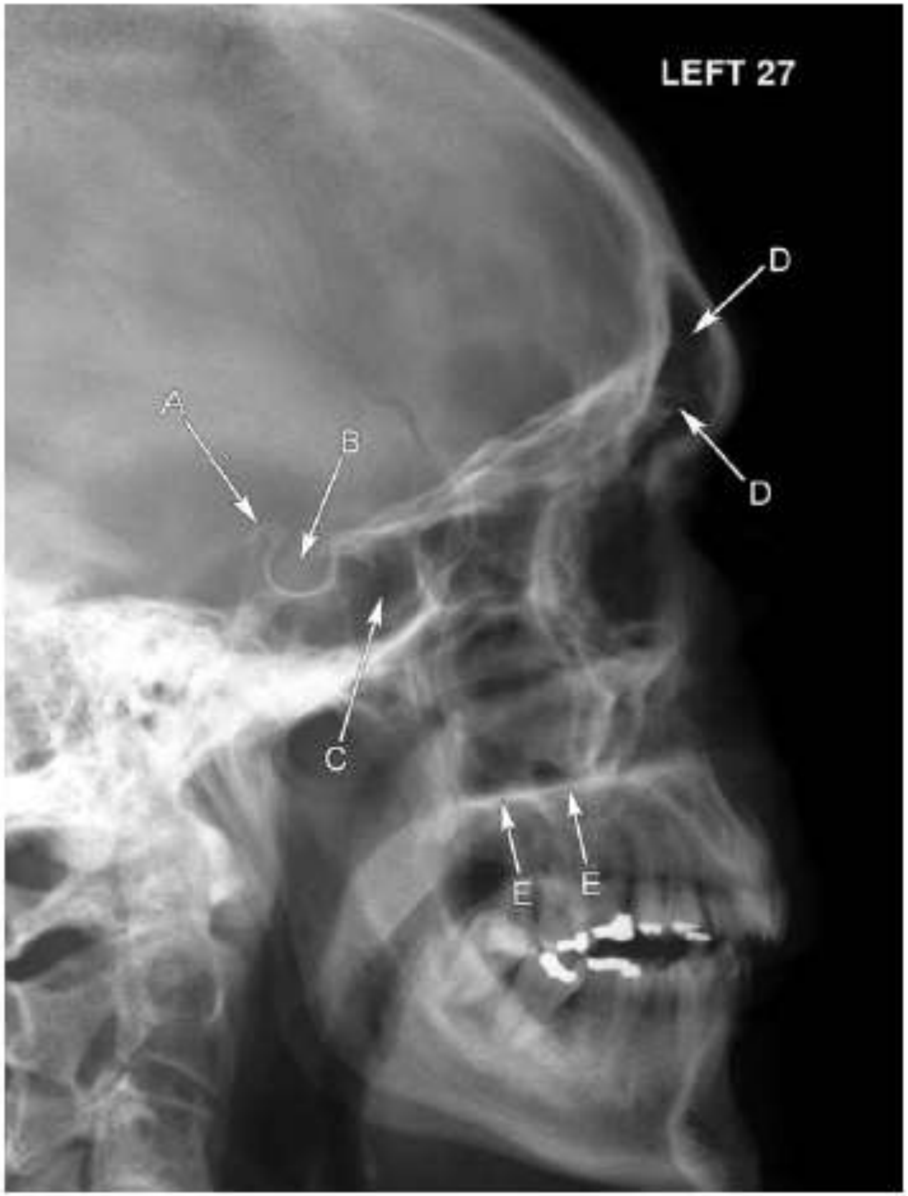
Name the structures labelled **A** to **D**.
E What passes through the structure labelled D?

1.4 Orthopantomogram (OPG)

A Right inferior alveolar canal.
B Right mandibular condyle.
C Right styloid process.
D Right mental foramen.
E Right mental nerve.

The mandible is made up of two halves, each half consisting of a body, an angle, a ramus, a coronoid process and a condylar neck and process. The condylar process forms the mandibular portion of the temporomandibular joint and articulates with the temporal bone. The mental foramen is the exit foramen for the inferior alveolar nerve (a branch of the mandibular division of the trigeminal nerve (CN V^3)). The styloid process of the temporal bone lies anterior to the mastoid process and is the origin for the stylohyoid muscle.

Question 2.2



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

2.2 Lateral X-ray of the skull

A Posterior clinoid process.
B Sella turcica (pituitary fossa).
C Sphenoid sinus.
D Frontal sinus.
E Hard palate.

The sella turcica is a depression within the sphenoid bone that houses the pituitary gland. The anterior border is formed by two small bony eminences called the anterior clinoid processes. The posterior border is formed by a flat square piece of bone called the dorsum sellae, from which two small bony eminences arise called the posterior clinoid processes. These not only deepen the sella but also form the attachment for the tentorium cerebelli. The sphenoid sinuses are paired sinuses within the body of the sphenoid bone. The hard palate forms the anterior two-thirds of the roof of the mouth, separating the mouth from the nasal cavity.

Question 2.3

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

2.3 Lateral X-ray of the cervical spine

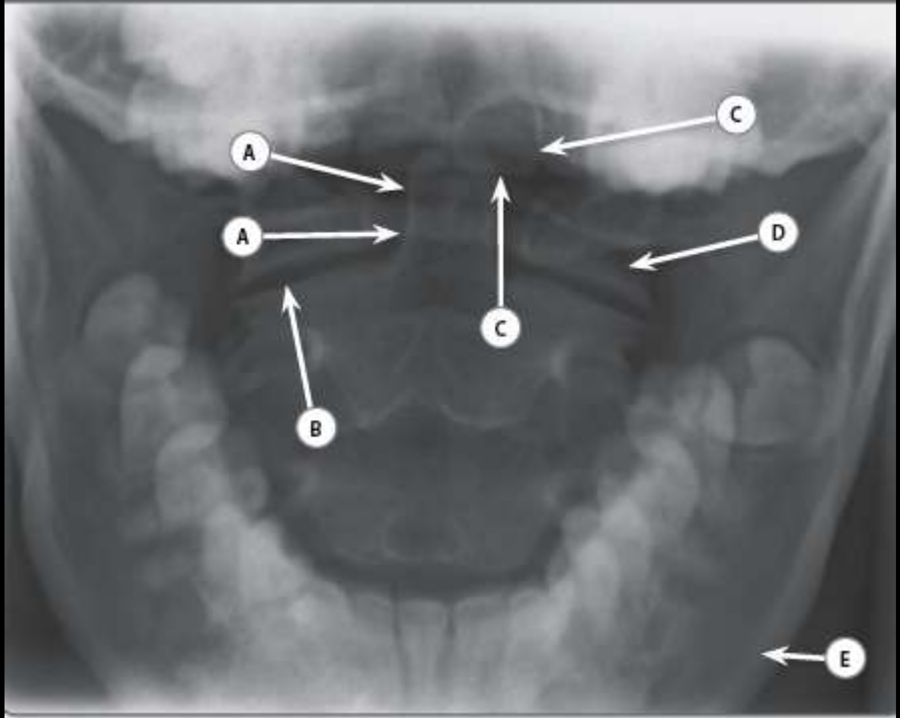
A Soft palate.
B Epiglottis.
C Hyoid bone.
D Thyroid cartilage.
E Trachea.

The soft palate forms the posterior third of the roof of the mouth. The epiglottis is a flap of elastic cartilage, which protects the glottis during swallowing. When enlarged in patients with epiglottitis, the epiglottis gives the characteristic 'thumbprint' sign. The hyoid bone is a horseshoe-shaped bone located between the mandible and the thyroid cartilage at the level of C3. It is the only bone in the body that does not articulate with another bone. The cricoid cartilage is situated inferior to the thyroid cartilage at the level of C6 and is the only complete ring of cartilage around the trachea. The trachea extends from the larynx (at the level of C5) to the carina (T4/5) and, apart from the cricoid cartilage, is surrounded by incomplete C-shaped rings of cartilage.

A recap of levels on the lateral C-spine:

Level	Structure
C3	Hyoid bone Bifurcation of the common carotid arteries
C5	Trachea
C6	Cricoid cartilage Commencement of the oesophagus

Case 5.15



Case 5.15

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

Case 5.15

A Odontoid peg

B Right atlantoaxial joint

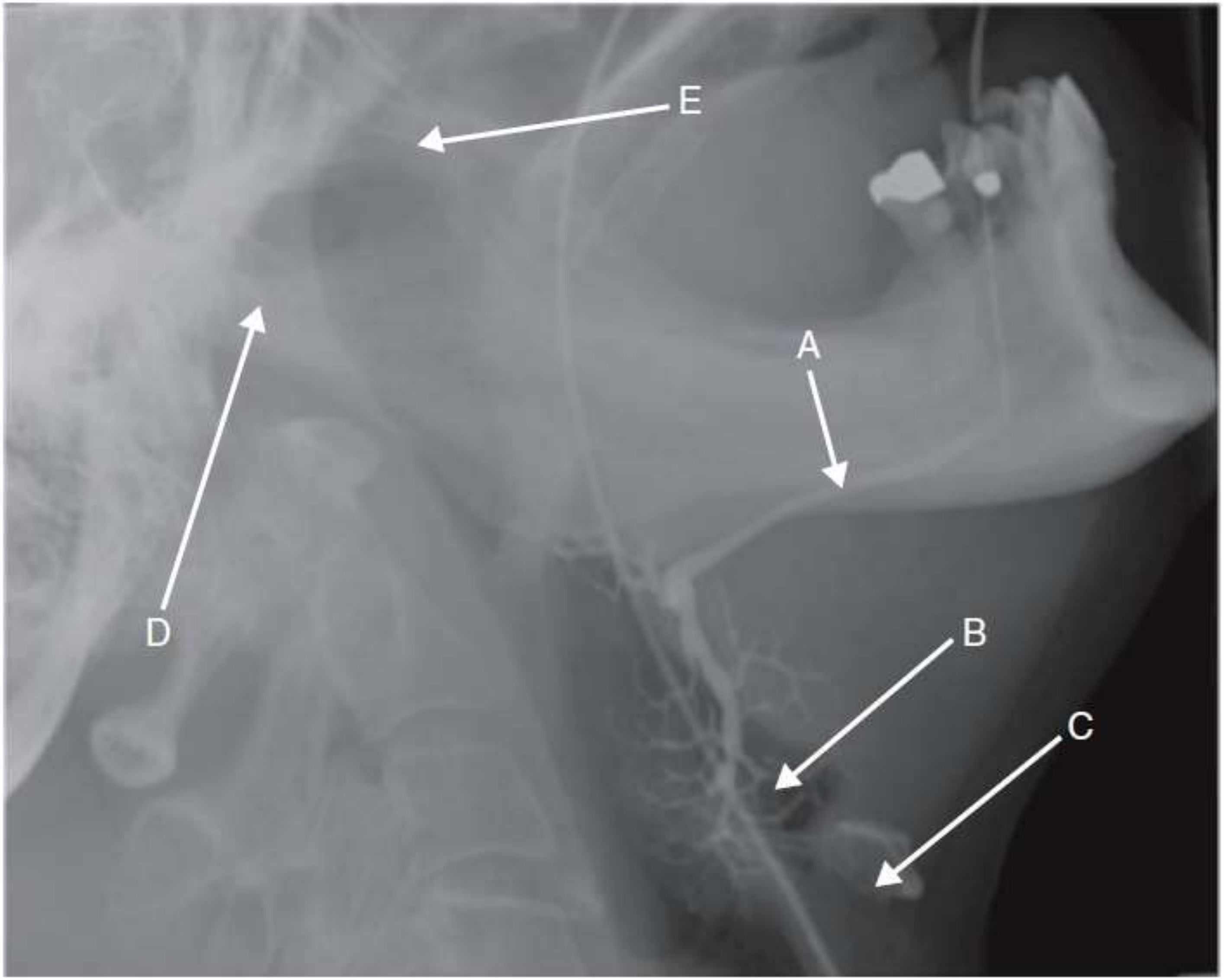
C Left central incisor

D Left lateral mass of C1

E Body of the left hemimandible

Peg views of the cervical spine are performed to assess the relative alignment of the lateral masses of C1 (the atlas) to C2 (the axis). The joint between them is the atlantoaxial joint. Detail may be obscured by overlapping teeth and the hard palate, which can also mimic fracture lines.

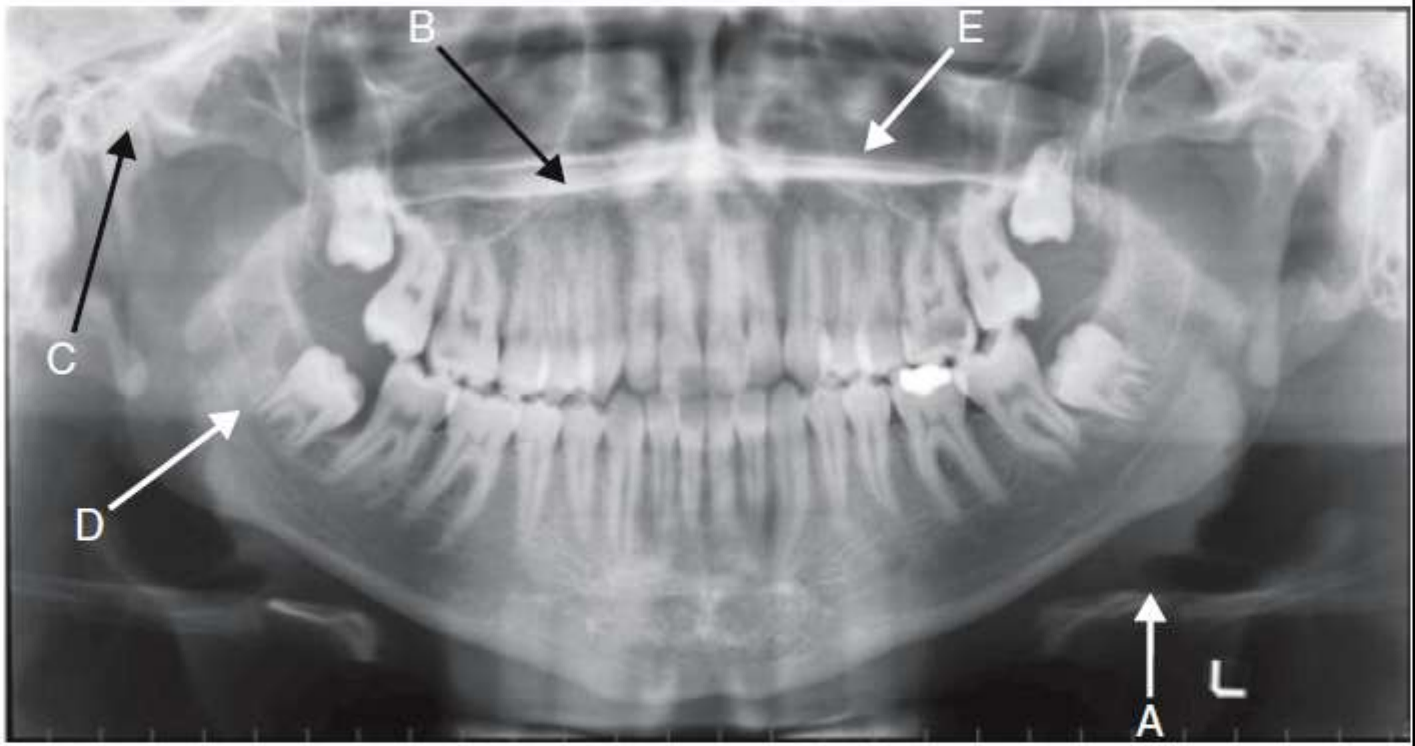
Case 5.2



5.2 Sialogram

(a) Main submandibular duct. This is also known as Wharton's duct, and conveys mixed mucinous and serous secretions, which are more prone to form opaque calculi.
(b) Intraglandular duct. On ultrasound scan examination, intraglandular ducts are visualized as small linear hypoechoic stripes.
(c) Hyoid bone. This does not articulate with any other bone, and is held in position by the thyroid ligaments. It is highly mobile, with mobility provided by a number of muscles and ligaments. It develops from the second and third pharyngeal arches.
(d) Condylar process of the mandible. The lateral extremity of the condyle is a small tubercle for the attachment of the temporomandibular ligament.
(e) Coronoid process of the mandible. This is a thin triangular eminence, whose lateral surface affords insertion to the temporalis and masseter muscles.

Case 5.5



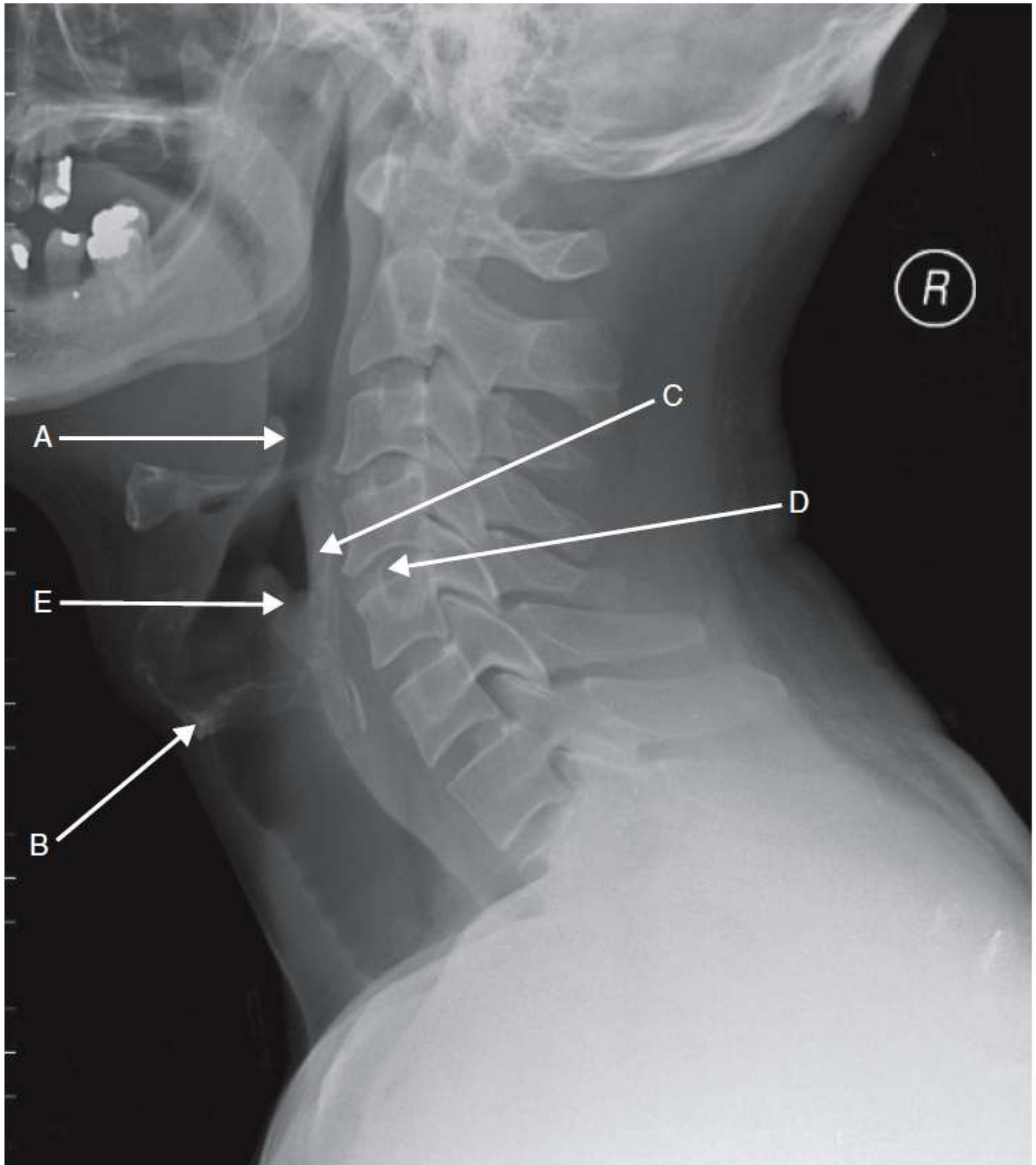
5.5 OPG (orthopantomogram)

(a) Hyoid bone. This lies at the level of C3 and consists of a body and superior and inferior cornu.
(b) Hard palate. Three foramina open onto the oral surface of the hard palate – the incisive fossa and the greater and lesser palatine foramina.
(c) Right mandibular condyle. The anterior projection of the ramus is called the coronoid process.
(d) Right inferior alveolar canal. This transmits the inferior alveolar vessels and nerve which are branches of the maxillary vessels and nerves. The proximal opening is the mandibular foramen on the inner surface of the ramus. Distally the canal opens at the mental foramen on the external surface of the body between the two premolars.
(e) Left maxillary sinus. The maxillary sinus opens via the ostium into the infundibulum.

OPGs are taken by a moving x-ray source and film. The trajectory that the x-ray source describes is that of a hemicircle behind the patient's head while the moving film mechanism remains diametrically opposite, anterior to the patient's face.

The primary use of the OPG is to assess dentition although mandibular pathology can also be diagnosed. Its advantage is that it allows broad coverage of the teeth and facial bones in a short acquisition time.

Case 5.18



5.18 Lateral C-spine radiograph

(a) Epiglottis. The epiglottis is a thin strip of cartilage attached inferiorly to the thyroid cartilage. During swallowing it covers the entrance of the larynx. It is attached on either side via pharyngeal folds to the lateral walls of the pharynx. Three anteriorly placed glosso-epiglottic folds attach to the base of the tongue and the spaces between the folds give rise to the valleculae.

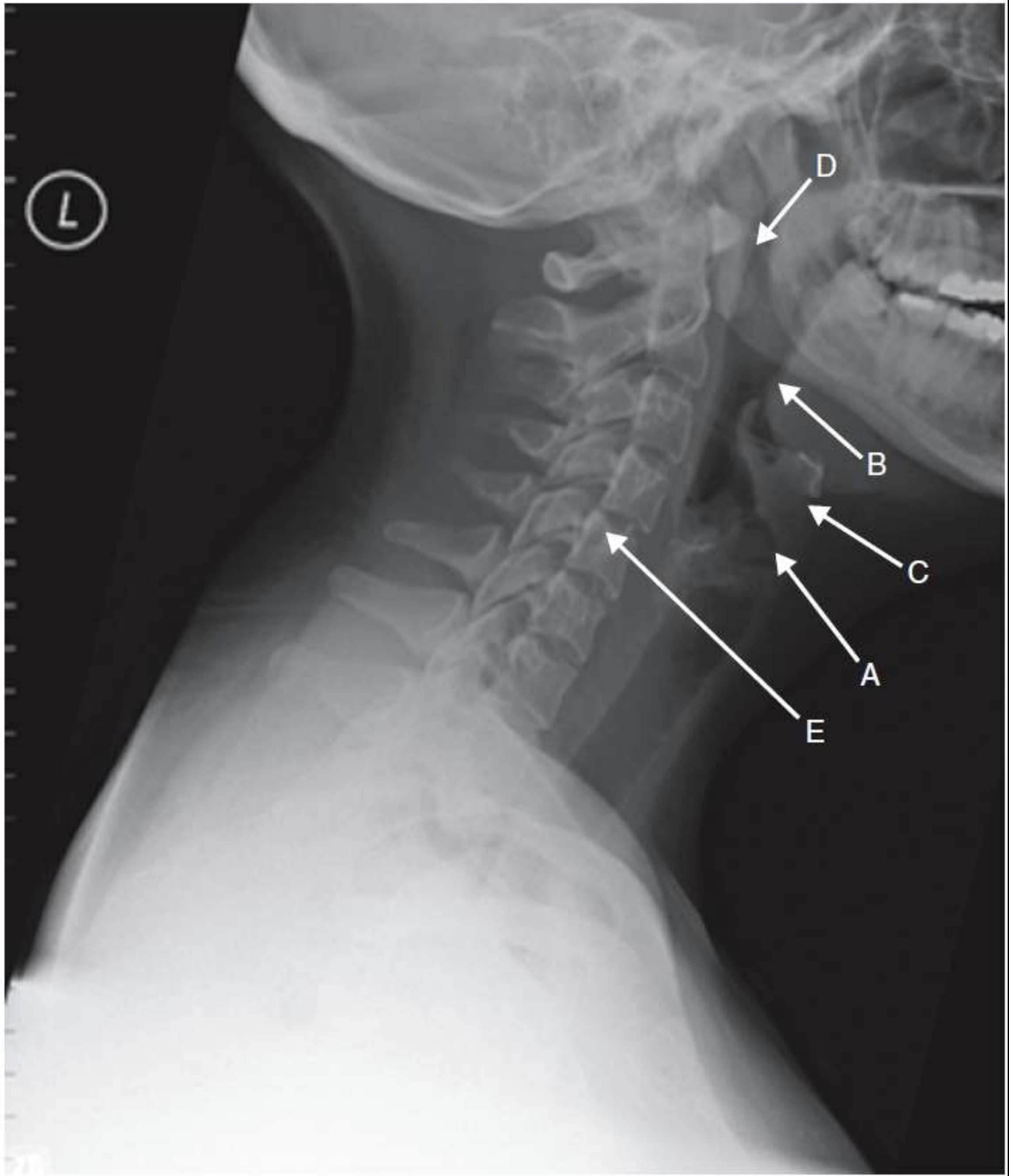
(b) Anterior arch of cricoid cartilage. The cricoid cartilage has a ring structure anteriorly and a flat surface posteriorly. The cricothyroid membrane joins the cricoid and thyroid cartilages.

(c) Superior cornu of thyroid cartilage. The thyroid cartilage forms the antero-lateral laryngeal borders. There is a notch anteriorly at C4 level known as the superior thyroid notch. Posteriorly the laminae of the thyroid cartilage form horns – the superior cornu, which joins with the posterior hyoid bone via the triticeal cartilage in the lateral thyrohyoid ligament, and the inferior cornu, which articulates with the cricoid cartilage.

(d) Anterior tubercle of transverse process of C5.

(e) Thyroid cartilage.

Case 6.17

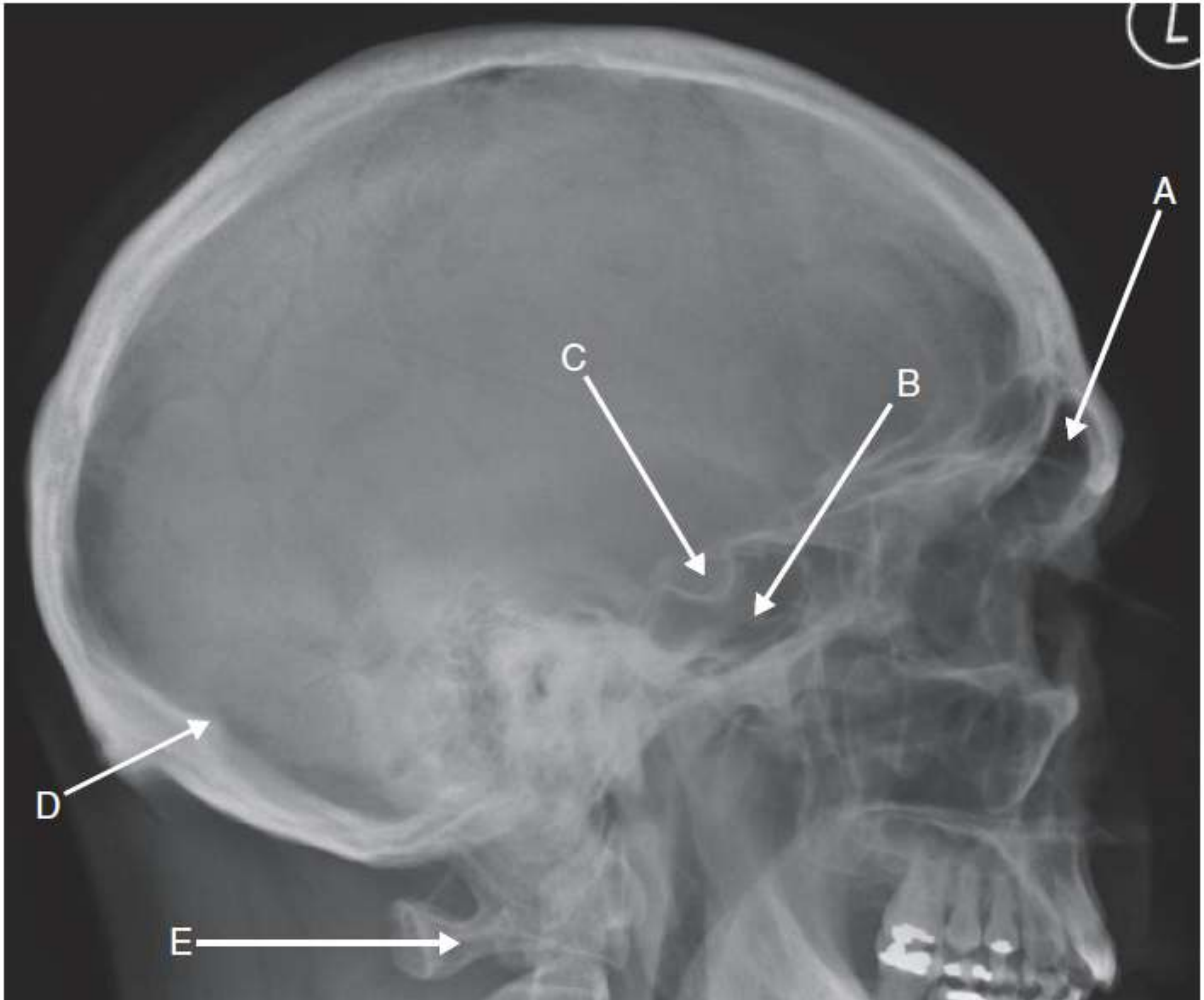


6.17 Lateral C-spine radiograph

(a) Gas in vocal cord.
(b) Base of tongue.

(c) Hyoid bone.
(d) Styloid process.
(e) Anterior tubercle of transverse process of C5.

Case 7.3

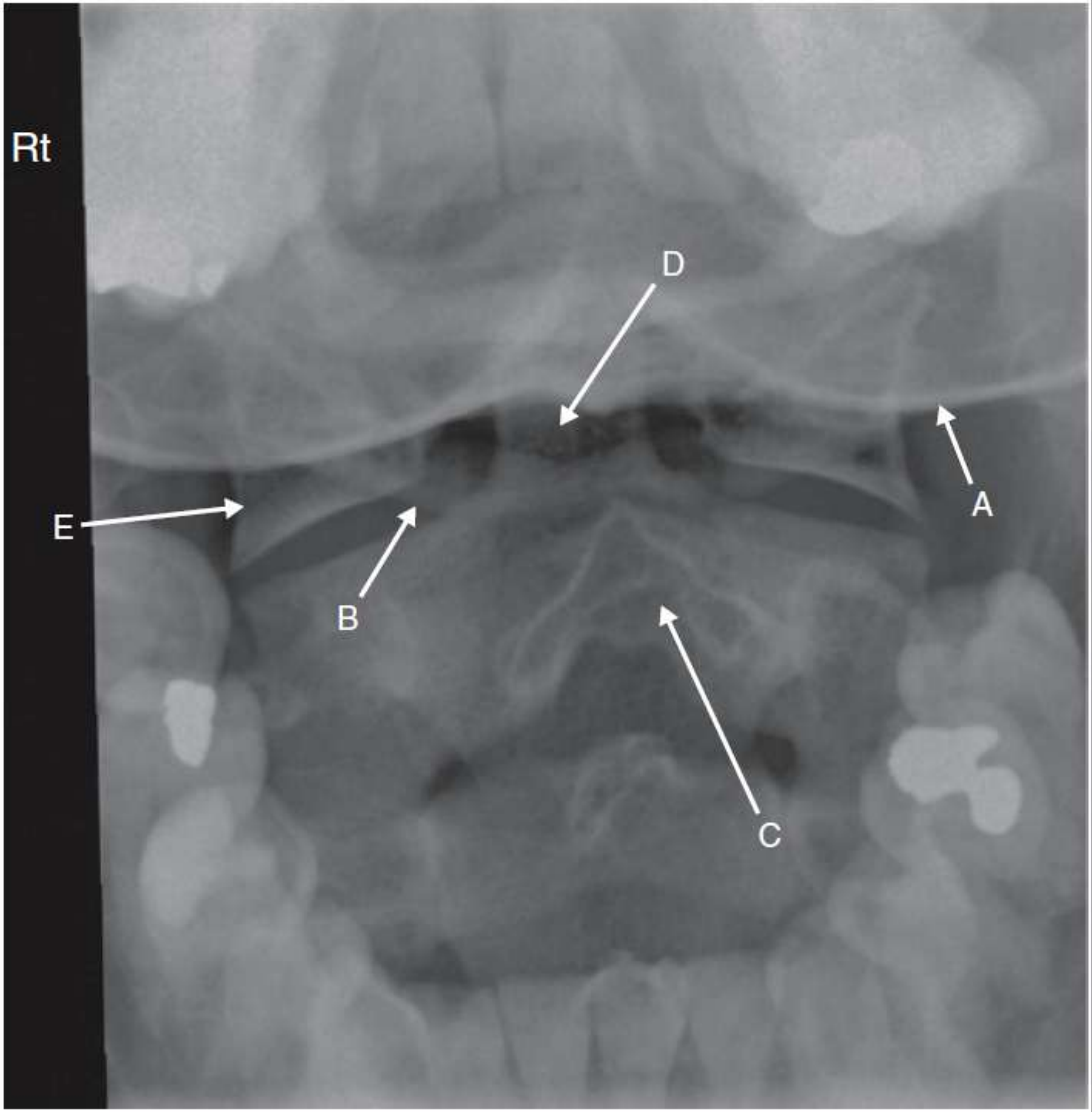


7.3 Lateral skull radiograph

(a) Frontal sinus.
(b) Sphenoid sinus.
(c) Pituitary fossa.
(d) Internal occipital protuberance.
(e) Posterior arch of C2.

Skull radiographs are no longer performed in trauma cases due to the poor sensitivity for intracerebral injury and the widespread availability of CT scans.

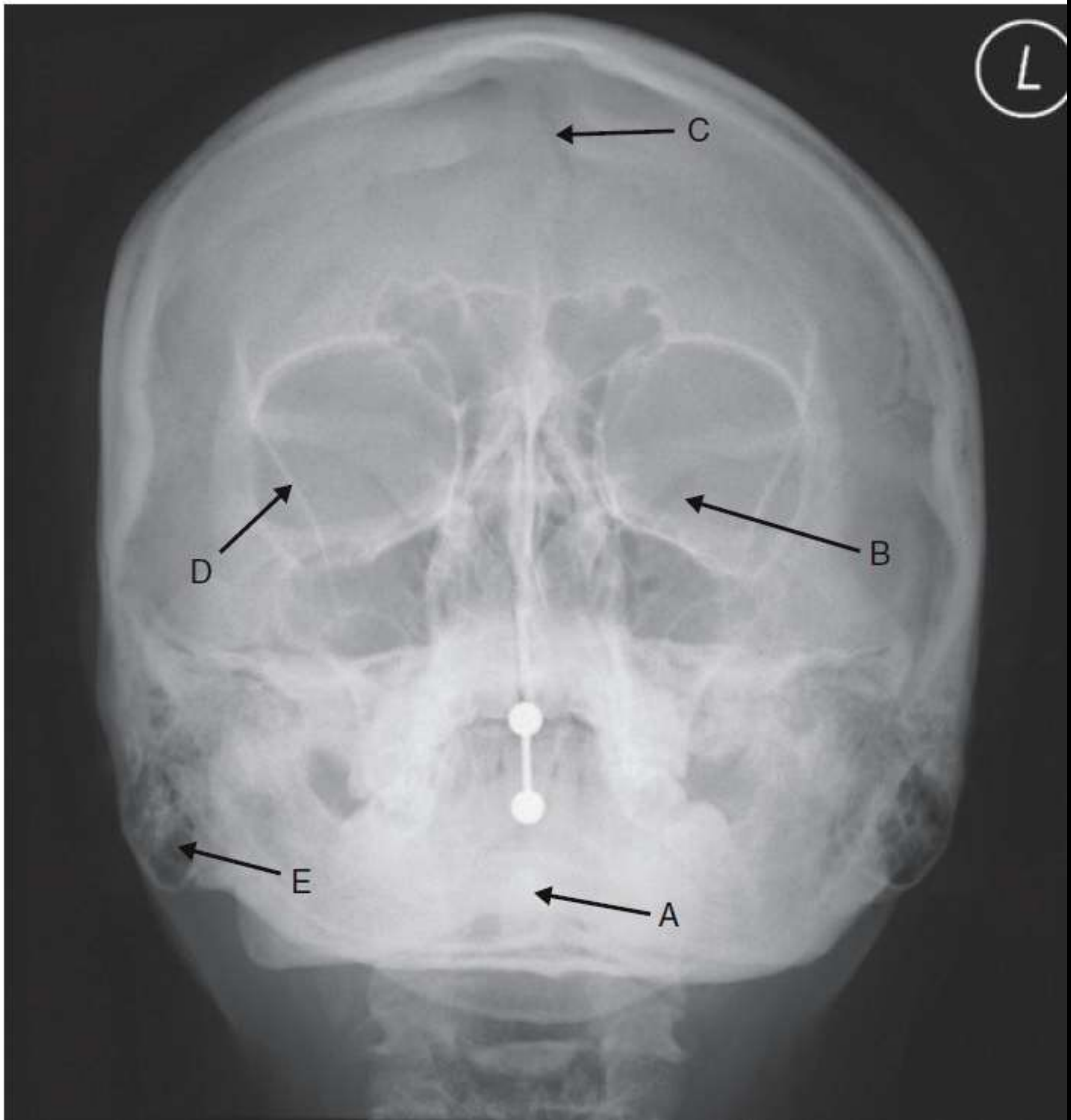
Case 8.16



8.16 C-spine odontoid peg view

(a) Occipital bone.
(b) Anterior arch of the atlas (C1).
(c) Spinous process of C2.
(d) Dens (odontoid peg).
(e) Right lateral mass of C1.

Case 8.20



8.20 AP radiograph facial bones

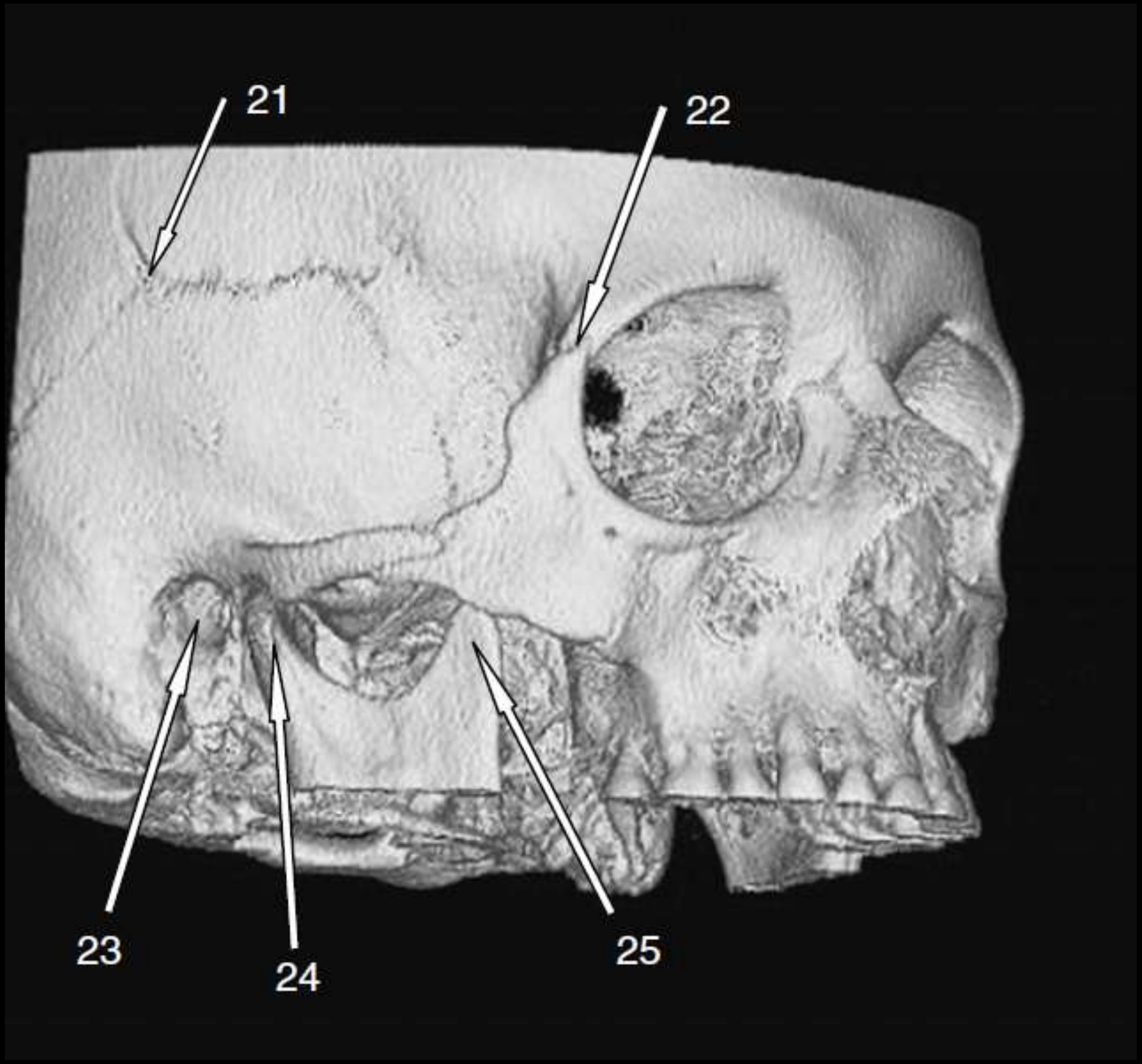
(a) Odontoid peg.
(b) Left superior orbital fissure.
(c) Sagittal suture.
(d) Right greater wing of sphenoid.
(e) Right mastoid process.


Left
11
12
13
14
15
SK
kV 90 mAs 20
DAP=5.11 e(2)mGycm2

Skull Radiograph

11. Left maxillary sinus
12. Right fronto-zygomatic suture
13. Right coronoid process of mandible
14. Right mastoid air cells
15. Odontoid process (dens) of C2 vertebra (axis)

All answers have 2 marks awarded. Always label the side when possible. Even if you get the structure right, you will only be awarded one point if the side is not included in the answer.


21
22
23
24
25

CT Head (3D Reconstruction)

21. Right pterion
22. Right fronto-zygomatic suture
23. Right external acoustic meatus of temporal bone
24. Right condyle of mandible
25. Right coronoid process mandible

3D reconstruction software is an easily available and useful tool; expect some similar cases in the exam.


6
7
8
9
10

CT Head (3D Reconstruction)

6. Right zygomatic arch
7. Left foramen ovale
8. Right internal carotid artery
9. Left occipital condyle
10. Right stylomastoid foramen

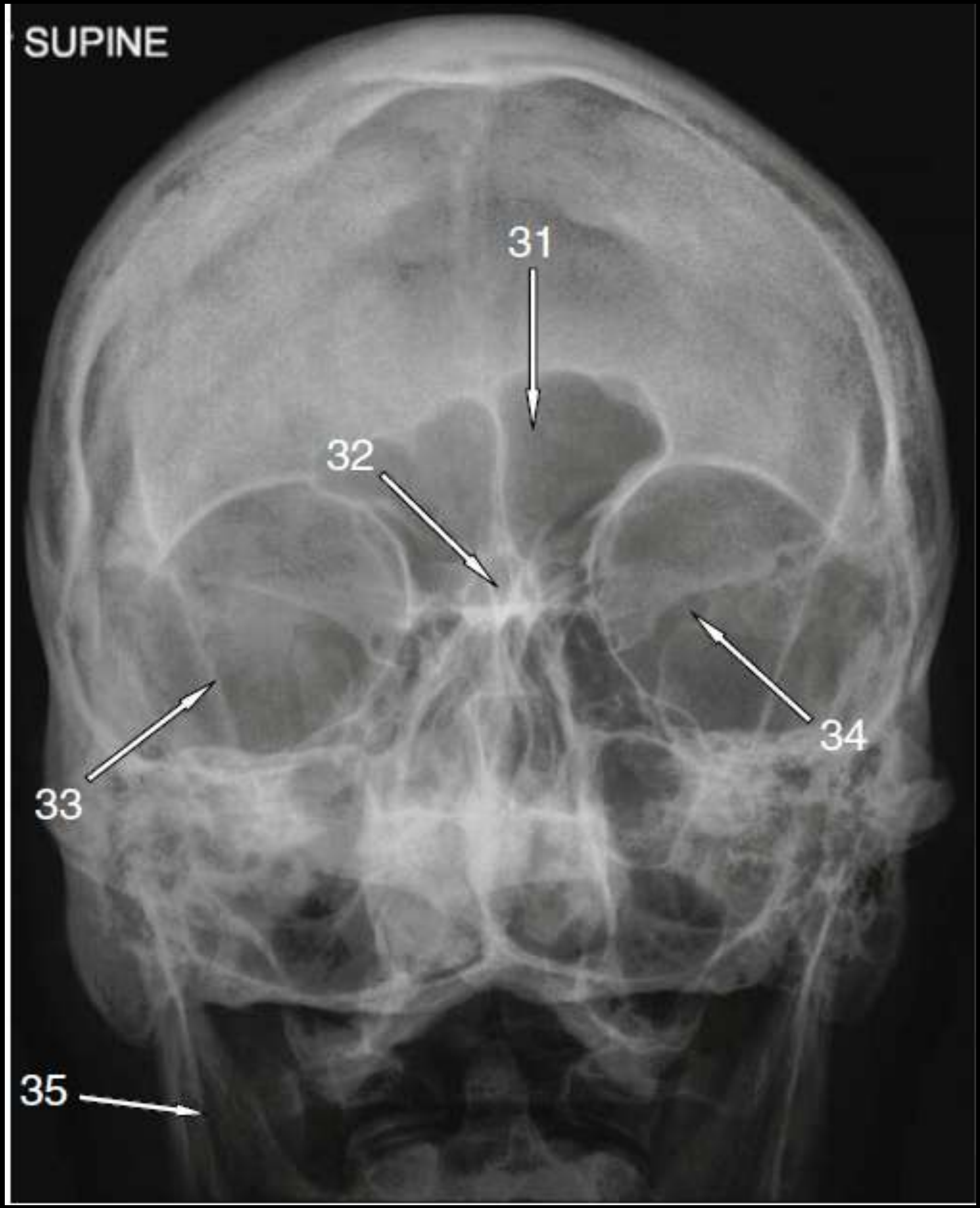
The foramen lacerum transmits the internal carotid artery (as well as the vessels and nerve of the pterygoid canal).

52.	What nerve root exits below 52?

C-Spine Radiograph

51. Pituitary fossa or sella turcica
52. C4 nerve root
53. Hyoid bone (body of)
54. Trachea
55. C7 spinous process

Remember that there are eight cervical nerves and seven cervical vertebrae. The first seven cervical nerves emerge above the named vertebrae (above C3 = C3 nerve root). The C8 nerve root exits below the C7 vertebra.

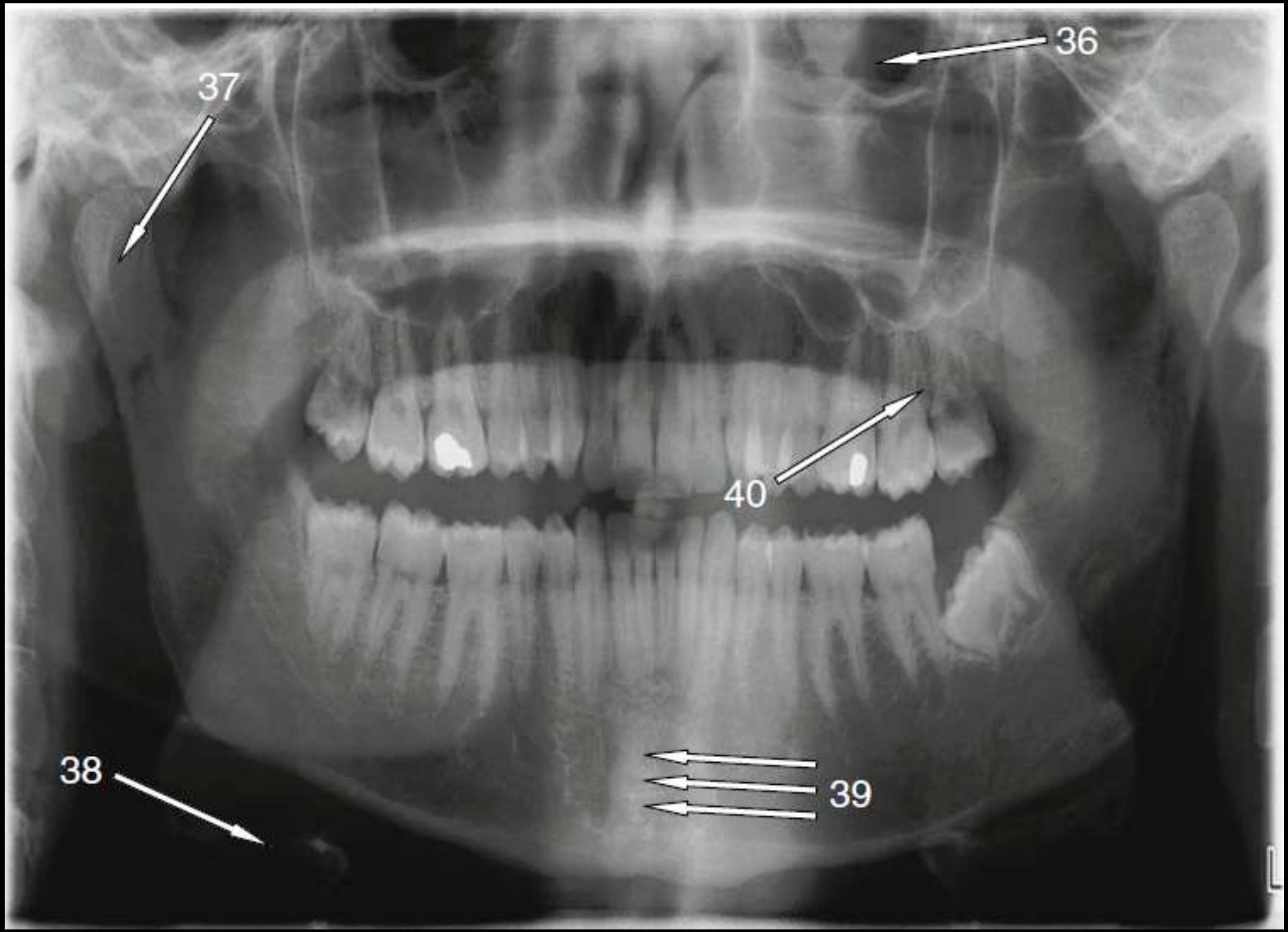

SUPINE
31
32
33
34
35

Skull Radiograph

31. Left frontal sinus
32. Crista galli
33. Right innominate line
34. Left superior orbital fissure
35. Right ramus of mandible

The innominate line is formed by the lateral greater wing of sphenoid.

The superior orbital fissure transmits cranial nerves III, IV, V (ophthalmic division), VI and sympathetic nerves.



Name the structure that opens into the buccal cavity at 40.

Orthopantomogram

36. Left maxillary sinus
37. Right condyle of mandible
38. Hyoid bone
39. Symphysis menti
40. Parotid duct

This is an orthopantomogram – a panoramic image of dental arches, mandible, temporomandibular joints and lower maxilla.

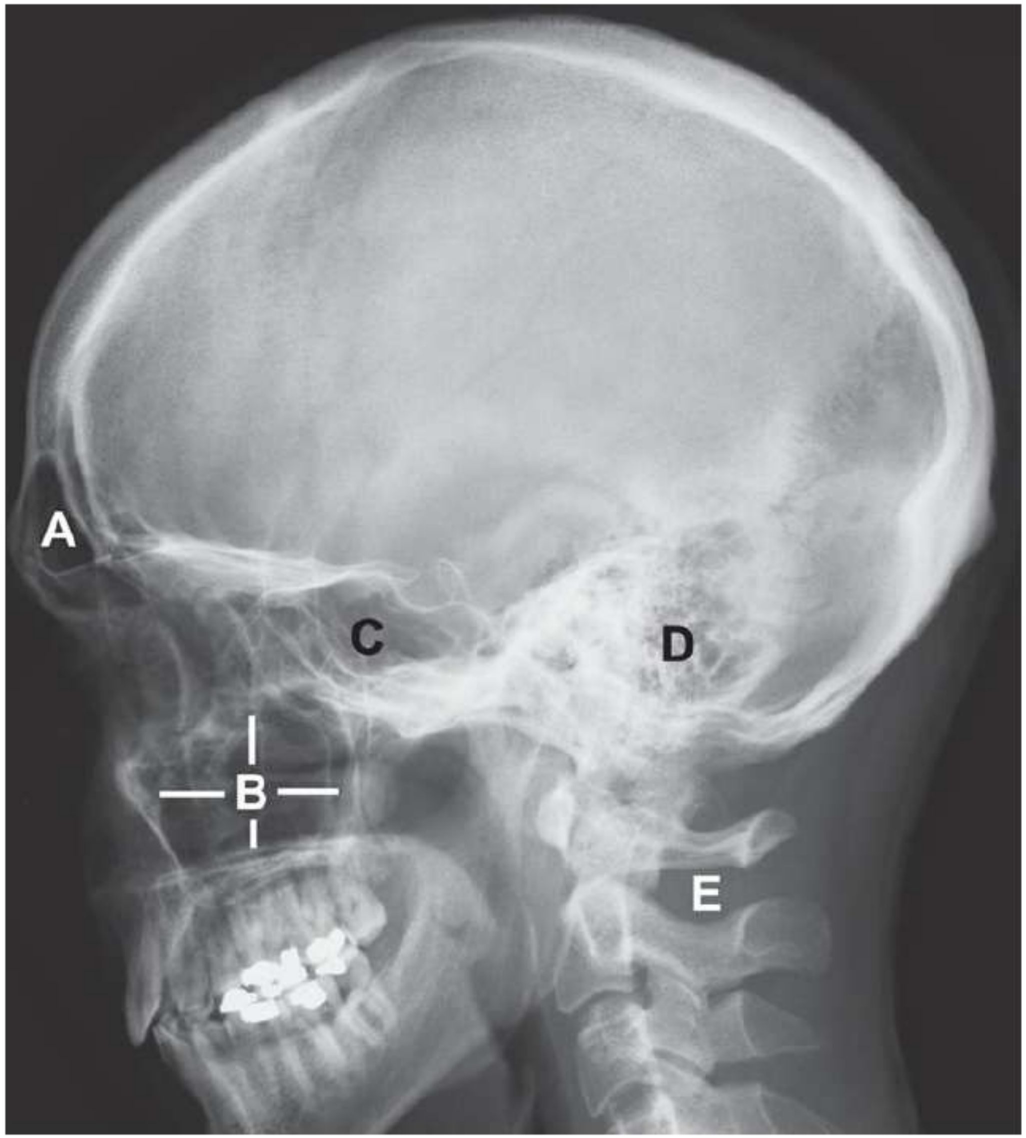

87
88
89
L
HBL
90
86

Cervical Spine Radiograph

86. Hyoid bone
87. External auditory meatus
88. Angle of mandible
89. External occipital protuberance
90. Spinous process of C5 vertebra

d Name the structure labelled D

e Name the structure which fills the space labelled E



Q1 Answers

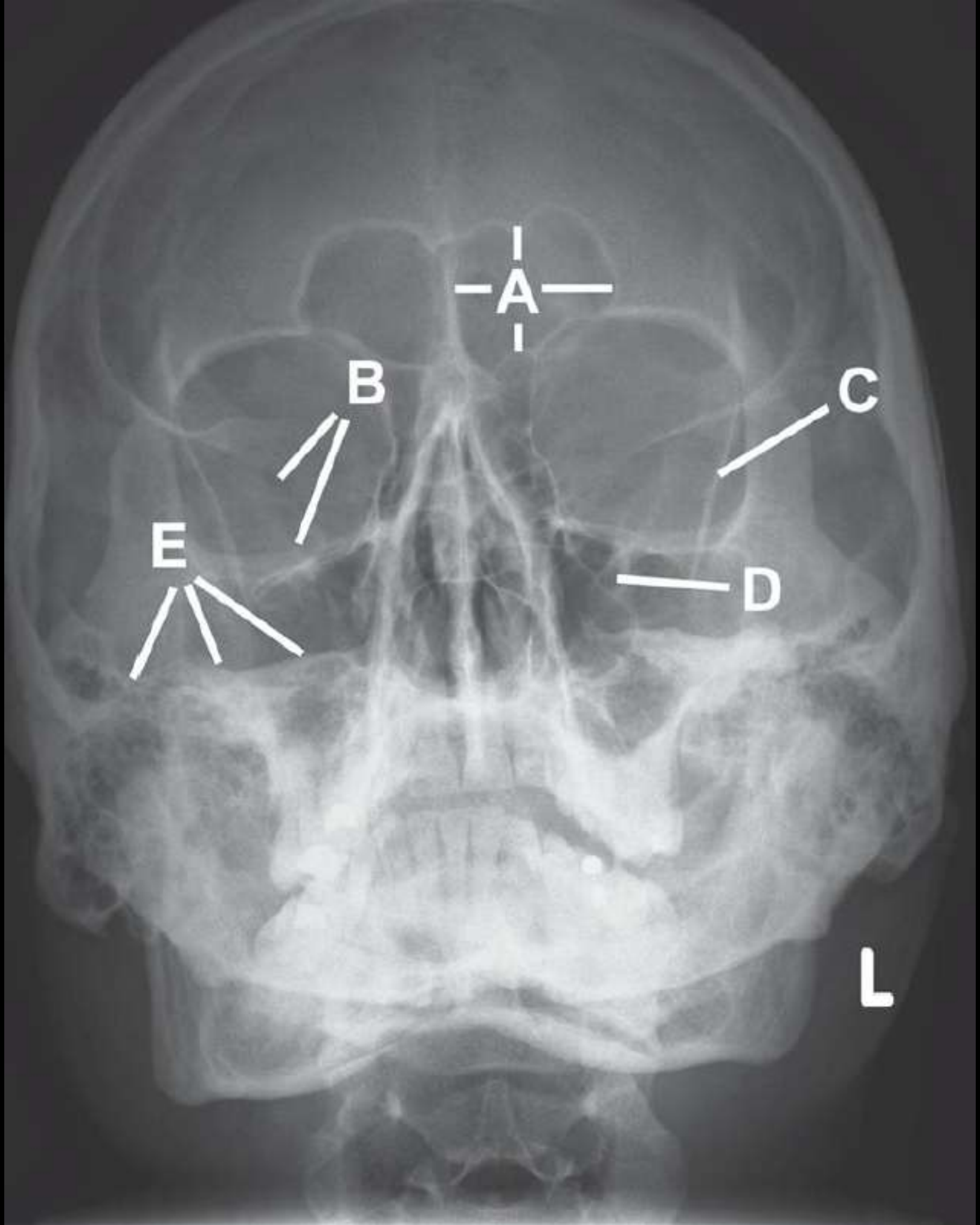
a Frontal sinus
b Maxillary sinus
c Sphenoid sinus
d Mastoid air cells
e Interspinous ligament

Radiograph of adult skull, lateral view

The paranasal sinuses should be radiolucent on plain radiography in adults; they can be filled with fluid and/or soft tissue in cases of trauma or disease. In children, the paranasal sinuses are much smaller (maxillary and ethmoidal) or even non-existent (sphenoid and frontal) at birth and progressively pneumatize with age; this is usually complete by the early teen years. The mastoid air cells are normally pneumatized throughout life.

Several ligaments hold the vertebrae together. Most superficially, the supraspinous ligament runs across the tips of the spinous processes and in this region is continuous with the ligamentum nuchae. Deep to this and between adjacent spinous processes lie the interspinous ligaments. Ligamentum flavum covers the internal space between vertebral bodies posteriorly within the spinal canal. The posterior longitudinal ligament runs along the posterior aspect of the vertebral bodies while the anterior longitudinal ligament runs along their anterior aspect.

Scuderi AJ, Harnsberger HR, Boyer RS. Pneumatization of the paranasal sinuses: Normal features of importance to the accurate interpretation of CT scans and MRI images. *Am J Roentgenol* 1993; 160:1101–1104.


A
B
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D
E
L

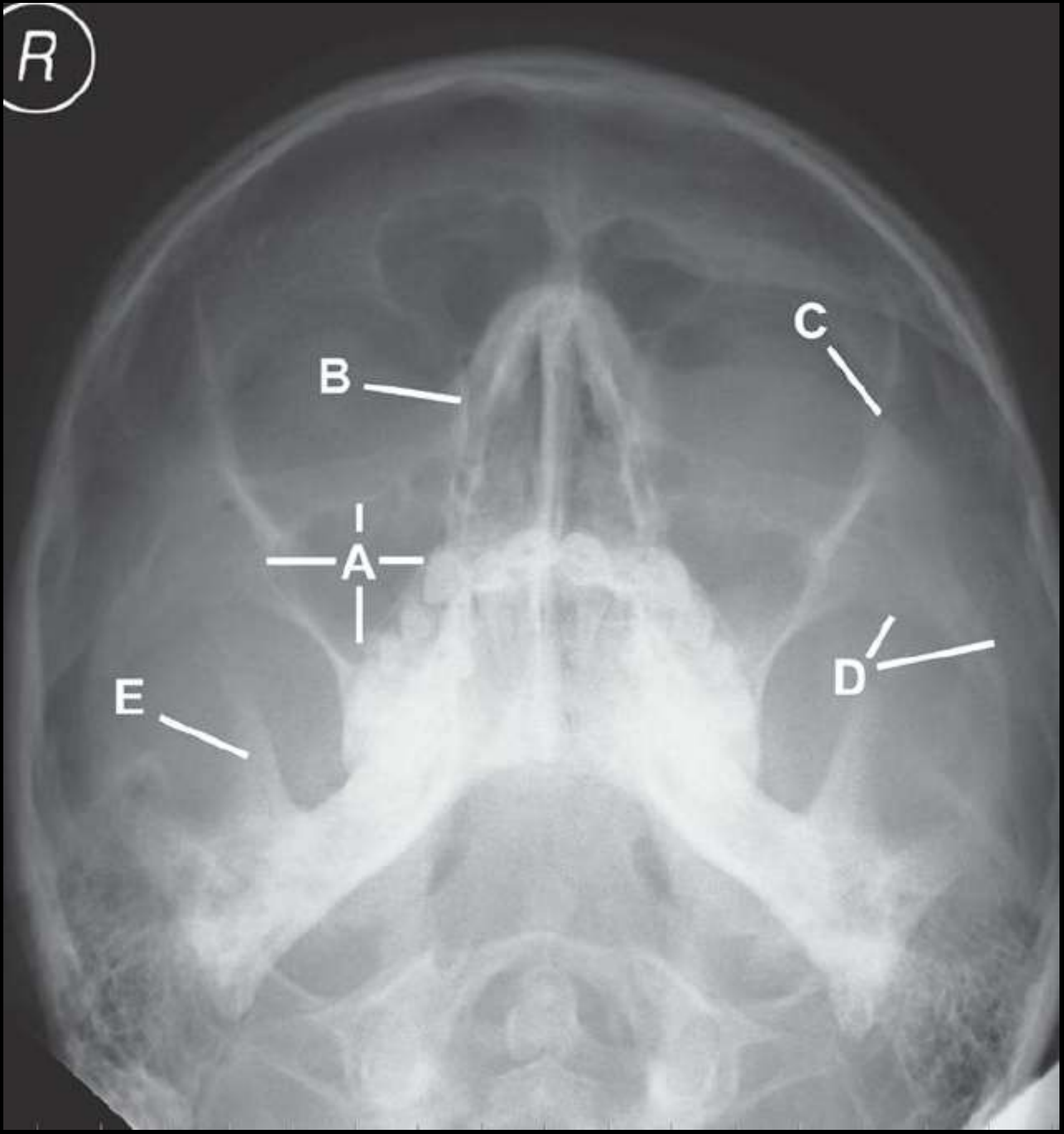
Q2 Answers

- **a** Frontal sinus
- **b** Superior orbital fissure
- **c** Innominate line
- **d** Foramen rotundum
- **e** Petrous ridge

Occipito-frontal facial radiograph

This view demonstrates the frontal and ethmoid sinuses well.

Projected within the orbit it is possible to discern the greater and lesser (more medial) wings of sphenoid and the triangular superior orbital fissure in between. The innominate line represents the lateral edge of the greater wing of sphenoid. The foramen rotundum lies beneath the superior orbital fissure.


R
B
C
A
D
E

Q3 Answers

a Maxillary sinus (or antrum)
b Lamina papyracea
c Fronto-zygomatic suture
d Zygomatic arch
e Coronoid process of mandible

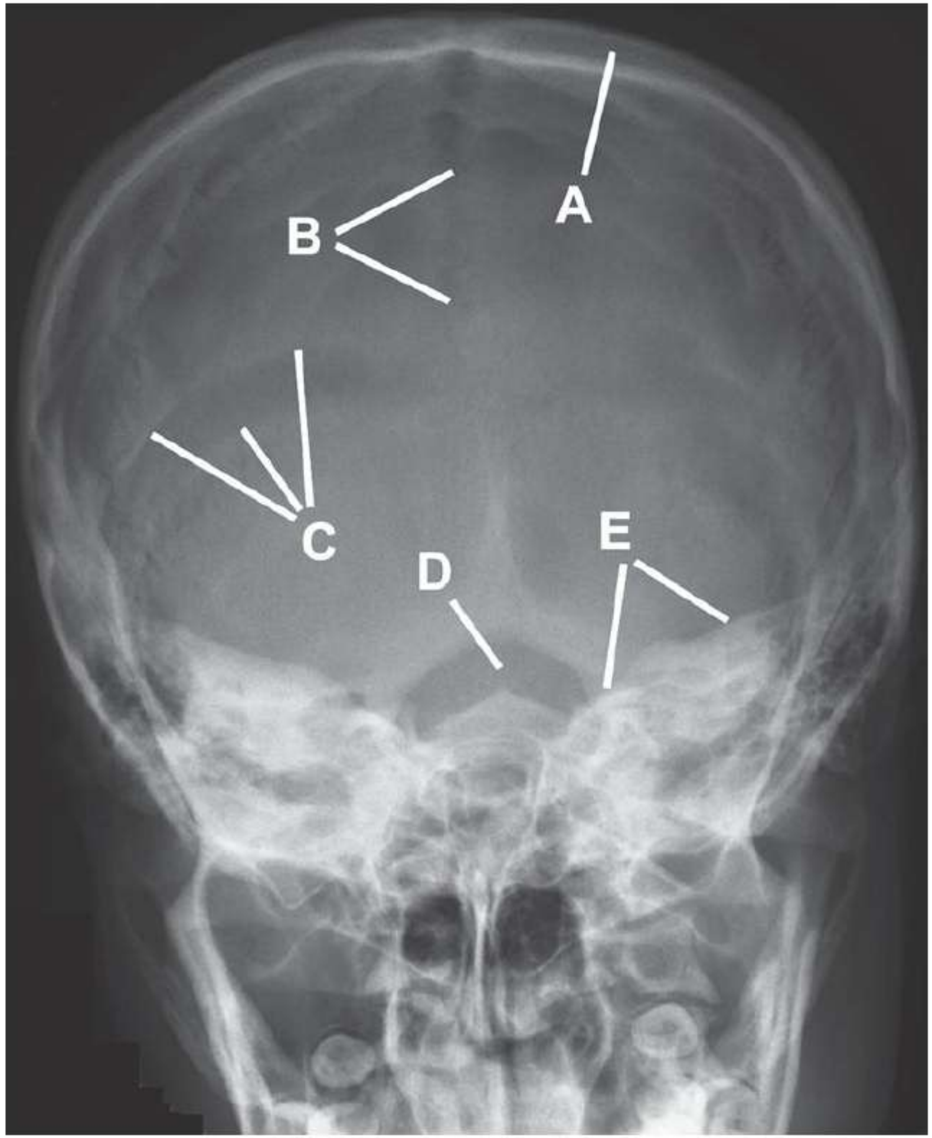
Occipito-mental (OM) radiograph

The OM view is used to evaluate the facial bones; it provides excellent visualization of the zygomatic arches and maxillary sinuses. The zygomatic arch is formed via a union of the temporal and zygomatic bones and is said to have the appearance of an elephant's trunk on an OM radiograph. The zygoma forms the prominence of the cheek and it also articulates with the frontal and maxillary bones via appropriately named sutures.

The medial wall represents the thinnest bony part of the orbit and is aptly named the lamina papyracea, meaning paper layer. The ethmoid bone forms most of the medial orbital wall but there are also contributions from the lacrimal, sphenoid and frontal bones.

Q4

a Name the skull layer identified with label A
b Name the suture labelled B
c Name the structure that runs along the bony groove identified as C
d Name three structures that pass through D
e Name the structure labelled E



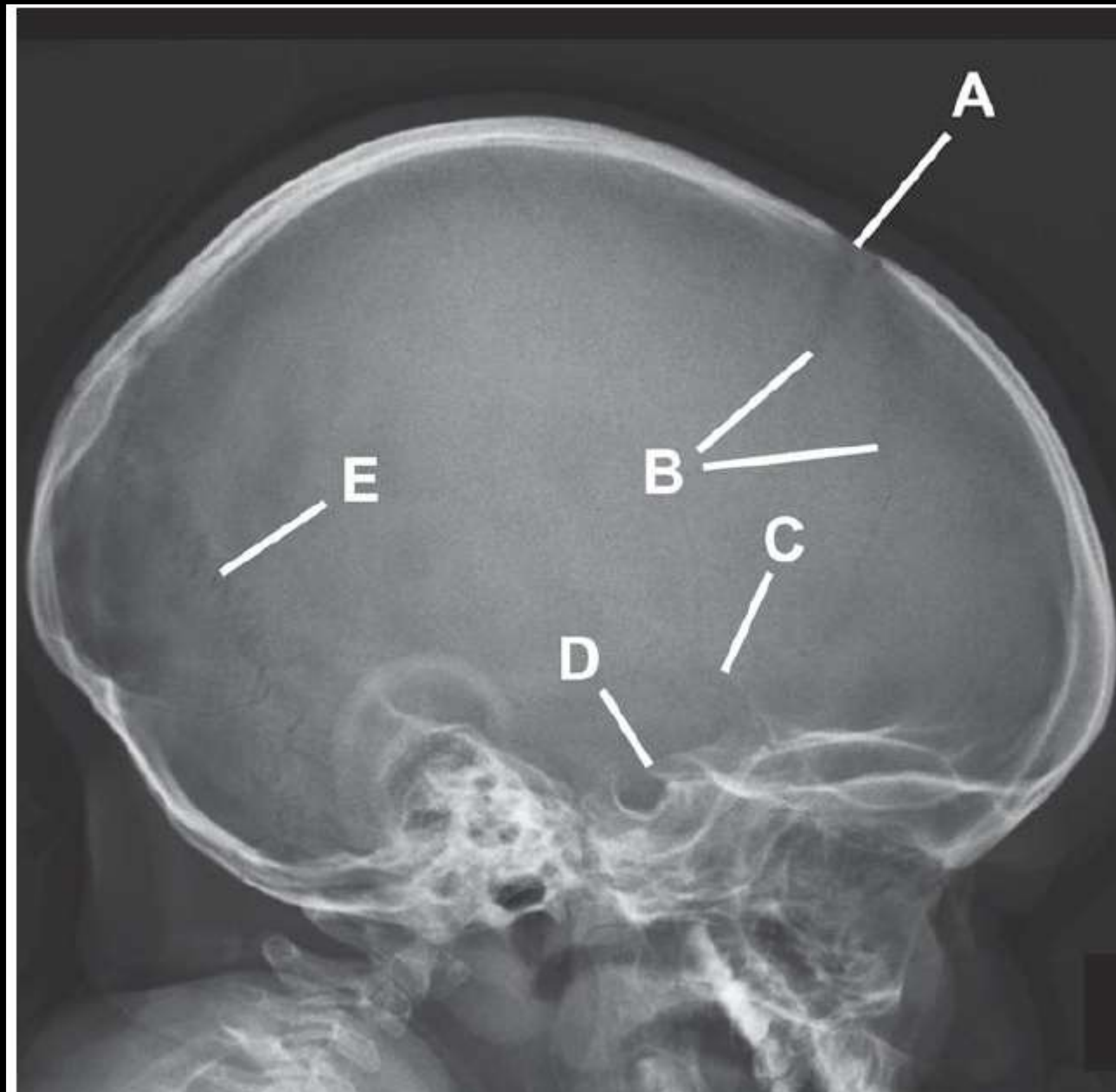
Q4 Answers

a Diploic layer
b Sagittal suture
c Right transverse venous sinus
d The following all pass through the foramen magnum: junction of medulla and cervical spinal cord, vertebral arteries, spinal arteries and veins, spinal root of the accessory nerve (CN XI), meninges, menigeal branches of vertebral arteries.
e Petrous ridge

Towne's view (antero-posterior (AP) fronto-occipital projection)

The Towne's view is directed in parallel with the antero-medial skull base and projects the frontal bones over the occipital bones. The facial bones are largely obscured although a Towne's view provides good visualisation of the mandibular condyles.

Skull bones are formed as two parallel layers of cortex surrounding a spongy cancellous layer known as the diploe. Numerous diploic veins connect the intra and extra-cranial vascular spaces.


A
B
C
D
E

Q5 Answers

a Anterior fontanelle
b Coronal suture
c Pterion
d Anterior clinoid process
e Lambdoid suture

Skull radiograph in a child of 16 months, lateral view

The skull sutures are unfused in utero, allowing the cranial shape to change during delivery. Antero-superiorly where the coronal suture meets the midline sagittal suture there is initially a defect in bone formation known as the anterior fontanelle. Closure of the anterior fontanelle is variable, but is usually complete by 24 months of age. Where the sagittal suture meets the lamboidal suture posteriorly there is a further defect known as the posterior fontanelle; this usually closes by two months of age. In adulthood, the remnant fontanellae are known anteriorly as the bregma and posteriorly as the lambda.

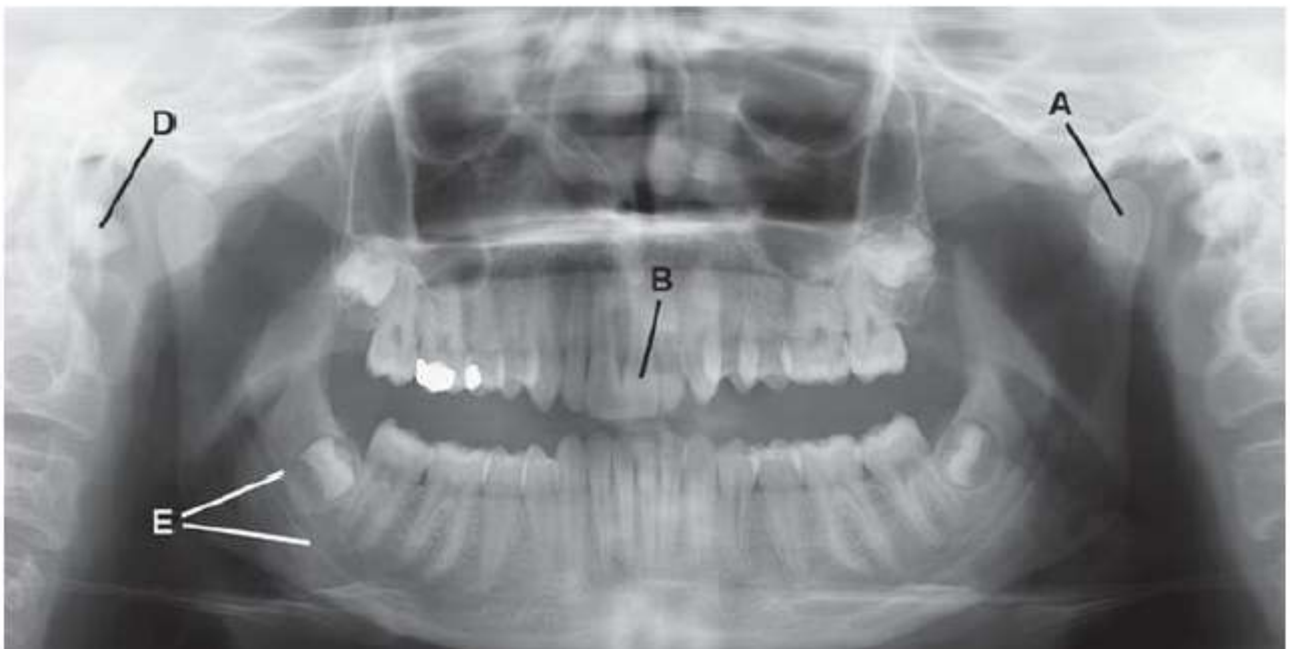
The weakest point in the adult skull is laterally at the junction of the frontal, temporal, sphenoidal and parietal bones. This H-shaped suture configuration is known as the pterion. Clinically this is important as blunt trauma to this region is more likely to result in fracture and importantly, the middle meningeal artery lies immediately beneath the pterion and can also be damaged.

The paired anterior clinoid processes are a posterior projection from the lesser wing of sphenoid. There are also paired posterior clinoid processes; these arise from the dorsum sellae of the sphenoid bone. The four clinoid processes provide attachment for structures around the pituitary fossa including the diaphragma sellae.

Aisenson MR. Closing of the anterior fontanelle. *Pediatrics* 1950; 6:223–226.

Q6

a Name the structure labelled A
b Name the structure labelled B
c Name all the left upper teeth lying lateral to B
d Name the structure labelled D
e Name the structure labelled E



Q6 Answers

a Condylar process of the mandible
b Medial incision, left upper quadrant
c Lateral incisor, canine, 1st and 2nd premolars and 1st, 2nd and 3rd molars (3rd is unerupted)
d Anterior arch of C1
e Mandibular canal

Orthopantomogram (OPG)

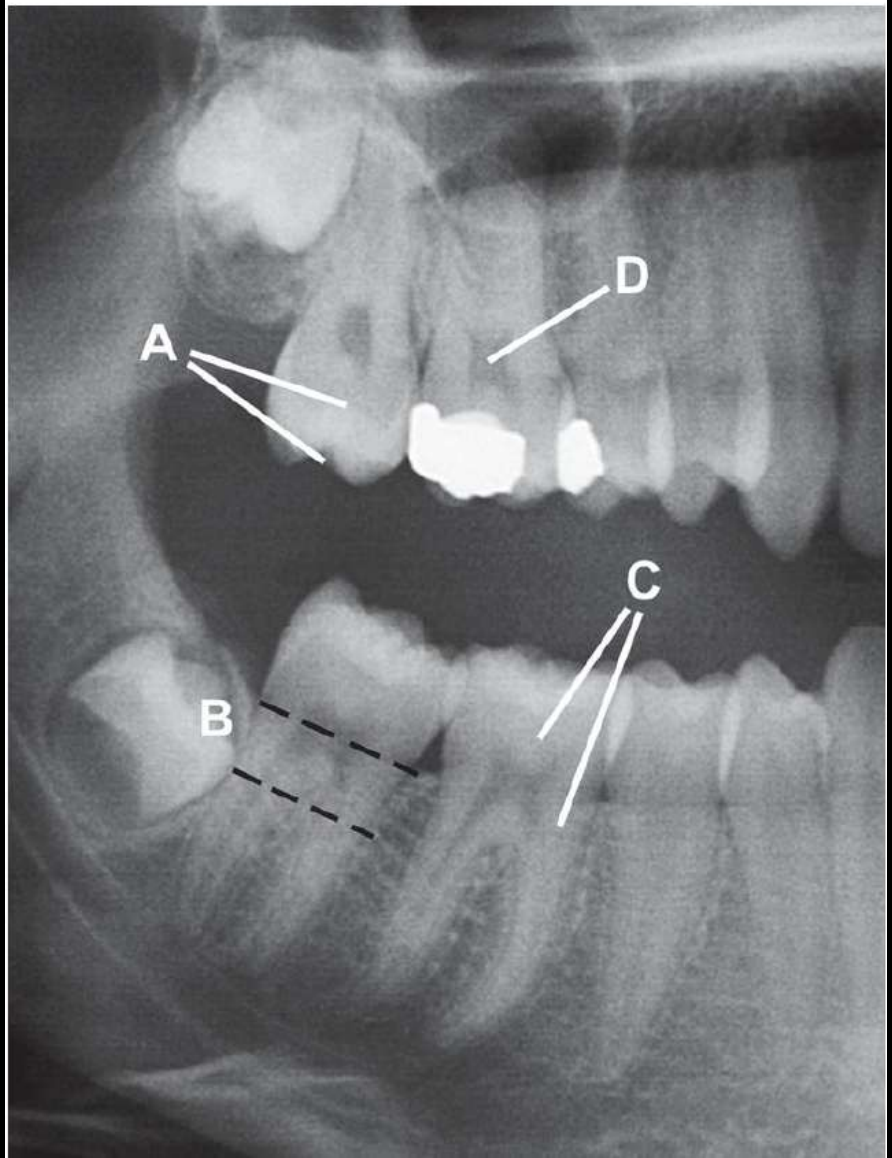
The OPG provides a single image of the entire dentition, lower maxilla and mandible. This is achieved through a form of tomography where the image is taken whilst moving round the patient. In addition to the structures described, an OPG also usually shows the anterior aspect of the upper cervical spine, maxillary sinuses, nasal septum and hyoid (all seen on this image).

Adult teeth number 32 (20 deciduous teeth in childhood) and are usually divided into quadrants of eight for descriptive purposes (left and right upper and lower). In each quadrant there is a medial and lateral incisor, a canine, two premolars and three molars. The third molar may remain unerupted well into adulthood (wisdom teeth).

The mandibular canal carries the inferior alveolar artery and nerve (a branch of CN V_3) which exit the mandible via the mental foramen (not shown here).

Q7

a Name the most radio-opaque part of the tooth labelled A
b Name the three constituent parts of a tooth as defined by B
c Name the structure labelled C
d Name the structure labelled D
e Name the radiolucent line seen around each tooth below the gumline



Q7 Answers

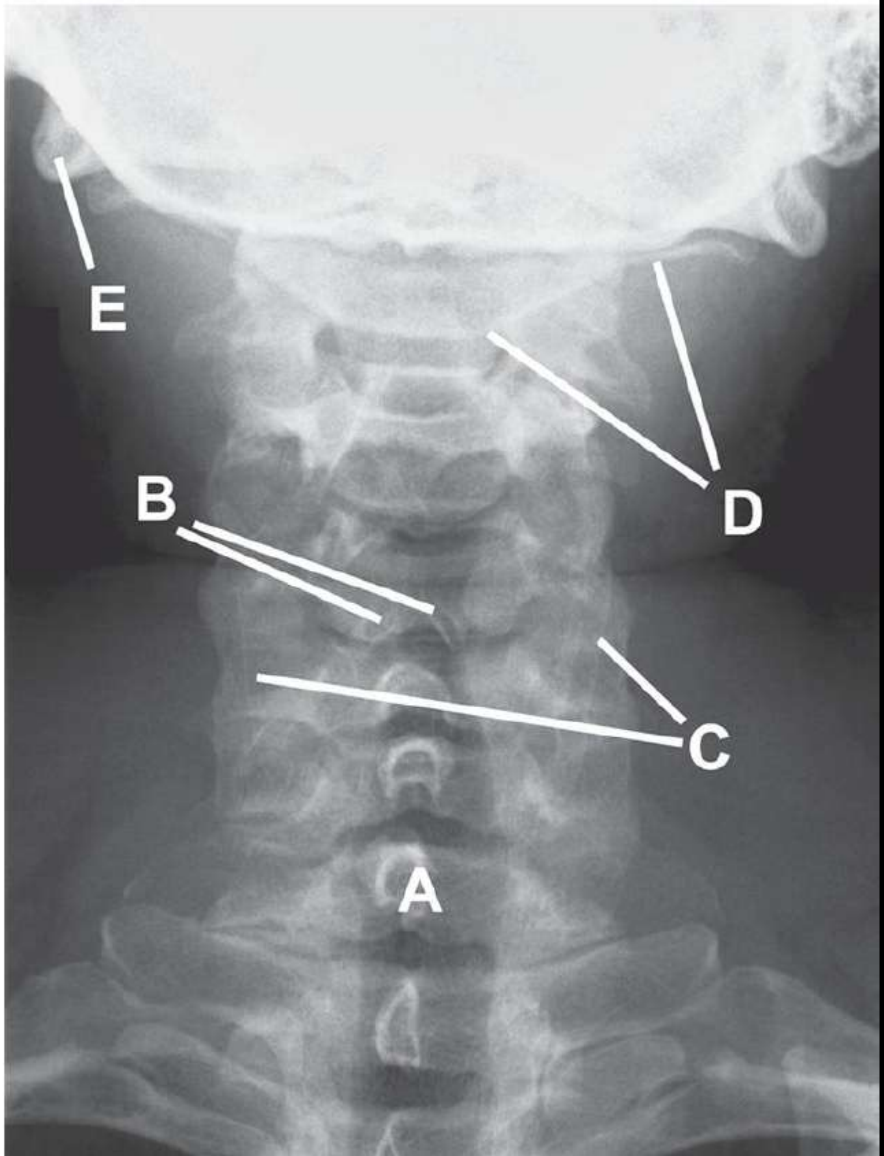
a Enamel
b Crown, neck and root
c Dentine
d Pulp cavity
e Periodontal membrane

Radiograph of upper and lower right teeth in an adult, zoomed up image

Each tooth is composed of a crown (above the gumline), a neck and a root. Teeth are primarily formed from dentine which is similar to compact bone. The inner core of a tooth is composed of soft tissues (and is therefore more radiolucent) and is known as the pulp cavity. Beneath the gumline, the division between tooth and surrounding bone is highlighted by the very dense bone of the lamina dura lying immediately outside the radiolucent line of the periodontal membrane of the tooth. The intra-oral part of each tooth (crown) is covered by dense radio-opaque enamel which is the hardest part of the tooth. Defects to the enamel (usually as a consequence of decay) are repaired with dental fillings; these are dense and appear radio-opaque on radiography (as shown).

Q26

a Name the vertebral body labelled A
b Name the normal variant demonstrated and labelled as B
c Name the structure outlined by calcification and labelled C
d Name the structure labelled D
e Name the structure labelled E



Q26 Answers

a C7 vertebra
b Bifid spinous process of C4 vertebra
c Thyroid cartilage
d Hyoid bone
e Angle of mandible

Radiograph of C-spine, AP view

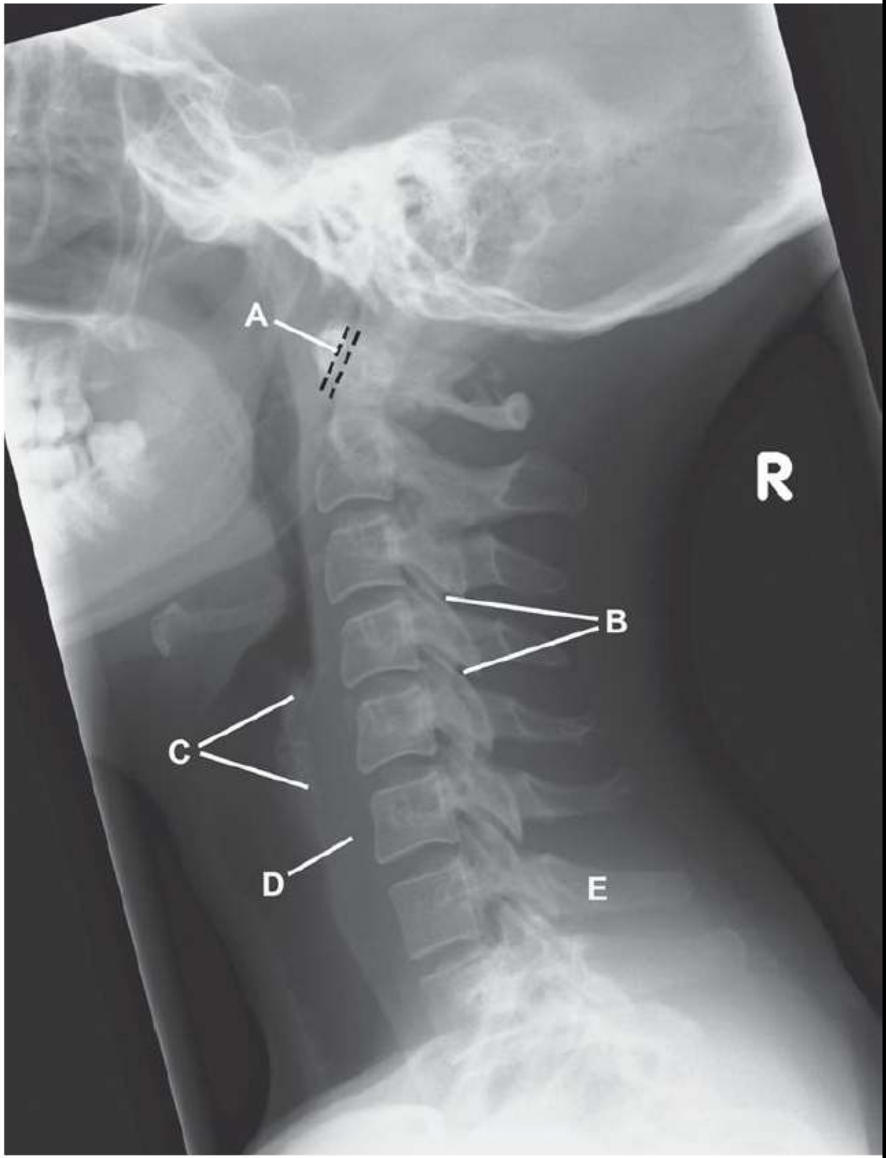
Individual vertebrae can be distinguished on an AP cervical radiograph by counting up from T1, which is the first to articulate with a rib (bear in mind C7 can sometimes articulate with a normal variant cervical rib, but this is usually much shorter than the typical upper thoracic ribs). Often, the dens of C2 is also visible and enables vertebral identification from the top.

The laryngeal cartilages can calcify with age and this makes their identification on plain radiography possible. The thyroid cartilage is the largest of the laryngeal cartilages. Each lamina of the thyroid cartilage lies antero-lateral to the vocal cords and their associated cartilages, providing protection and support. These laminae slope outwards from below as shown and meet in the midline at the laryngeal prominence (also known as Adam's apple). The thyroid cartilage is connected to the hyoid bone above via the thyrohyoid membrane and to the cricoid cartilage below via the cricothyroid ligament. It is the top free edge of the cricothyroid membrane that forms the vocal cord. In the mid-line running between the arch of the cricoid and the inferior aspect of the thyroid cartilage is a thickening of the cricothyroid membrane called the cricothyroid ligament.

The hyoid bone divides the neck into infra and supra-hyoid regions and provides anchorage for a number of muscles in the anterior neck. The hyoid is active during swallowing and speech.

Q27

a Name the upper limit of normal size in adults for the space labelled A
b Name the structures labelled B
c Name the structures labelled C
d Name the structure labelled D
e Name the structure labelled E



Q27 Answers

a 3mm
b Zygapophyseal (facet) joint spaces
c Calcification within laryngeal cartilages
d Prevertebral soft tissues
e Spinous process of C7 (vertebra prominens)

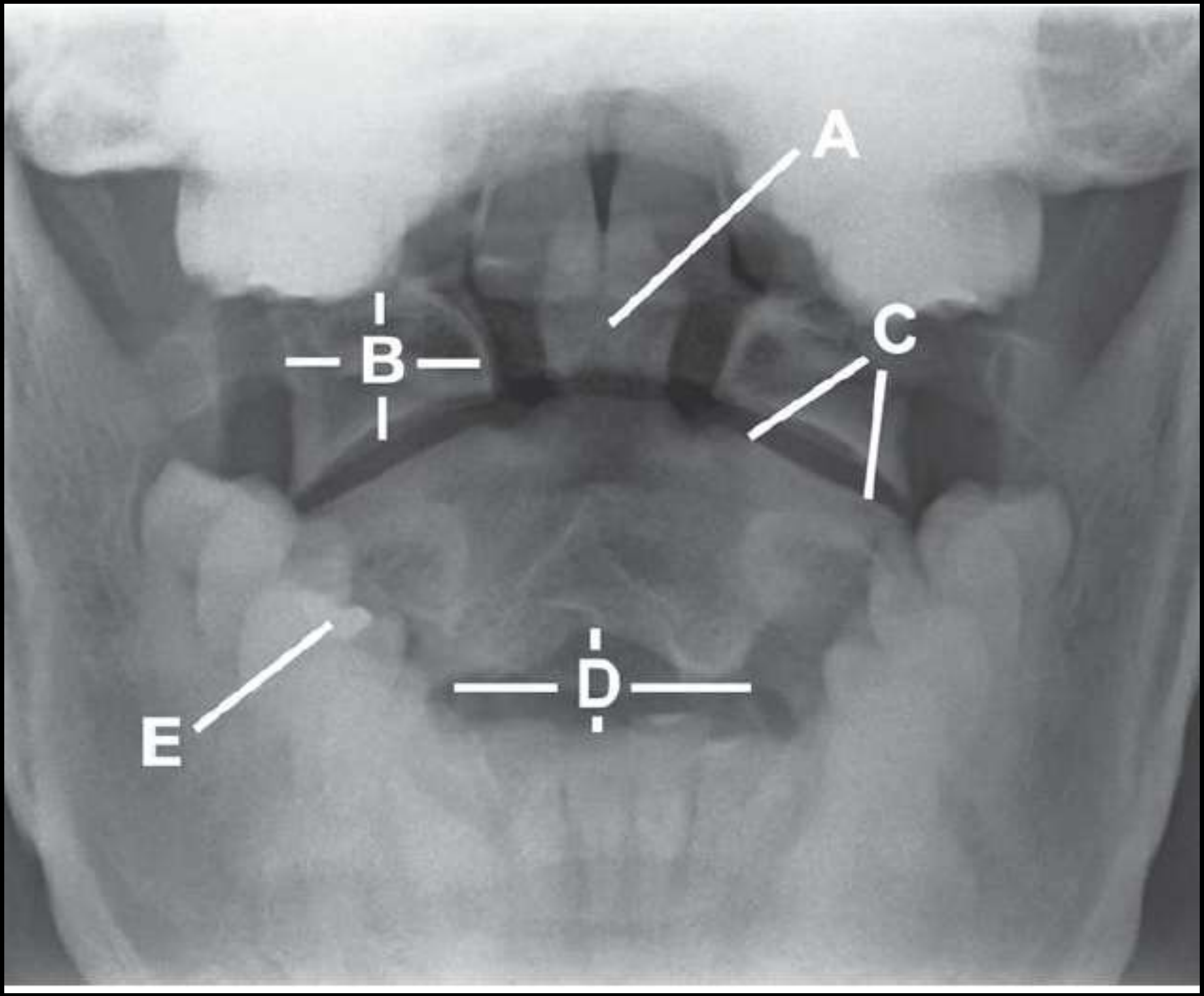
Radiograph of neck, lateral view

The distance between the anterior arch of C1 and the dens of C2 should be less than 3mm in adults and can be up to 5mm in children. Disruption of the joint may be indicated by widening of this space.

The cervical spine is more mobile than other parts of the vertebral column; the obliquely orientated superior and inferior facets allow rotation, flexion/extension and lateral bending. Facet joints are also known as zygapophyseal joints. On a true lateral view, the facet joints should run in parallel with one another.

The prevertebral soft tissues of the neck usually measure only a few millimetres anterior to the vertebral bodies of C1–4. Below this level the prevertebral layer expands (primarily due to the oesophagus) and when measured is usually equivalent in size to the corresponding vertebral body. Another way to remember this is with the phrase '7 at 2 and 2 at 7'; this translates as 7mm of soft tissue at the C2 level and 2cm of soft tissue at the C7 level. Trauma, infection and malignancy can all enlarge the prevertebral soft tissue.

The spinous process of C7 is the largest of all cervical vertebrae and so is also named vertebra prominens; this may be useful when trying to identify a particular vertebra if the provided views are limited.



A
B
C
D
E

Q28 Answers

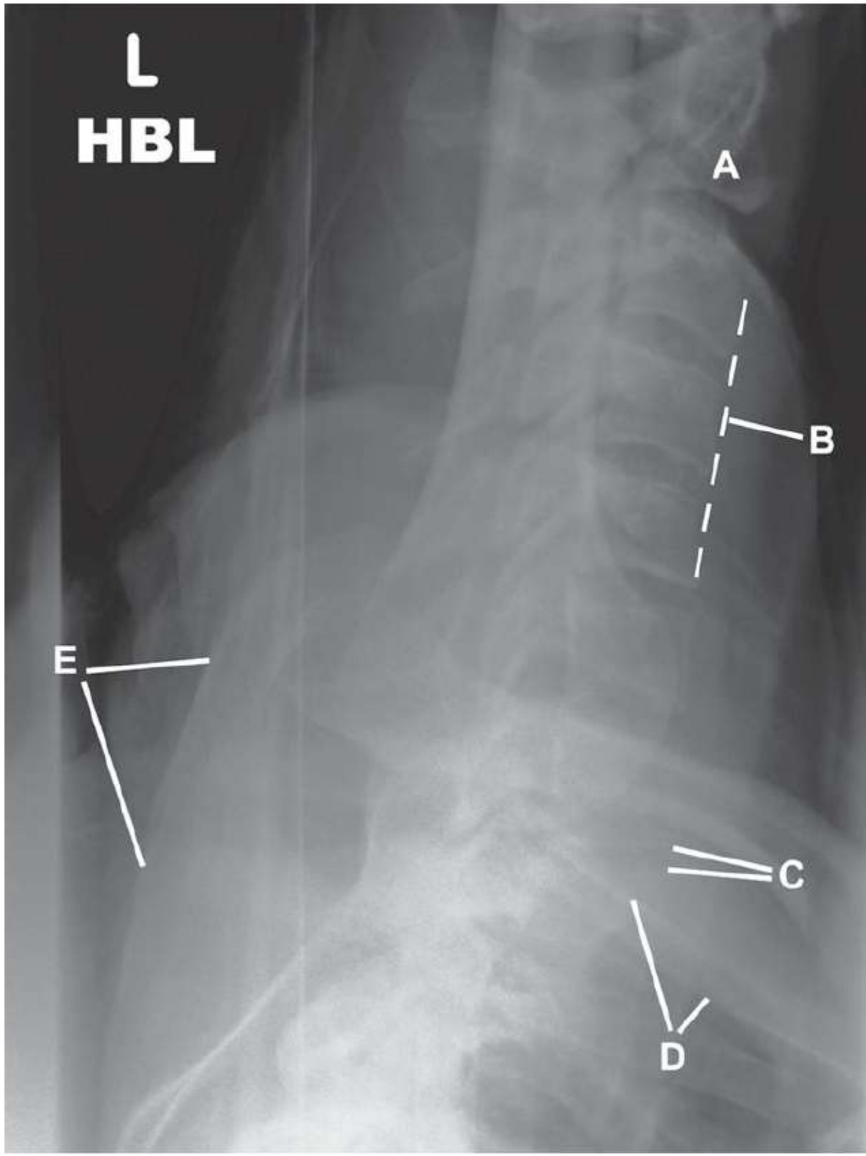
a Dens (odontoid peg) of C2
b Lateral mass of C1
c Superior articular facet of C2
d C2–3 interspace
e Reparative 'filling' in left lower molar tooth

Radiograph of odontoid peg, AP open mouth view

With an open mouth view, the dens of C2 is seen to lie centrally between the two lateral masses of C1. The vertebral body and spinous process of C2 are also usually seen. There is some overlap from the dentition and mandible on this view; these features should be recognized.

Q29

a Name the structure labelled A
b Name the line labelled B
c Name the inter vertebral space labelled C
d Name the structure labelled D
e Name the structure labelled E



Q29 Answers

- **a** Body of C2 vertebra
- **b** Anterior vertebral line
- **c** C7/T1 joint (interspace)
- **d** 1st rib
- **e** Posterior border of the scapula

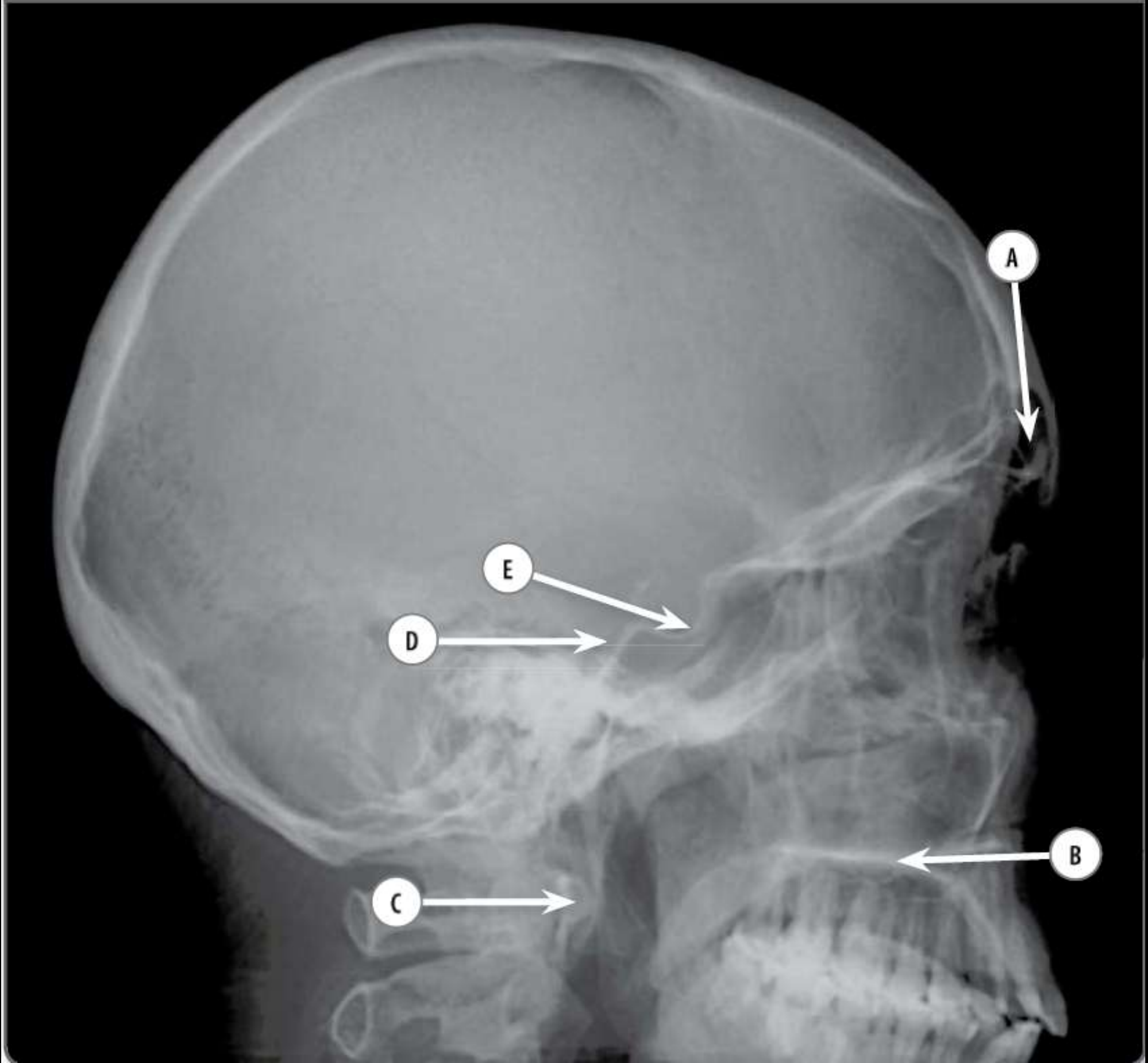
Radiograph of cervical and upper thoracic spine, lateral 'swimmers' view

On a lateral c-spine radiograph, overlap of the shoulders can restrict visualization of the C7/T1 joint. The swimmers view places the patient with one arm up and the other down (as if in mid stroke of front crawl or freestyle) to minimize this bony overlap.

Several vertical lines can be used to assess spinal alignment including the anterior vertebral line which joins the anterior aspects of the vertebral bodies.

It is important to recognize the other overlapping bony contours seen on this view such as the humerus, scapula, clavicle and ribs.

Case 1.21



Case 1.21

A Frontal sinus

B Hard palate

C Anterior arch of atlas

D Clivus

E Pituitary fossa

Lateral skull radiograph.

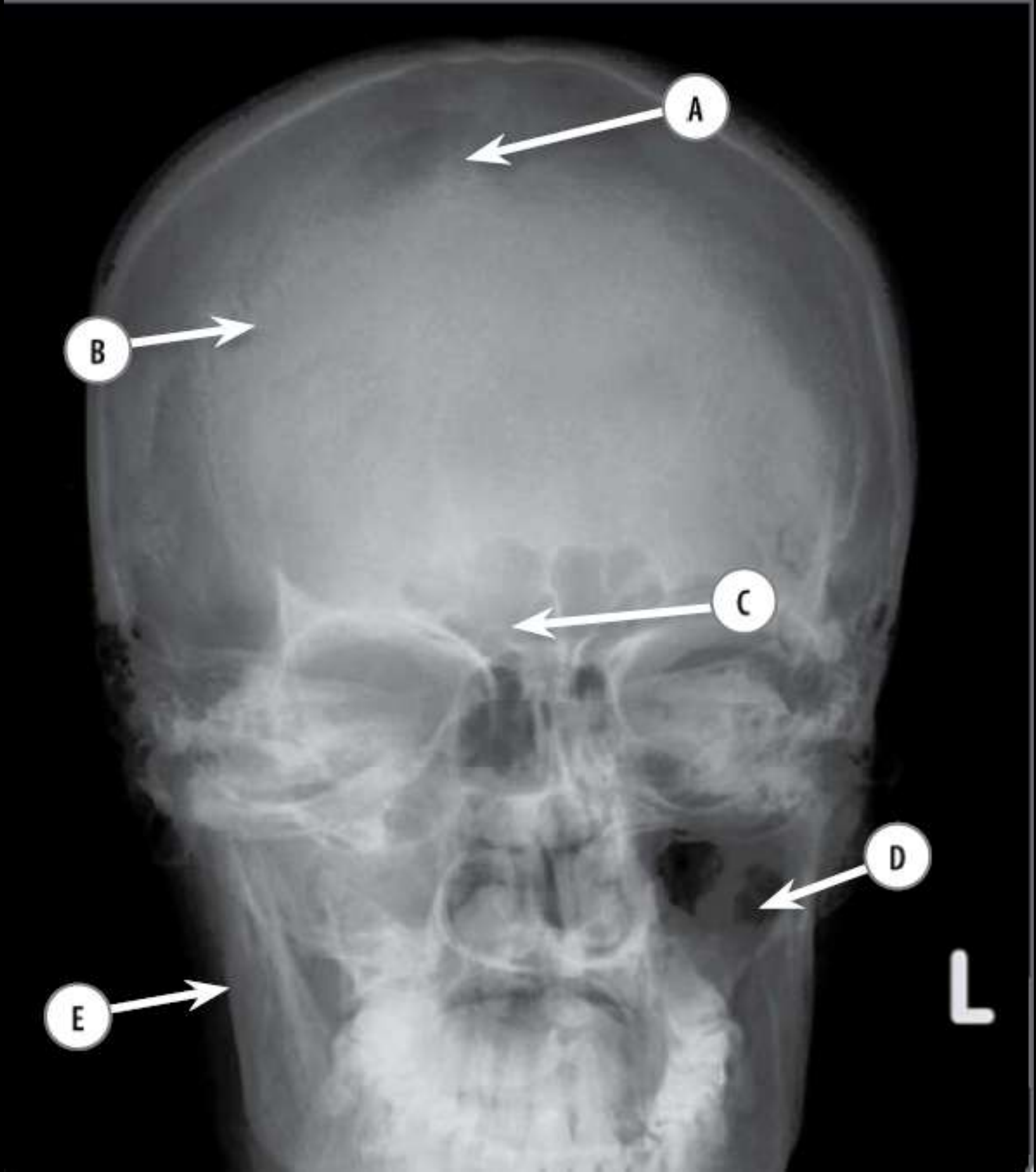
The frontal sinuses are often asymmetrical and lie between the inner and outer tables of the frontal bone above the nose and medial orbits. They are lined by mucus secreting epithelium, and drain through the frontonasal duct into the infundibulum, which opens into the semilunar hiatus of the middle meatus.

The palate forms the floor of the nasal cavities and the roof of the mouth. The hard (bony) palate is concave and formed from the palatine processes of the maxillae and the horizontal plates of the palatine bones.

The pituitary fossa is a depression in the sella turcica of the upper surface of the sphenoid bone in which the pituitary gland sits. The sella turcica is surrounded by the anterior and posterior clinoid processes (clinoid meaning 'bedpost') like the posts of a four poster bed. The posterior part of the sella turcica is the dorsum sellae, which is continuous with the clivus.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 6.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 934, 957.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 4.

Case 1.22



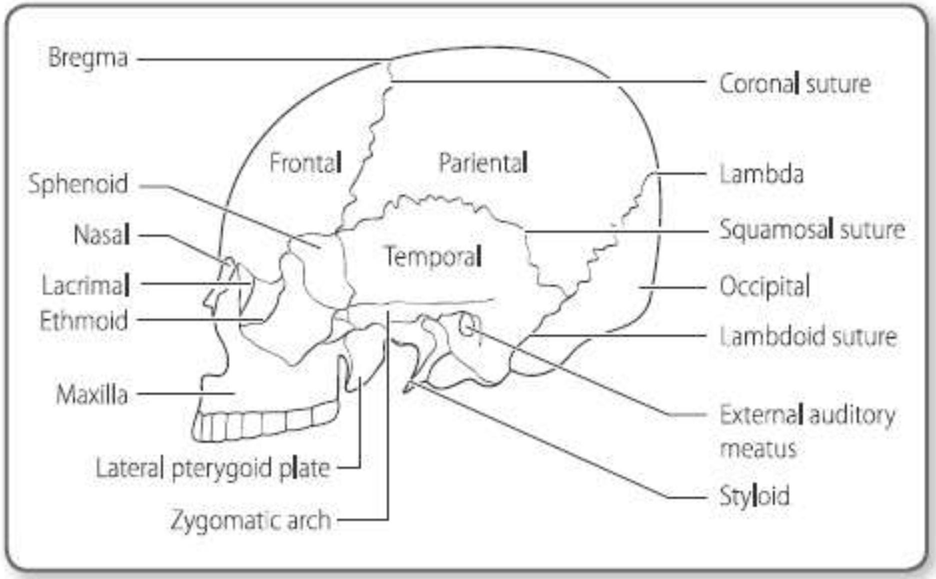


Figure 1.3 The cranial bones and sutures.

Case 1.22

A Sagittal suture

B Right lambdoid suture

C Right frontal sinus

D Left maxillary sinus

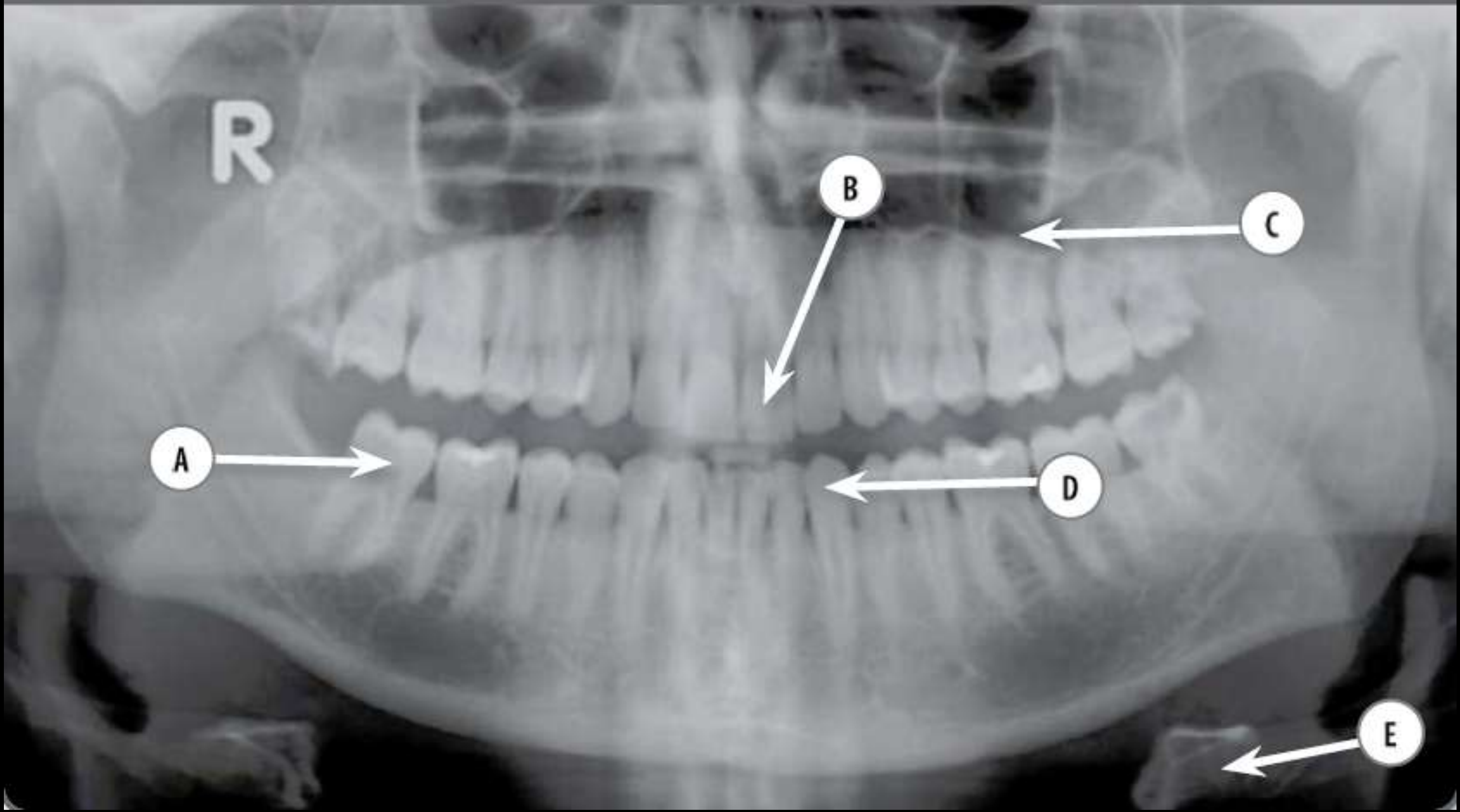
E Ramus of right mandible

Occipitofrontal skull projection.

The sagittal suture is in the midline between the two parietal bones. The two parietal bones are joined to the occipital bone by the lambdoid suture, which is often visible on an occipitofrontal projection. The frontal bones join the parietal bones at the coronal suture. The bregma is the junction between the coronal and sagittal sutures, and the lambda is the junction between the lambdoid and sagittal sutures (**Figure 1.3**).

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 2–6.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 5.

Case 1.25



Case 1.25

A Right lower second molar

B Left upper central incisor

C Floor of left maxillary sinus

D Left lower canine

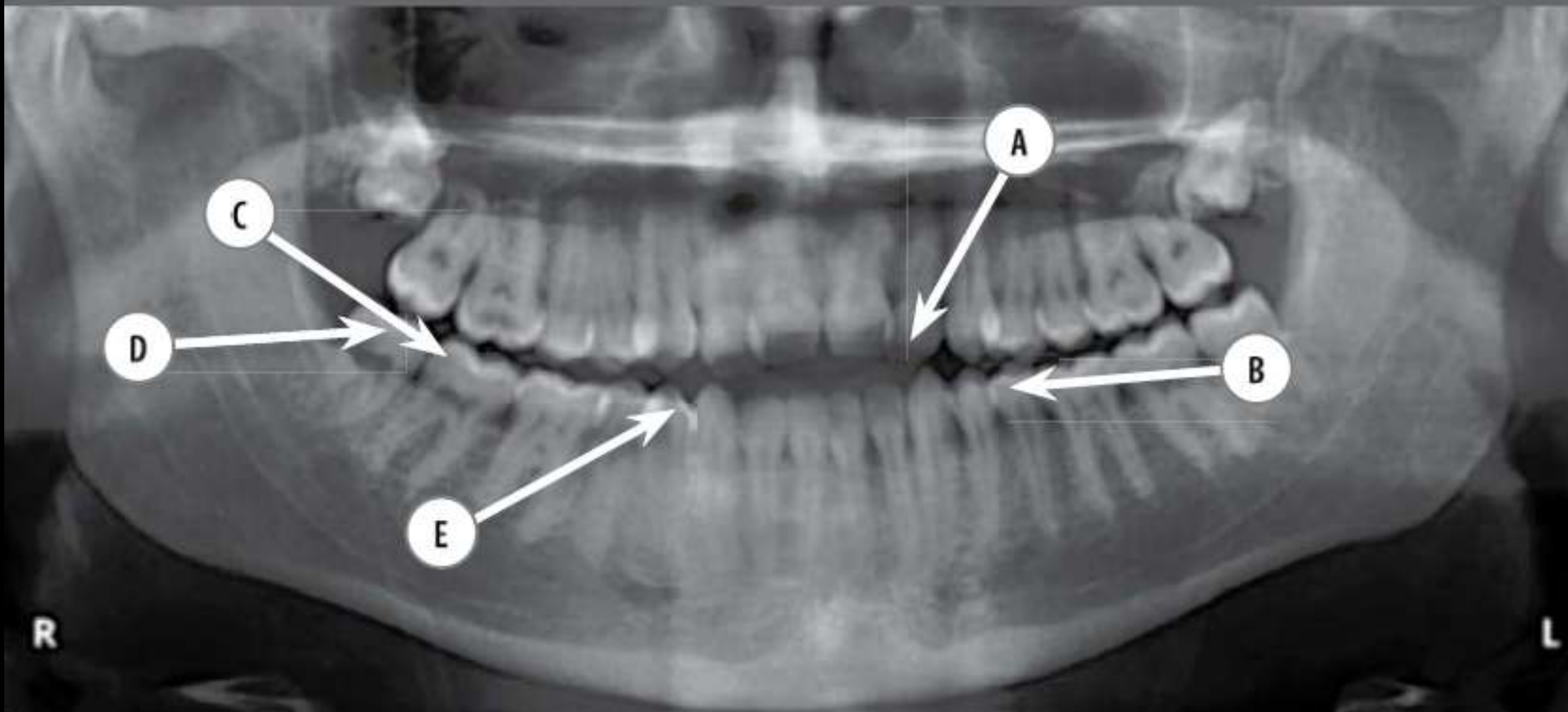
E Hyoid bone

Orthopantomogram (OPG).

An OPG is a panoramic radiograph of the mandible and maxilla in order to image the dentition. It is acquired by rotating a horizontal arm from ear to ear. This means that the central hyoid bone is projected into both edges of the film.

One must not neglect to learn the teeth. OPGs are common examinations.

Case 1.26



Case 1.26

A Upper left lateral incisor

B Lower left 2nd premolar

C Upper right 1st molar

D Lower right 3rd molar (Wisdom tooth)

E Lower right canine

Orthopantomogram (OPG).

There are 20 deciduous or milk teeth which usually begin erupting by 6 months of age. The symphysis menti fuses at 2 years of age. The permanent teeth develop in the maxilla and mandible during childhood, and are calcified by 3 years of age.

As the permanent teeth erupt, the roots of the deciduous teeth are resorbed. The medial teeth begin erupting before the lateral teeth, and the lower before the upper. The permanent teeth are present by 12–13 years of age, except the wisdom teeth (third molars) which erupt in early adulthood.

There are 20 deciduous teeth, and 32 permanent teeth. In each quadrant:
- child: two incisors, one canine, two molars.
- adult: two incisors, one canine, two premolars, three molars.

Supernumerary teeth can be seen on an OPG, and they characteristically occur lateral to the last tooth in each series.

At the centre of each tooth sits the radiolucent highly vascular pulp tissue, which is surrounded by a layer of dentine. Dentine comprises an organic and calcified structure, arranged in porous tubules, and has a radiographic density similar to compact bone. The exposed intraoral portion of each tooth (the crown) has an outer layer of enamel which comprises calcium hydroxyapatite crystals. This is densely radio-opaque. At the cementoenamel junction, which sits at the level of the alveolar ridge, the tooth is no longer covered with enamel, but with cementum. This cementum provides the surround to the root system.

The root and neck of the tooth are surrounded by the radiolucent periodontal membrane. The lamina dura is a dense line of bone which surrounds this and each root, and is continuous with the lamina dura of adjacent teeth (**Figures 1.5 and 1.6**).

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 19
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 34.
Weber E, Netter FH, Vilensky JA, Carmichael SW. Netter's Concise Radiologic Anatomy. Philadelphia: Saunders/Elsevier, 2009: 46.

Case 1.26

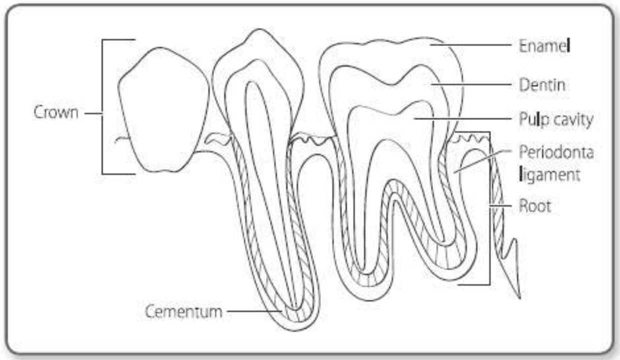


Figure 1.5 The anatomy of the tooth.

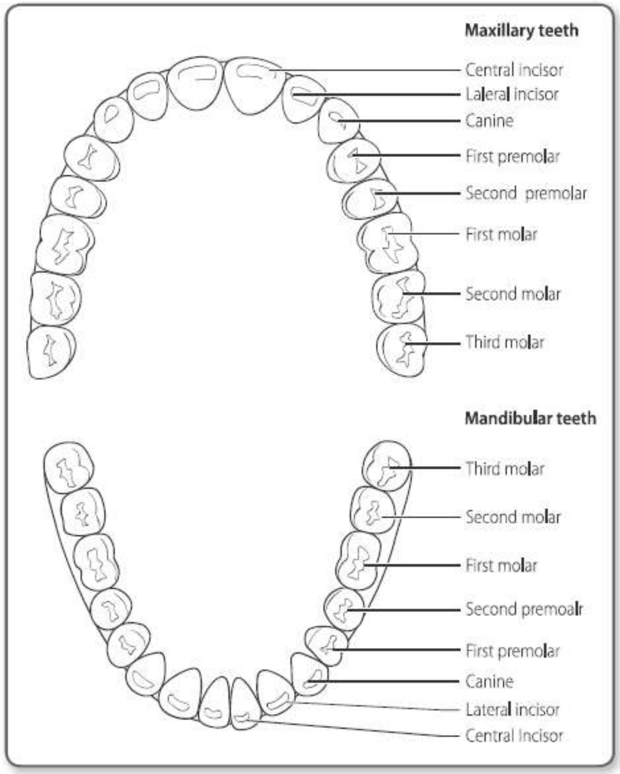
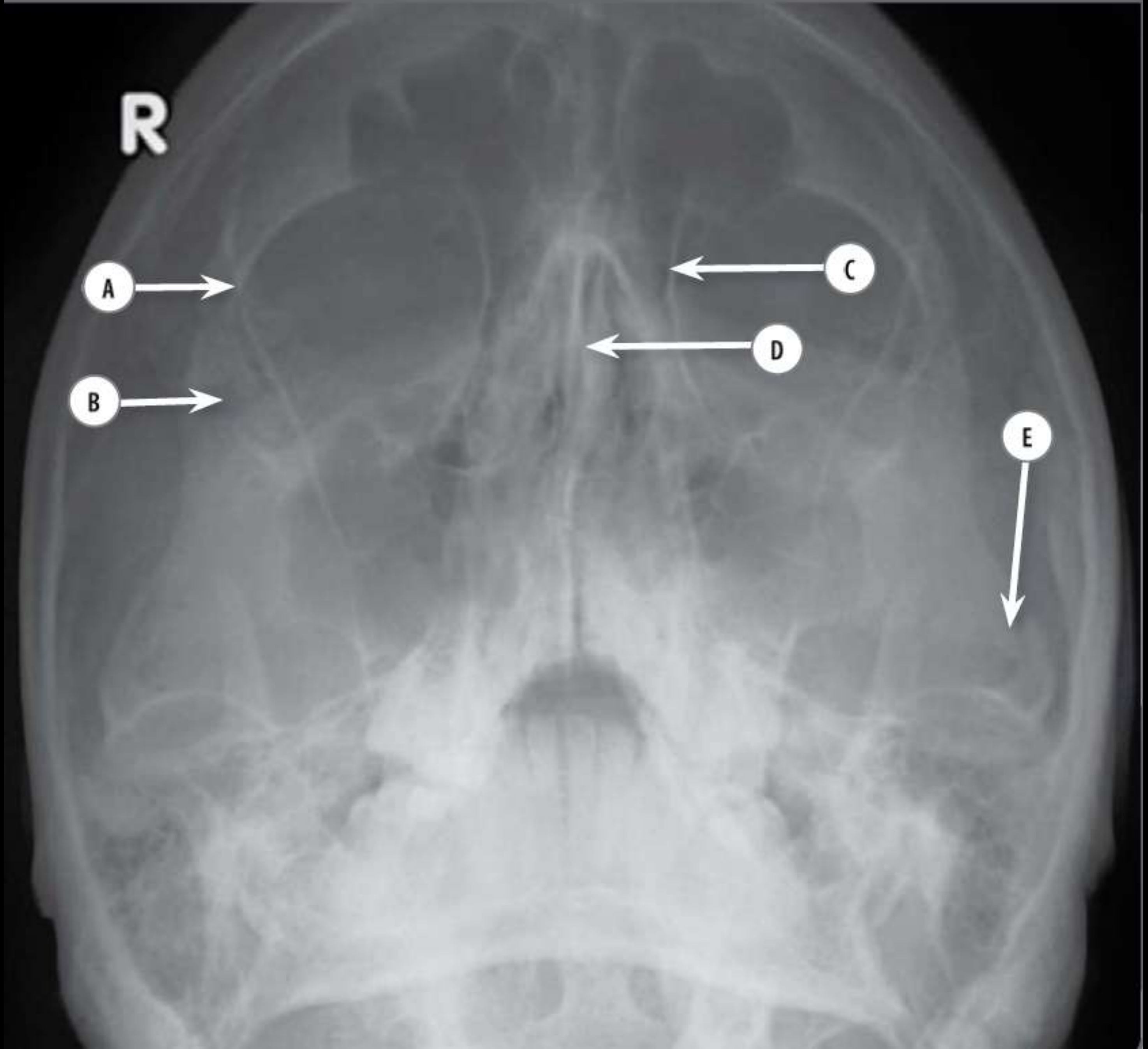


Figure 1.6 The distribution of adult teeth.

Case 1.27



Case 1.27

A Right zygomaticofrontal suture

B Frontal process of right zygoma

C Left lamina papyracea

D Nasal septum

E Left zygomatic arch

Occipitofrontal projection of facial bones.

The zygomatic/malar bone forms the prominence of the cheek, and articulates with the frontal, maxillary and temporal bones at the zygomaticofrontal, zygomaticomaxillary and zygomaticotemporal sutures respectively. It forms the boundary of the temporal fossa superiorly and the infratemporal fossa inferiorly.

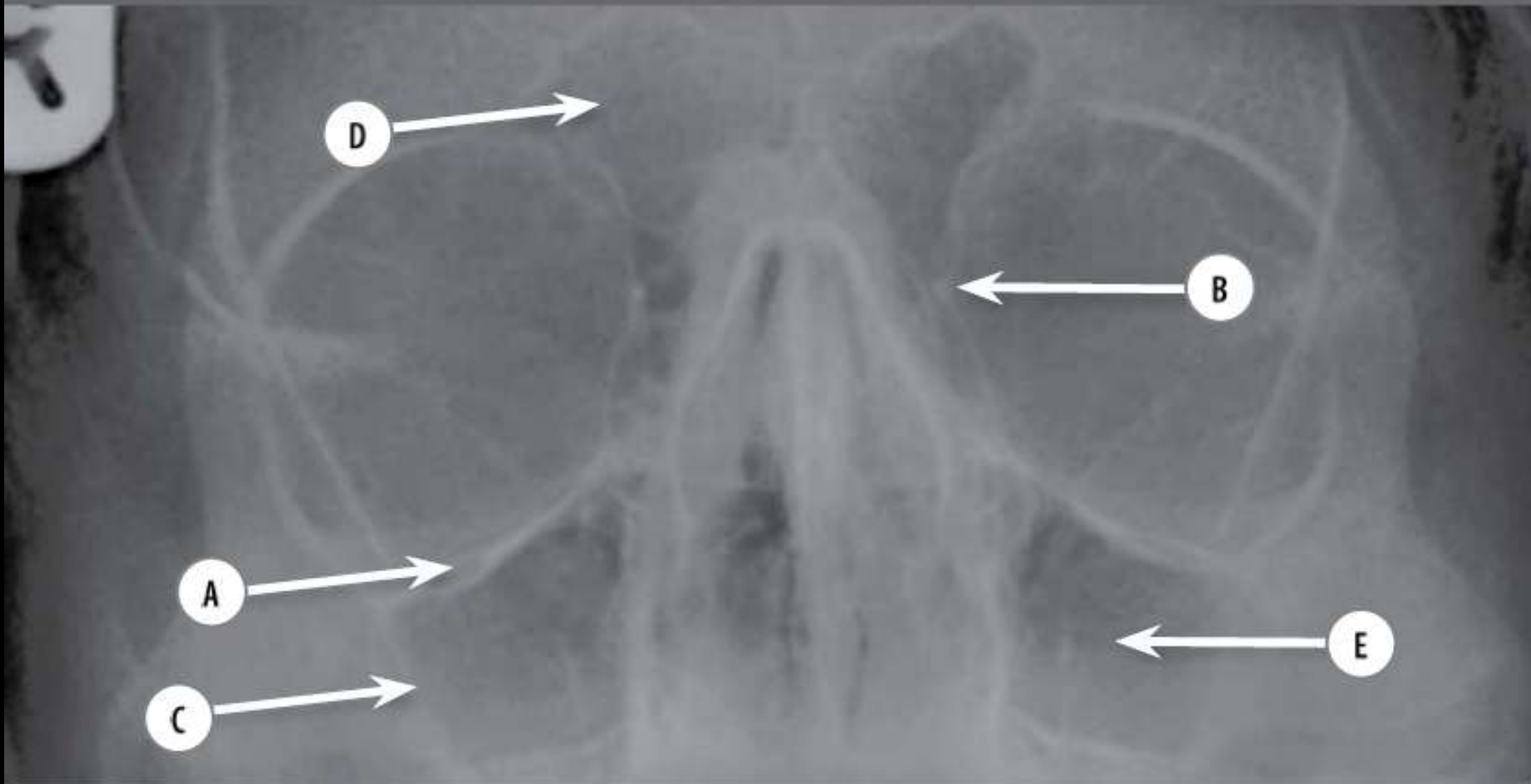
The medial orbit of the wall is formed mainly from ethmoid bone, with contributions from maxillary, lacrimal and sphenoid bones. The paper thin bone separating the orbit from the ethmoid air cells is the lamina papyracea.

The nasal septum is part bony and part cartilaginous and divides the nasal cavity in two in the sagittal plane. The main contributors are:

- **perpendicular plate of ethmoid** – descends from the cribriform plate to form the superior part of the septum
- **vomer** – is thin and flat, and forms the posterior and inferior septum
- **septal cartilage** – joins with the bony septum.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 7.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 899, 824.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 12.

Case 1.28



Case 1.28

A Right infraorbital foramen

B Left lamina papyracea

C Lateral wall of right maxillary sinus

D Right frontal sinus

E Left maxillary sinus

Radiograph of the orbits.

The maxillary sinuses, or antra, are the largest paranasal sinuses. They are pyramidal in shape and are situated in the bodies of the maxillae.

- The zygomatic bone forms the apex
- The lateral wall of the nasal cavity forms the base/medial wall of maxillary sinus. This is continued superiorly as a bony projection called the uncinate process
- The floor of the orbit forms the roof

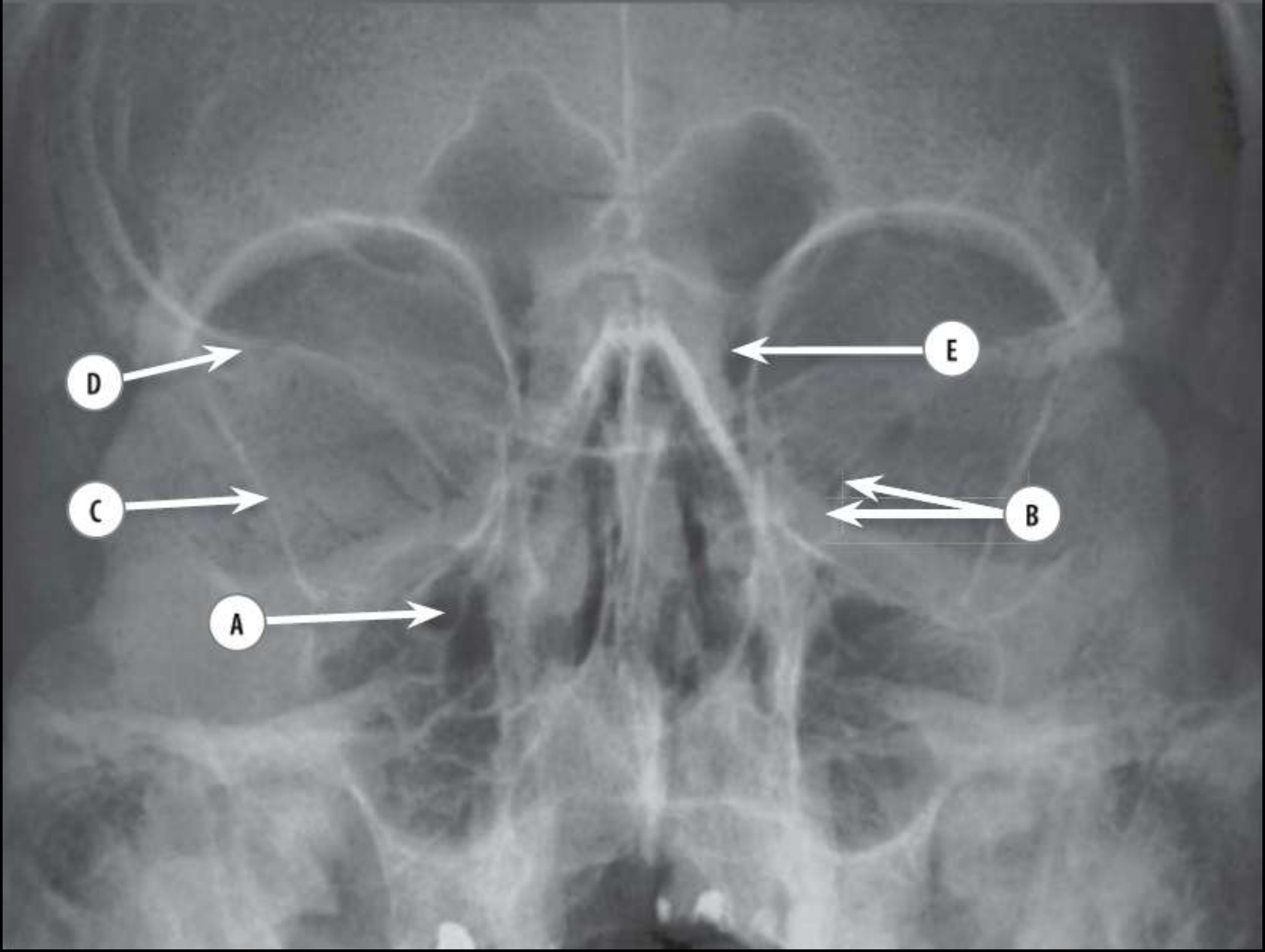
- The alveolar part of the maxilla forms the floor. There are often elevations on the floor of the maxillary sinus formed from the roots of the maxillary teeth below.

The superior alveolar branches of the maxillary artery supply the majority of the maxillary sinus, with the greater palatine artery supplying the floor. The anterior, middle and posterior superior alveolar nerves – branches of the maxillary nerve – innervate the maxillary sinus.

The infraorbital foramen transmits the terminal branch of the maxillary (cranial nerve V2): the infraorbital nerve. This supplies the skin of the cheek, lower eye lid, lateral side of nose, inferior septum and upper lip, upper premolars, incisors and canines, and the mucosa of the upper lip and maxillary sinus.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 6.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 825.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 15.

Case 1.29



Case 1.29

A Right foramen rotundum

B Left superior orbital fissure

C Right greater wing of sphenoid

D Right body of sphenoid

E Left ethmoidal air cells

Detail of occipitofrontal projection

The sphenoid bone forms part of the middle cranial fossa and contributes to the bony orbit. It consists of a body, greater and lesser wings and pterygoid processes. The wings spread laterally, and the pterygoid processes (lateral and medial pterygoid plates) project inferiorly. The body contains the sphenoid sinuses.

The superior orbital fissure is adjacent to the optic foramen medially. It is a slit between the greater and lesser wings of sphenoid. It transmits V1, III, IV, and VI cranial nerves, superior ophthalmic veins, and a branch of the middle meningeal artery. The ophthalmic artery may communicate with the middle meningeal, therefore forming an anastomotic connection between the internal and external carotid systems.

The foramen rotundum is often visible on facial plain films. It is in the greater wing of sphenoid, posterior to the superior orbital fissure. It travels from the middle cranial fossa to the pterygopalatine fossa and transmits the maxillary (V2) nerve (**Figure 1.7**).

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 2.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 824.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 5.

Case 1.29

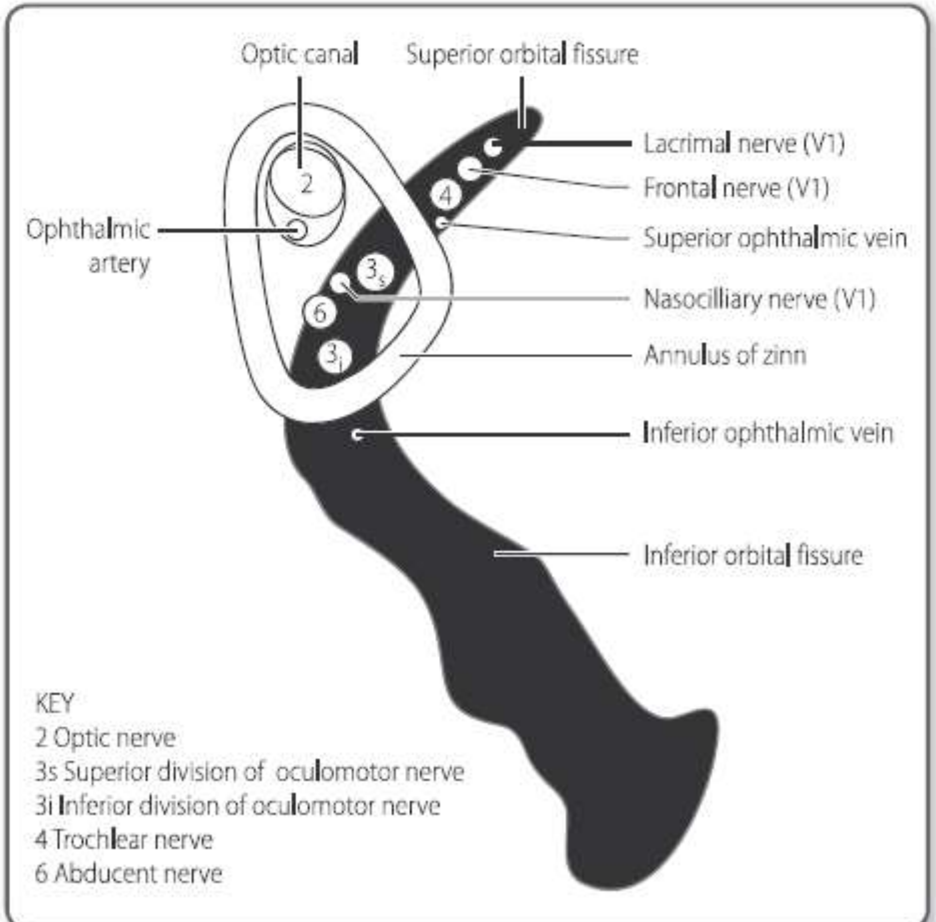
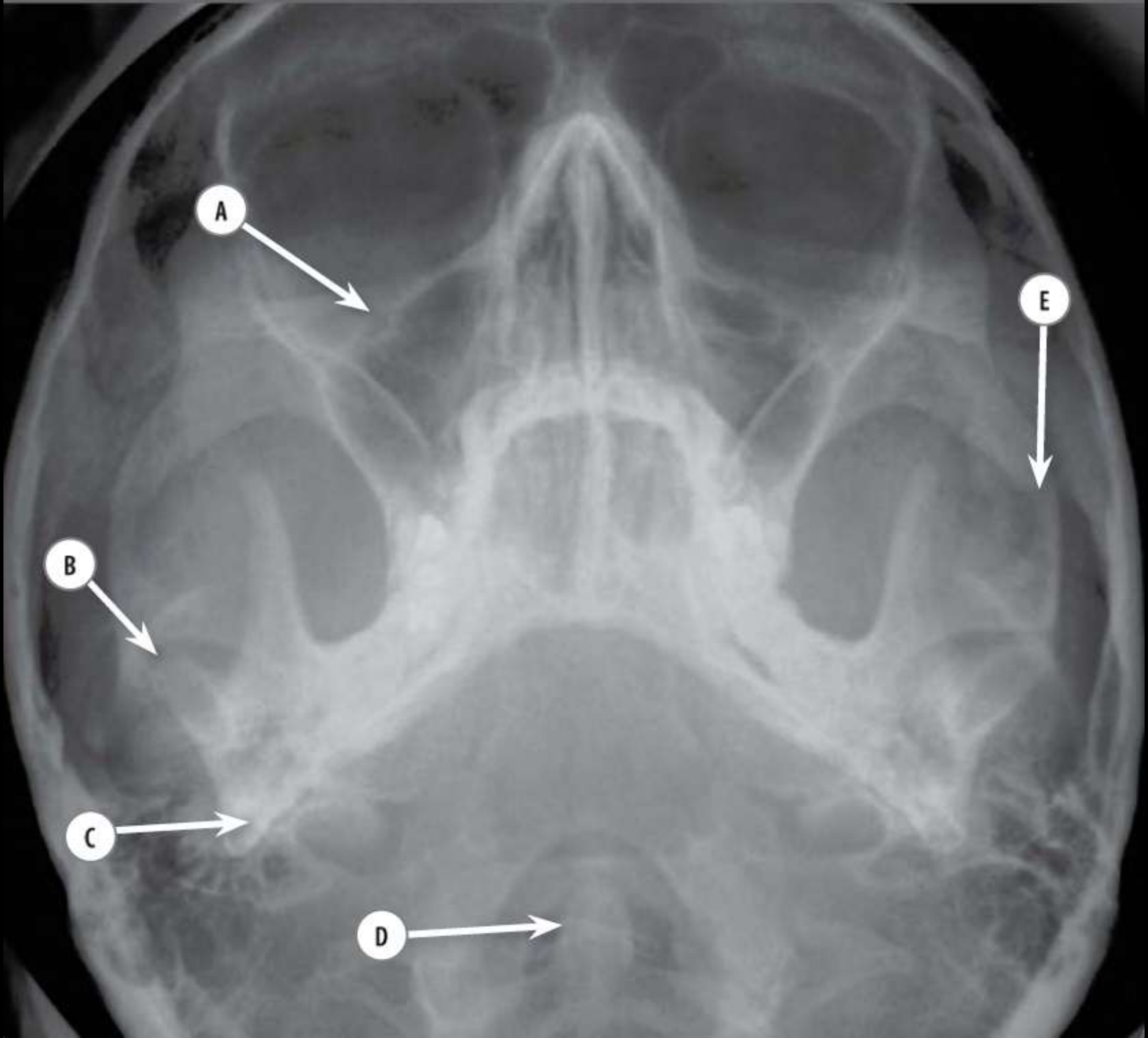


Figure 1.7 The structures of the superior orbital fissure.

Case 1.53



Case 1.53

A Right infraorbital foramen

B Right temporomandibular joint

C Right angle of mandible

D Odontoid peg

E Left zygomatic arch

Plain radiograph of the facial bones in an occipitomental projection.

Each half of the mandible is made up of a horizontal body, and vertical ramus, which meet at the angle of the mandible. The two halves of the mandible meet at the symphysis menti in the midline. The ramus has two bony projections at

its superior margin – the coronoid process anteriorly, and the condylar process posteriorly, which articulates with the temporal bone at the temporomandibular joint.

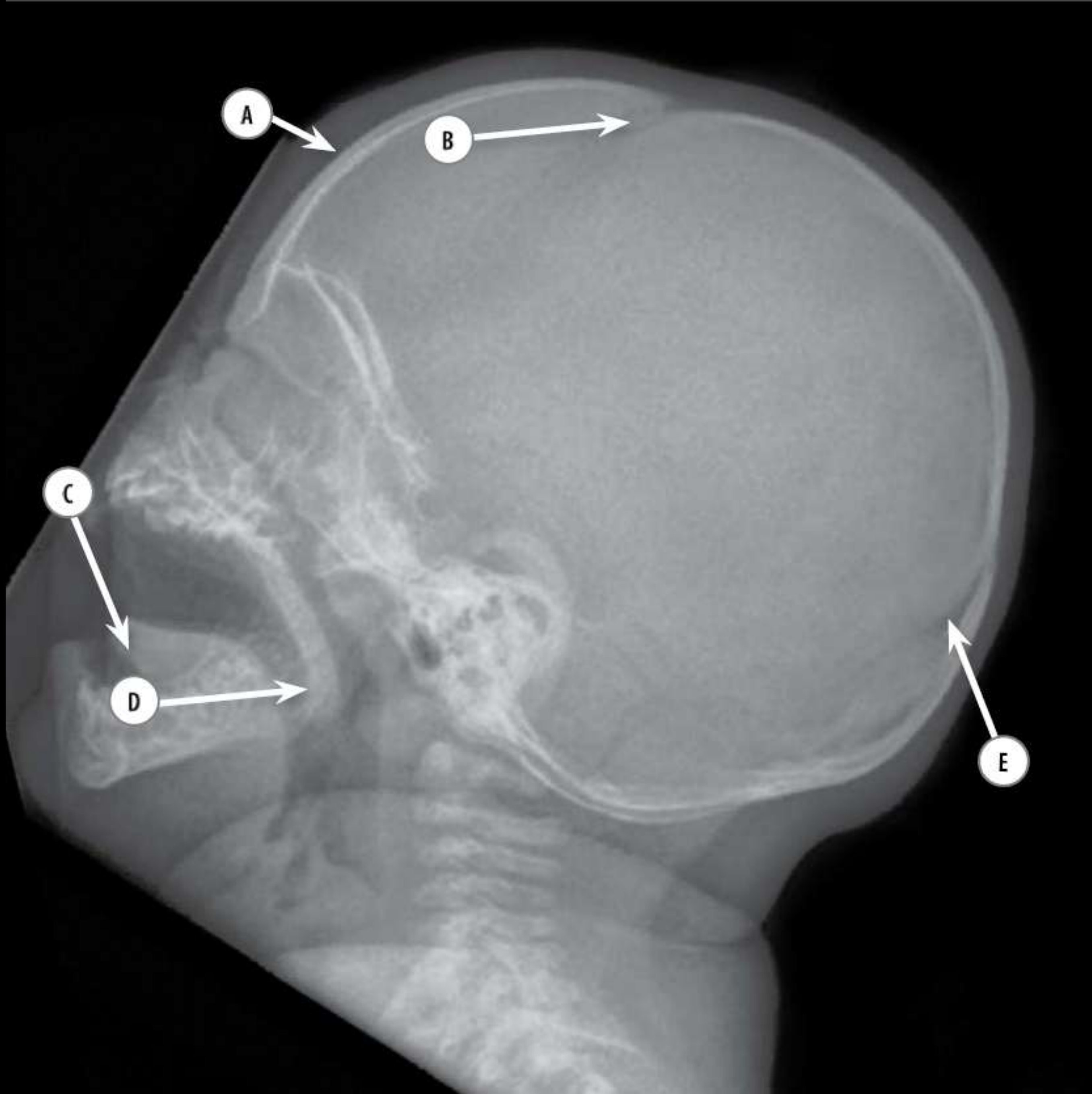
The zygoma articulates with the temporal, frontal, and maxillary bones. These sutures are known as:

- zygomaticotemporal suture
- zygomaticofrontal suture
- zygomaticomaxillary suture

Its anterior end acts to reinforce the orbit at its inferolateral margin. The zygoma can be assessed on an occipitomental projection, or a modified Towne's view (PA with mouth open).

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 11, 16.

Case 1.55



Case 1.55

A Frontal bone (outer table of skull vault)

B Coronal suture

C Tongue

D Soft palate

E Lambdoid suture

Lateral radiograph of an infant's skull.

The skull vault is made up of an inner and outer table (or diploe), between which is found the diploic space. This space is filled with marrow, and is traversed by the diploic veins.

The frontal bone develops in two halves in children, separated vertically by the metopic suture. This usually fuses by the age of 5, however, in some individuals it does not fuse. A persistent metopic suture is found in approximately 5–10% of the population. The floor of the anterior cranial fossa is largely made up of the orbital plates of the frontal bone, with the cribriform plate located between them.

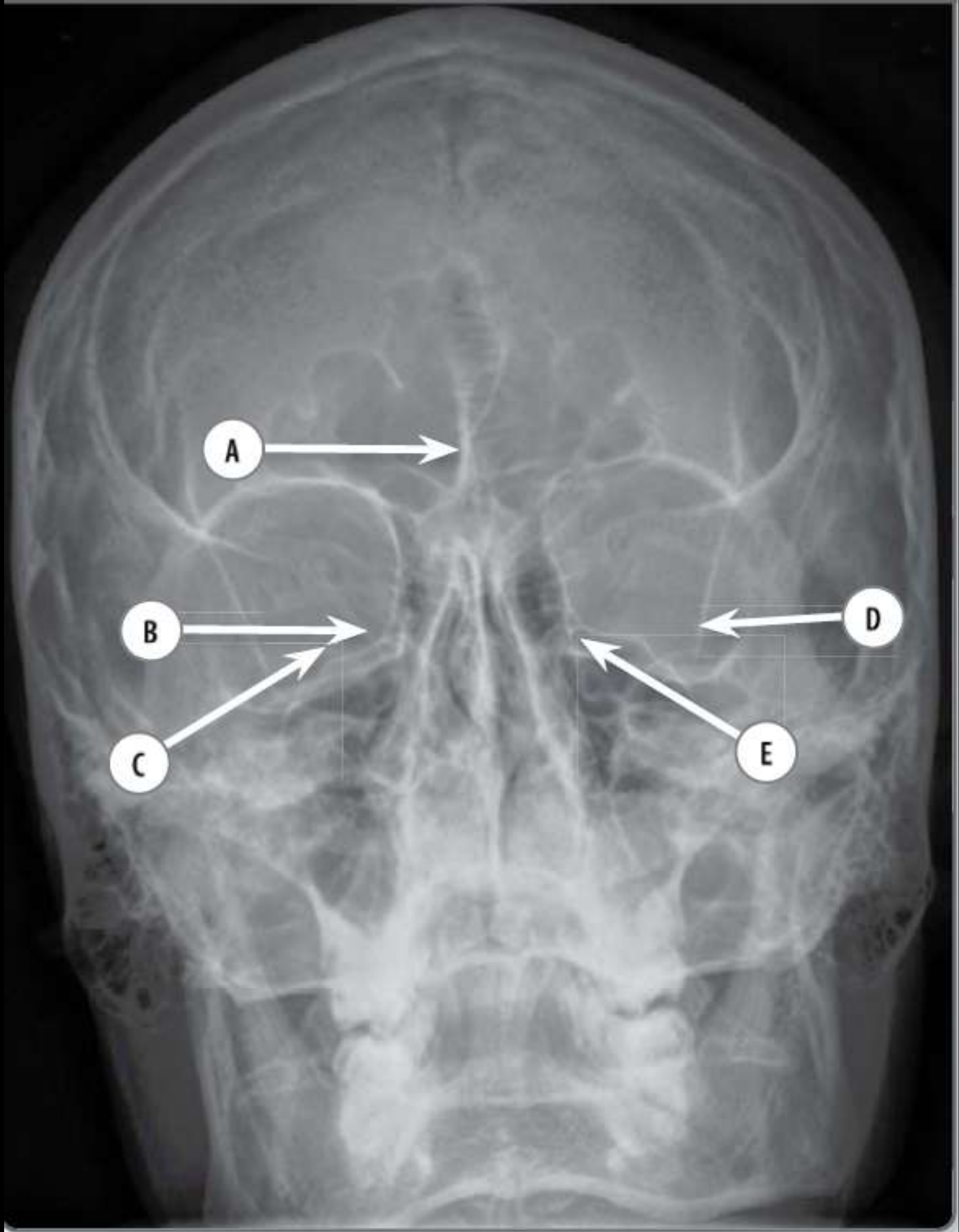
The coronal suture marks the interface between the frontal and parietal bones. The parietal bones are separated from each other by the sagittal suture, which runs perpendicularly from the coronal suture, until it meets the lambdoid suture posteriorly. The lambdoid sutures run at an oblique angle, separating the parietal and occipital bones. The parietal bone also articulates with the greater wing of sphenoid anteriorly, and inferiorly it meets the temporal bone.

The side of the skull vault below the parietal and frontal bones is formed by the greater wing of sphenoid and the squamous part of the temporal bone. The point at which the sutures between the frontal, parietal, sphenoidal and temporal bones meet is known as the pterion. These sutures are as follows:

- **sphenosquamosal:** between the sphenoid and temporal bones
- **sphenofrontal:** between the greater wing of sphenoid and frontal bones
- **sphenoparietal:** between the greater wing of sphenoid and parietal bones
- **squamosal:** between the temporal and parietal bones

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 1–3.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 21.

Case 1.59



Case 1.59

A Crista galli

B Right superior orbital fissure

C Right greater wing of sphenoid

D Left innominate line

E Left foramen rotundum

Frontal skull radiograph.

The crista galli is a bony protrusion from the internal surface of the floor of the anterior cranial fossa in the midline. It marks a point of attachment of the falx cerebri, which is a dural septum that runs in the sagittal plane between the two hemispheres.

The superior orbital fissure is triangular in shape, and is found between the greater and lesser wings of the sphenoid bone. The structures which pass through this fissure are:

- 3rd cranial nerve
- 4th cranial nerve
- first division (orbital) of 5th cranial nerve
- 6th cranial nerve
- superior orbital vein
- middle meningeal artery branch vessel

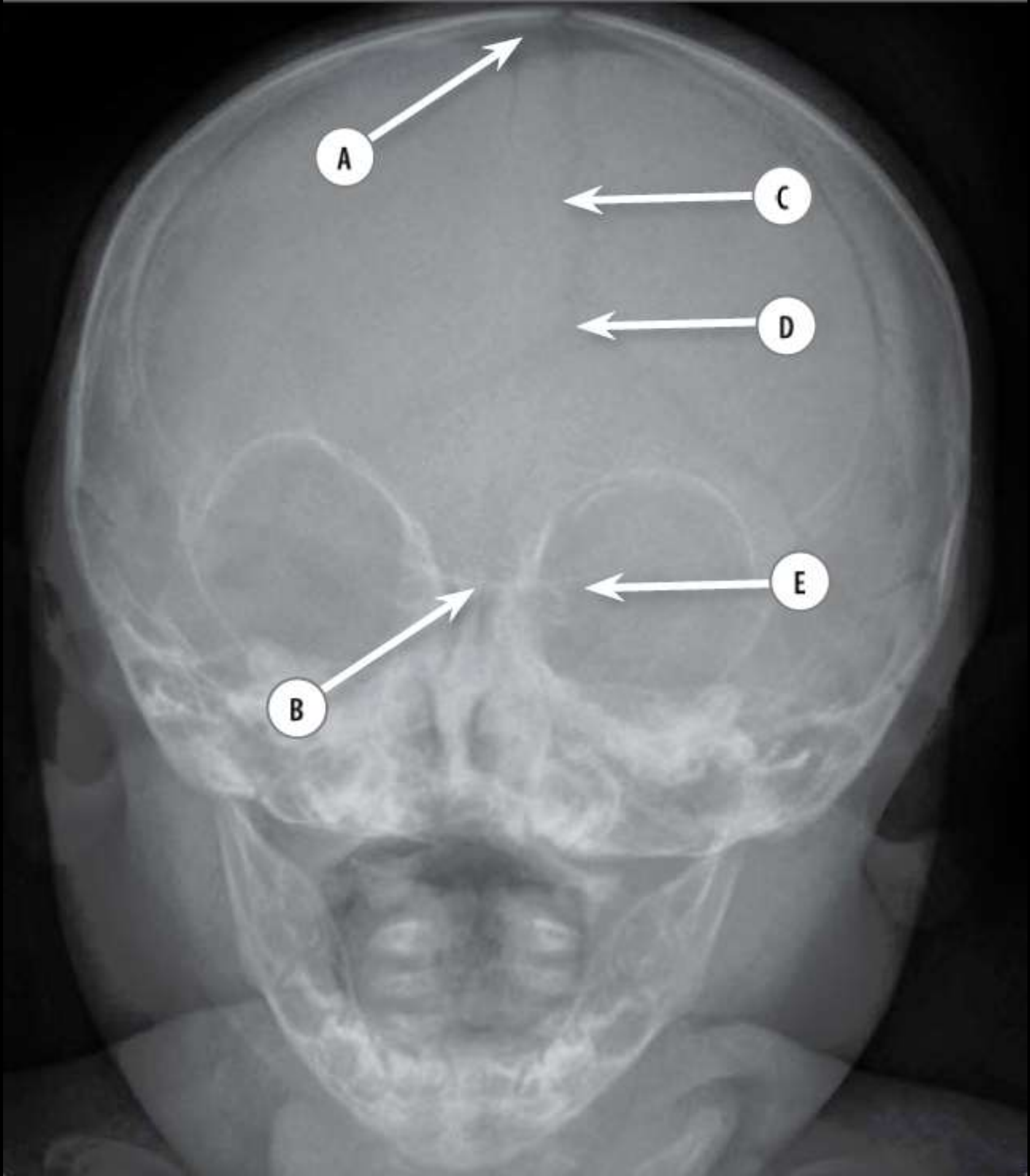
The foramen rotundum passes from Meckel's cave in the middle cranial fossa to the pterygopalatine fossa, with the second division (maxillary) of the 5th cranial nerve running through it. It is circular in shape, and is found posteriorly to the superior orbital fissure in the greater wing of the sphenoid bone. It is best seen on an angled occipitofrontal view (20° caudal), or an occipitomental view.

The innominate line is seen on occipitomental views of the orbits as a straight line running obliquely from the upper outer part of the orbit, inferiorly and medially. It is caused by the beam hitting the curve of the greater wing of sphenoid at a tangent.

Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 64, 98.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 8, 11–13.

Case 1.60



Case 1.60

A Anterior fontanelle

B Planum sphenoidale

C Sagittal suture

D Lambda

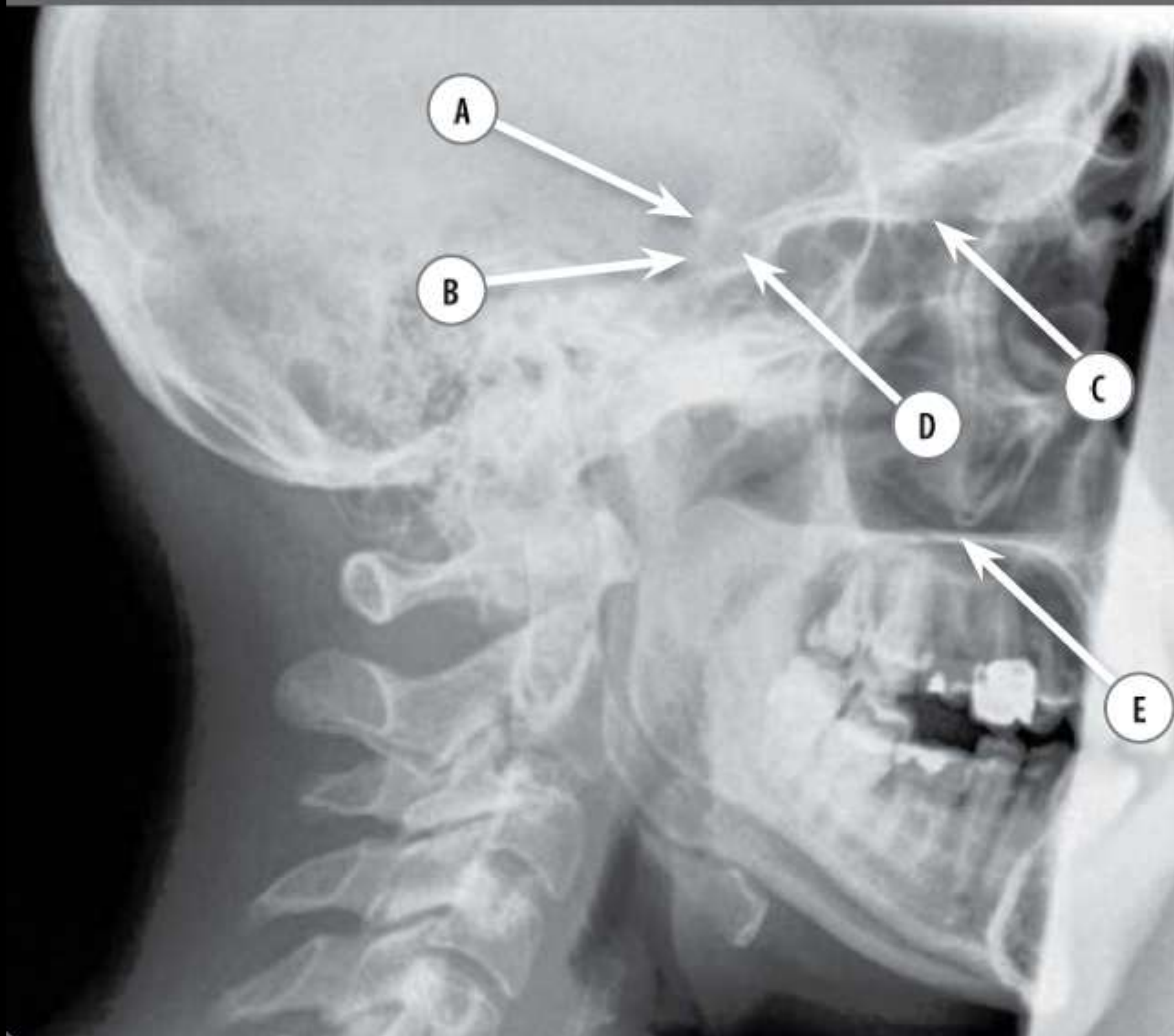
E Left lesser wing of sphenoid

Frontal skull radiograph from an infant.

The sutures have quite a different appearance in the neonate/infant compared to an adult. They begin as straight lines, with open fontanelles at the points where they meet, and there may be wormian bones visible. In the first few days of life, some overlapping of the bones may be seen. As the skull grows and matures, the sutures begin to fuse, and change from having a straight appearance to an interlocking pattern. This appearance develops in the first year, and by 2 years of age the sutures have a more adult, serrated pattern. The anterior fontanelle forms a diamond shape between the coronal, metopic and sagittal sutures. It usually closes by the age of 18 months, at which point the junction between the coronal and sagittal sutures becomes known as the bregma. The posterior fontanelle forms a triangular shape between the sagittal and lambdoid sutures. It usually closes by 6–8 months, and the junction of these sutures is then known as the lambda.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 1, 10.

Case 1.61



Case 1.61

A Posterior clinoid process

B Dorsum sellae

C Floor of anterior cranial fossa

D Pituitary fossa (sella turcica)

E Hard palate

Lateral skull radiograph.

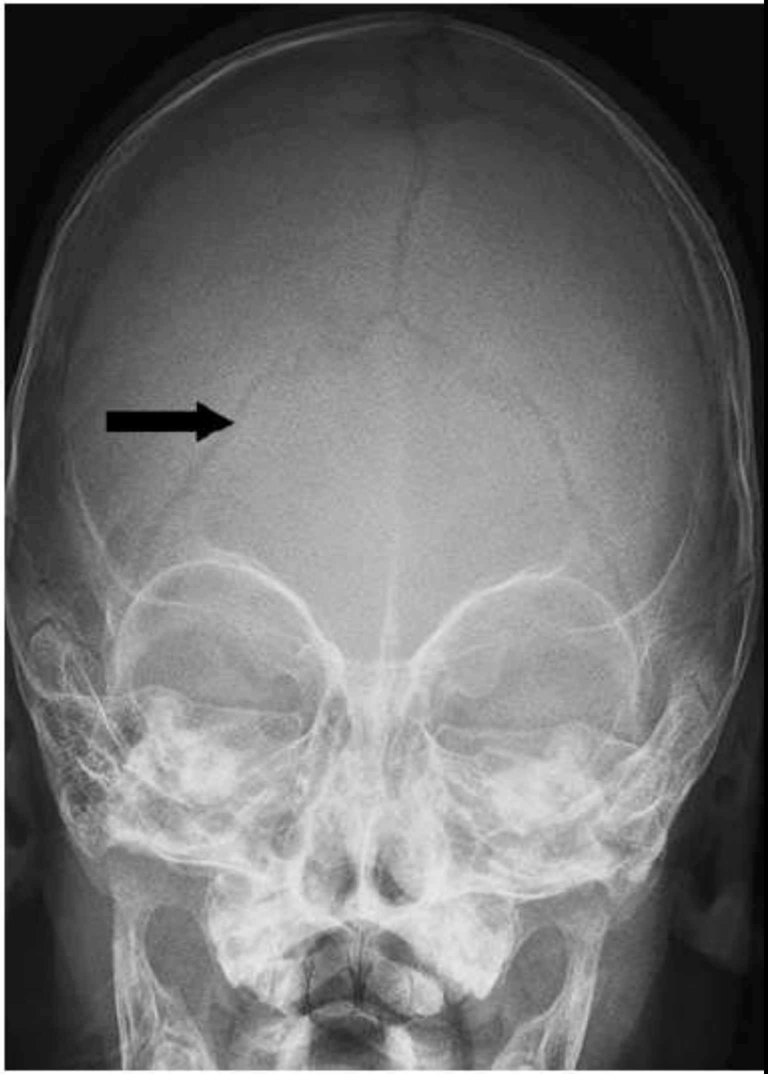
The pituitary fossa, or sella turcica, is found on the superior surface of the body of sphenoid. The posterior part of the pituitary fossa is known as the dorsum sellae

– this is continuous with the clivus behind. The posterior clinoid processes form two lateral projections, which extend from the dorsum sellae. Anteriorly is found the tuberculum sellae, which is a bony prominence on the anterior surface of the sella. There are two bony projections from the anterior aspect of the sella, which are called the anterior clinoid processes – these are part of the lesser wing of sphenoid. Anterior to the tuberculum sellae, between the anterior clinoid processes, is a depression which is known as the sulcus chiasmaticus; the optic chiasm lies over it, and the optic canals are found to each side of it.

The planum sphenoidale is a horizontal portion of the lesser wing of sphenoid, anterior to the sulcus chiasmaticus. It articulates with the cribriform plate anteriorly.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 3.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 22.

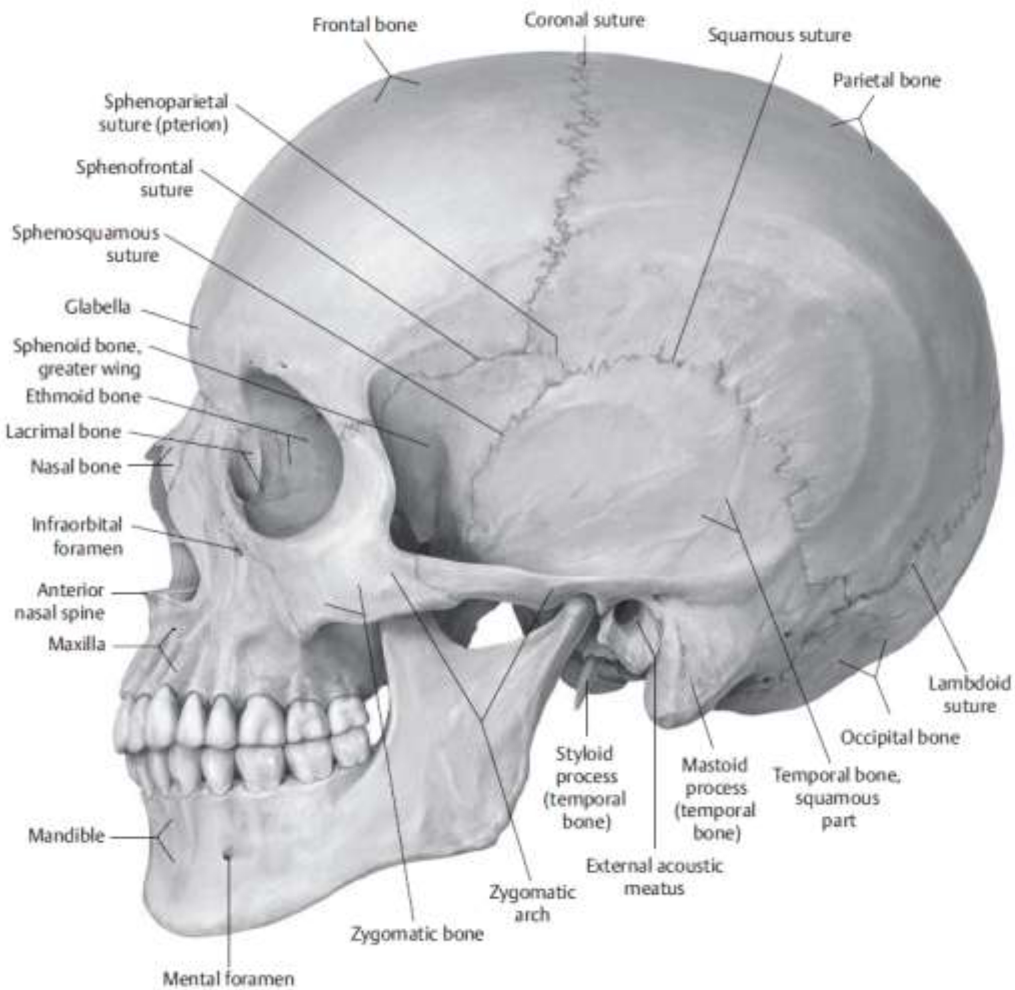
- **Question 19:**



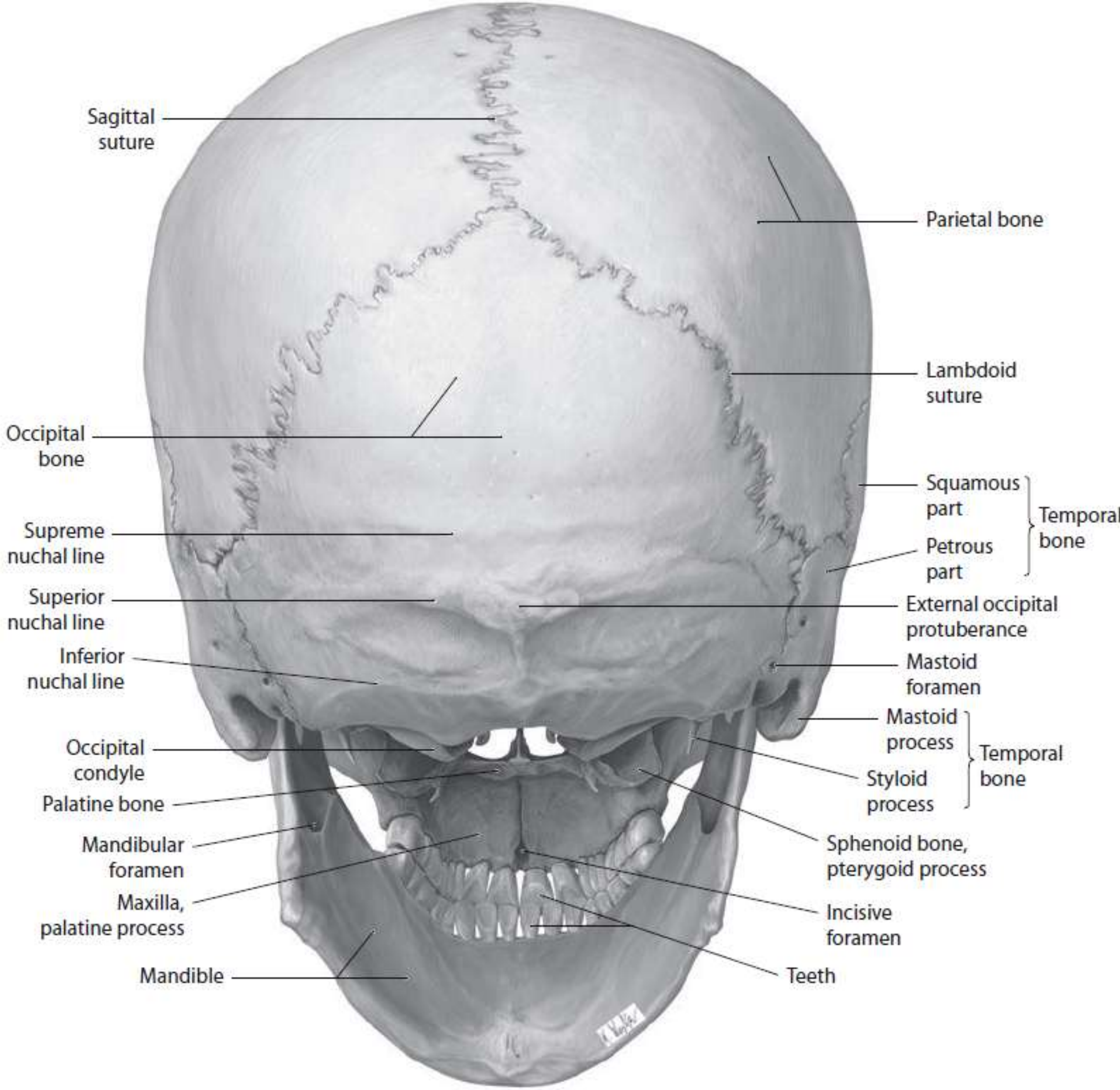
Question 19: AP radiograph of an infant's skull

Answer: Lambdoid suture

- The lambdoid suture forms the connective tissue joint between the occipital bone and the parietal bones.
- The point at which it joins the sagittal suture is called the lambda.
- The lambdoid suture can be differentiated from the coronal suture at the front of the skull by the shape it makes at the junction of the sagittal suture. It is shaped like the Greek letter λ, whereas the junction of the coronal suture with the sagittal suture looks like the letter T when viewed from above.
- The following figures illustrate the different cranial sutures.



From Atlas of Anatomy, © Thieme 2008, illustration by Karl Wesker.



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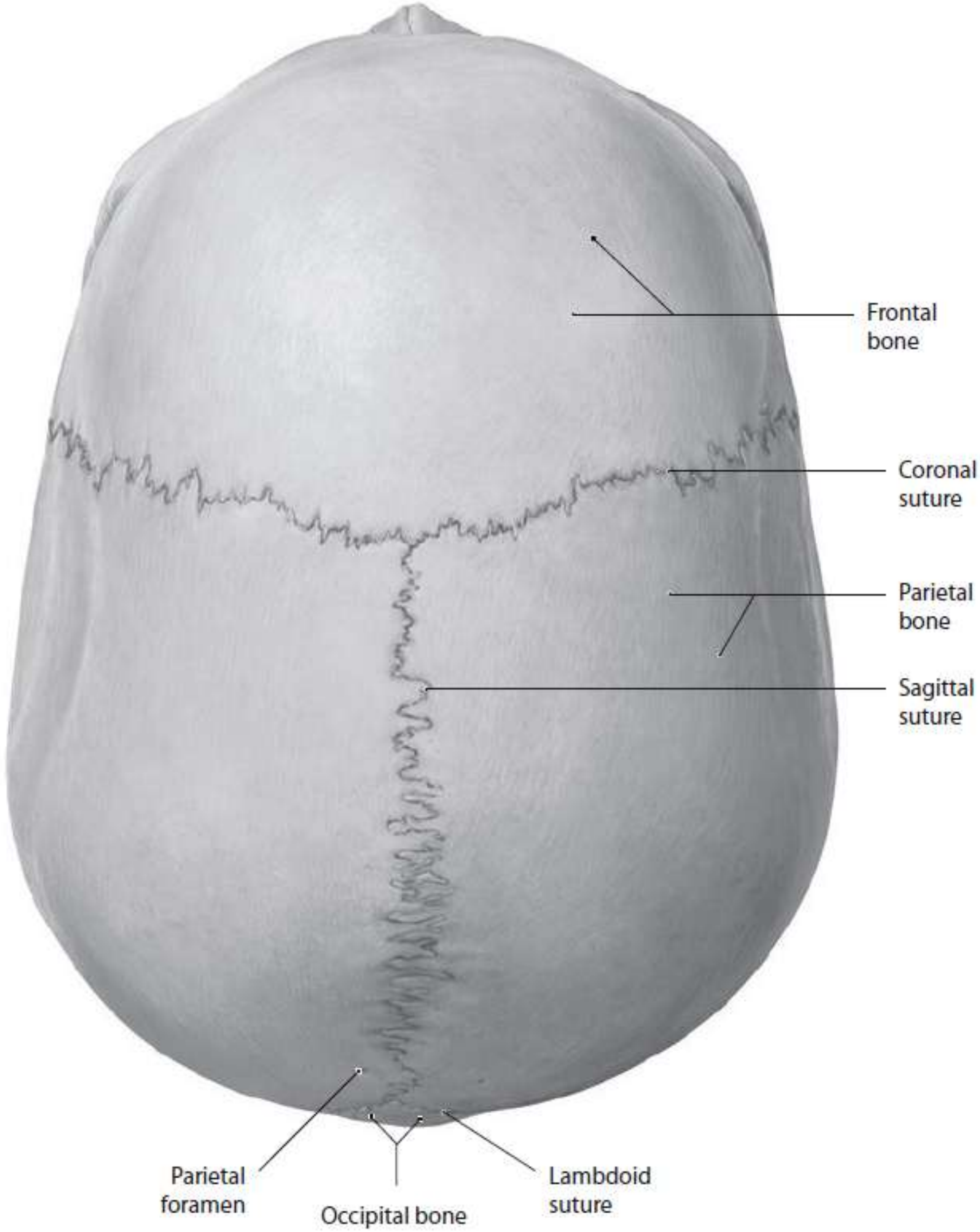
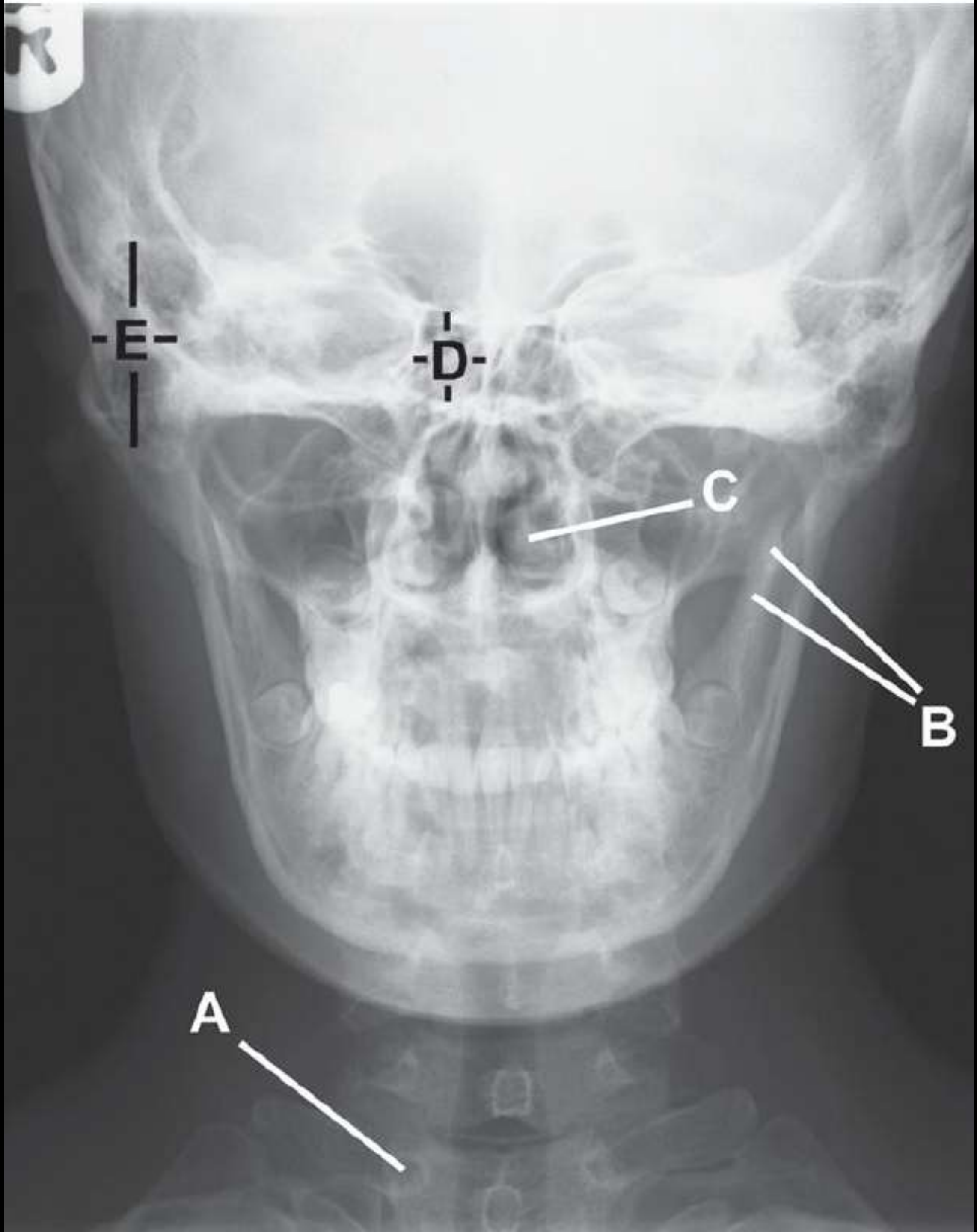


From Atlas of Anatomy, © Thieme 2008, illustration by Karl Wesker.



E
D
C
B
A

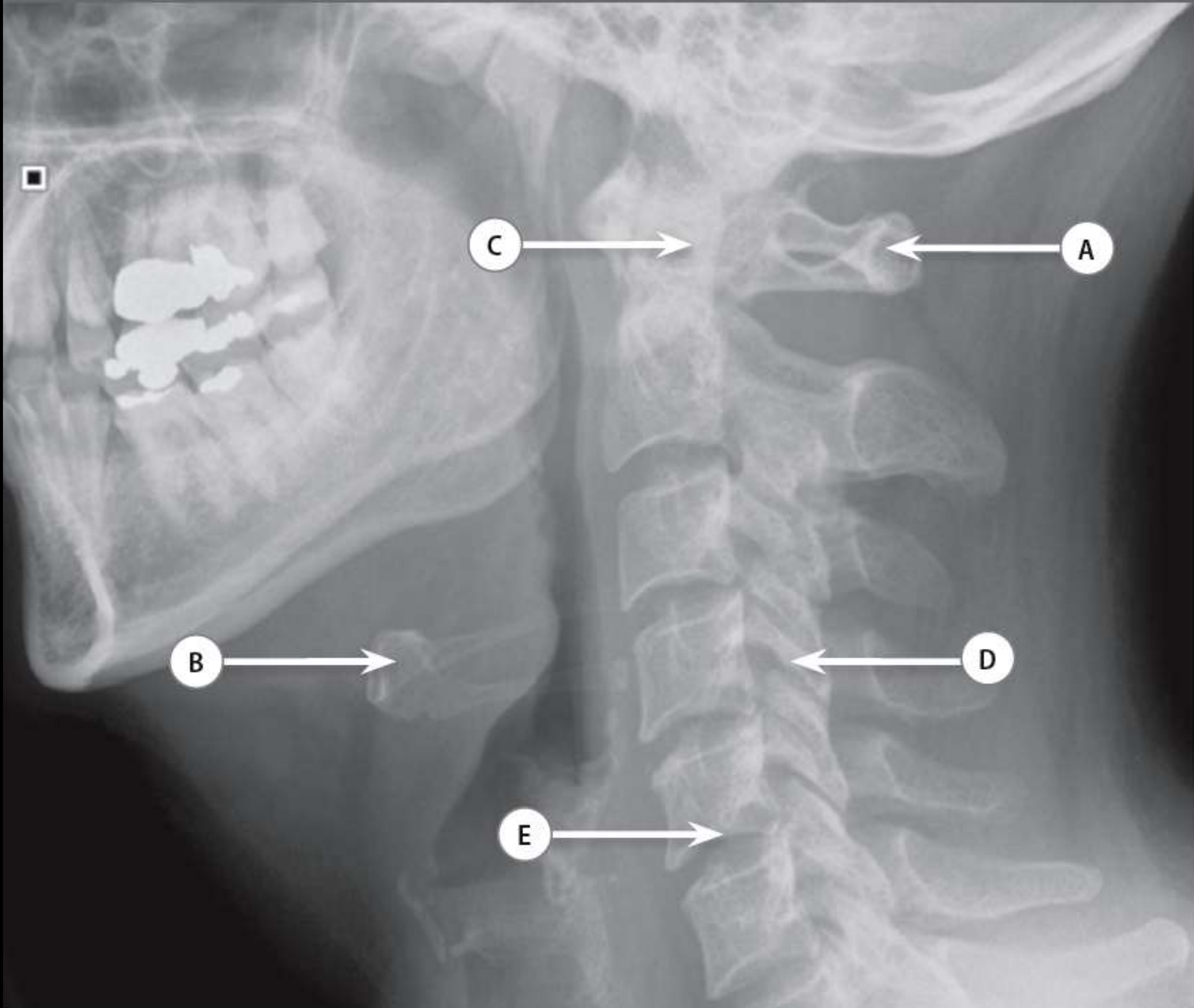
Q8 Answers

- **a** Right pedicle of T1 vertebra
- **b** Coronoid process of mandible
- **c** Inferior nasal concha (or turbinate)
- **d** Ethmoid sinus
- **e** Mastoid air cells

Radiograph of mandible, AP view

The midline part of the mandible is known as the body and has the mandibular protuberance anteriorly (the point of the chin). The mandibular rami are the more vertical lateral components of the mandible; the angle of the mandible is where the ramus meets the body, there are two of these. Both the condylar and coronoid processes of the mandible arise from the ramus. The condylar process articulates within the mandibular fossa of the temporal bone to form the temporomandibular joint (TMJ). The coronoid process arises more anteriorly and provides attachment for the temporalis, one of the four muscles of mastication.

Case 5.7



Case 5.7

A Spinous process of atlas

B Body of hyoid bone

C Odontoid peg

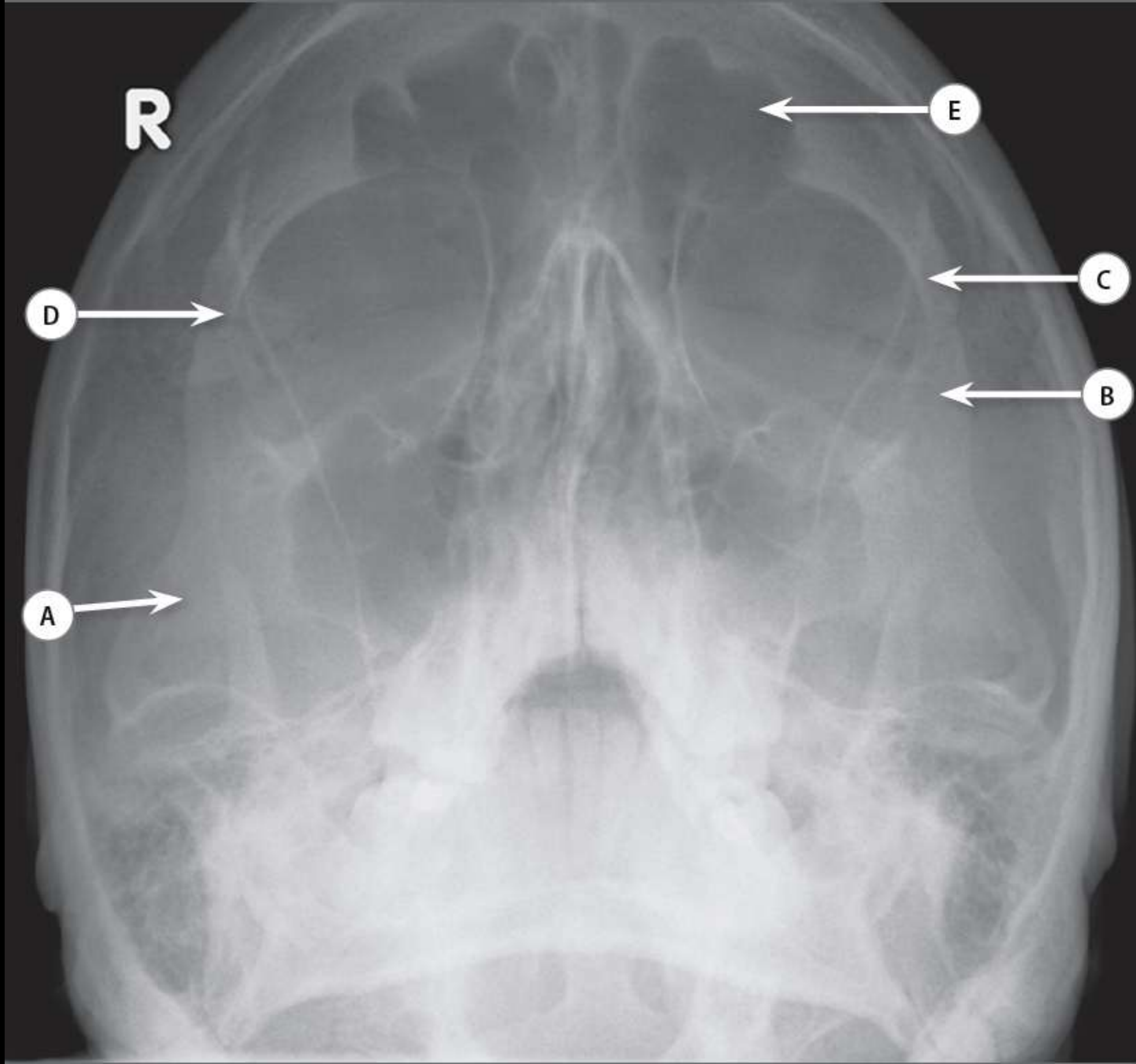
D Inferior facet of C4

E Inferior end plate of C5

Lateral radiograph of the C-spine.

For further discussion see Chapter 4, Case 4.19.

Case 5.20



Case 5.20

A Right zygomatic arch

B Frontal process of left zygoma

C Zygomatic process of left frontal bone

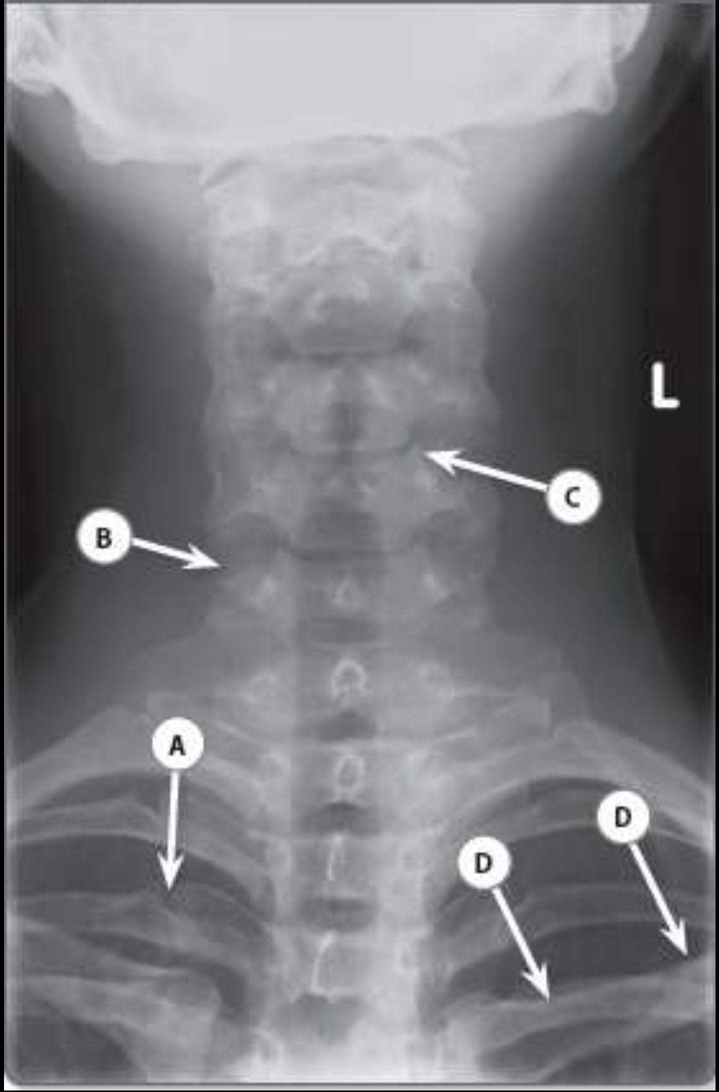
D Right zygomaticofrontal suture

E Left frontal sinus

Occipitomental radiograph.

For further discussion see Chapter 1, Case 1.27.

Case 10.1



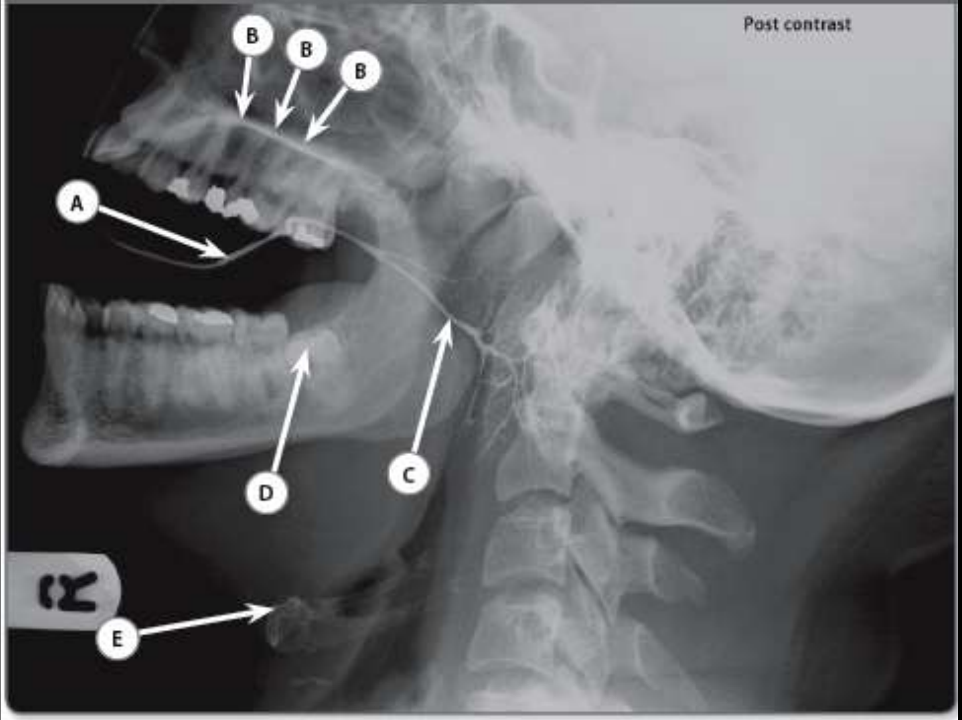
E	Which anatomical variant is present on this image?	

Case 10.1

- **A** Right costotransverse joint
- **B** Right transverse process of C6
- **C** Left uncinate process of C5
- **D** Left clavicle
- **E** Left cervical rib

The uncinate process forms the uncovertebral joint (or neurocentral joint of Luschka) with the vertebral body above. Each rib articulates with its thoracic vertebra at two joints: the costotransverse joint, between the tubercle of the rib and the transverse process; and the costovertebral joint, between the head of the rib and articular facets of the vertebral body. Cervical ribs articulate with the C7 vertebra, usually unilaterally, and are present in around 0.2% of the population.

Case 9.6



Case 9.6

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the non-anatomical structure labelled A.	
B	Name the structure labelled B.	
C	Where does the structure labelled C drain into?	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 9.6

A Catheter with contrast

B Palatine process of maxilla

C Oral vestibule opposite to the second upper molar tooth

D Crown of unerupted right inferior third molar tooth (right lower eighth tooth)

E Body of the hyoid bone

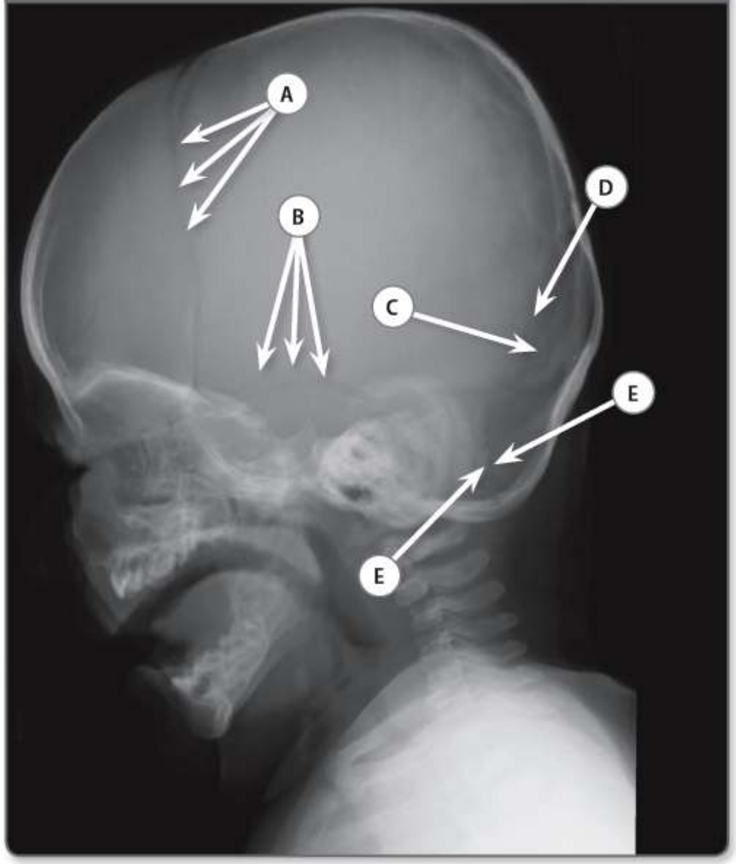
There are three paired major salivary glands: parotid, submandibular and sublingual. Of these, the parotid and submandibular are investigated most frequently by sialography. **Table 9.1** will help to distinguish between them.

Be aware that the arrow may point not only at anatomical structures, but also at various devices visible on the radiograph, such as the catheter used to cannulate the parotid duct and contrast injection in this case.

Table 9.1 Characteristic features of main salivary glands

	Parotid gland	Submandibular gland
Location	Superficial and posterior to the ramus of the mandible	Lies inferior to the mandible, between the body of the mandible and hyoid bone
Main duct	Duct of Stensen: emerges from the gland anteriorly	Duct of Wharton: emerges from the gland superoanteriorly
Drainage	Papilla in the oral vestibule opposite to the second upper molar tooth	Papilla on the floor of the buccal cavity

Case 14.5



Case 14.5

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	What osseous anatomical variant is labelled C?	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 14.5

A Coronal suture

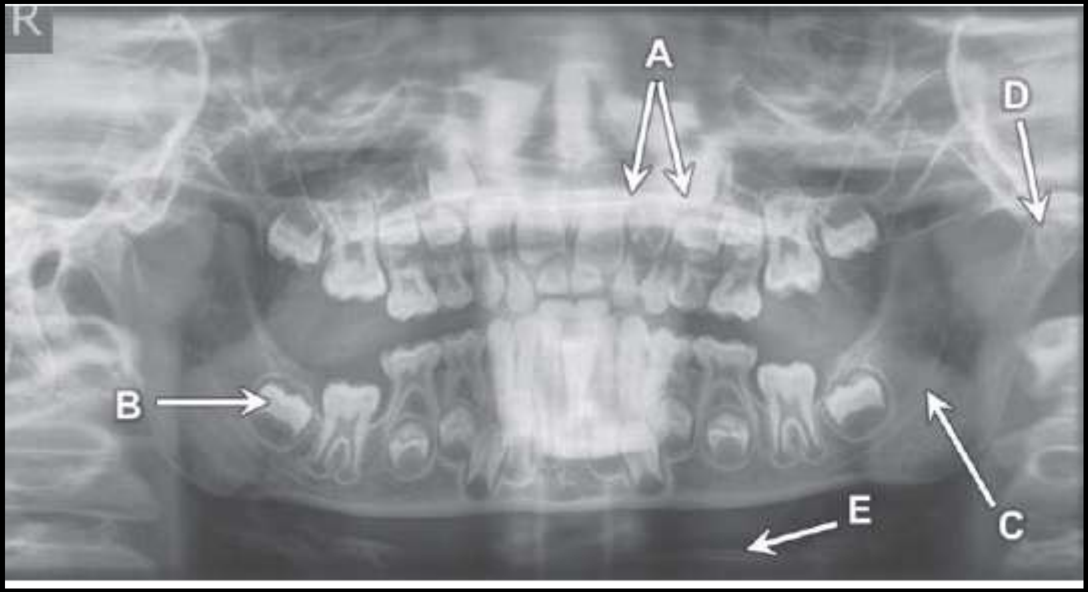
B Temporosquamal suture

C Wormian bone

D Lambdoid suture

E Occipitomastoid suture

Knowledge of the normal anatomy of the infant skull is vital to minimise the risk of confusing a normal suture for a fracture. Anatomy of the sutures is also of relevance in the assessment of craniosynostosis, when there is either symmetrical or asymmetrical premature sutural fusion which gives rise to an abnormally shaped calvarium. Wormian bones are usually a normal variant, most frequently located in the lambdoid suture. However, if numerous (greater than 10) or excessively large, they can be a marker of pathological processes such as osteogenesis imperfecta or pyknodysostosis.



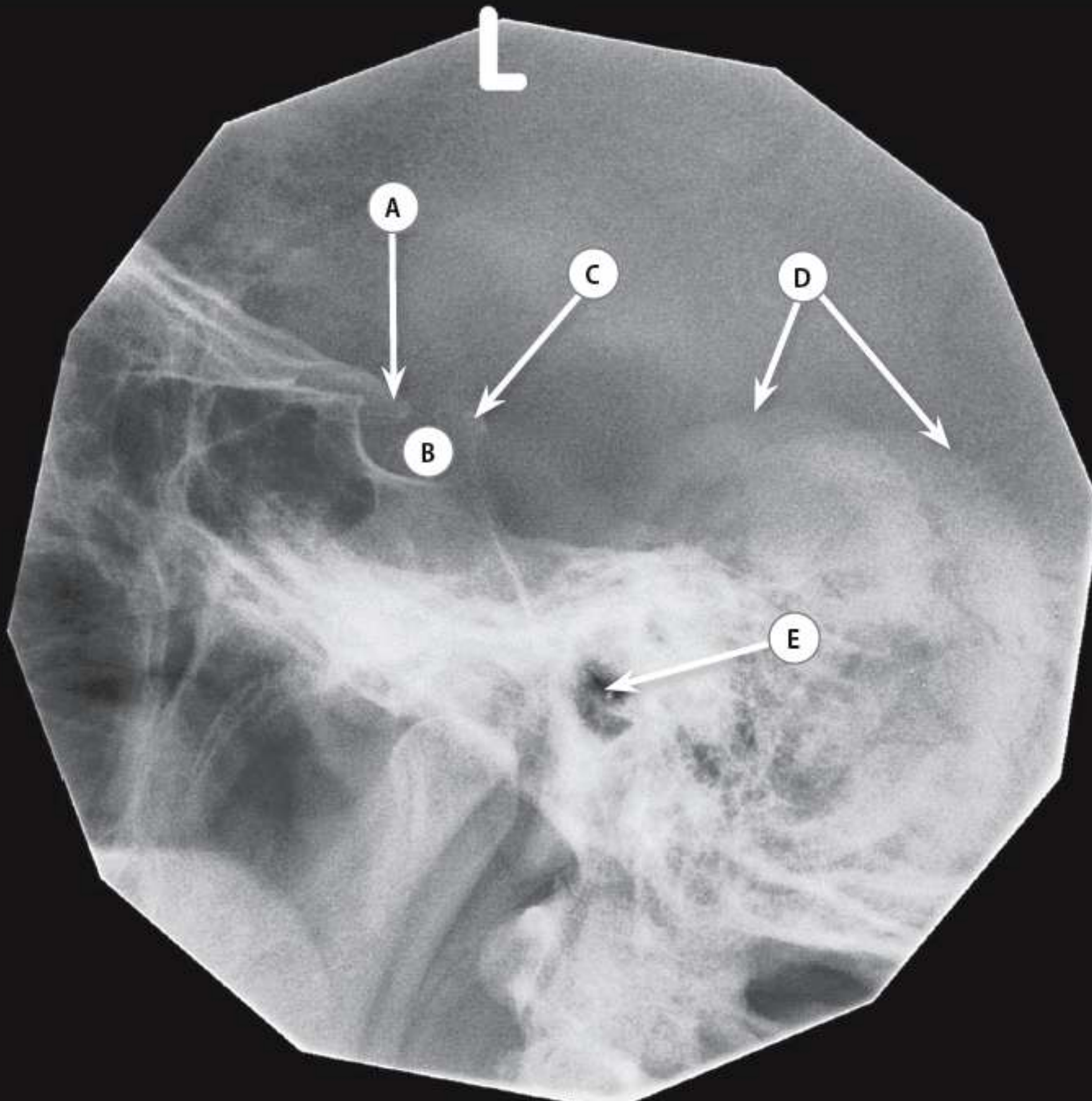
R
A
D
B
C
E

Case 13

Orthopantomogram (child).

1. Hard palate
2. Right lower third molar
3. Left inferior alveolar canal
4. Left mandibular condyle
5. Hyoid bone

Case 15.4



Case 15.4

A Anterior clinoid process

B Pituitary fossa

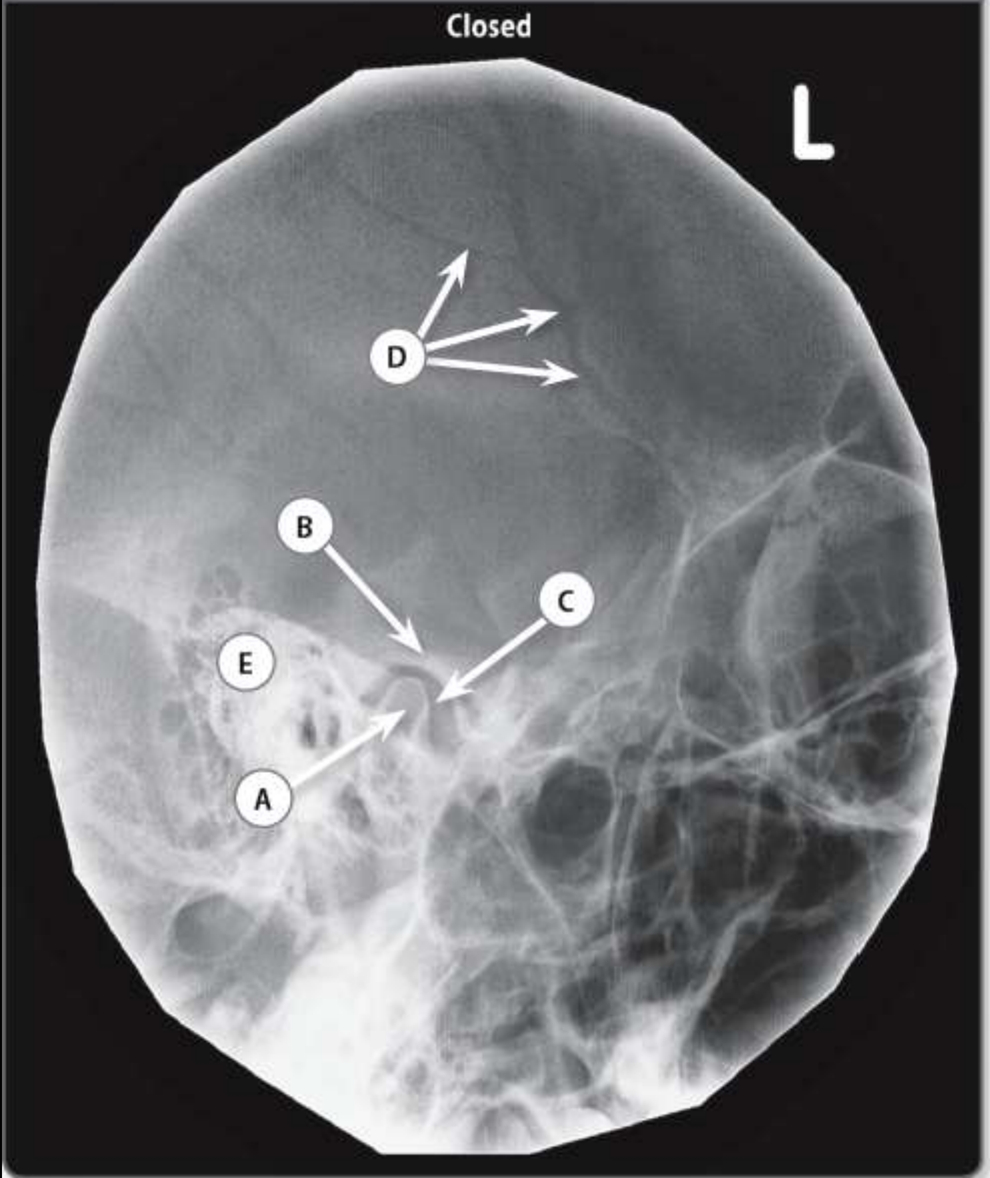
C Posterior clinoid process

D Pinnae of ears

E Left external auditory canal

The pituitary fossa (sella turcica, meaning Turkish saddle) is a saddle-shaped depression in the superior portion of the sphenoid bone in the middle cranial fossa. The saddle of the sella, in which the pituitary gland sits, is called the hypophyseal fossa. The tuberculum sellae is a small bony bulge situated anterior to the hypophyseal fossa. The dorsum sellae forms the posterior boundary of the saddle, terminating laterally as the posterior clinoid processes. The anterior clinoid processes are frontal continuations of the sella.

Case 14.9



Case 14.9

- **A** Left mandibular condyle
- **B** Glenoid fossa of the left temporal bone
- **C** Left temporomandibular joint (TMJ)
- **D** Grooves for middle meningeal artery branches
- **E** Mastoid portion of the left temporal bone

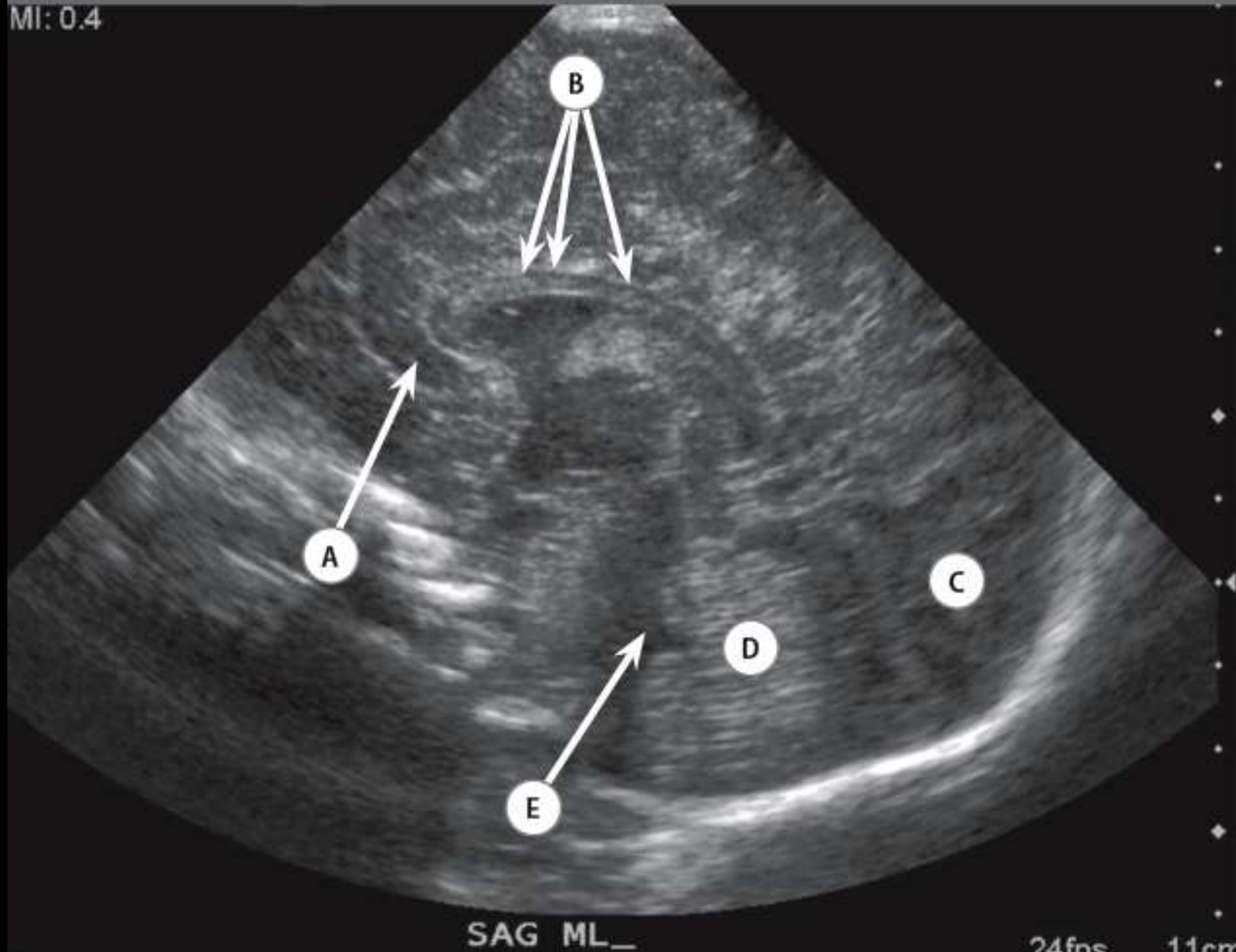
The TMJ is a synovial joint formed by the mandible and the temporal bone, lying anterior to the external acoustic meatus. It consists of the following parts:

- mandibular condyle
- glenoid fossa of the temporal bone
- joint capsule
- articular disc
- ligaments
- lateral pterygoid plate.

MRI is the modality of choice for assessing the TMJ. However, structures including the mandibular condyle and the glenoid fossa of the temporal bone are readily visible on plain radiographs.

ULTRASOUND

Case 12.14



Case 12.14

A Cingulate gyrus

B Body of corpus callosum

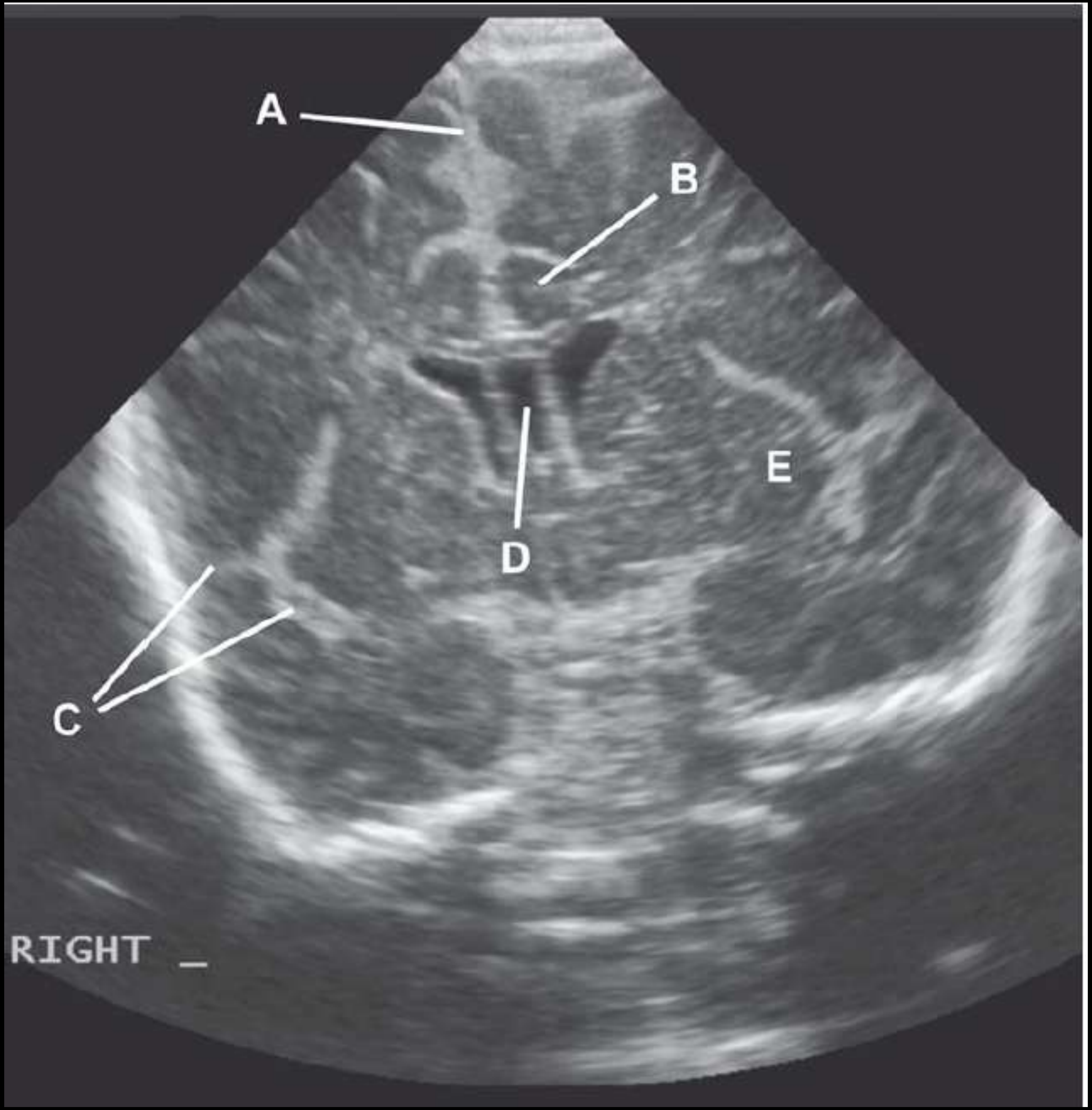
C Occipital lobe

D Cerebellum

E Fourth ventricle

Cranial ultrasound in a neonate is a safe diagnostic tool. The midline plane is a standard view which gives a good overview of the appearances of the gross anatomy of the supra- and infratentorial brain.

Although it is unlikely to be an investigation you will encounter in everyday clinical practice, approach it by applying basic sonographic rules (fluid is black and soft tissues are grey) and with knowledge of the anatomical structures seen on the midsagittal MRI of the brain, with which with you may be more familiar.


A
B
E
D
C
RIGHT

Q14 Answers

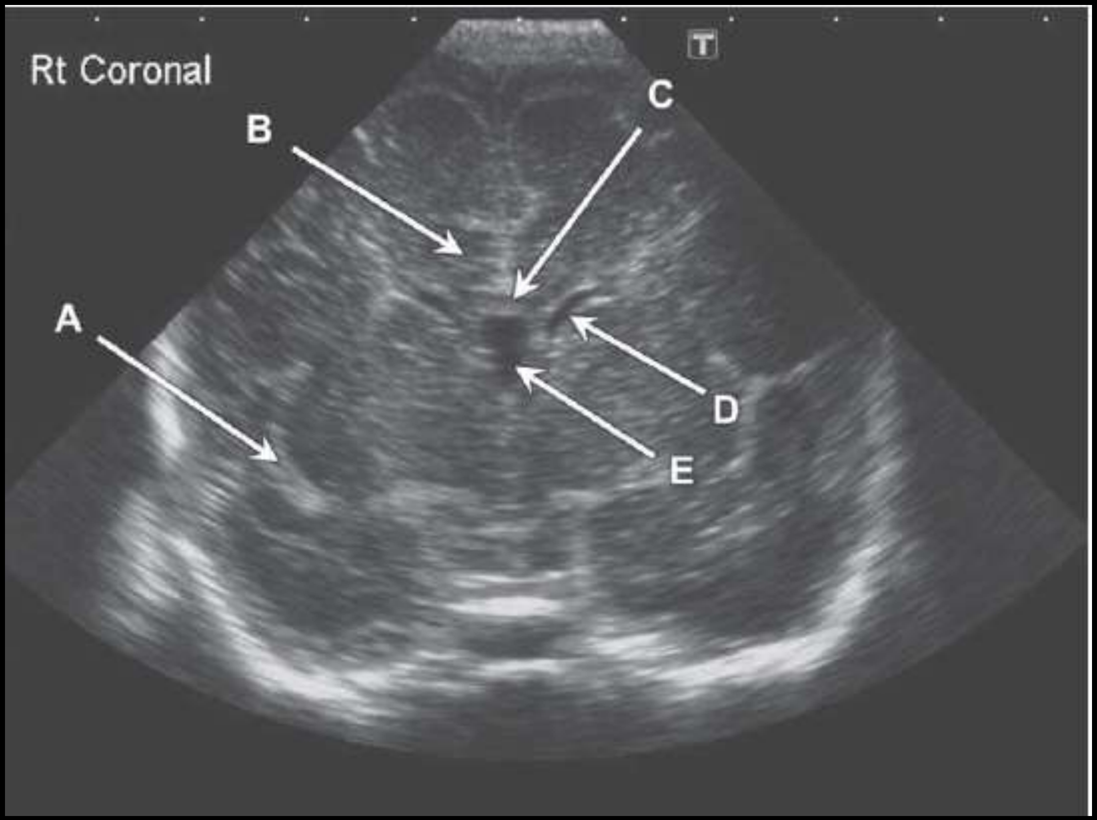
a Interhemispheric fissure containing falx cerebri
b Cingulate gyrus
c Sylvian fissure
d Cavum septum pellucidum
e Insular cortex

Ultrasound of neonatal brain, coronal section

Prior to closure of the anterior fontanelle it is possible to visualize the neonatal brain using ultrasound.

The two cerebral hemispheres meet in the midline and are separated by the interhemispheric (great longitudinal) fissure. The falx cerebri is a double dural layer running through this fissure connecting the superior and inferior sagittal venous sinuses. The inferior border of the interhemispheric fissure is bounded by the corpus callosum. The first major gyrus superior to and running parallel with the corpus callosum (best seen on sagittal view) is the cingulate gyrus. Functionally the cingulate gyri are part of the limbic system.

Cavum septum pellucidum is a normal variant where CSF is found between the septi pellucidum in the midline. The insular cortex lies deep to the sylvian fissure (or lateral sulcus).


Rt Coronal
A
B
C
D
E

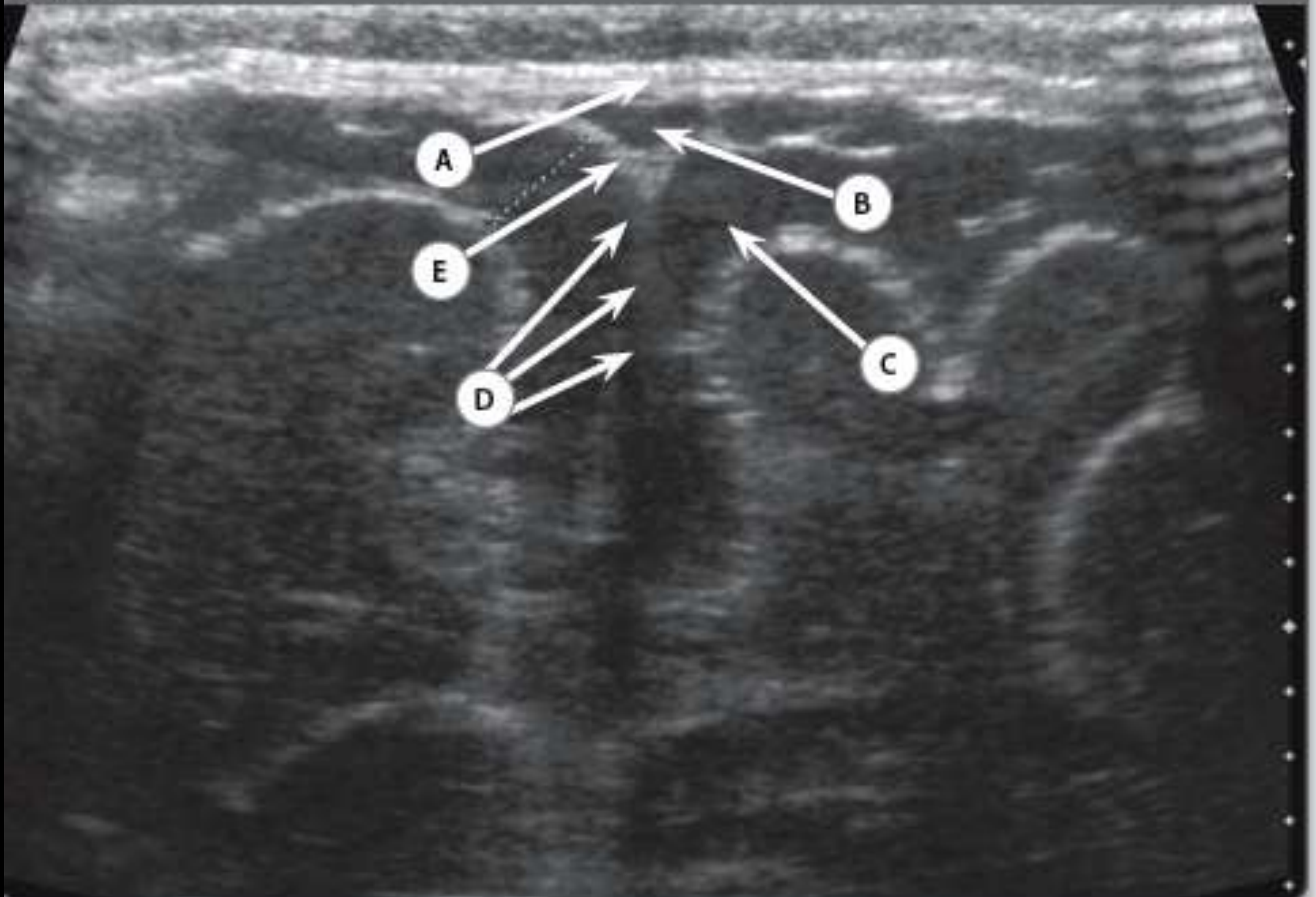
Case 10

Transcranial ultrasound. Neonatal brain.

1. Right Sylvian fissure
2. Right cingulate gyrus
3. Corpus callosum
4. Left lateral ventricle
5. Third ventricle

The fontanelles are used as acoustic windows to image the neonatal brain. This image is obtained with the probe at the anterior fontanelle and angled a little posteriorly.

Case 6.7



Case 6.7

A Outer dural layer (periosteum)

B Superior sagittal sinus

C Subarachnoid space

D Falx cerebri

E Inner dural layer

The cerebral envelope consists of three layers and two spaces, as illustrated in **Figure 6.2**.

- **Extradural space** – a potential space between the skull vault and outer layer of the dura mater which is traversed by branches of meningeal arteries (a source of extradural haematoma)
- **Dura mater** – fibrous mater consisting of two layers, the outer and inner, which separate to enclose the dural venous sinuses

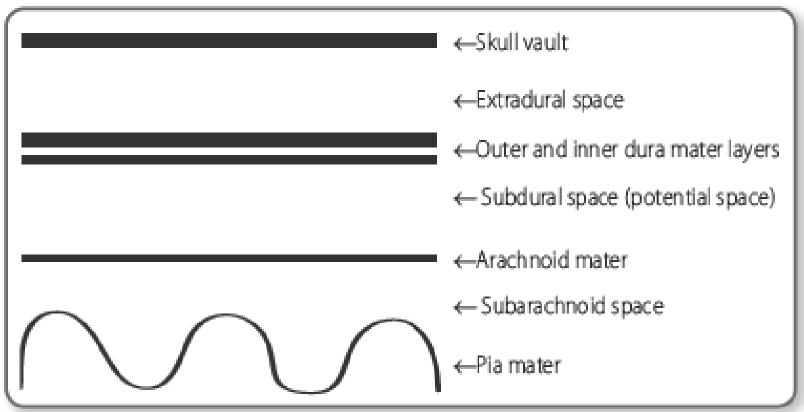


Figure 6.2 Schematic illustration of the cerebral envelope.

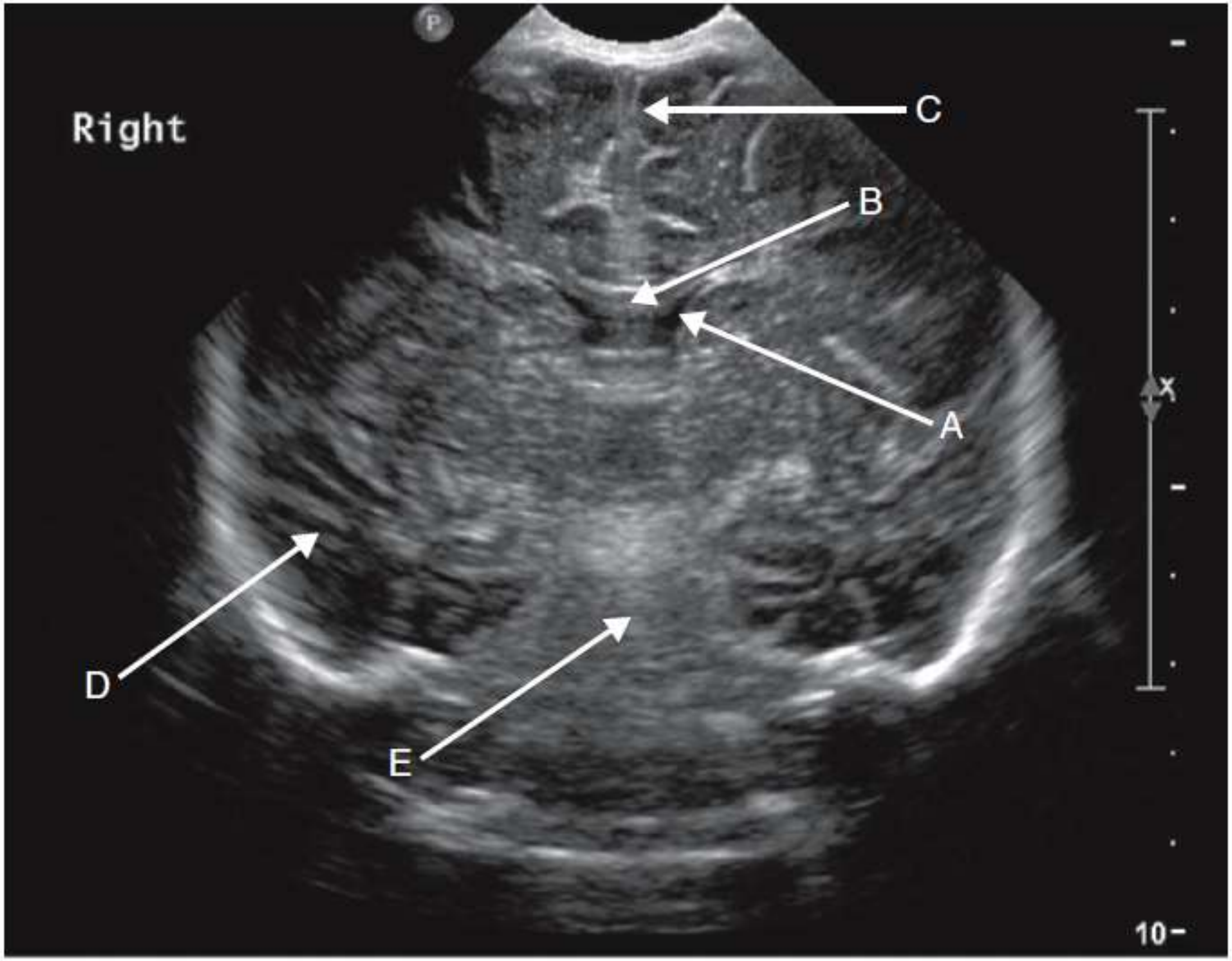
- **Subdural space** – potential space only, since dura and subarachnoid maters are closely applied together
- **Arachnoid mater** – avascular, lattice-like layer
- **Subarachnoid space** – contains cerebrospinal fluid
- **Pia mater** – vascular layer, closely applied to cerebral surface.


P
38
37
36
39
40

36. Left caudate nucleus head
37. Corpus callosum
38. Falx cerebri
39. Left lateral ventricle
40. Right Sylvian fissure

Some degree of asymmetry of the lateral ventricles is usual. A cavum septum pellucidum is a usual feature in premature babies and often persists into infancy.

Case 1.2



1.2 Coronal neonatal ultrasound through the anterior fontanelle

(a) Left lateral ventricle. The combined width of the lateral ventricles on coronal imaging should be less than a third of the total width of the intracranial fossa at the same level.
(b) Corpus callosum.
(c) Superior sagittal sinus. Colour flow and Doppler can be used to assess venous sinus patency.
(d) Right temporal lobe.
(e) Pons.

Ultrasound of the neonatal brain is a very useful non-invasive diagnostic test that does not utilize ionizing radiation.

The acoustic windows utilized include:

Anterior fontanelle until its closure at 2 years, allowing coronal and sagittal imaging of the supratentorial brain.

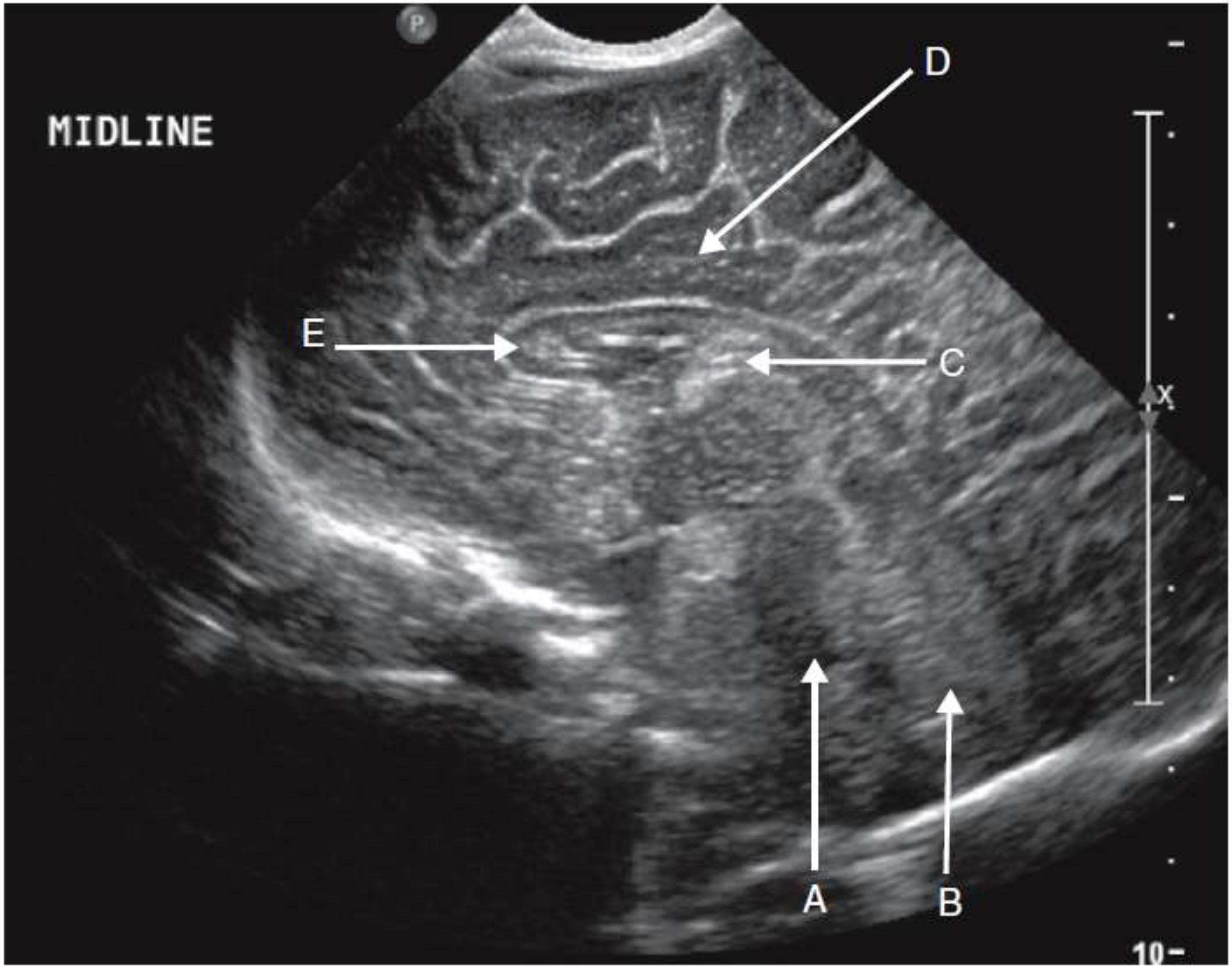
Posterior fontanelle up until its closure at 2 months, allowing axial imaging of the supratentorial brain.

Temporal or sphenoidal fontanelle until its closure at 3 months, allowing axial imaging of the brainstem and colour flow and Doppler of the circle of Willis.

Mastoid fontanelle allowing imaging of the posterior fossa. The mastoid process develops in the second year. The fontanelle closes towards the end of the first year.

Focal echogenic change can be related to parenchymal ischaemia or haemorrhage. Parenchymal cystic change is also well demonstrated.

Case 2.3



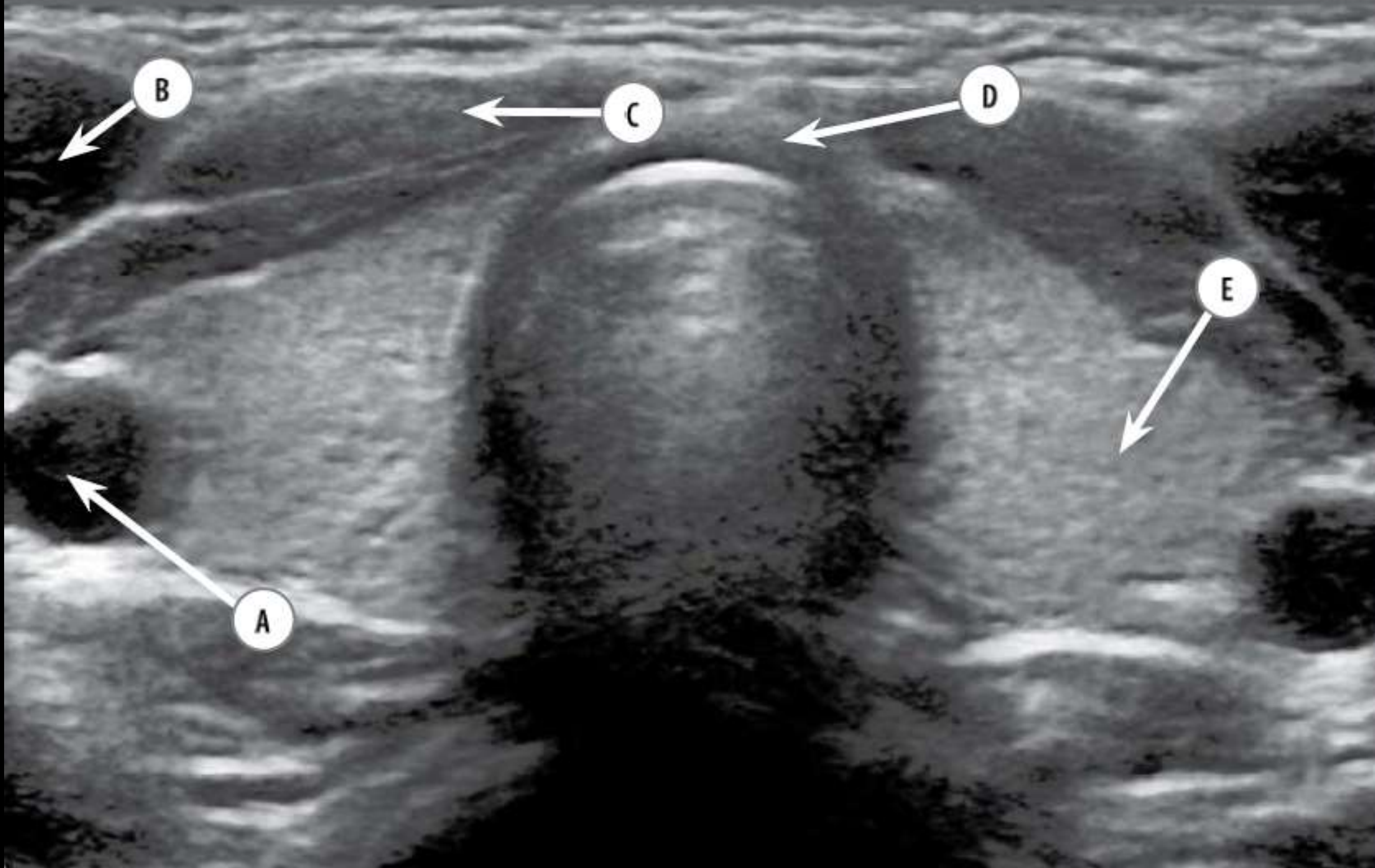
2.3 Sagittal neonatal cerebral ultrasound through the anterior fontanelle

(a) Fourth ventricle.
(b) Cerebellum.
(c) Choroid plexus.
(d) Cingulate gyrus.
(e) Corpus callosum.

The sagittal midline ultrasound of the neonatal brain allows assessment of the midline structures of the brain that are frequently affected by congenital anomalies.

The choroid plexus should be smooth in outline, uniformly echogenic and should not extend anterior to the caudo-thalamic groove. The caudo-thalamic groove is a useful landmark adjacent to the lateral ventricle where the caudate lobe and the thalamus abut each other. It is important to identify this because any echogenic structure anterior to this even if it is apparently continuous with the choroid plexus represents haemorrhage within the ventricle. An oblique sagittal scan angled through the lateral ventricle along the choroid plexus will demonstrate the caudo-thalamic groove, which can also be demonstrated scanning in the coronal plane.

Case 1.39



Case 1.39

A Right internal jugular vein

B Right sternomastoid

C Right strap muscle

D Thyroid isthmus

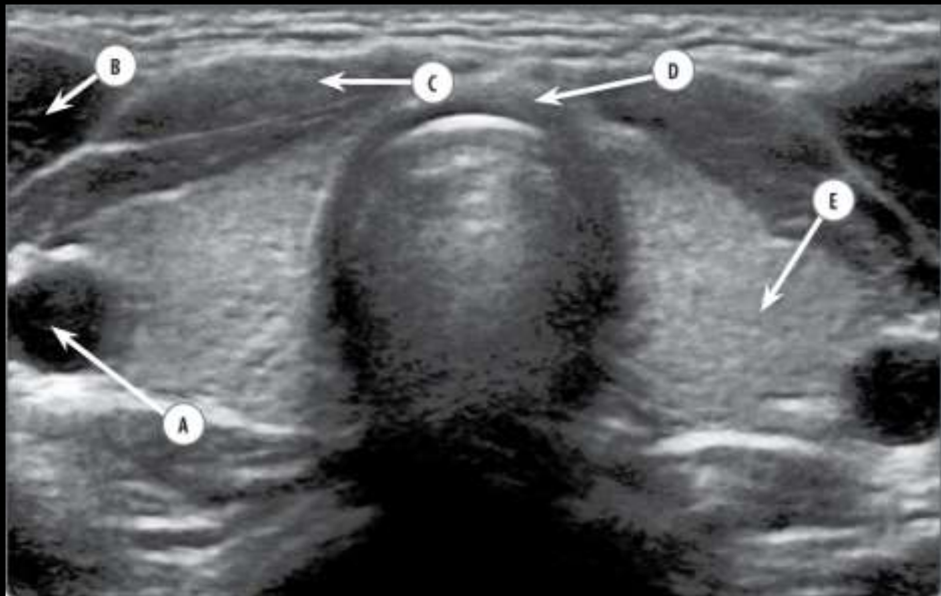
E Left lobe of thyroid

Transverse ultrasound section of the thyroid gland.

The thyroid gland is derived from the first and second pharyngeal pouches and lies deep to the sternohyoid and sternothyroid muscles. The central isthmus lies anterior to the trachea and joins the two lateral lobes. On ultrasound the strap

muscles and sternomastoid muscle are usually visible anteriorly, along with the common carotid artery and internal jugular vein running adjacent to it in the carotid sheath (**Figure 1.9**).

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 29.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 1040.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 42.



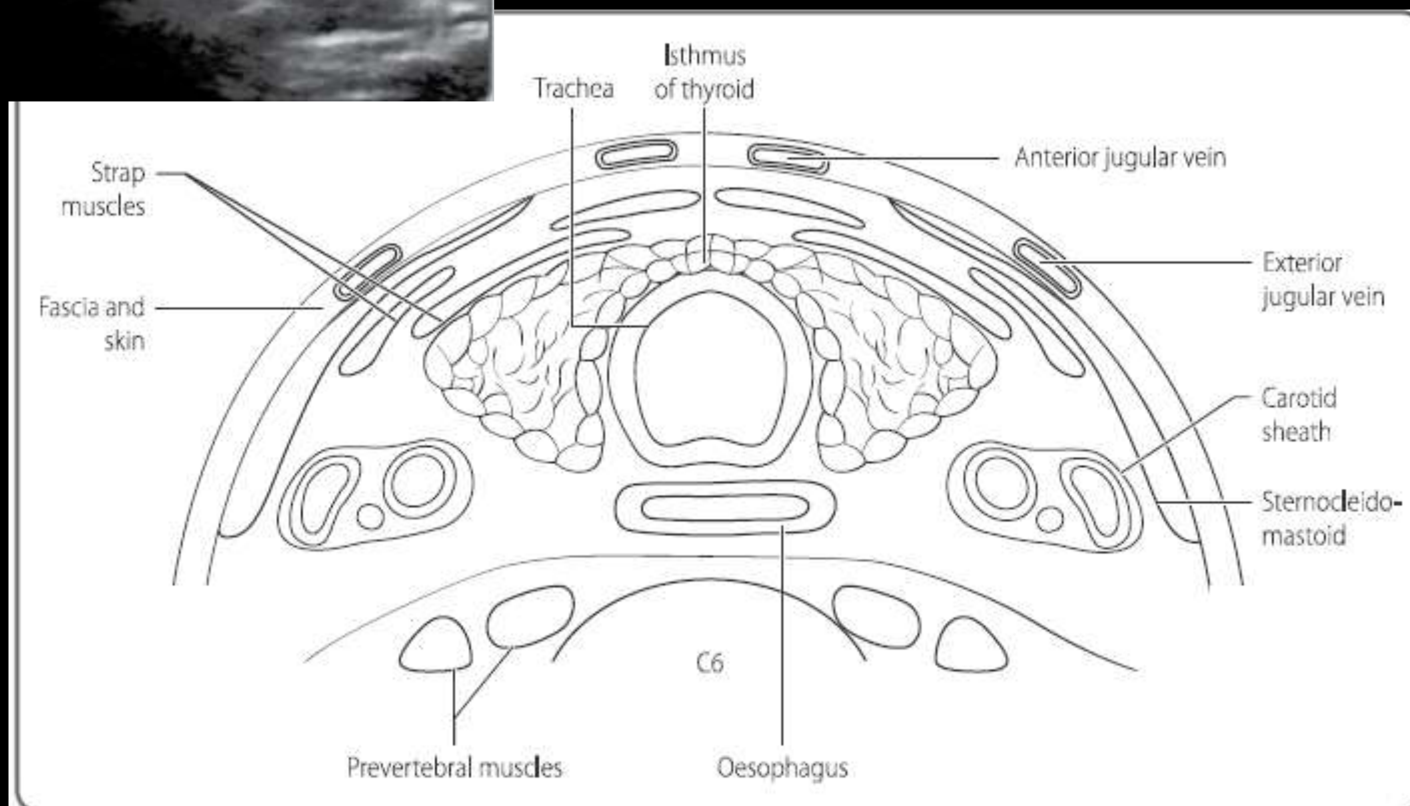
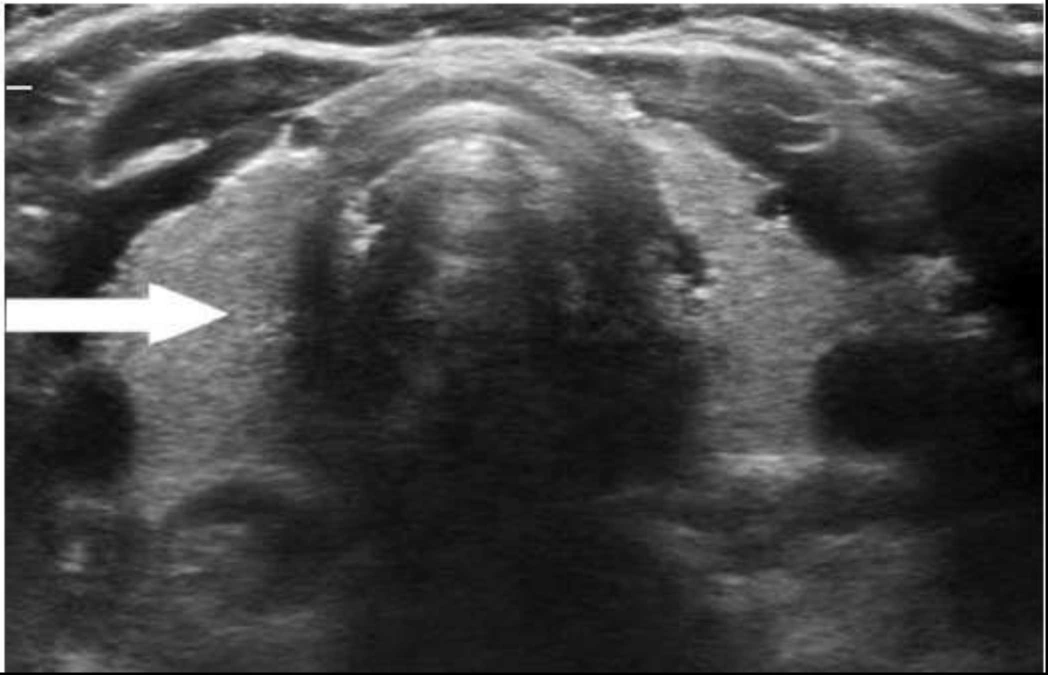


Figure 1.9 The thyroid and its associated structures.

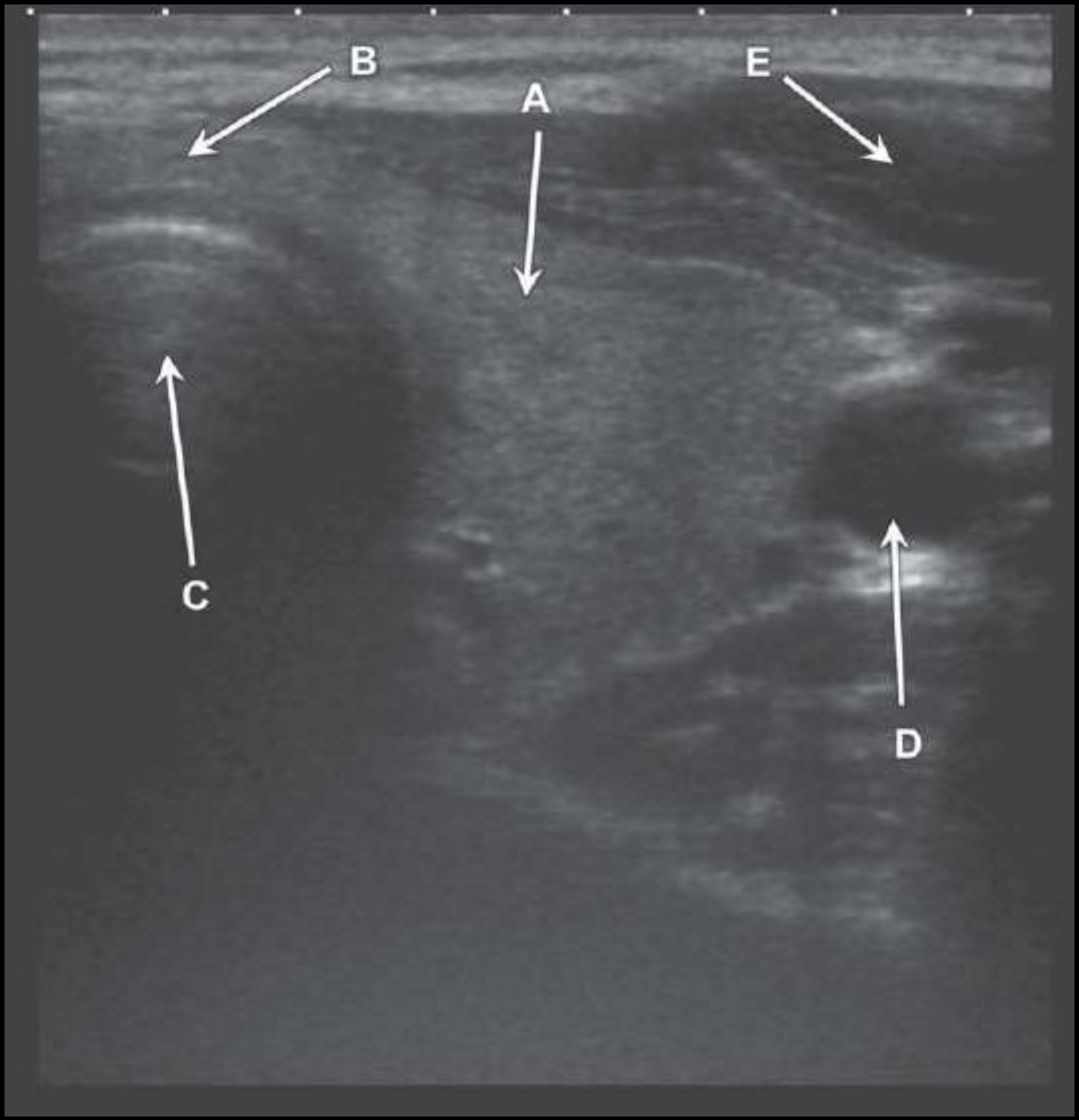
- Question 3:



Question 3: Ultrasound of the neck

Answer: Right lobe of thyroid gland

- On ultrasound, the thyroid gland can be recognised as a reflective, homogeneous structure with a grainy texture in the midline of the neck.
- The right lobe is often larger than the left.
- Each lobe is approximately 4 cm in height when imaged in the longitudinal plane.
- The trachea, seen between the two lobes of the gland, is a useful landmark.

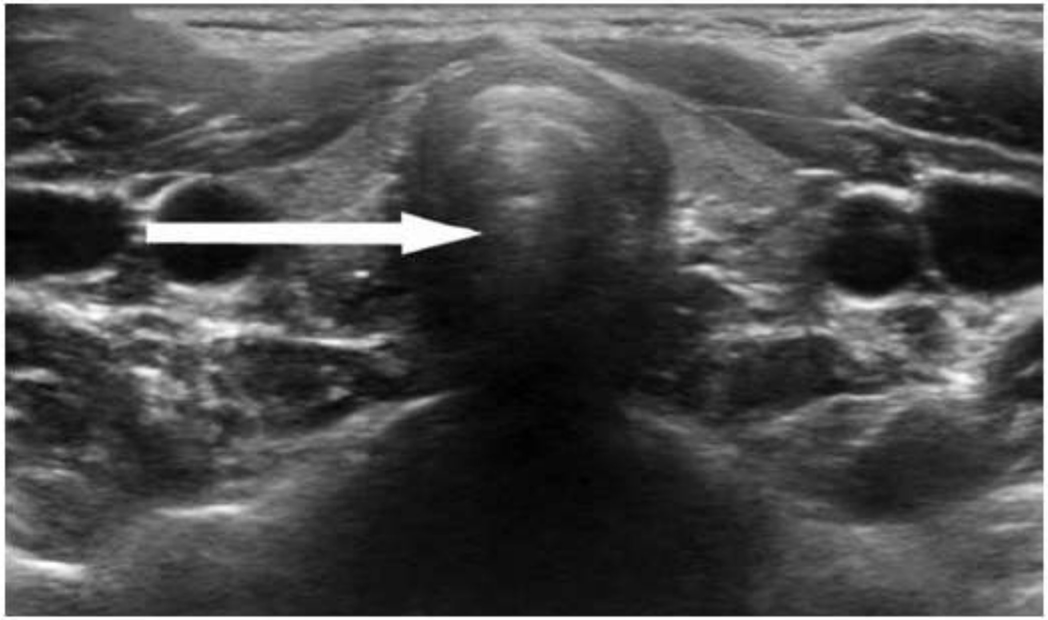

B
E
A
C
D

Case 13

Ultrasound neck. Transverse section.

1. Left lobe of thyroid gland
2. Thyroid isthmus
3. Trachea
4. Left common carotid artery
5. Left sternocleidomastoid muscle

- **Question 6:**



Question 6: Ultrasound of the neck

Answer: Trachea

- The trachea lies in the midline between the two lobes of the thyroid gland.
- Anteriorly, a tracheal ring can be seen. Fifteen to twenty incomplete cartilaginous rings make up the trachea.
- Posteriorly, an acoustic shadow is formed by the air within the trachea, which is a poor ultrasound medium and prevents visualisation of deeper structures.

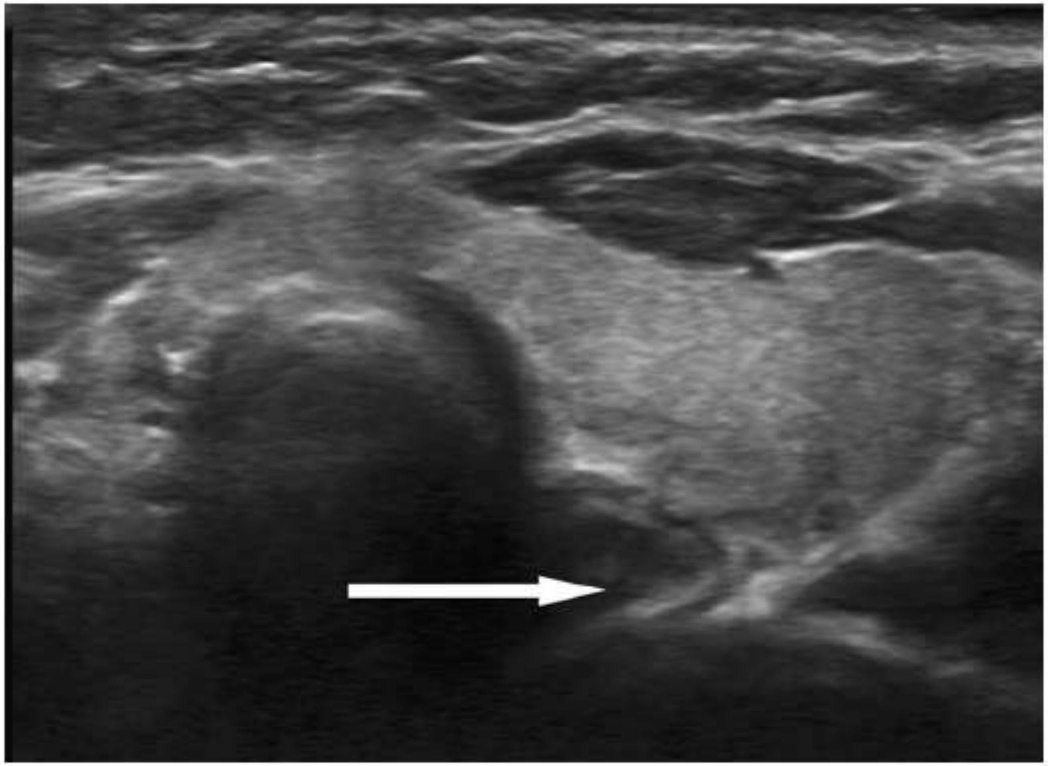
- Question 9:

Question 9: Ultrasound of the neck

Answer: Left internal jugular vein

- On ultrasound, blood vessels are anechoic structures.
- The internal jugular vein is usually lateral and slightly posterior to the common carotid artery. It is normally of a larger calibre compared to the artery but, in this case, the vein is not fully distended.

- **Question 13:**

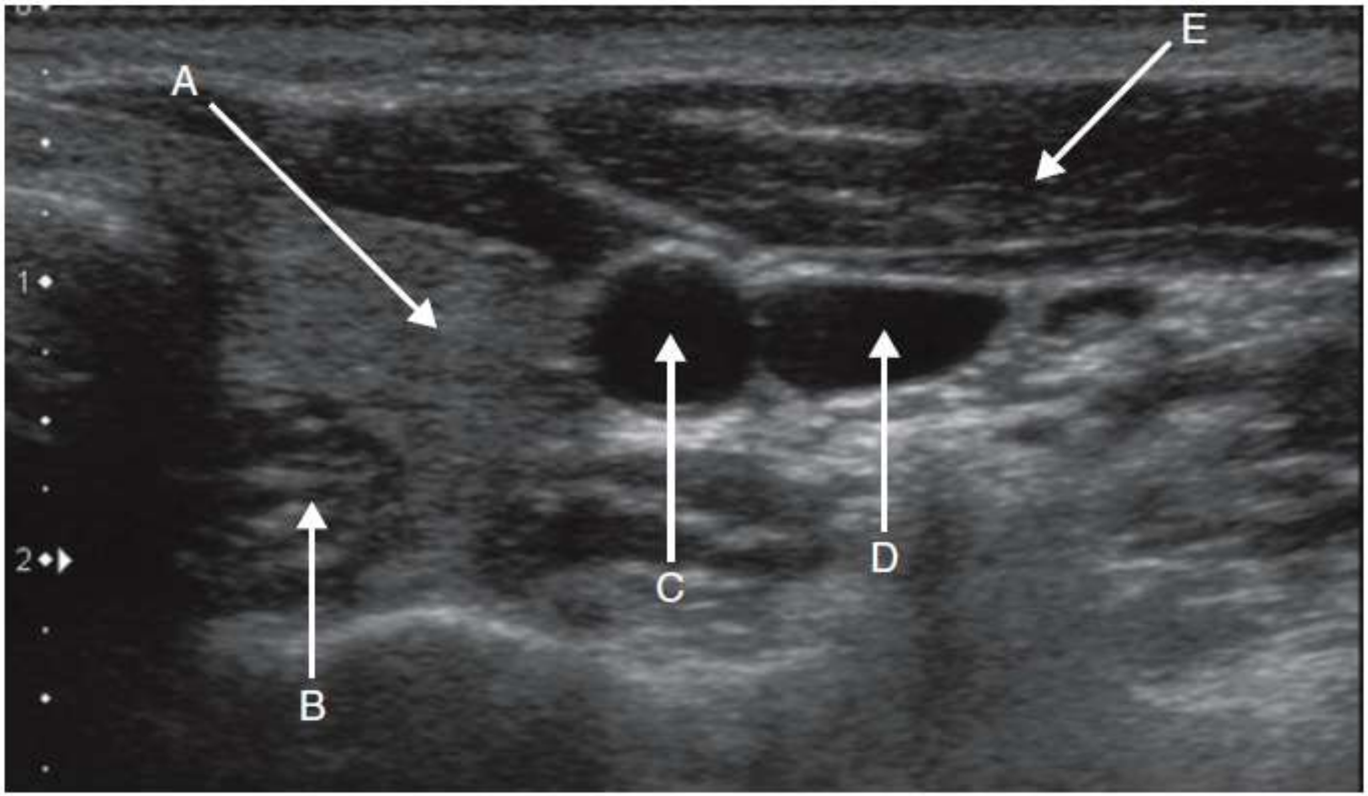


Question 13: Ultrasound of the neck

Answer: Oesophagus

- The oesophagus lies to the left of the trachea, posterior to the left lobe of the thyroid.
- There are specks of increased reflectivity within the lumen that are caused by the presence of air within the oesophagus.
- You can also see the layers of muscle in the wall of the oesophagus.

Case 1.4



1.4 Transverse ultrasound of the thyroid gland

(a) Left lobe of the thyroid gland. Each lobe measures approximately 4 cm in height, and extends from the thyroid cartilage of the trachea (superiorly), to the sixth tracheal ring (inferiorly).

The recurrent laryngeal nerve runs posterior to this. This can be identified on ultrasound as a linear hypoechoic structure between the thyroid anteriorly and the longus collis muscle posteriorly.

(b) Cervical oesophagus. This lies slightly to the left of the trachea and can be confused as a mass. It is readily identified by the central echobright area representing the air and saliva in the lumen. The surrounding hypoechoic rim is muscle.

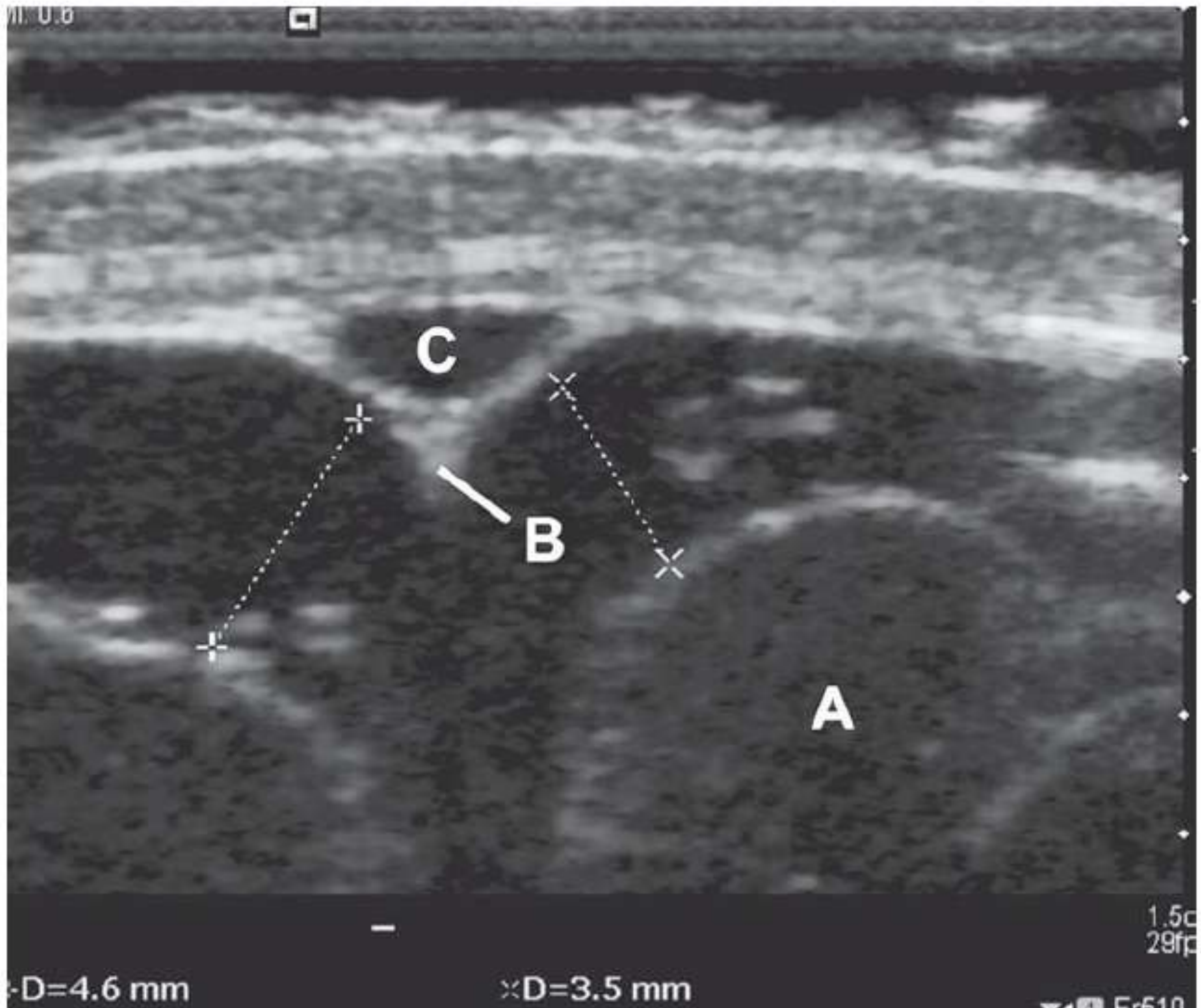
(c) Left common carotid artery. This divides into external and internal branches at the upper border of the thyroid cartilage, at approximately C4 level. The vagus nerve (cranial nerve X) runs in the carotid sheath in the infrahyoid part of the neck.

(d) Left internal jugular vein. This originates as a continuation of the sigmoid sinus and continues in the carotid sheath as it descends down the neck.

(e) Left sternocleidomastoid muscle. The muscle is a powerful rotator of the neck. Birth trauma may be associated with muscle damage, leading to contraction of the muscle causing congenital torticollis.

Q15

- **a** Name the structure labelled A
- **b** Name the structure labelled B
- **c** Name the structure labelled C
- **d** Name the space which has been measured
- **e** Describe how blood gets from A to C



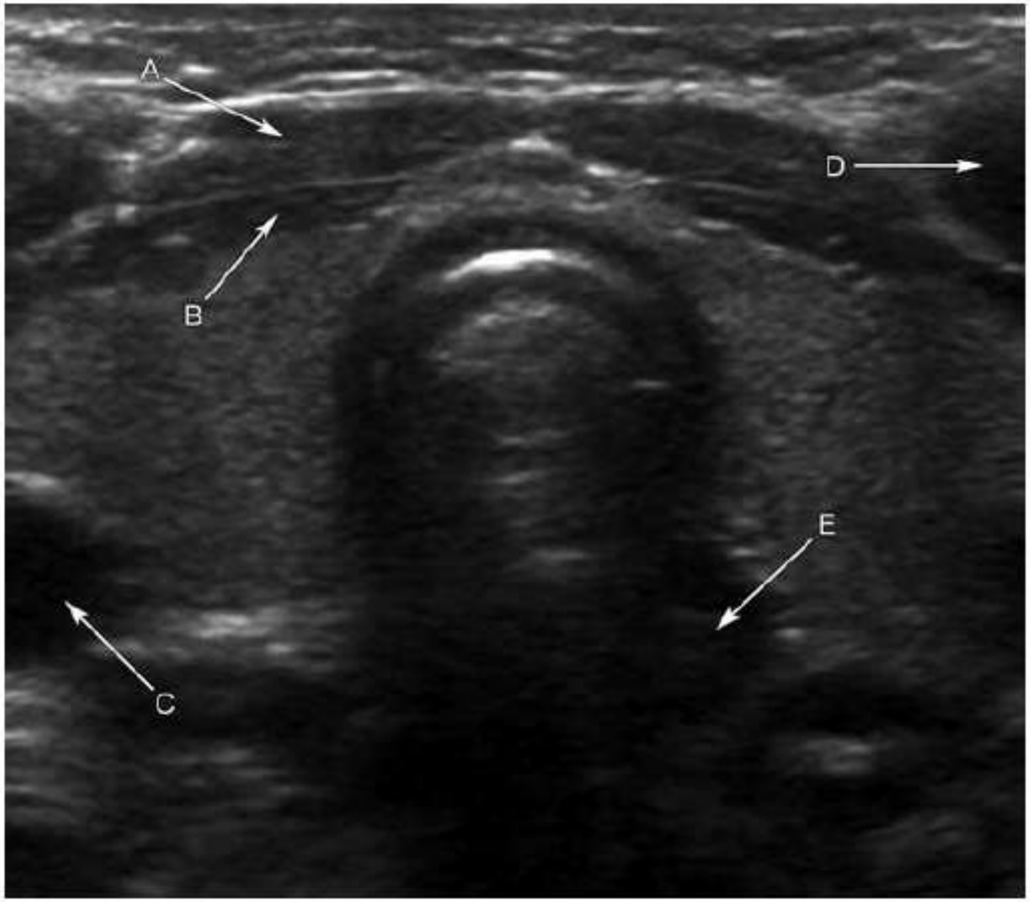
Q15 Answers

a Cerebral hemisphere, frontal/parietal lobe
b Origin of falx cerebri
c Superior sagittal sinus
d Subarachnoid space
e Superficial cerebral veins drain to the superior sagittal sinus

Ultrasound of neonatal brain, coronal section with close up view of subarachnoid space

As part of the assessment of the neonatal brain using ultrasound, the subarachnoid spaces are measured. The subarachnoid space is filled with CSF and surrounds the brain. Multiple bridging cerebral veins cross the subarachnoid space and drain into the venous sinuses. The arachnoid layer is usually closely adherent to the more superficial dura. Only a *potential* space exists between these layers; however this potential space can become real if the bridging cerebral veins are damaged leading to a subdural haemorrhage. The third meningeal layer is the pia and it is closely adherent to the brain surface and separated from the arachnoid layer by the aforementioned CSF filling the subarachnoid space.

Question 8.5

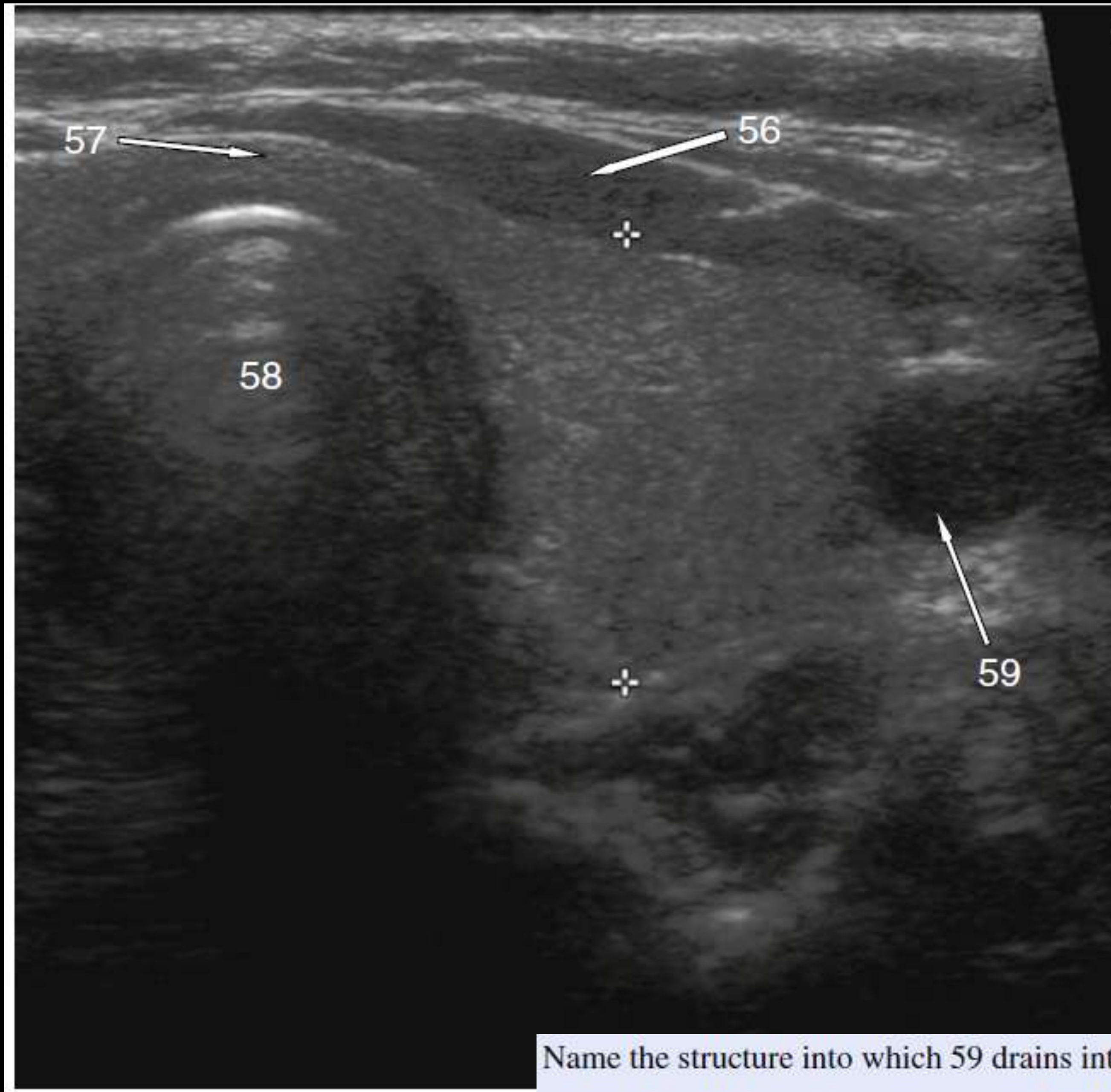


This is a transverse ultrasound of the neck.
Name the structures labelled **A** to **E**.

8.5 Transverse ultrasound at the level of the thyroid isthmus

A Right sternohyoid muscle.
B Right sternothyroid muscle.
C Right common carotid artery.
D Left sternocleidomastoid muscle.
E Oesophagus.

The sternohyoid and sternothyroid are two of the four pairs of infrahyoid (strap) muscles. They are innervated by the ansa cervicalis (C1–C3). They serve to depress the hyoid bone. The sternocleidomastoid muscle anatomically divides the anterior and posterior triangles of the neck.

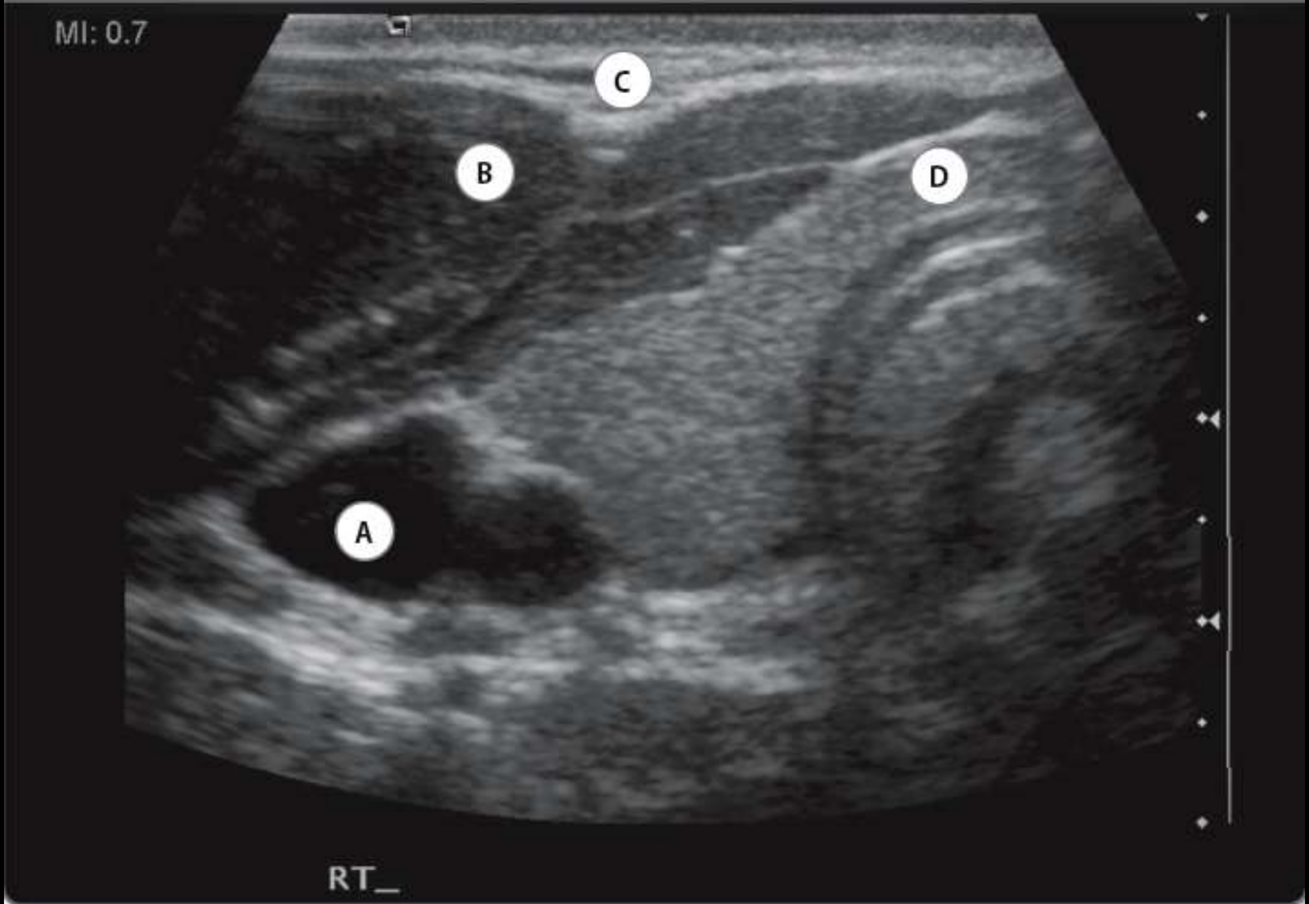


Name the structure into which 59 drains into?

Ultrasound Neck

56. Left sternomastoid muscle
57. Thyroid isthmus
58. Trachea
59. Left Internal jugular vein
60. Left brachiocephalic vein

Case 7.2



Case 7.2

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the fibrous structure labelled C.	
D	Name the structure labelled D.	
E	Which nerve runs in the carotid sheath?	

Case 7.2

A Right internal jugular vein

B Right sternocleidomastoid muscle

C Deep cervical fascia

D Thyroid isthmus

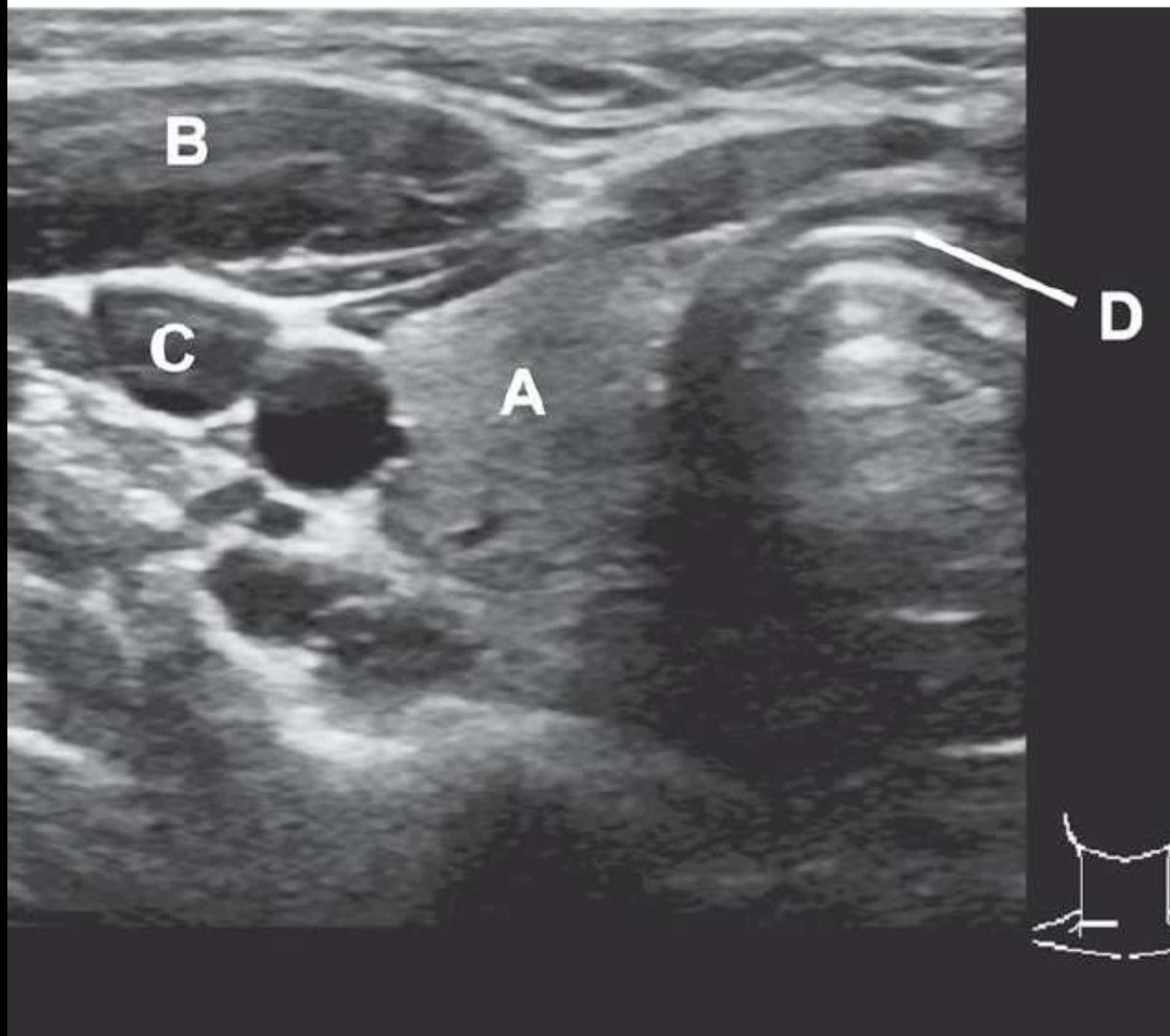
E Vagus nerve (X)

This US image shows structures in the neck at level VI and you should be able to orientate yourself by the:

- Thyroid isthmus, located inferior to the cricoid cartilage and medial to the sternocleidomastoid muscle
- Common carotid artery which divides to internal and external branches above the superior margin of the thyroid cartilage.

Q34

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the echogenic structure labelled D
e Name the constituent part of structure A that passes over structure D



Q34 Answers

- **a** Right lobe of thyroid
- **b** Sternocleidomastoid muscle
- **c** Internal jugular vein
- **d** Tracheal ring
- **e** Isthmus of the thyroid

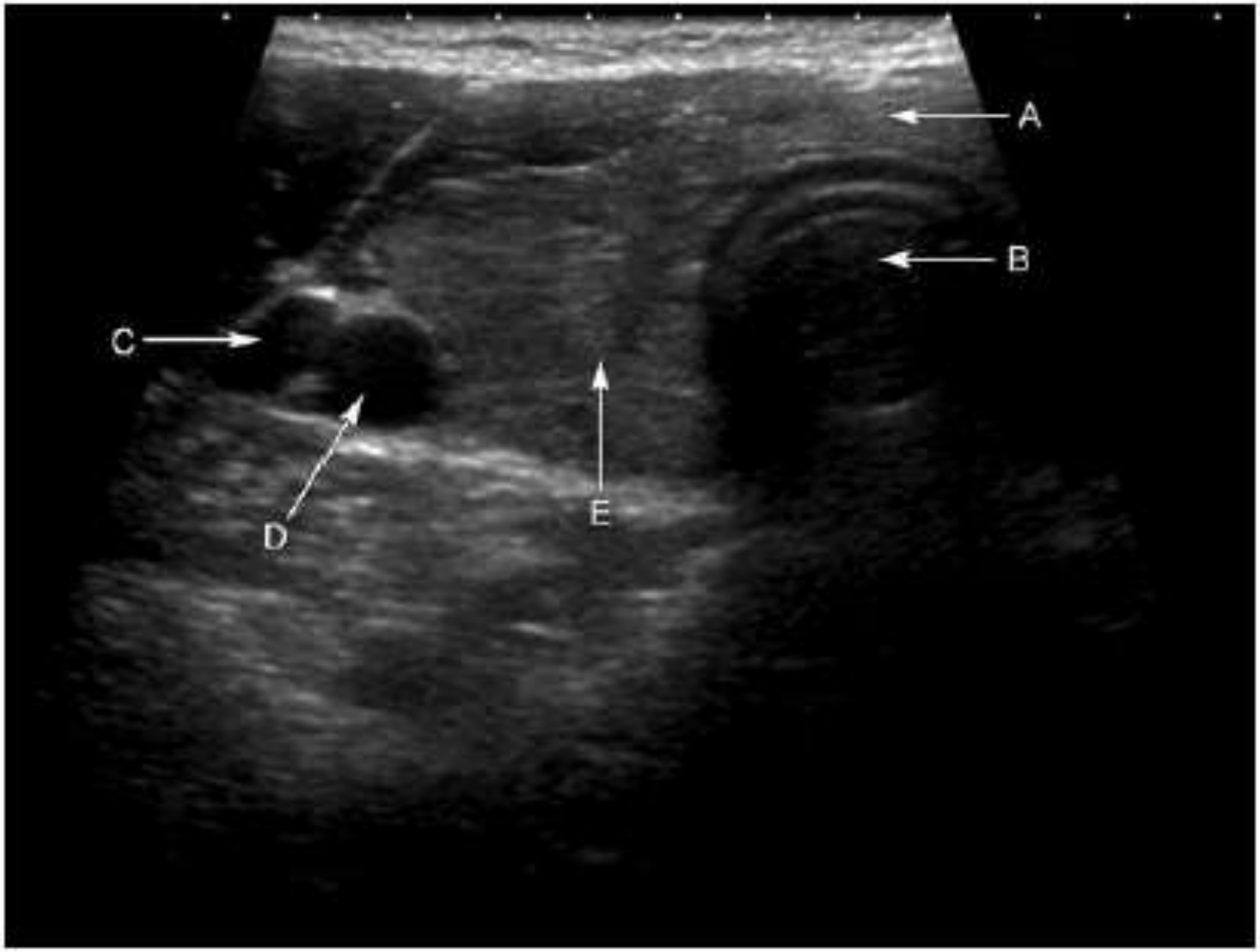
Ultrasound scan through right lobe of thyroid, axial section

The thyroid gland has two lobes which lie on either side of the trachea just inferior to the thyroid cartilage at the level of C5 to T1. These lobes are joined in the midline by an isthmus. The thyroid is enclosed within the pretracheal fascia and hence moves with the trachea during swallowing. Strap muscles (sternohyoid and sternothyroid) cover the thyroid and are visible in the image provided.

Immediately lateral to the thyroid lie the internal carotid arteries. Antero-lateral to these are the internal jugular veins. These major blood vessels to the head are protected throughout their superficial course within the neck by the sternocleidomastoid muscle.

The trachea is supported anteriorly by C-shaped arches of hyaline cartilage. These prevent the trachea from collapsing and are brightly echogenic on ultrasound.

Question 1.3 This is an axial ultrasound of the neck.



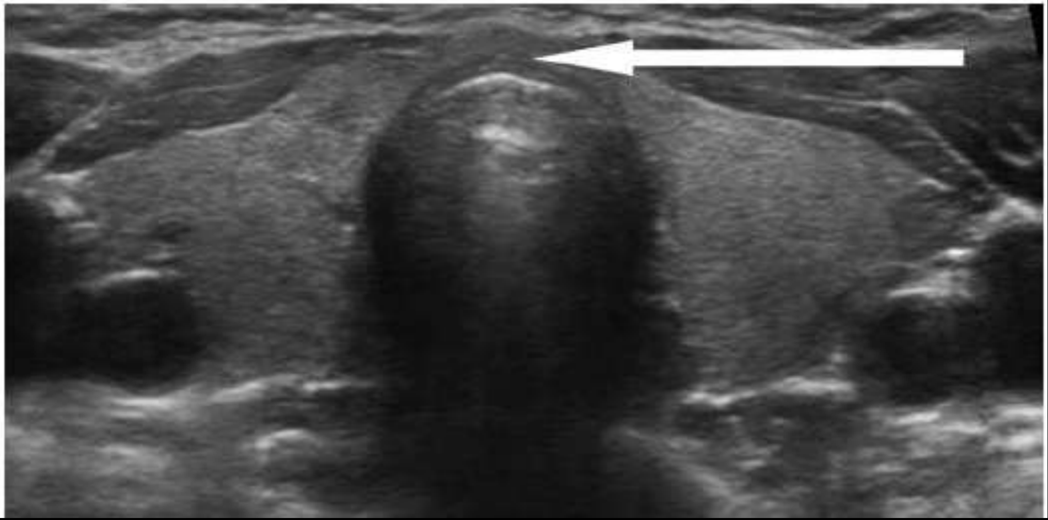
Name the structures labelled **A** to **E**.

1.3 Transverse ultrasound of the thyroid gland

A Isthmus of thyroid gland.
B Trachea.
C Right internal jugular vein.
D Right common carotid artery.
E Right lobe of the thyroid gland.

The thyroid gland consists of two lobes joined by a central isthmus. Each lobe is divided into an upper and lower pole. The central isthmus lies anterior to the trachea at the level of C6. The carotid sheath lies posterolaterally to the thyroid lobes and contains the internal jugular vein (laterally), common carotid artery (medially) and the vagus nerve (not visualized on ultrasound).

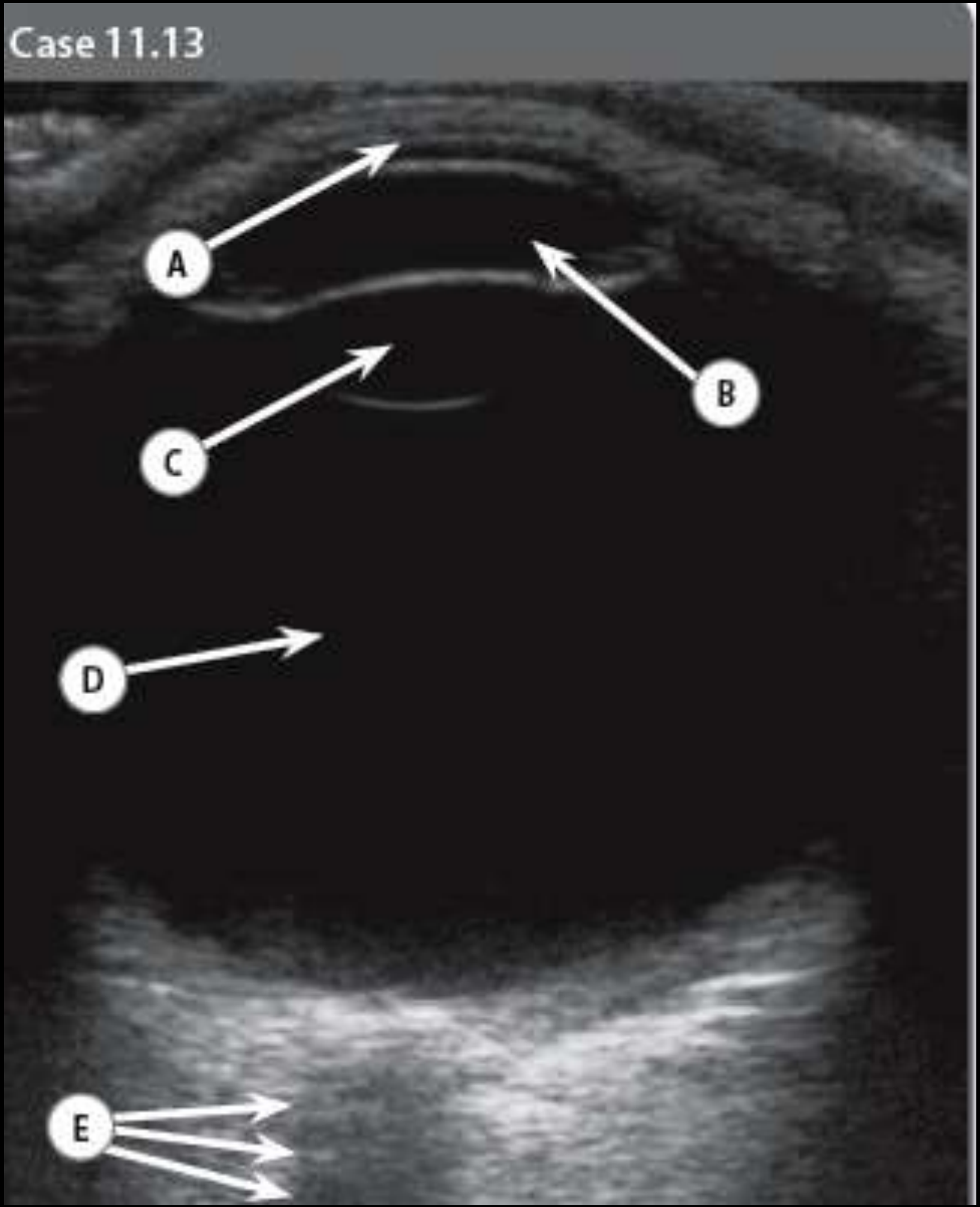
- **Question 44:**



Question 44: Ultrasound of the neck

Answer: Isthmus

- The isthmus connects the two lobes of the thyroid gland and passes anterior to the trachea in the midline of the neck.
- A pyramidal lobe may extend cranially from the isthmus—this is a remnant of the thyroglossal duct.


Case 11.13
A
B
C
D
E

Case 11.13

A Cornea

B Aqueous humour

C Lens

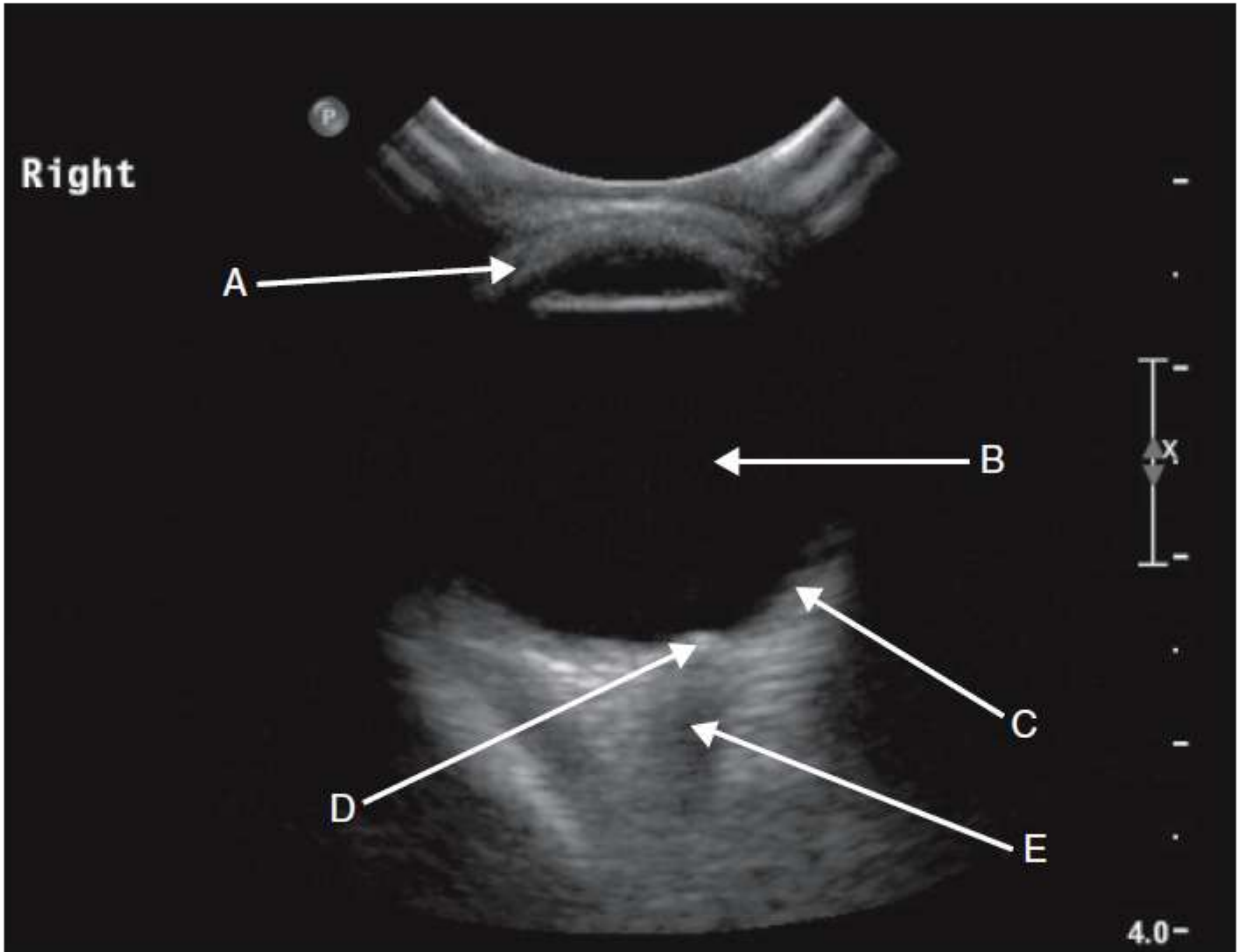
D Vitreous humour

E Optic sheath

This is an axial ultrasound of the orbit. Dynamic imaging of the eye can be obtained with ultrasound, using the eyelid as an acoustic window. The wall of the ocular globe has a multilayered coat with the most outer layer formed by fibrous sclera, the middle layer by vascular choroid and the inner layer by the very thin retina. Internally, the ocular globe contains structures with high water content, namely aqueous humour, vitreous humour and the lens. These appear hypoechoic on ultrasound.

The optic sheath covers the optic complex (optic nerve and ophthalmic artery); this cannot be readily identified with conventional 2D ultrasound.

Case 5.14

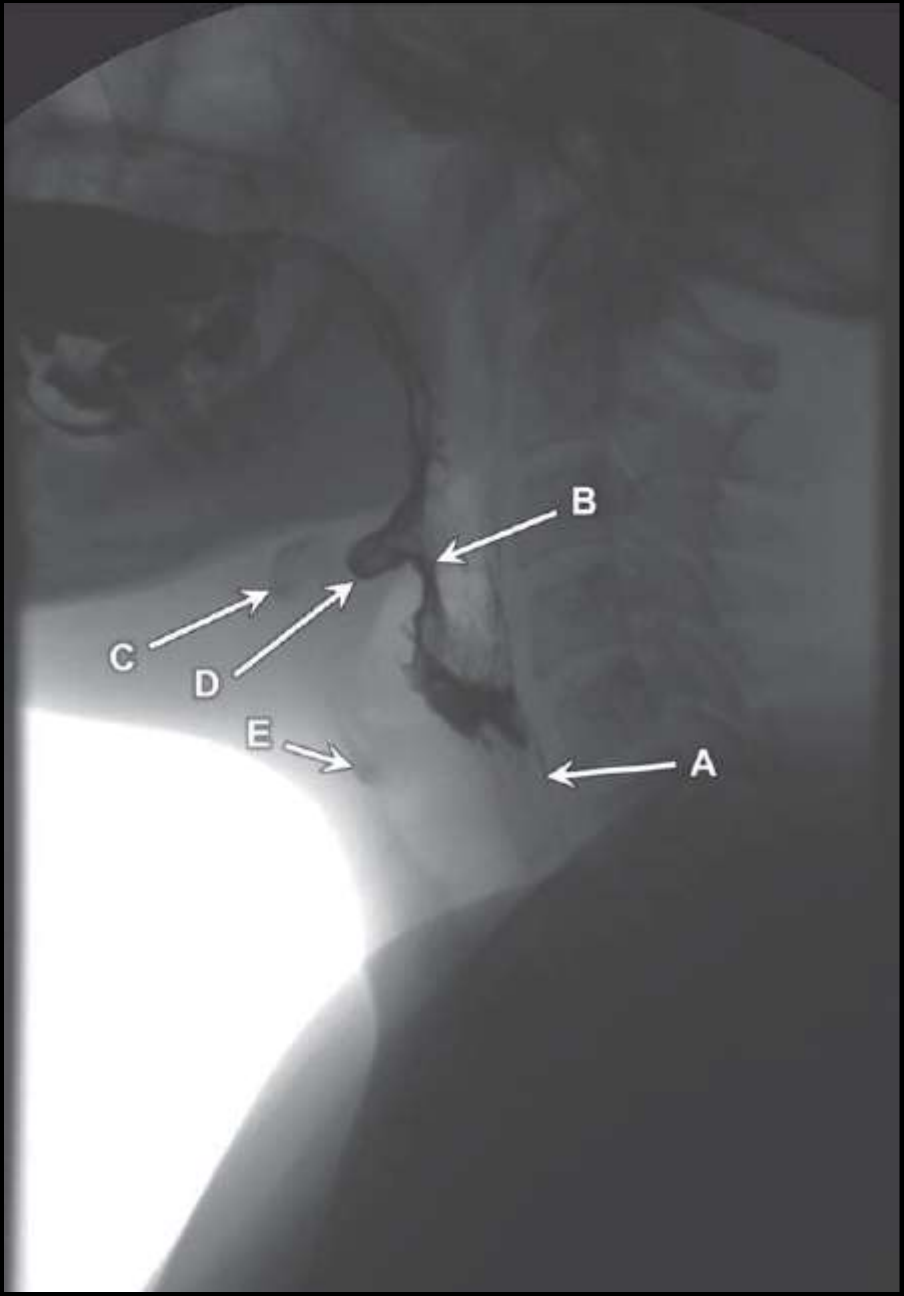


5.14 Ultrasound orbit

(a) Cornea. The most superficial structure apparent is the eyelid. The next interface marks the thin layer of fluid over and bathing the cornea.
(b) Vitreous humour. This is contained in the posterior chamber of the eye. Between the two chambers lie the iris, lens, suspensory ligaments and ciliary muscles.
(c) Retina.
(d) Optic disc. The layers of the globe internal to external are the retina, the choroid and the sclera.
(e) Optic nerve. The optic nerve is normally less than 5mm in diameter, if it is greater than this then raised intracranial pressure or an expansive lesion of the optic nerve may be present.

Ultrasound of the eye is performed with the lid closed using an ultrasound gel cushion to avoid unnecessary pressure on the globe. The high spatial resolution of ultrasound makes it particularly good for assessing the globe.

FLUORO

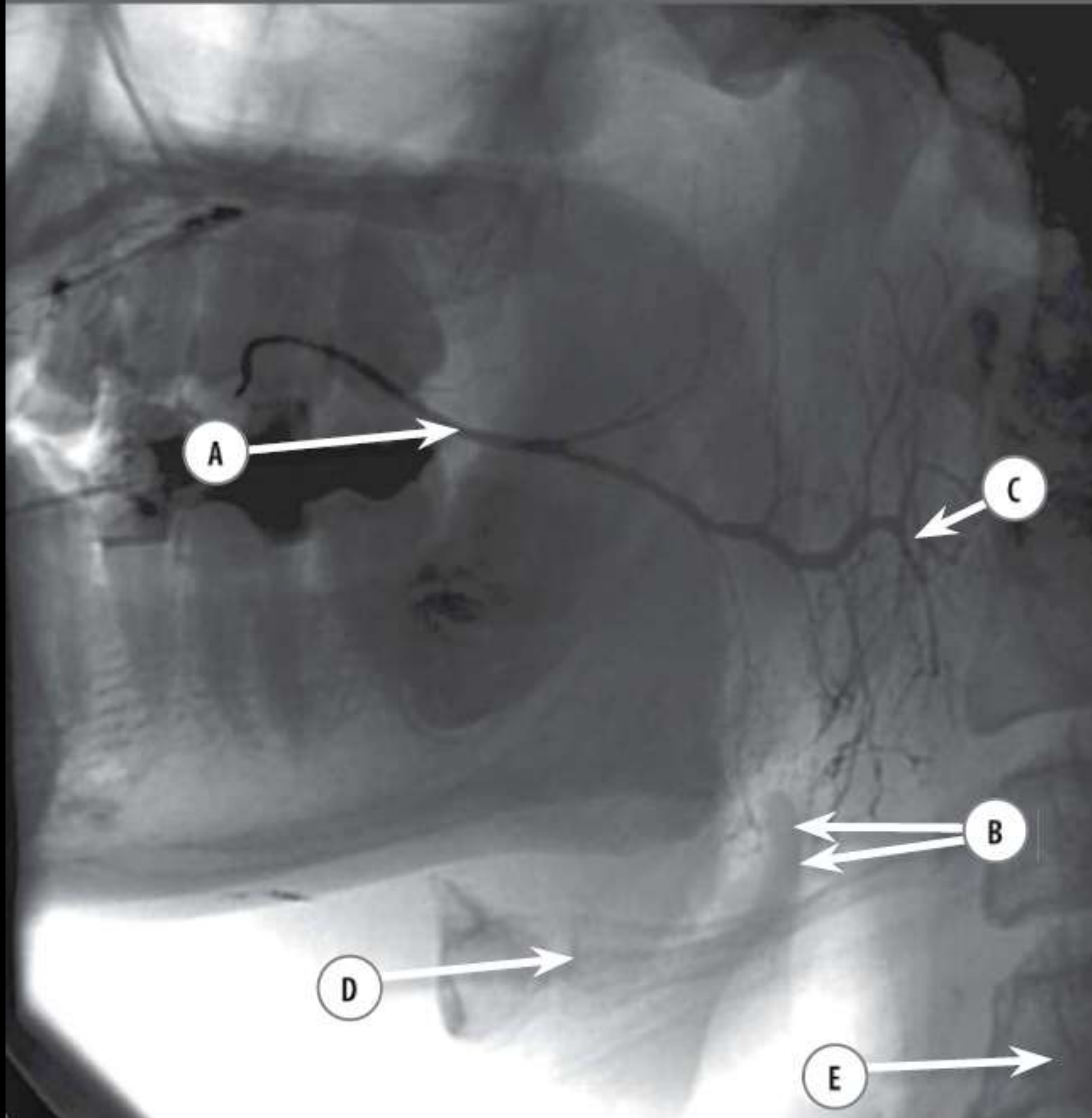

B
C
D
E
A

Case 8

Barium swallow. Lateral view.

1. Oesophagus
2. Epiglottis
3. Hyoid bone
4. Vallecula
5. Thyroid cartilage

Case 1.30



Case 1.30

A Parotid (Stensen's) duct

B Epiglottis

C Secondary ductules

D Hyoid

E Body of C4 vertebra

Parotid sialogram.

In this investigation, the parotid duct is cannulated and radio-opaque contrast injected to outline the ductal system. The parotid is the largest of the three salivary glands. It is irregularly shaped as it occupies the space between the ramus of the mandible and the styloid process of the temporal bone. There is a large superficial part and a smaller deeper part, which are continuous around the ramus of the mandible via the isthmus.

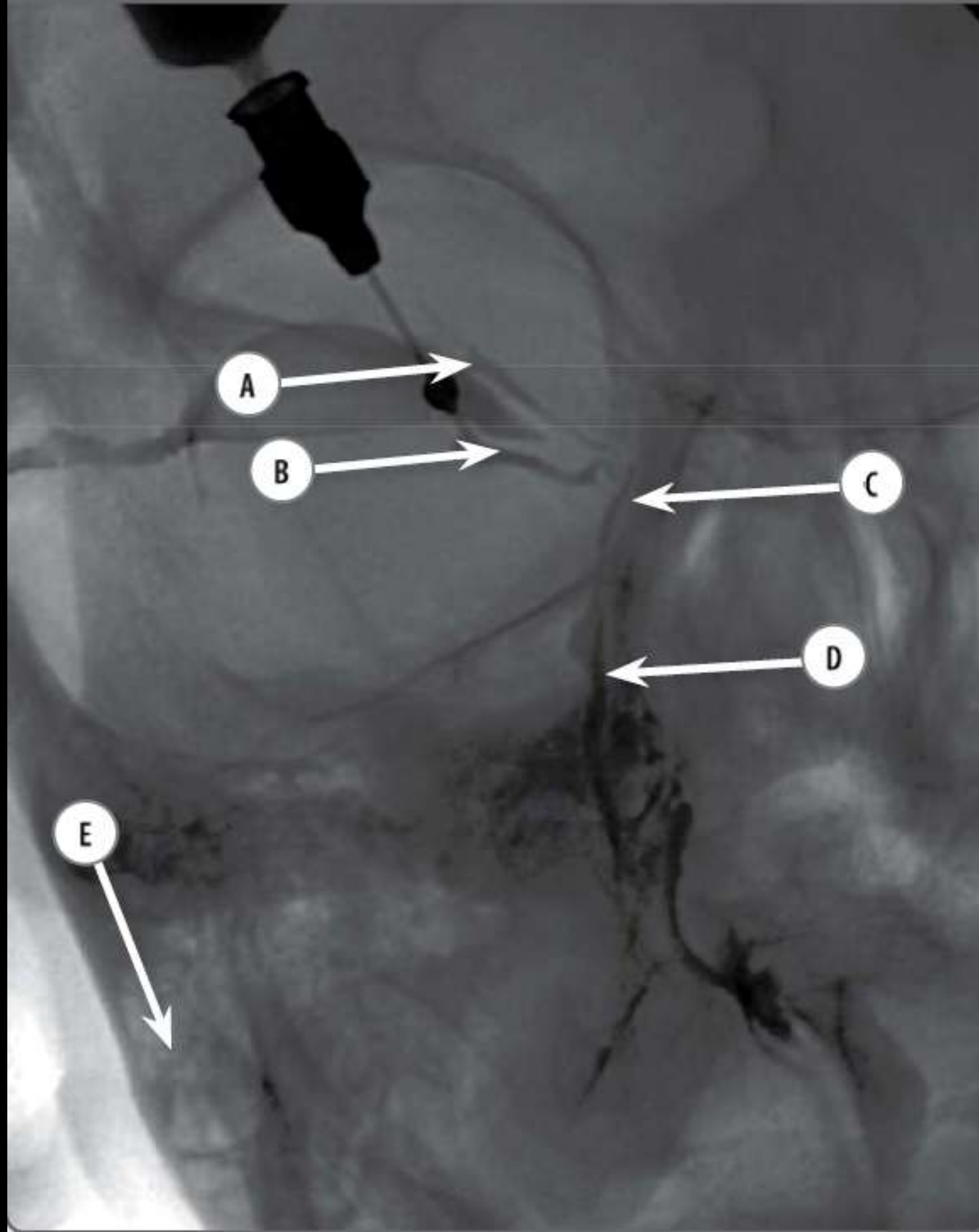
The parotid (Stenson's) duct arches over the masseter muscle before turning medially to pierce the buccinator muscle where it drains into the mouth opposite the second upper molar tooth.

The serous secretions have digestive functions and wash particles of food into the oral cavity. The gland is supplied by branches from the external carotid (which travels through the isthmus) and superficial temporal arteries, and is drained by the retromandibular veins. The facial nerve exits the stylomastoid foramen, runs

through the deep parotid and into the superficial parotid where it lies superficial to the external carotid. Here it divides into its five terminal branches.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 35.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 926.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 22.

Case 1.31



Case 1.31

A Right superior canaliculus

B Right inferior canaliculus

C Right lacrimal sac

D Right nasolacrimal duct

E Right mastoid air cells

A macrodacryocystogram.

The canaliculi are injected with radio-opaque contrast media to outline the drainage and ducts of the lacrimal apparatus.

The lacrimal gland lies in the superolateral aspect of the orbit in its own fossa. It lies lateral to levator palpebrae superioris which grooves it, dividing it into superior and inferior parts.

The gland secretes tears, which collect in the lacrimal lake at the medial angle of the eye. The tears drain through lacrimal puncta, and into superior and inferior lacrimal canaliculi. The canaliculi drain into the lacrimal sac, and from here into the nasolacrimal duct, which runs in a bony canal to the inferior meatus of the nasal cavity. The valve of Hasner is a mucosal fold at the distal end which prevents reflux into the duct (**Figure 1.8**).

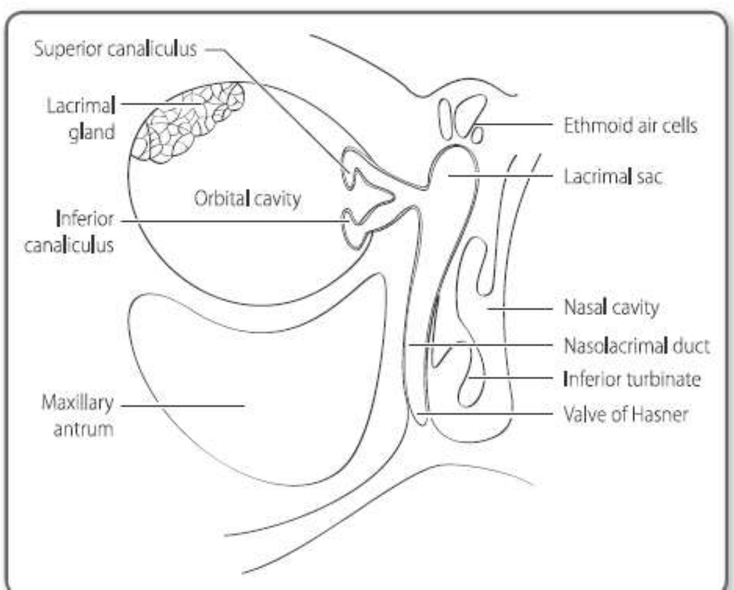
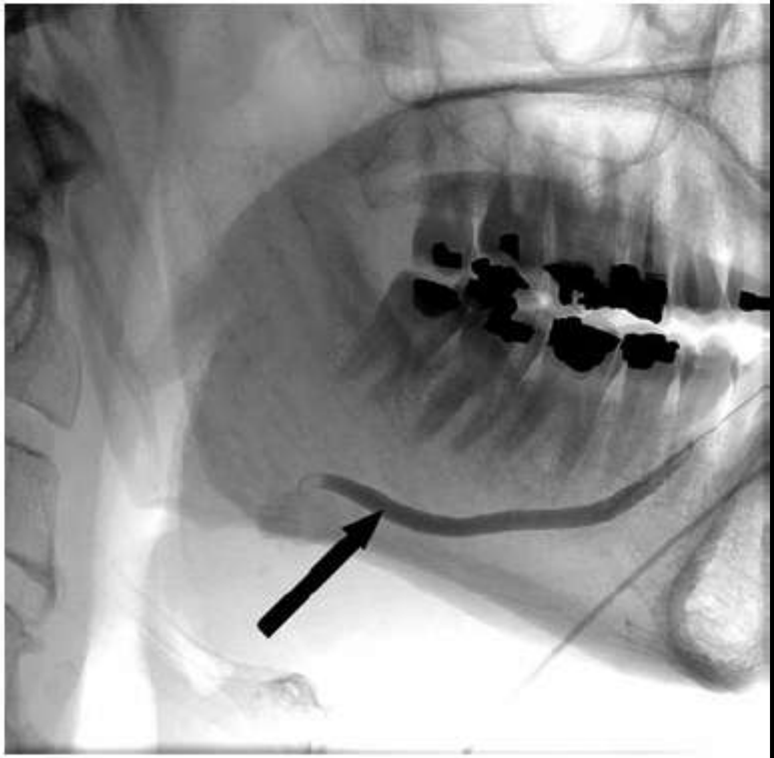


Figure 1.8 The lacrimal apparatus.

Question 15:

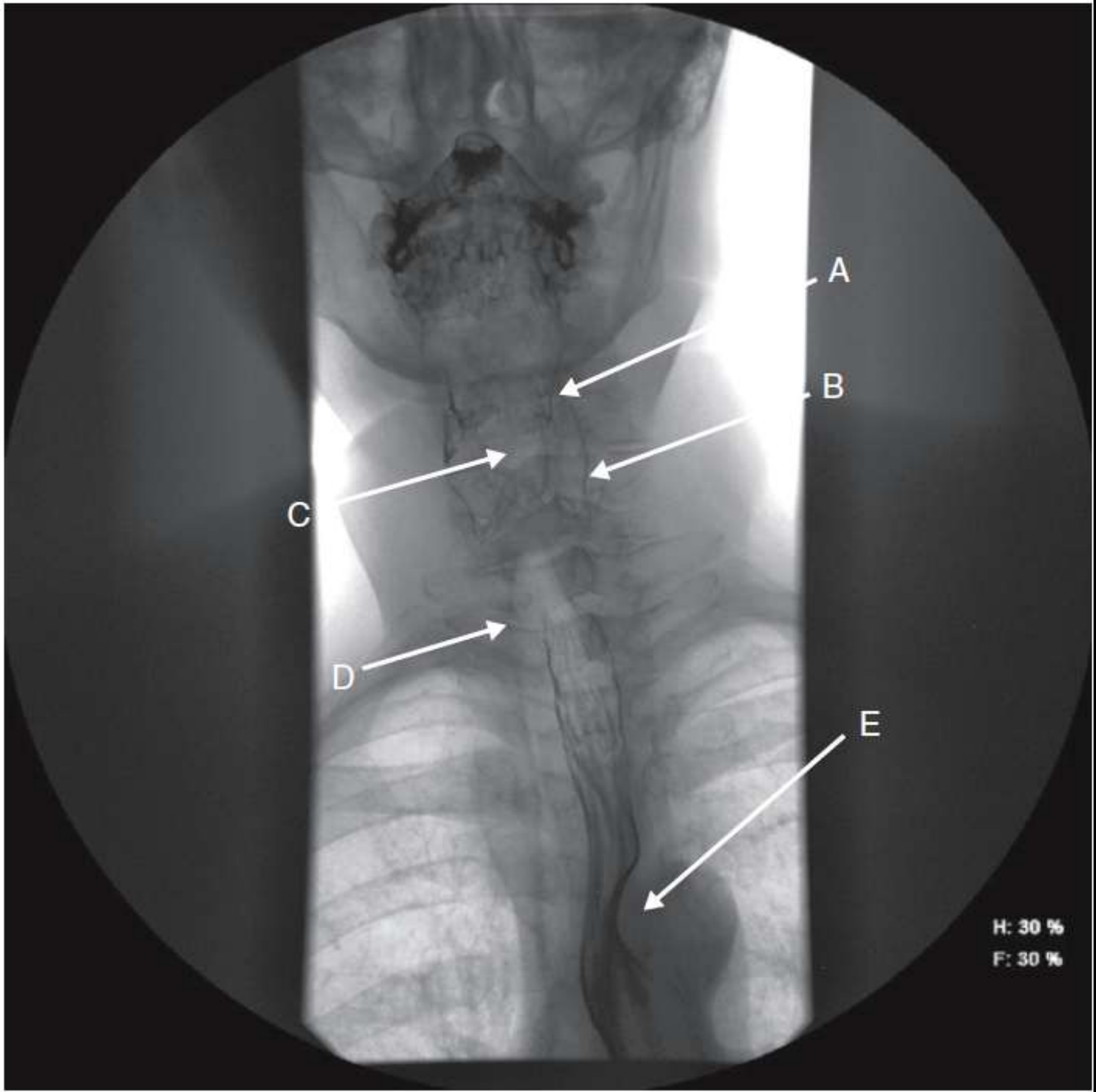


Question 15: Sialogram

Answer: Submandibular (Wharton's) duct

- The submandibular duct drains saliva produced by the submandibular gland into the floor of the mouth at the base of the tongue.
- The duct is approximately 5 cm long.

Case 3.7

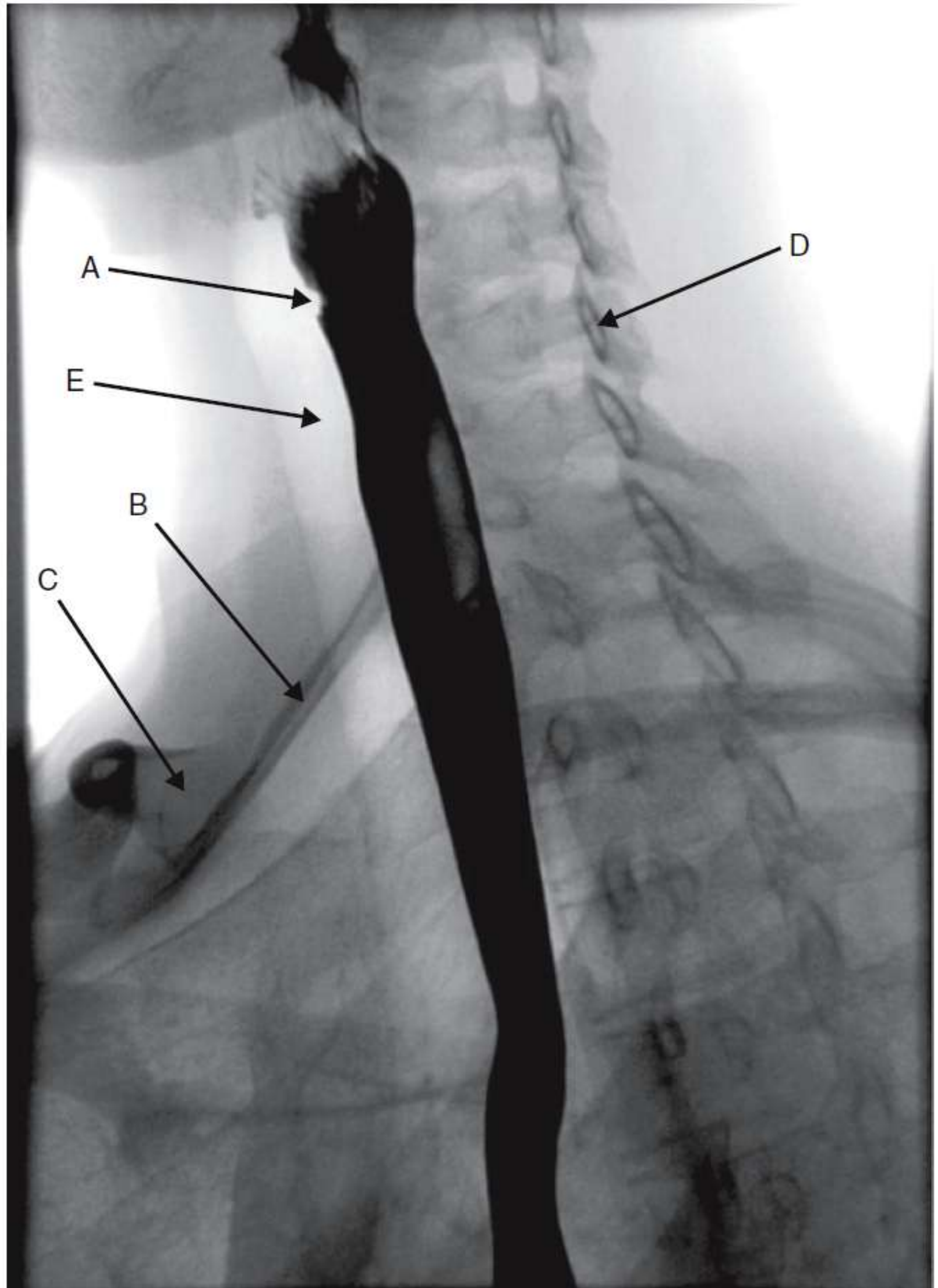


3.7 Barium swallow

(a) Vallecula. The valleculae are paired depressions situated either side of the median glossoepiglottic fold. They separate the epiglottis from the base of the tongue and serve to hold saliva before the swallowing reflex commences.
(b) Piriform fossa. This is a recess bounded medially by the aryepiglottic fold and laterally by the thyroid cartilage. The internal branch of the superior laryngeal nerve is located immediately deep to the mucosa in this region. Fish bones can become lodged in this area.
(c) Laryngeal vestibule. This forms the opening into the larynx and is located above the vestibular folds (false cords).
(d) Air in the trachea. The trachea extends from the lower part of the larynx, level with the sixth cervical vertebra, to the upper border of the fifth thoracic vertebra. It is a midline structure but passes inferiorly to lie just to the right of midline at the level of the aortic arch (T4).
(e) Aortic arch impression.

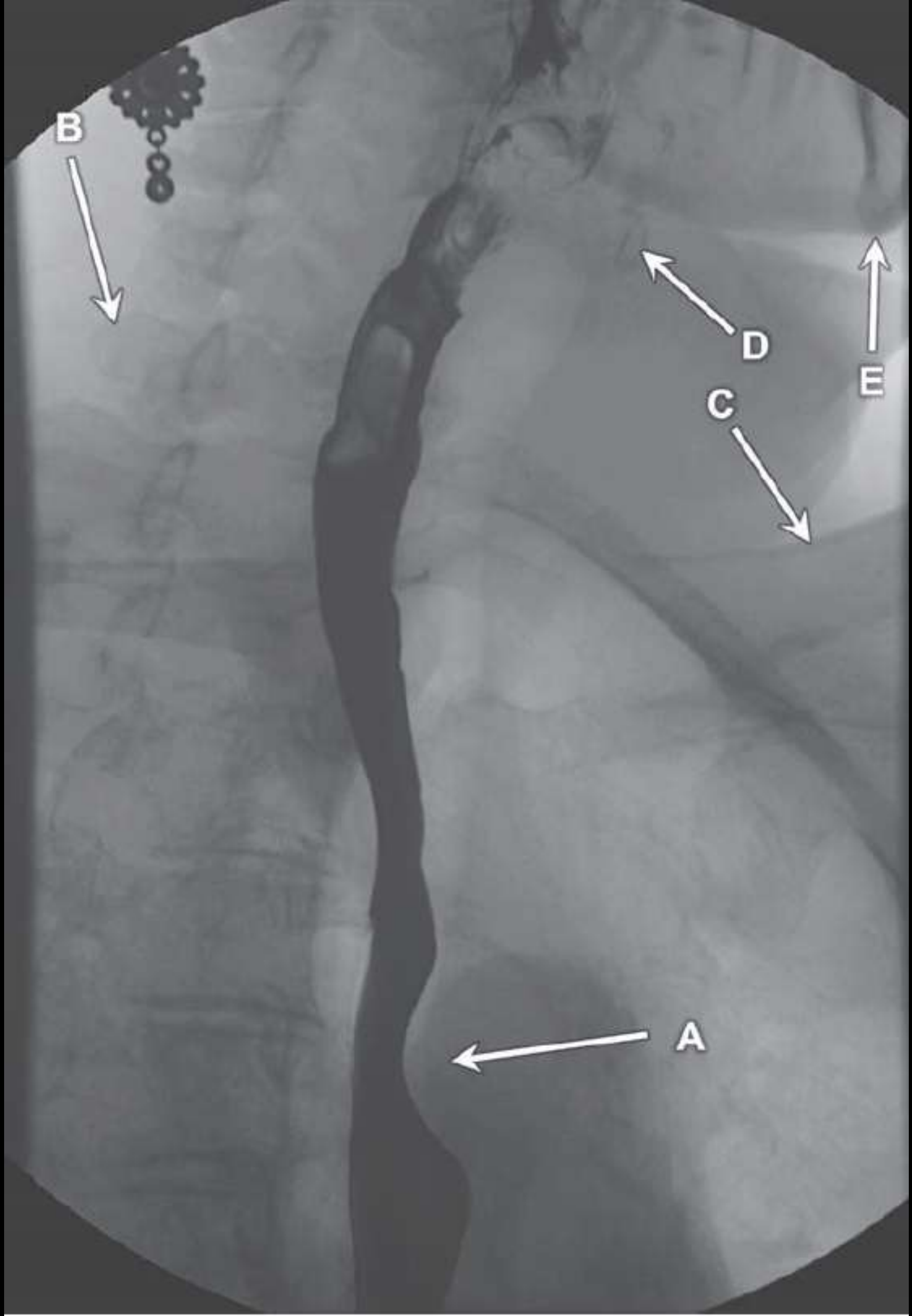
There are three sites of natural oesophageal indentation which include the aortic arch (T4 level), the left main bronchus (T5 level) where the indentation is left-sided and the left atrium. Caustic strictures tend to occur at sites of oesophageal indentation since transit of solids and liquids is slowed at these sites.

Case 2.6



2.6 Barium swallow – oblique view

(a) Post cricoid venous plexus.
(b) First rib.
(c) Clavicle.
(d) Left lamina of C5.
(e) Trachea.

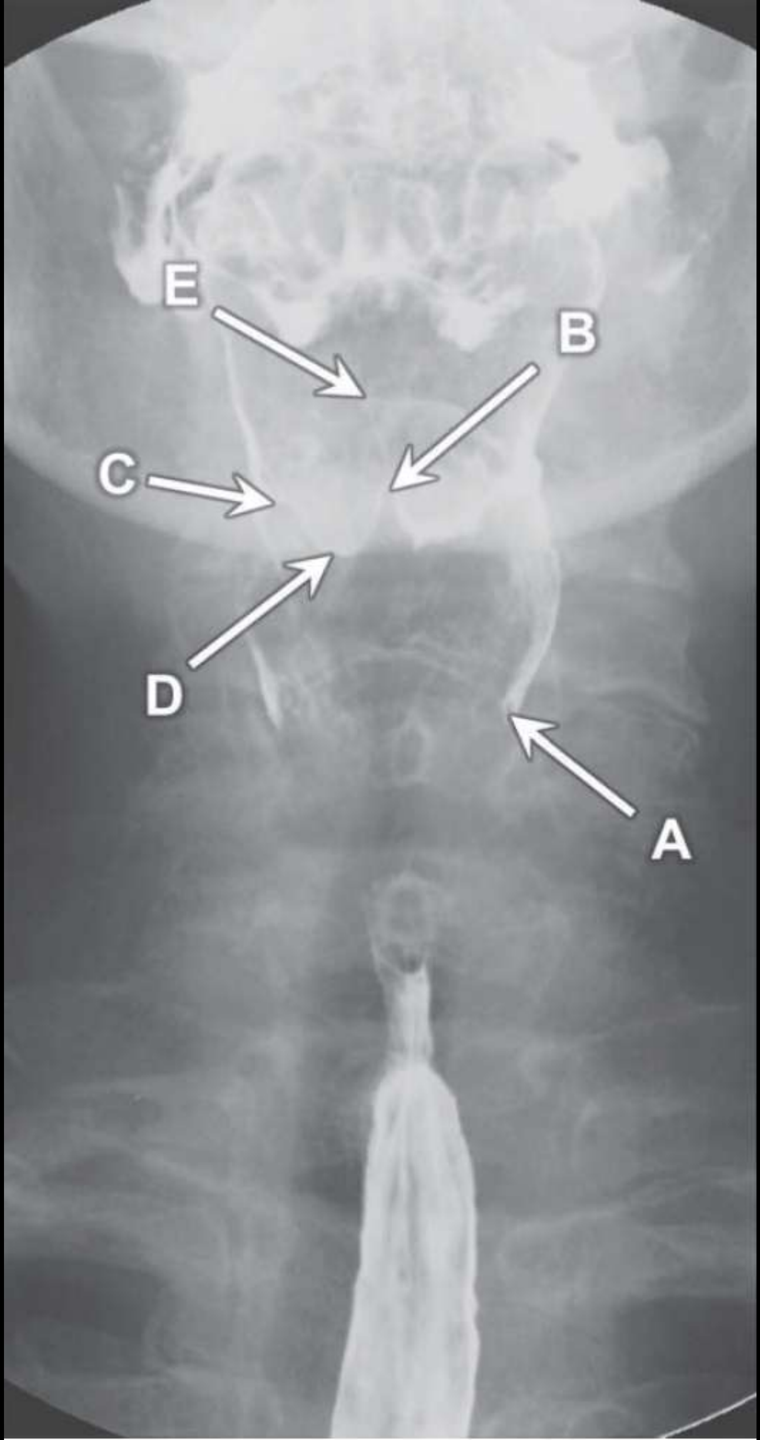

B
D
E
C
A

Case 10

Barium swallow. Oblique 'spot' view of the upper oesophagus.

1. Aortic arch
2. Spinous process of C7 vertebra
3. Left clavicle
4. Thyroid cartilage
5. Mental process of the mandible

Why the left clavicle? The patient is rotated to their left and an oblique view has been taken through their upper chest. The mediastinal structures are projected left of centre. If this were a PA view in the right lateral oblique position, the aortic arch would be on the other side of the image.

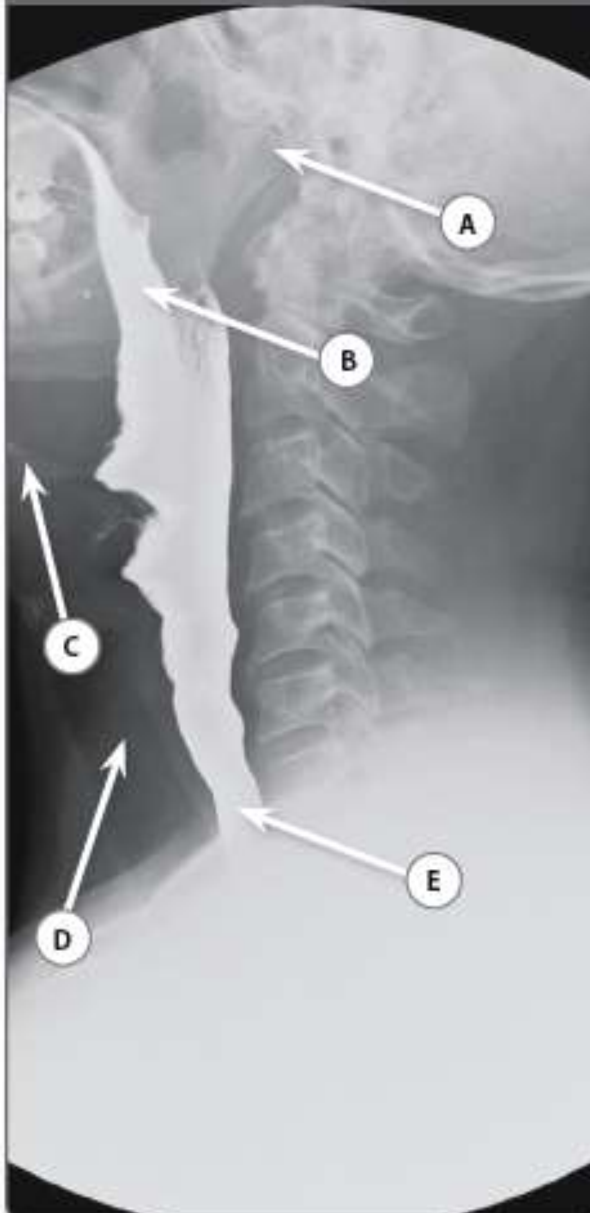

E
B
C
D
A

Case 15

Barium swallow. AP pharyngeal view.

1. Left pyriform sinus
2. Median epiglottic fold
3. Right lateral epiglottic fold
4. Right vallecula
5. Epiglottis

Case 8.5



D	Name the lucent structure labelled D.	

Case 8.5

A Mandibular condyle

B Oropharynx

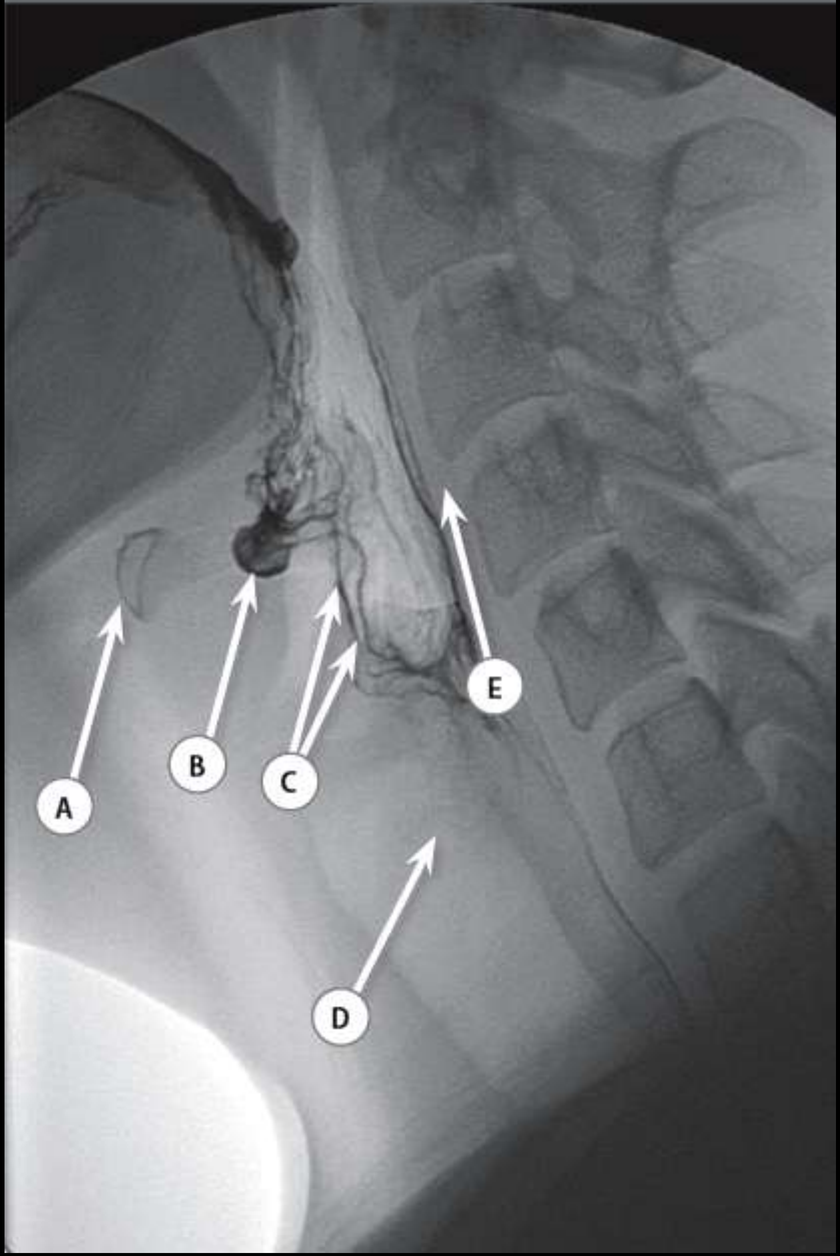
C Hyoid bone

D Trachea

E Oesophagus

The oesophagus is a continuation of the oropharynx. Beginning at the level of C6, it descends posteriorly to the trachea, just anterior to the lower cervical vertebrae (hence osteophytic compression is a not uncommon cause of dysphagia).

Case 12.12



Case 12.12

A Body of the hyoid bone

B Vallecula

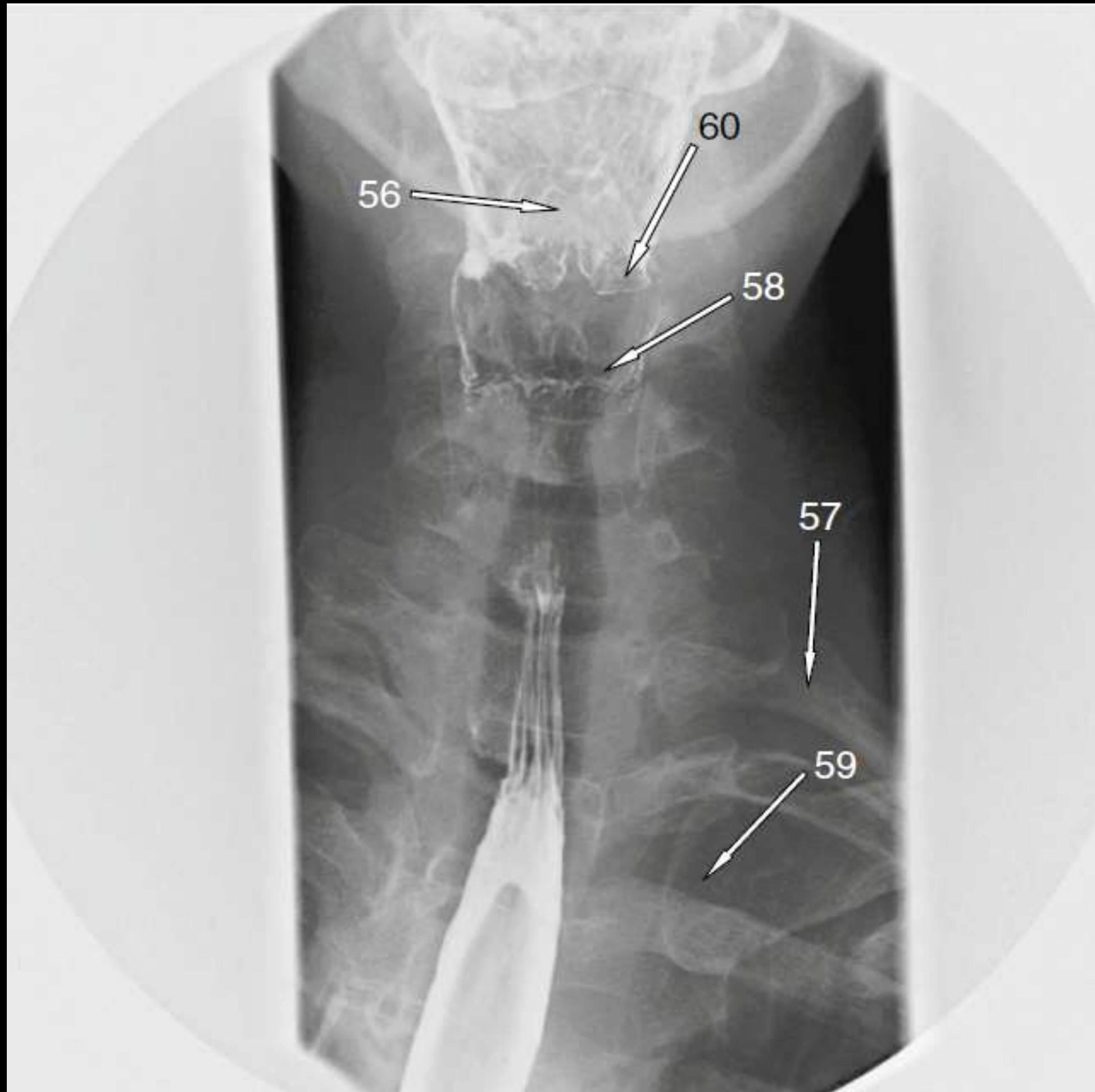
C Piriform fossae

D Trachea

E Retropharyngeal soft tissues

The **hypopharynx** is the most inferior part of the pharynx, extending from the inferior margin of the valleculae to the oesophagus (level of C6 vertebrae).

The **piriform fossa** (from the Latin for 'pear-shaped') is the lateral recess of the hypopharynx at the laryngeal orifice.

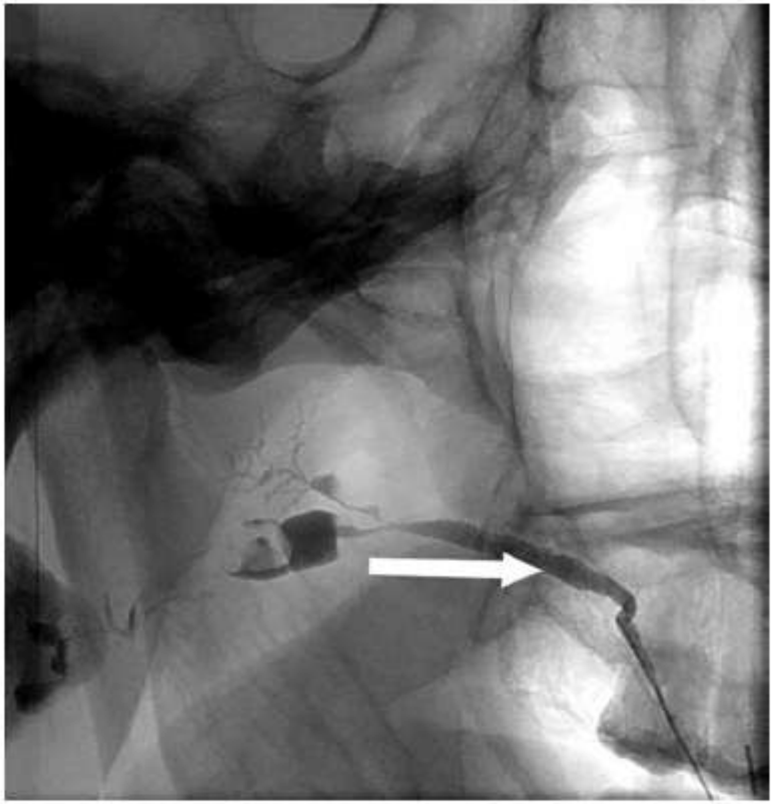

60
56
58
57
59

Barium Swallow (Anterior View Neck)

56. Epiglottis
57. Left first rib
58. Piriform fossa
59. Medial end of left clavicle
60. Valleculae

In the upper part of this image, the en face view of the base of the tongue is seen. The median glossoepiglottic fold crosses from tongue base to epiglottis, dividing the retroglottic space into two cup-shaped valleculae (60).

Question 16:



Question 16: Sialogram

Answer: Parotid (Stensen's) duct

- The parotid duct conveys saliva from the parotid gland into the oral cavity.
- The gland opens out into the mucosal surface of the inner cheek opposite the upper second molar tooth.
- Initially, it is difficult to ascertain what the image shows. Images like this can appear in the examination and the best way to tackle a confusing one is to find recognisable landmarks. If you look carefully, you will see that the mandibular condyle can be discerned on the left side of the image, and teeth can be seen at the bottom right-hand corner.
- By finding these landmarks, you will be guided as to which body part is being shown.

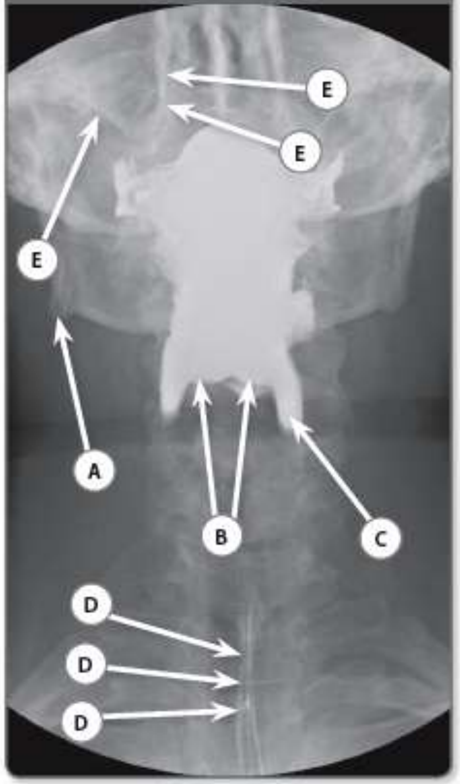
- **Question 48:**

Question 48: Barium swallow

Answer: Left pyriform sinus

- The pyriform sinuses are a pair of deep recesses that lie on either side of the laryngeal orifice.
- They are bounded laterally by the thyroid cartilage.
- The valleculae can be seen superior to the pyriform sinuses.

Case 7.10



Case 7.10

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	What structure is causing the impression labelled B?	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 7.10

- A Angle of right mandible
- B Epiglottis
- C Left piriform recess
- D Oesophagus
- E Right maxillary sinus

The pharynx consists of three parts (from superior to inferior): nasopharynx; oropharynx; and laryngopharynx (hypopharynx). The latter two parts are shown filled with barium in this image. The laryngopharynx extends from the tip of the epiglottis to the point at which the pharynx becomes the oesophagus (at the level of the C6 vertebra). The piriform recesses are parts of the laryngopharynx and pass laterally to the larynx.

ANGIO

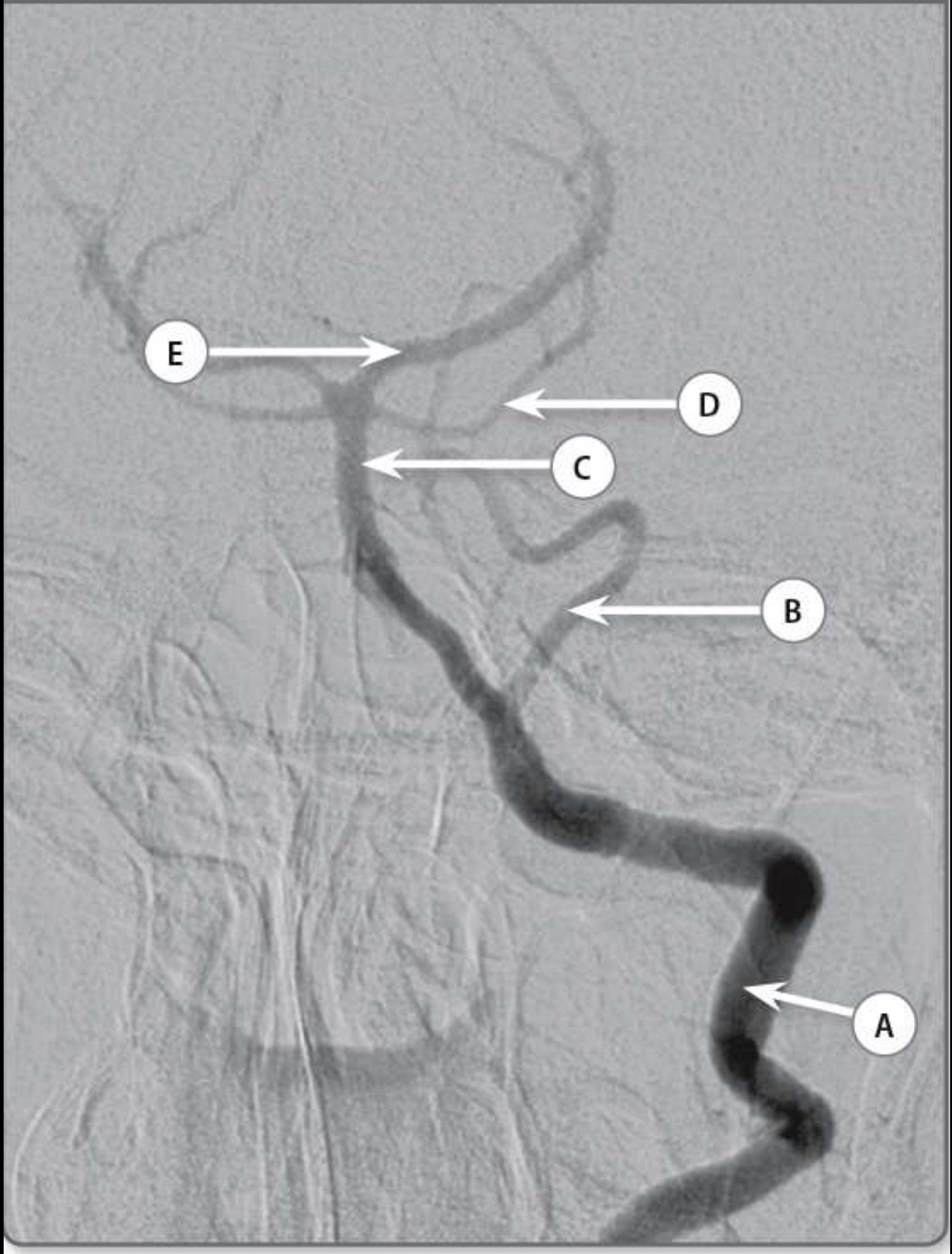
- **Question 25:**

Question 25: MR venogram (MIP image)

Answer: Superior sagittal sinus

- The superior sagittal sinus is part of the venous drainage system of the brain.
- The superior sagittal sinus travels from anteriorly to posteriorly within the falx cerebri.
- It is a midline structure that drains into the confluence of the sinuses (torcular herophili) at the internal occipital protuberance.
- It receives blood from both the superficial cerebral veins and the deep cerebral veins.

Case 5.2



Case 5.2

A Left vertebral artery

B Left posterior inferior cerebellar artery

C Basilar artery

D Left superior cerebellar artery

E Left posterior cerebral artery

Angiogram of the left vertebral artery.

For further discussion see Chapter 1, Cases 1.14–1.17.

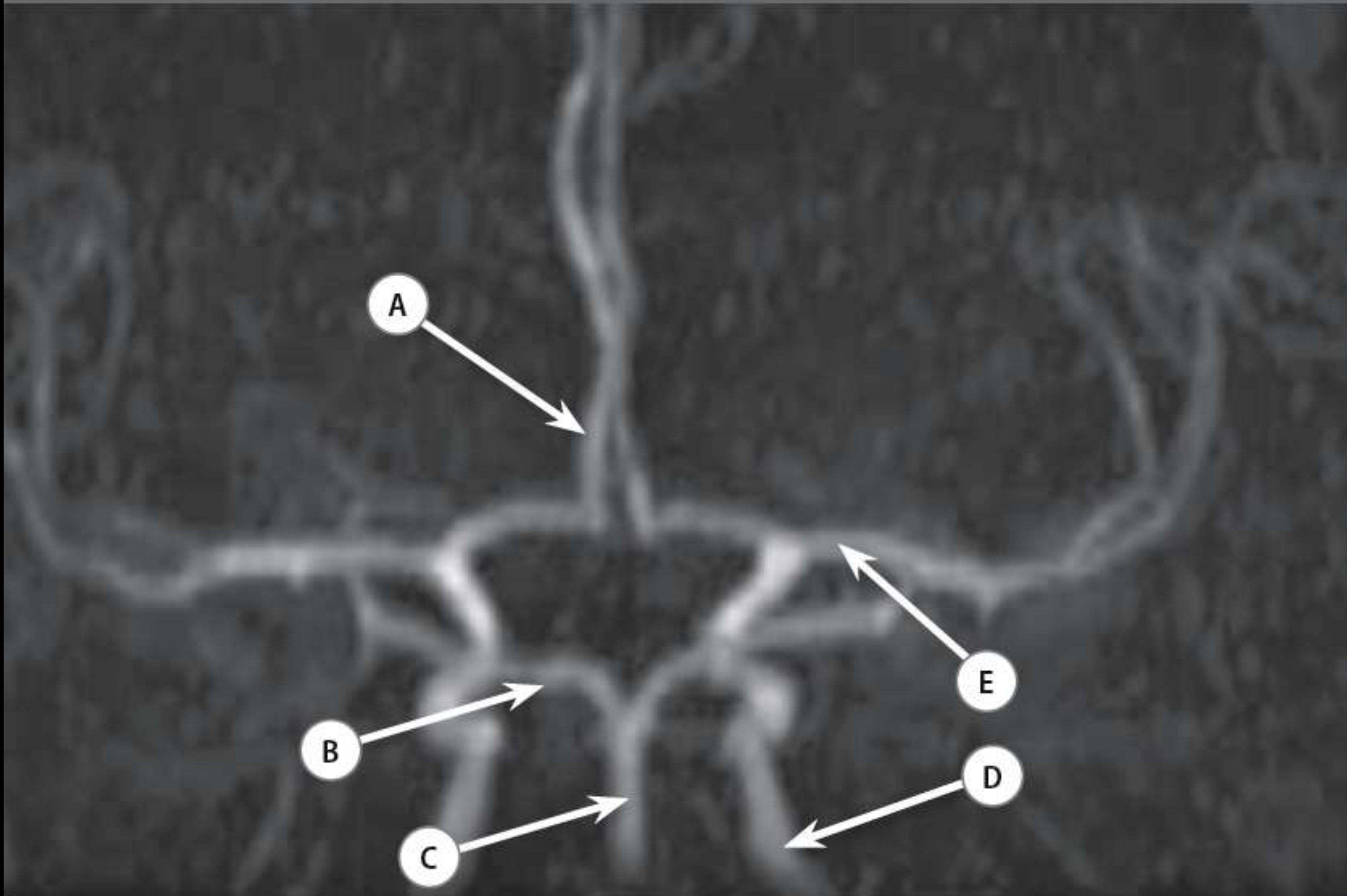

8
7
10
6
9

DSA

6. Confluence of venous sinuses (torcula herophili)
7. Vein of Labbe
8. Internal cerebral vein
9. Sigmoid sinus
10. Cavernous sinus

This is a digitally subtracted cerebral angiogram in the venous phase. Torcula herophili is the confluence of the sinuses and turns to one side (usually to the left side) to become the transverse sinus.

Case 5.6



Case 5.6

A Right anterior cerebral artery

B Right posterior cerebral artery

C Basilar artery

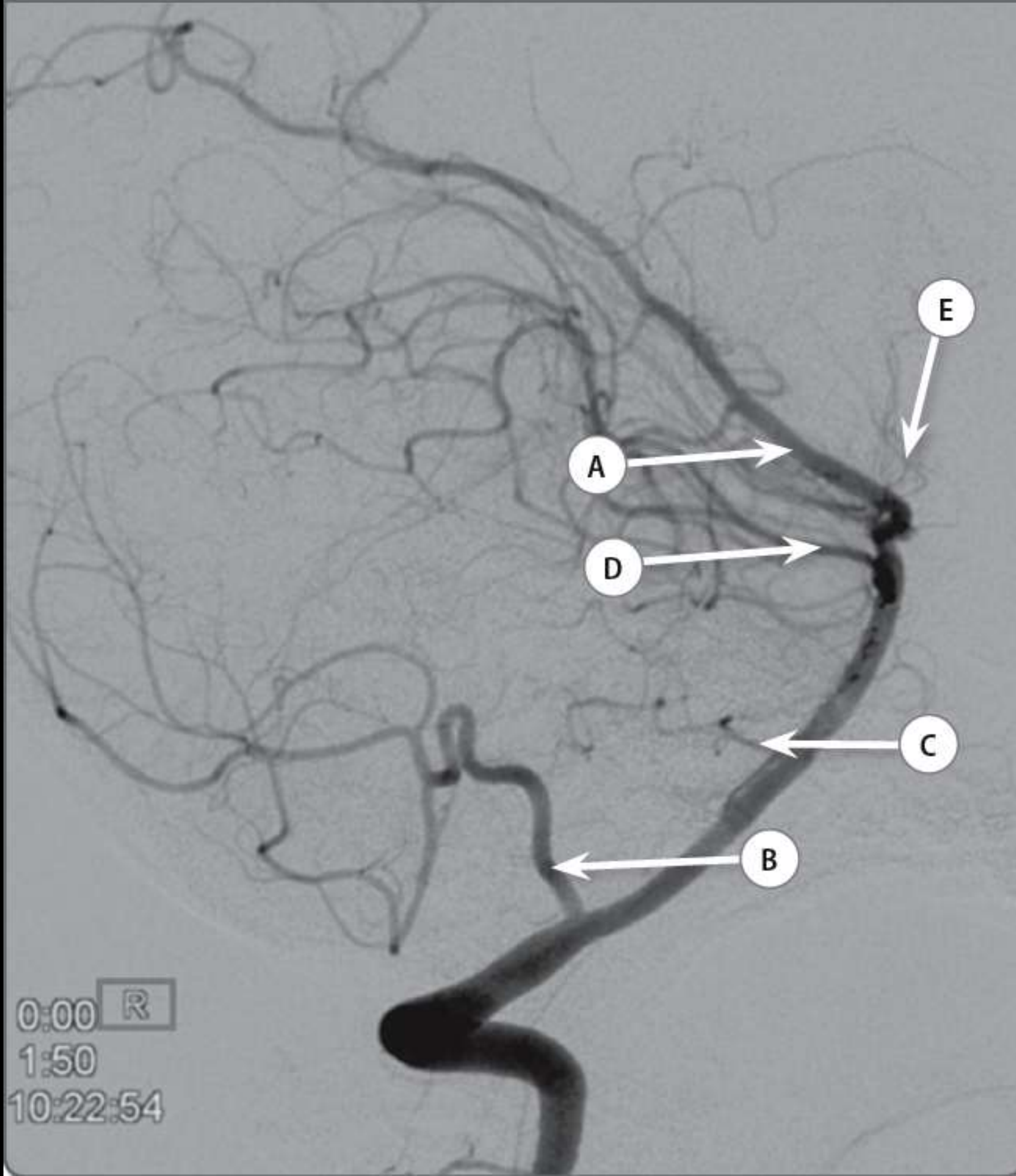
D Left internal carotid artery

E Left middle cerebral artery (MCA)

MR angiogram of the brain.

For further discussion see Chapter 1, cases 1.14–1.17.

Case 6.1



Case 6.1

A Right posterior cerebral artery

B Right posterior inferior cerebellar artery (PICA)

C Right anterior inferior cerebellar artery (AICA)

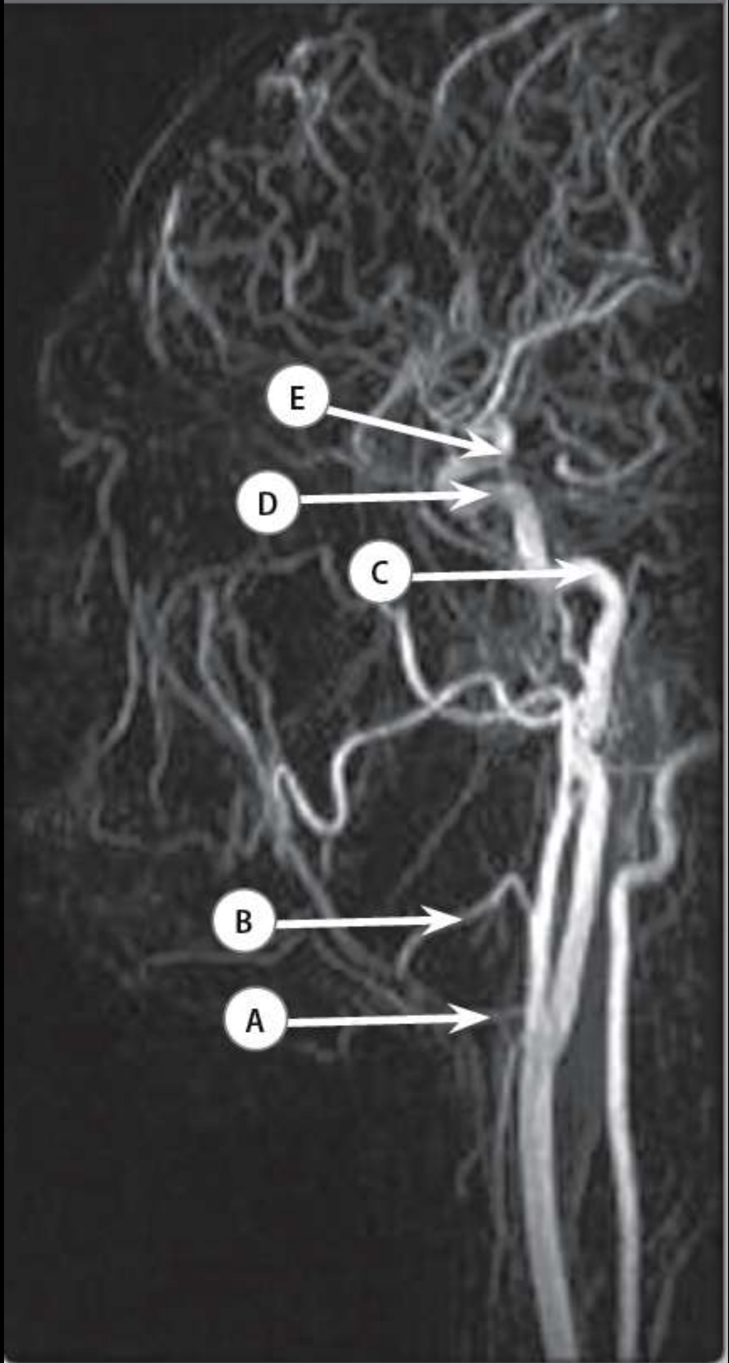
D Left superior cerebellar artery

E Thalamostriate/thalamoperforating arteries

Angiogram of the right vertebral artery

For further discussion, see Chapter 1, Cases 1.14–1.17.

Case 6.4



Case 6.4

A Left lingual artery

B Left facial artery

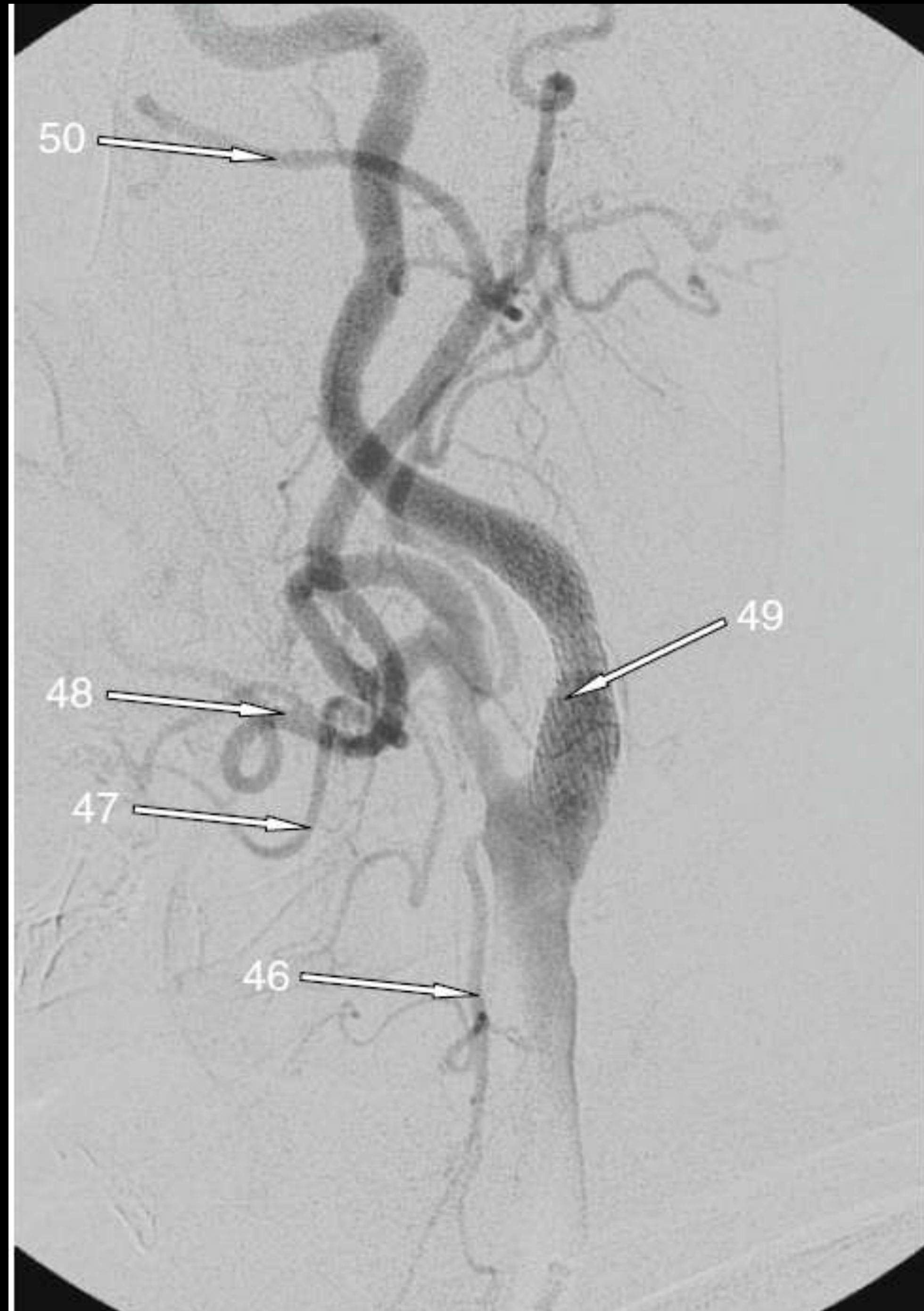
C Petrous portion of left internal carotid artery

D Cavernous portion of left internal carotid artery

E Supraclinoid/intracranial portion of left internal carotid artery

MR angiogram of the neck.

For further discussion, see Chapter 1, Cases 1.14–1.17.


50
49
48
47
46

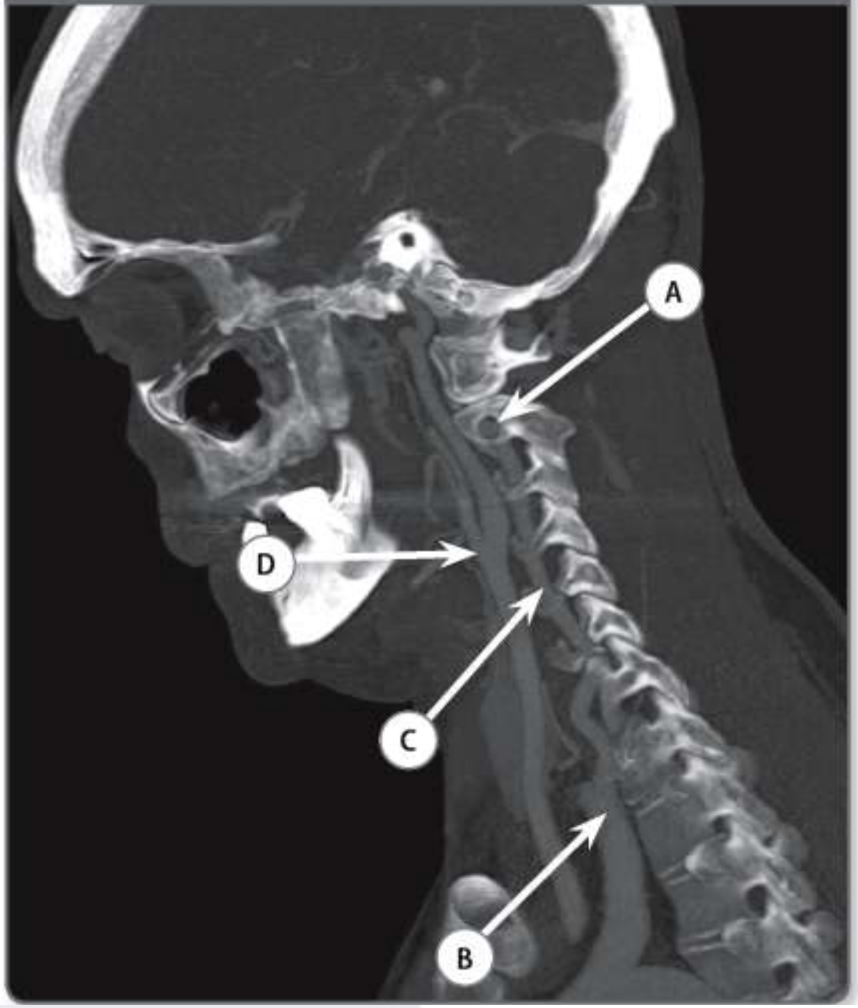
DSA

46. Superior thyroid artery
47. Lingual artery
48. Facial artery
49. Internal carotid artery
50. Maxillary artery

A useful mnemonic for memorising the branches of the external carotid artery (inferior to superior) is '*S*ome *A*natomists *L*ike *F*reaking *O*ut *M*edical *S*tudents'.

- Superior thyroid artery
- Ascending pharyngeal artery
- Lingual artery
- Facial artery
- Occipital artery
- Maxillary artery
- Superficial temporal artery

Case 15.16



E	What is the first branch of the external carotid artery called?	

Case 15.16

A Foramen transversarium of the axis (C2)

B Subclavian artery

C Vertebral artery

D Carotid bifurcation

E Superior thyroid artery

The four major arteries on each side of the neck are:

1. **Common carotid artery** – bifurcates at the level of C4 vertebral body into its internal and external branches at the carotid bifurcation
2. **Internal carotid artery** – does not give off any branches in the neck
3. **External carotid artery** – eight branches are described, supplying the cervical organs, face, scalp and dura.

'Several Angry Ladies Fighting Over PMS' is a useful mnemonic for memorising:

Several – Superior thyroid artery

Angry – Ascending pharyngeal artery

Ladies – Lingual artery

Fighting – Facial artery

Over – Occipital artery

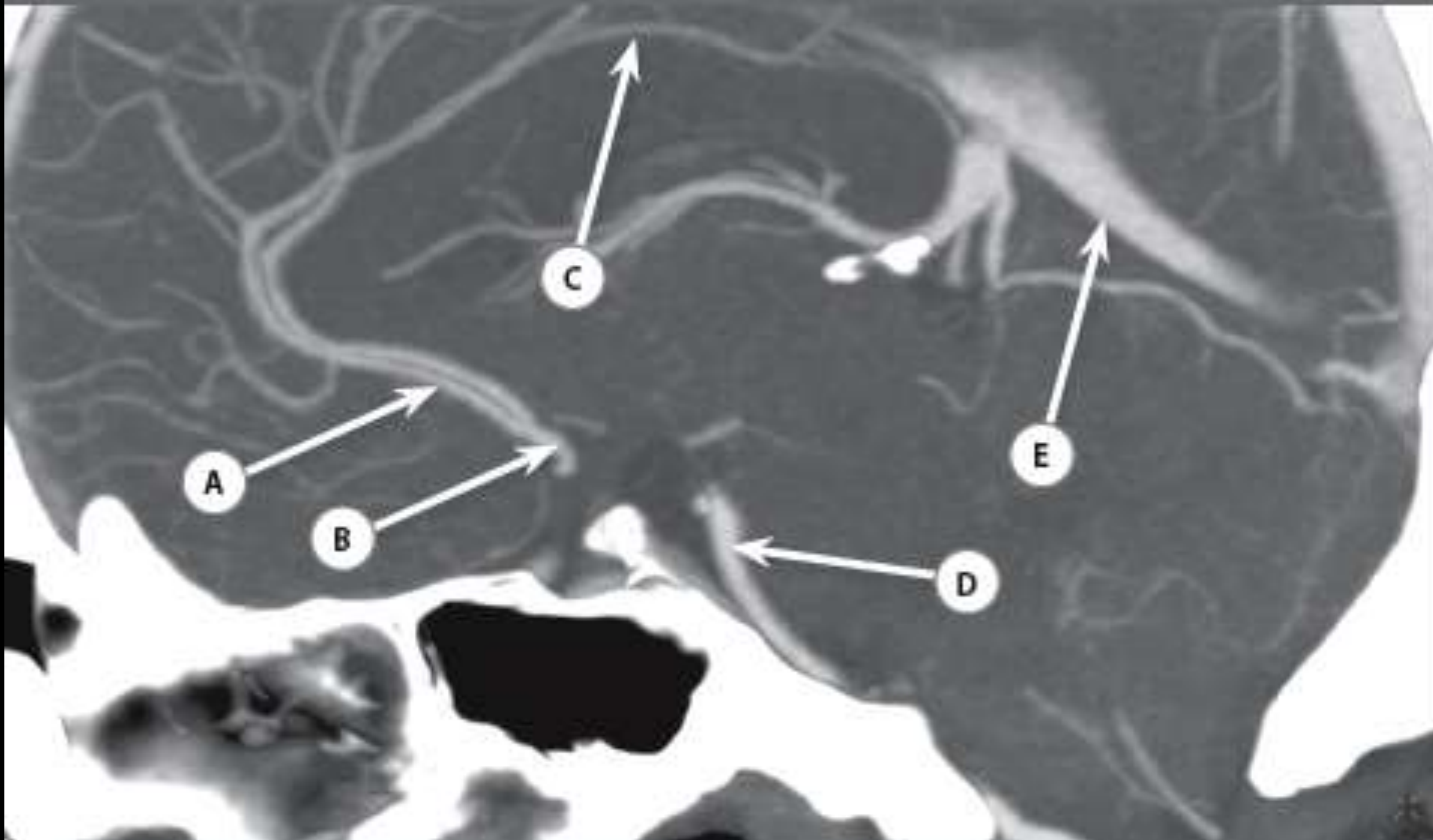
P – Posterior auricular artery

M – Maxillary artery

S – Superficial temporal artery

4. **Vertebral artery** – the first branch of the subclavian artery which travels through the foramina transversaria of the cervical vertebrae prior to entering the skull via foramen magnum.

Case 9.13



Case 9.13

A A2 (post-communicating) segment of the anterior cerebral artery (ACA)

B A1 (pre-communicating) segment of the ACA

C Pericallosal artery

D Basilar artery

E Straight venous sinus

The ACA is a terminal branch of the internal carotid artery and is divided into three segments:

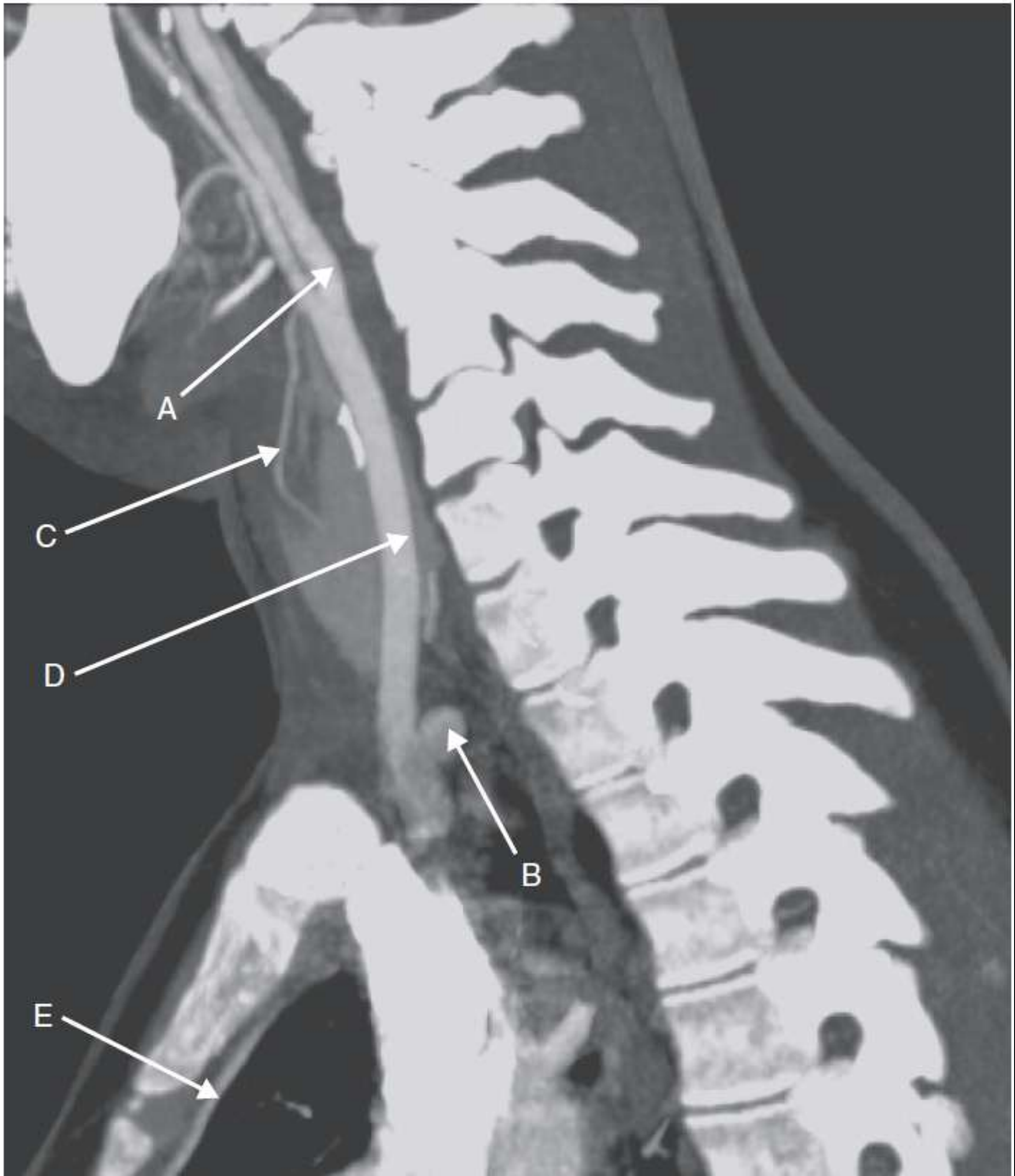
A1 – pre-communicating (horizontal) segment which gives off the anterior communicating artery (A-com)

A2 – post-communicating segment which extends from A-com to the bifurcation and divides into the callosomarginal and pericallosal arteries

A3 – pericallosal artery – terminal branch of ACA which extends posteriorly in the pericallosal sulcus

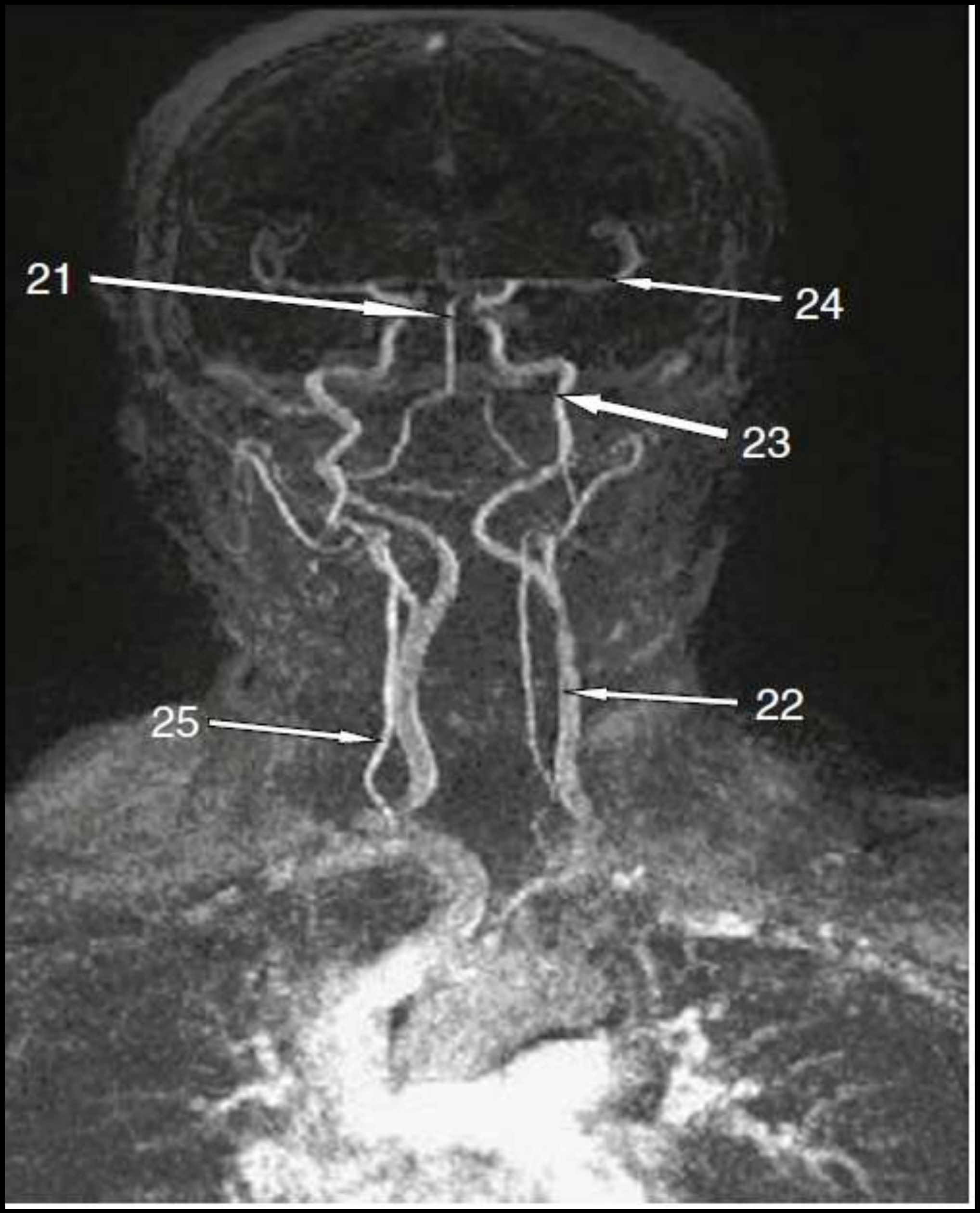
A4 – callosomarginal artery – present in only 60% of cases running anteriorly from the bifurcation.

Case 6.9



6.9 CT right carotid oblique MIP (maximum intensity projection) image

(a) Right internal carotid artery.
(b) Right internal thoracic artery.
(c) Right superior thyroid artery.
(d) Right common carotid artery (CCA).
(e) Right subclavian artery (SCA). It is difficult to ascertain this is the right side on this image. However, the anatomical relationship of the right SCA with the common carotid artery (CCA) is the clue.

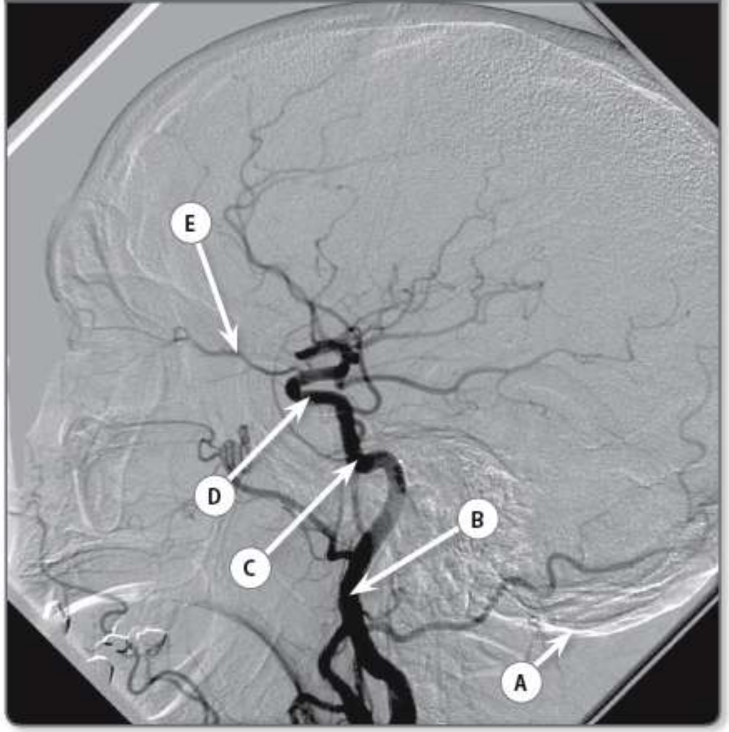


21
24
23
22
25

MRA

21. Basilar artery
22. Left common carotid artery
23. Left internal carotid artery
24. Left middle cerebral artery
25. Left vertebral artery

Case 3.2



Case 3.2

QUESTION		WRITE YOUR ANSWER HERE
A	Name the osseous structure labelled A.	
B	Name the ICA segment labelled B.	
C	Name the ICA segment labelled C.	
D	Name the ICA segment labelled D.	
E	Name the artery labelled E.	

Case 3.2

A Occipital bone

B Cervical portion of internal carotid artery

C Petrous portion of internal carotid artery

D Cavernous portion of internal carotid artery

E Ophthalmic artery

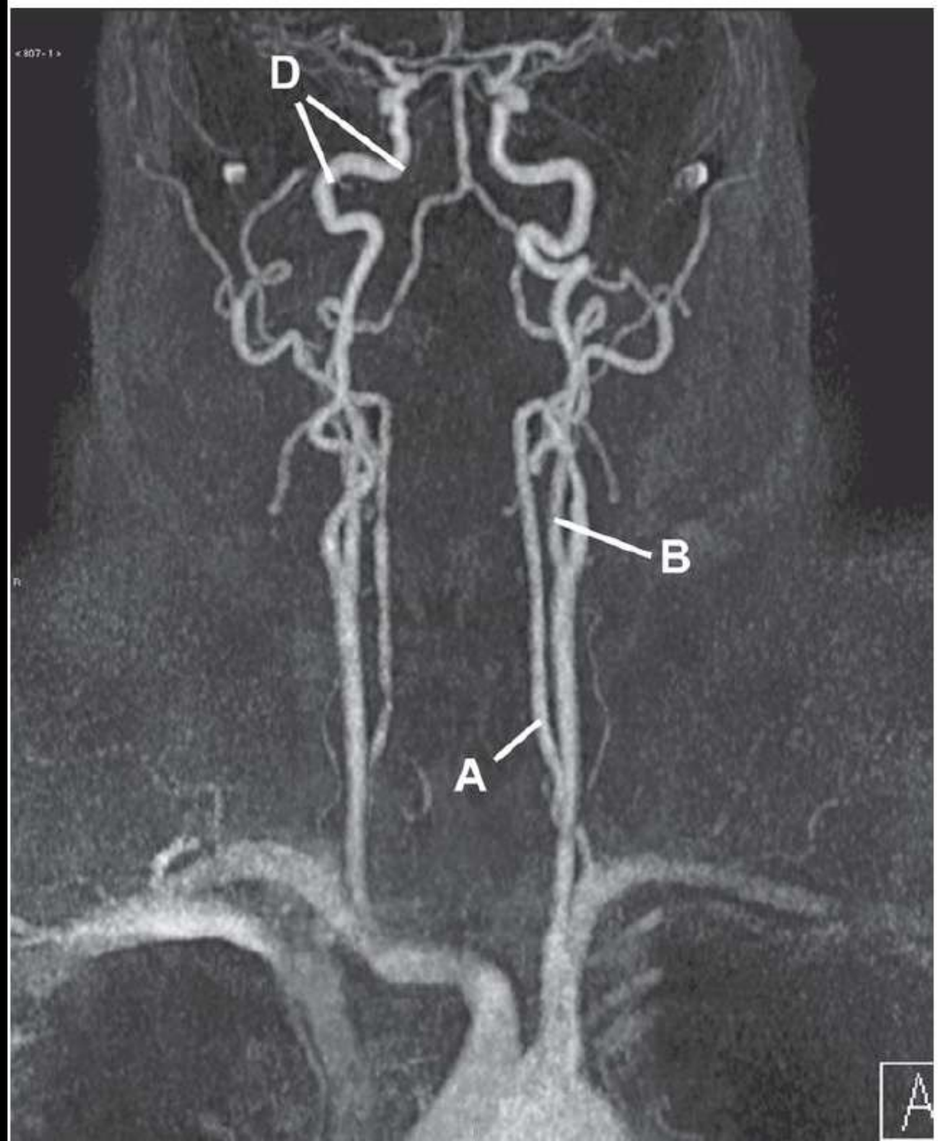
There are two internal carotid artery (ICA) classification systems: anatomical and clinical. The anatomical system subdivides the ICA into four portions which can be appreciated on DSA angiography. The clinical system divides the ICA into seven segments, which can be identified on CT and MR angiography.

The following mnemonic will aid you in memorising the four ICA portions: 'Carotid Parts Cannot be Ignored':

- **C**ervical
- **P**etrous
- **C**avernous
- **I**ntracranial (supraclinoid).

Q40

a Name the structure labelled A
b Name the structure labelled B
c Name three of the commonly described branches of B
d Name the structure through which D passes at the segment labelled
e Name the vessel from which the left common carotid artery arises



Q40 Answers

a Vertebral artery
b External carotid artery
c There are eight commonly described branches of the external carotid artery, these are: superior thyroid, ascending pharyngeal, lingual, facial, occipital, posterior auricular, superficial temporal and maxillary arteries
d Foramen lacerum within the petrous bone
e Aortic arch

Magnetic resonance angiography (MRA) of major head and neck arteries, anterior view

---

The major vessels supplying the head and neck are the paired common carotid and vertebral arteries.

The vertebral arteries arise from the subclavian arteries in the root of the neck. They course through the transverse formina of C6 to C1 vertebrae before entering the cranium via the foramen magnum to form the basilar artery in the midline. The vertebral arteries give off no branches in the neck.

The left common carotid artery arises directly from the aortic arch, while the right common carotid is one of the terminal branches of the brachiocephalic artery; the other is the right subclavian artery. At the level of C3/C4, both common carotid arteries bifurcate into their internal and external branches. The internal carotid begins postero-lateral to the external carotid artery. The internal carotid provides no branches within the neck, instead heading straight for the carotid canal in the skull base. Once through the carotid canal, the internal carotid artery turns 90 degrees antero-medially and passes through the foramen lacerum within the petrous temporal bone. Turning superiorly once again, the internal carotid enters the cavernous sinus within the cranial vault and undergoes two final turns before terminating as the anterior and middle cerebral arteries. The external carotid provides arterial blood to the upper neck, face (including scalp) and nasopharynx. There are eight commonly described branches of the external carotid artery (superior thyroid, ascending pharyngeal, lingual, facial, occipital, posterior auricular, superficial temporal and maxillary arteries), but individual variation is described.

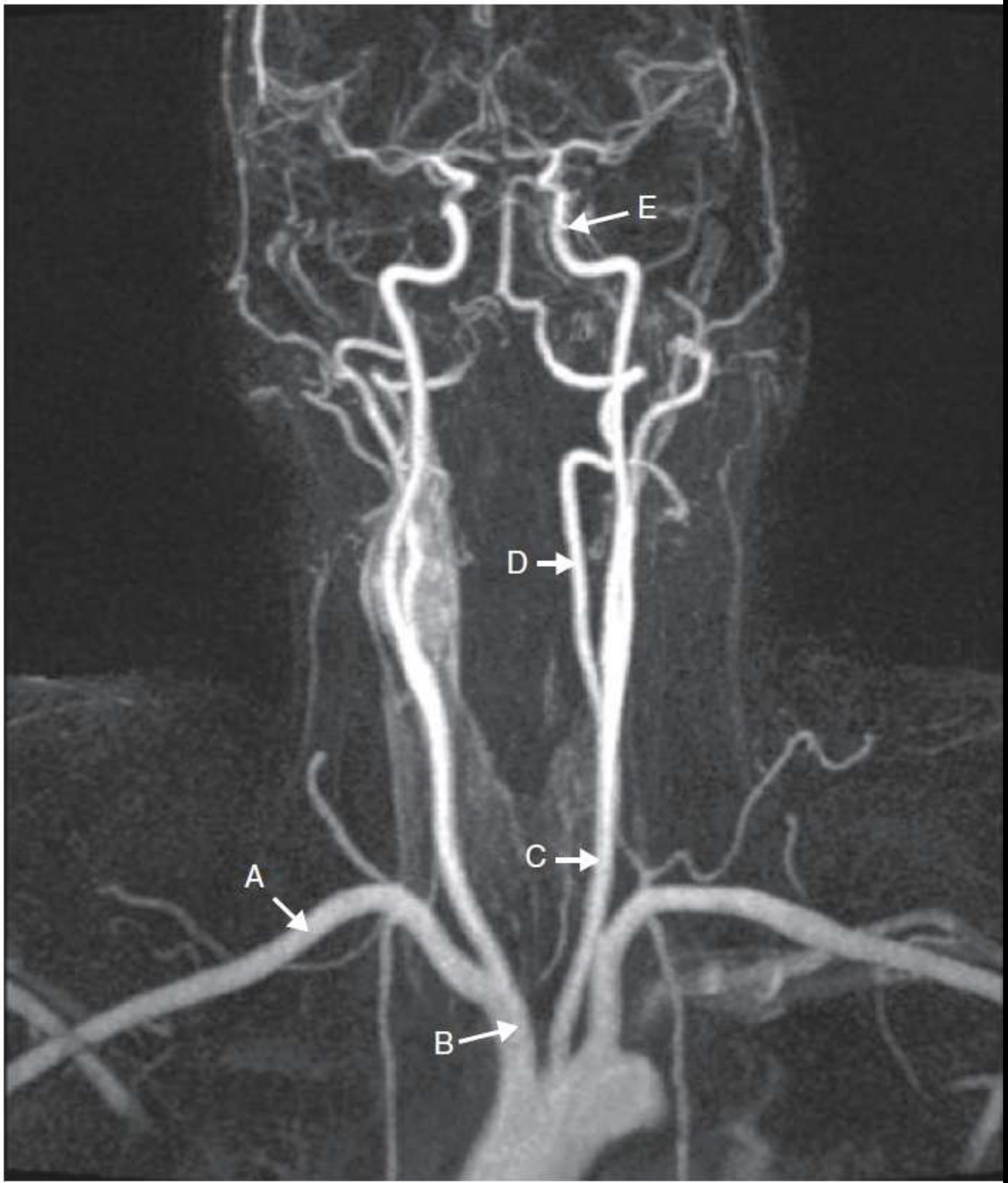

7
8
9
6
10

MRA

6. Right posterior cerebral artery
7. Right anterior cerebral artery
8. Right middle cerebral artery
9. Basilar artery
10. Left vertebral artery

The Circle of Willis is an anastomosis between right and left internal carotid arteries, their branches and the posterior cerebral arteries. It is complete in 90 %, and there is variation of at least one vessel in around 60 %.

Case 6.3



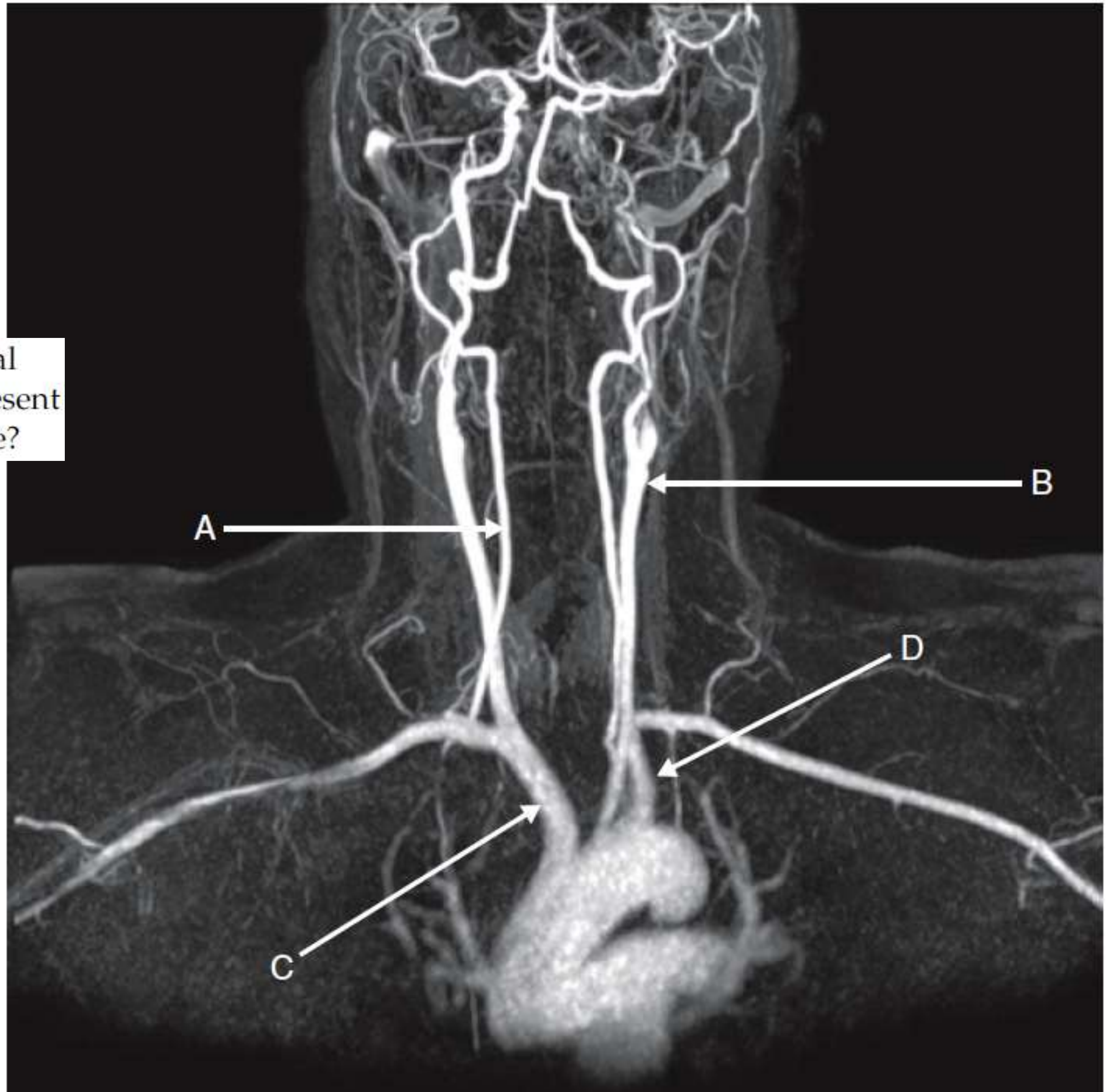
6.3 MRA carotids

(a) Right subclavian artery. This arises from the bifurcation of the brachiocephalic trunk behind the right sternoclavicular joint. An anomalous right subclavian artery occurs in 1% of the population.
(b) The brachiocephalic trunk. This bifurcates into the right common carotid and subclavian arteries and is the first major branch of the ascending aorta.

(c) Left common carotid artery. In 20% of the population this takes origin from the brachiocephalic trunk.
(d) Left vertebral artery. This travels through the transverse foramina of C6 to C1 where it passes medially to enter the foramen magnum.
(e) Left internal carotid artery. This begins at the level of C4 at the carotid bifurcation.

Imaging of the carotid arteries and other vessels with MR can largely be achieved without contrast. Either the signal from flowing blood entering an image plane can be measured (time of flight MRA) or the velocity differences in flowing blood can measured (phase contrast MRA). However, these imaging techniques depend on laminar flow and therefore turbulent flow, as seen with stenoses, can result in signal loss and subsequent overestimation of stenoses and occlusion.

Case 8.10

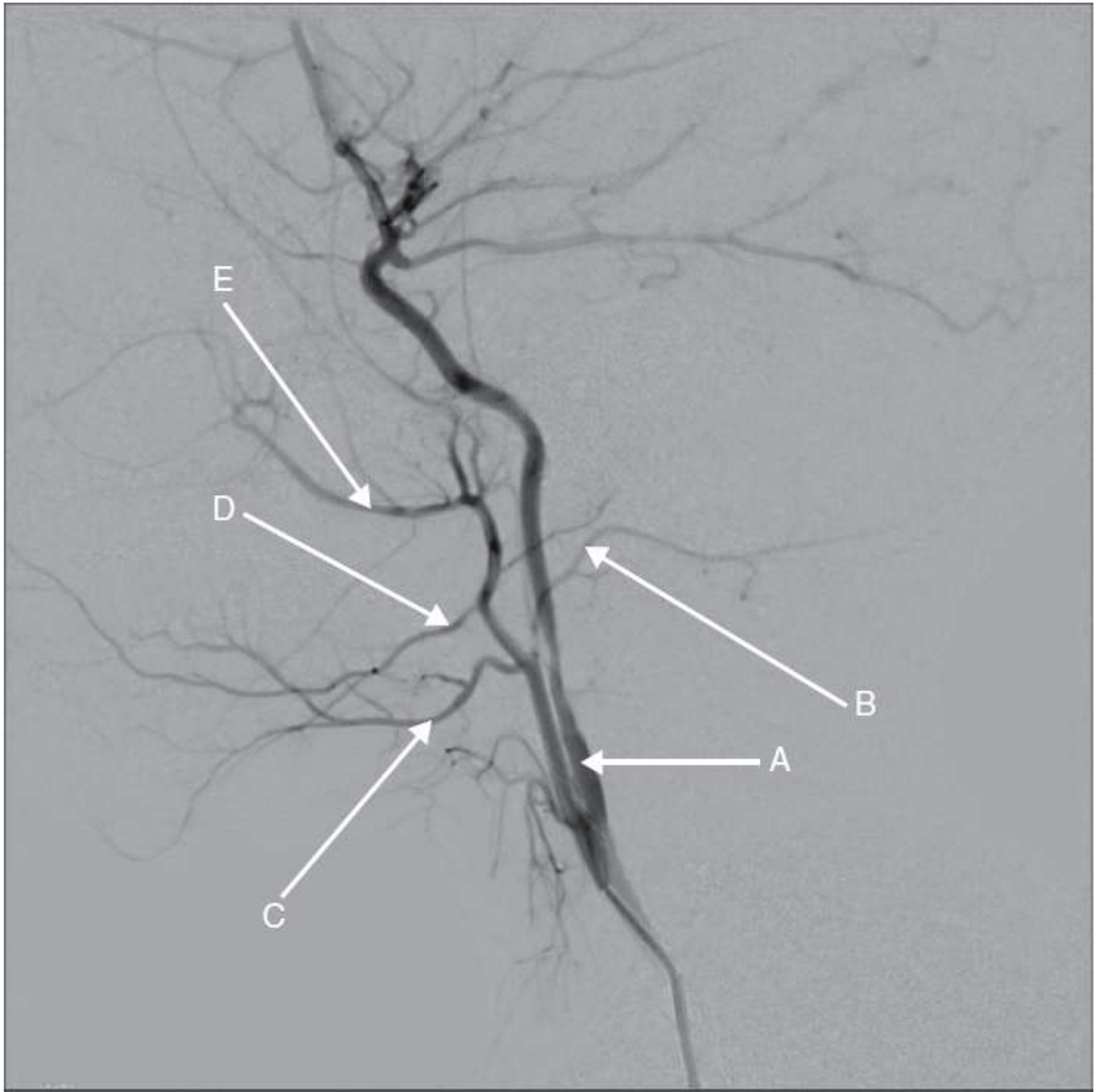


(e)	Which normal variant is present on this image?

8.10 MRA carotids

(a) Right vertebral artery.
(b) Left common carotid artery. The left internal carotid artery just superior to this is seen to be occluded on this study.
(c) Brachiocephalic trunk (innominate artery).
(d) Left subclavian artery.
(e) Left vertebral artery arising directly from the arch of the aorta. This occurs in 6% of the population, with the most frequent location for its origin being between the left common carotid and subclavian arteries.

Case 4.3



4.3 Cerebral angiogram common carotid artery

(a) Internal carotid artery. The internal carotid and external carotid arteries arise from the bifurcation of the common carotid artery at C4 level. The internal carotid artery gives off no branches in the neck while the external carotid artery gives off several.

Close to its origin the external carotid artery has two branches, the superior thyroid artery arises anteriorly and the ascending pharyngeal artery arises medially.

(b) Occipital artery.

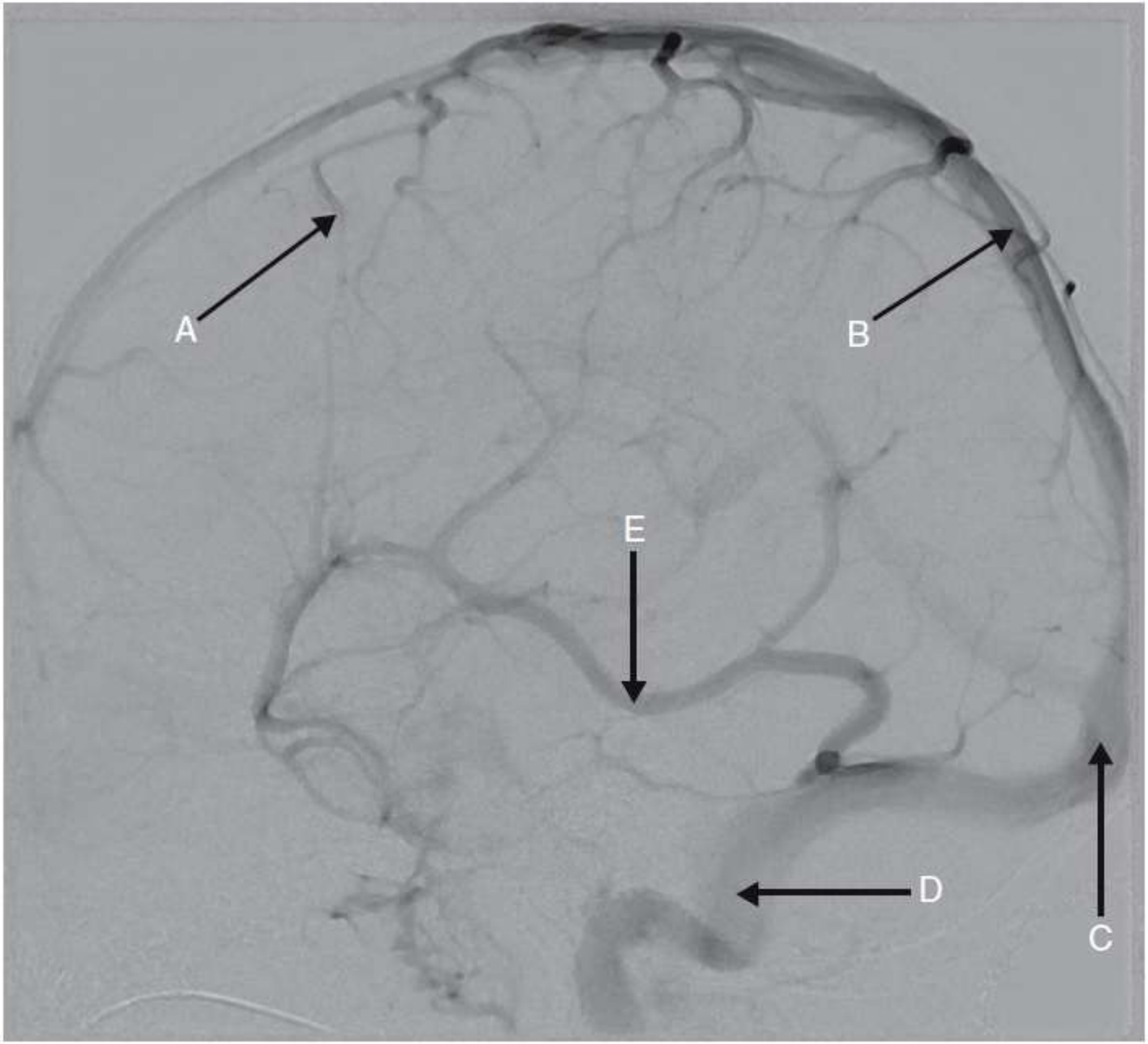
(c) Lingual artery. The lingual artery is the third branch of the external carotid artery and runs anteriorly and supplies the tongue.

(d) Facial artery. The facial artery arises anteriorly, usually at the same level as the occipital artery arises posteriorly.

The posterior auricular branch is the next branch that arises posteriorly to supply the region of the pinna.

(e) Maxillary artery. The external carotid then divides to form the maxillary artery and the superficial temporal artery.

Case 2.16



2.16 Cerebral venography

(a) Superior cerebral veins.

(b) Superior sagittal sinus. There are ten named dural venous sinuses. The brain drains centrifugally into the superficial system and centripetally towards the deep cerebral system.

Thrombus in the sinus system is diagnosed with either CT or MR; the abnormal thrombus can be discerned from the adjacent flowing blood giving rise to the 'empty delta' sign on contrast-enhanced images.

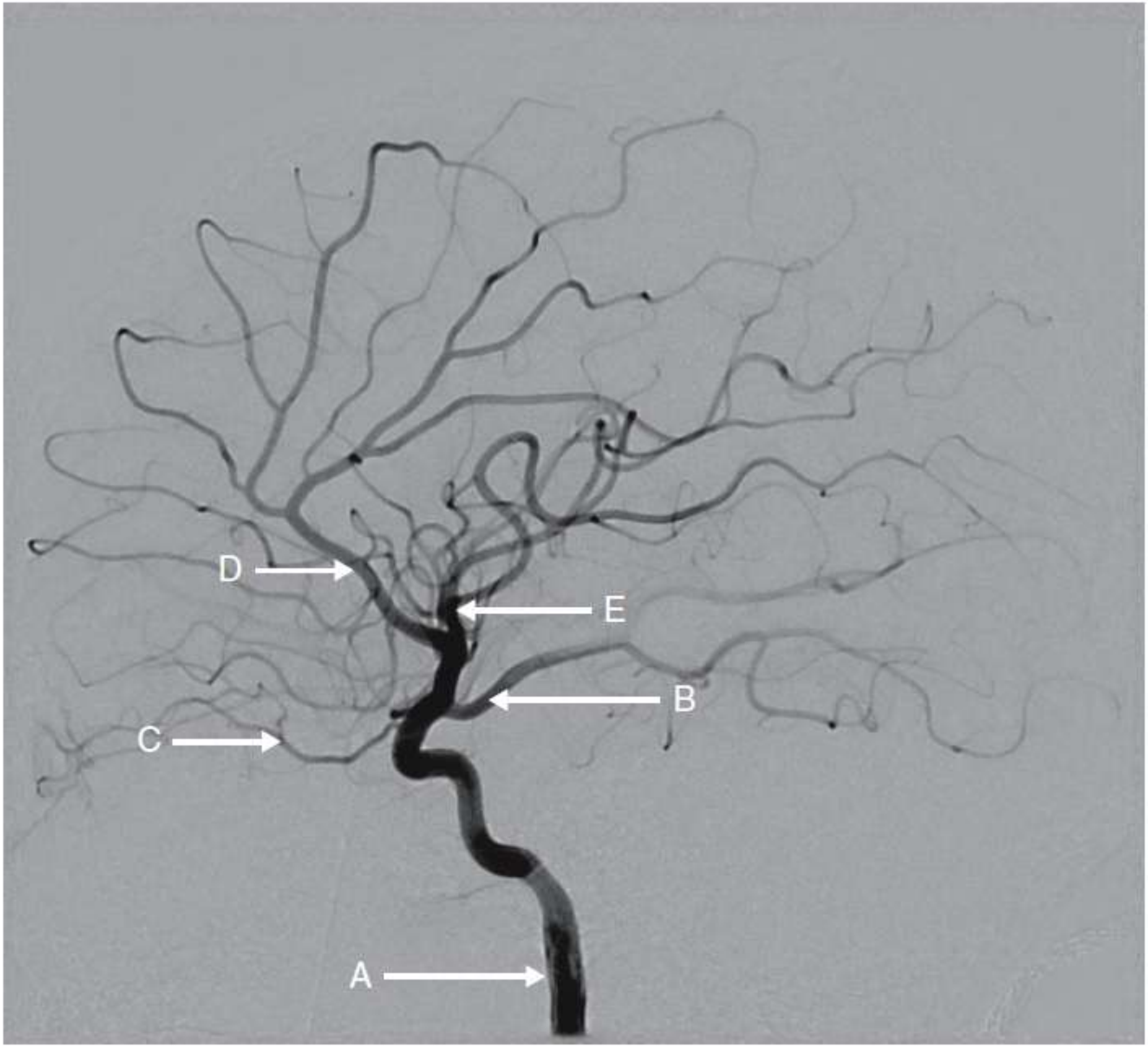
(c) Confluence of sinuses (or torcular herophili).

(d) Sigmoid sinus. These empty into the jugular vein on each side. usually the right jugular vein is more dominant and therefore larger.

The straight and superior sagittal sinuses join at the torcula to form the transverse sinus on each side which run antero-laterally to become the sigmoid sinuses.

(e) Basal vein of Rosenthal. The deep cerebral system consists most centrally of the two internal cerebral veins, which run posteriorly in the roof of the third ventricle inferior to the corpus callosum and join the basal vein of Rosenthal, as well as posterior fossa veins to form the deep cerebral vein (of Galen). This ascends for a short distance to join the inferior sagittal sinus and form the straight sinus (which are only faintly seen on this study).

Case 3.3



3.3 Cerebral angiogram

(a) Internal carotid artery.
(b) Posterior communicating artery.
(c) Ophthalmic artery.
(d) Anterior cerebral artery.
(e) Middle cerebral artery.

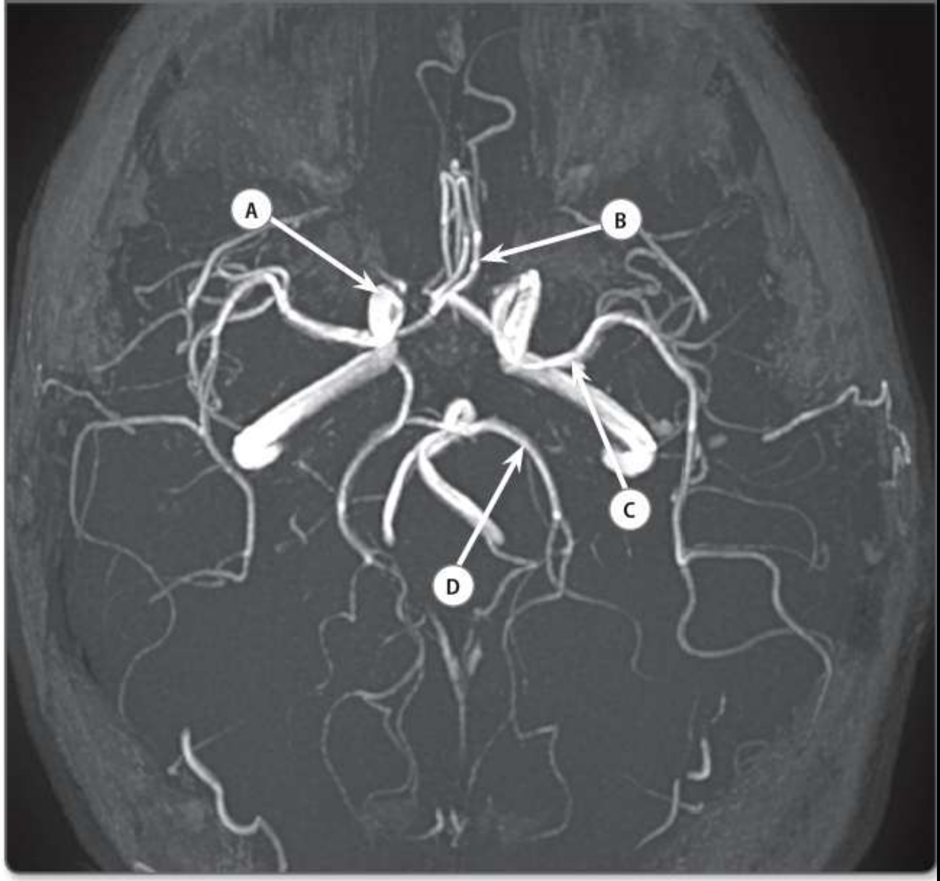
There are four segments of the internal carotid artery:

1. cervical
2. petrous
3. lacerum
4. cavernous.

The circle of Willis is a ring of arteries in the suprasellar fossa that allows collateral supply to the brain. It is made up of the anterior communicating artery, anterior cerebral arteries, middle cerebral arteries, posterior communicating arteries and the

posterior cerebral arteries. The circle is often susceptible to congenital anomalies and has a variable degree of completeness, demonstrating conventional anatomy in approximately one third of people.

Case 15.20



Case 15.20

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 15.20

A Supraclinoid (intracranial) segment of the right internal carotid artery

B Left anterior cerebral artery

C M1 segment of the left middle cerebral artery

D Left posterior cerebral artery

E Absence of the left posterior communicating (P-com) artery

A complete circle of Willis (**Figure 15.1**) is seen in less than 50% of population. There are many potential anatomical variations, of which hypoplasia or absence of one of the P-com arteries is the most common (25–33% of cases).

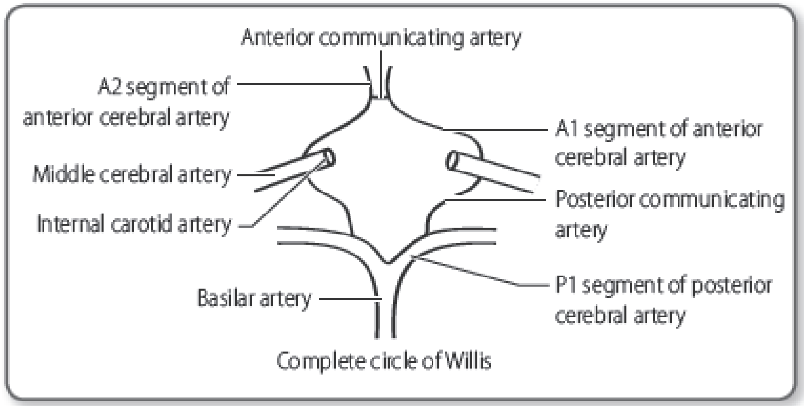
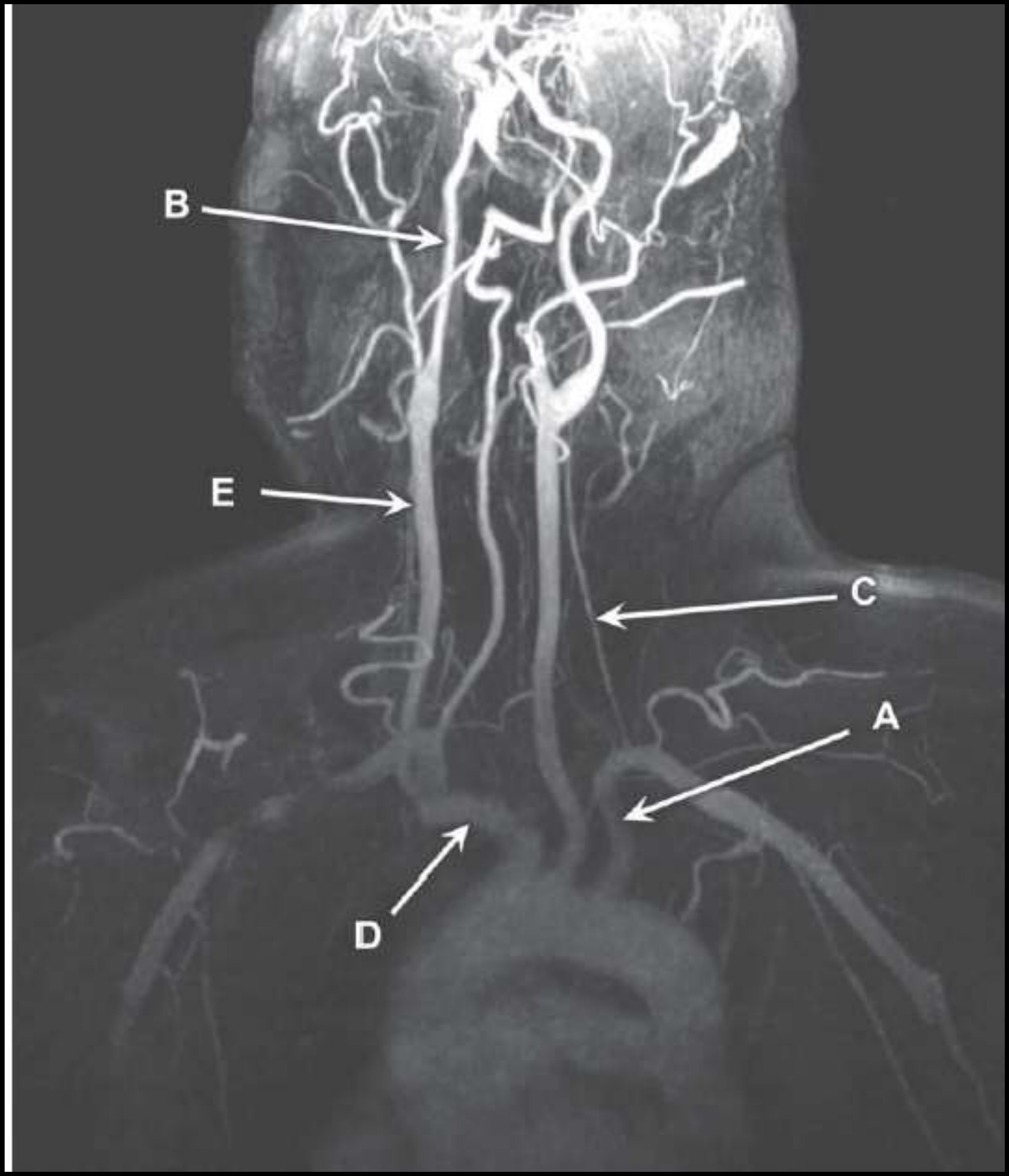


Figure 15.1 Schematic illustration of the complete circle of Willis.

Hypoplasia or absence of the A1 segment of the anterior cerebral artery is present in 10–20%.

Fetal origin of the posterior cerebral artery (PCA) with hypoplasia of the P1 segment (in which the PCA is supplied by the internal carotid artery via P-com) is present in 15–25%.

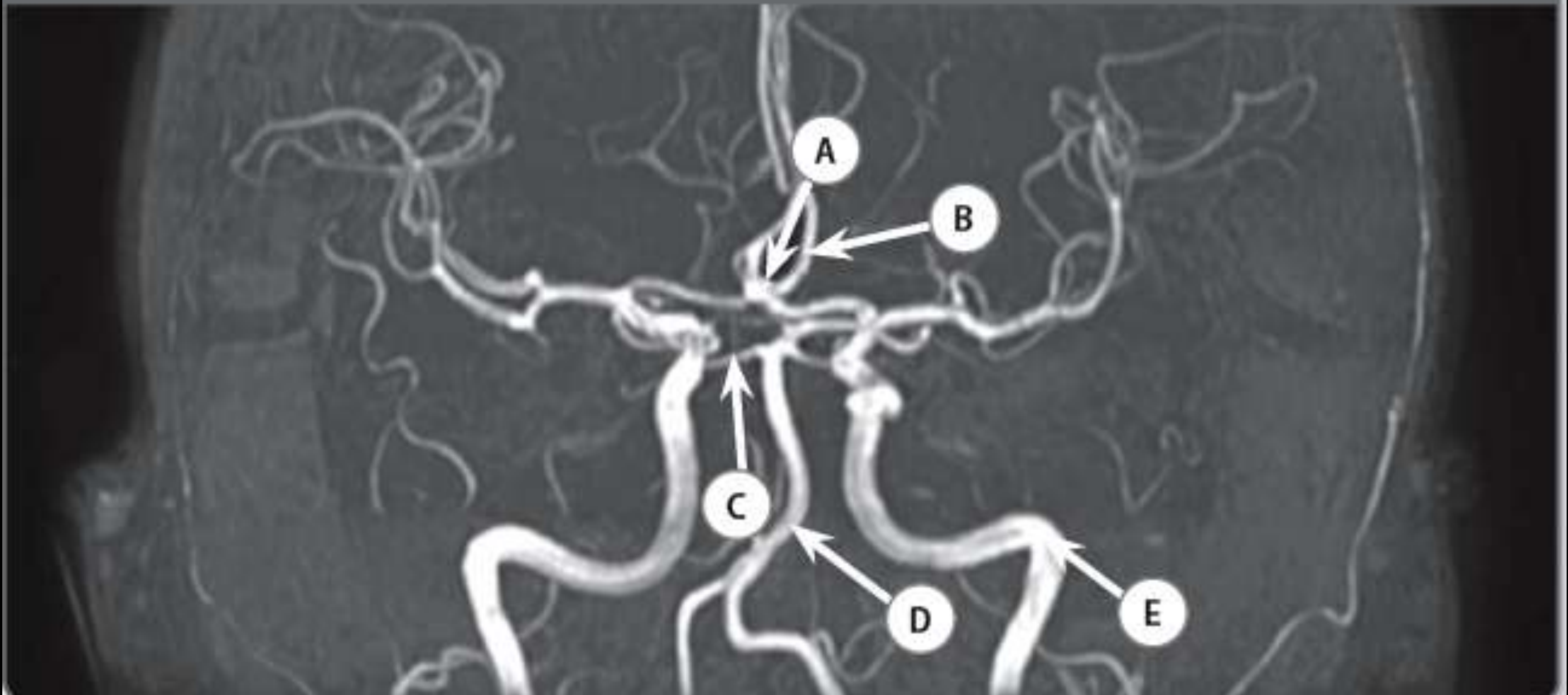

B
E
C
A
D

Case 10

MR-angiogram. Aortic arch/ neck (MIP). Oblique view.

1. Left subclavian artery
2. Right internal carotid artery
3. Left vertebral artery
4. Right brachiocephalic (innominate) artery
5. Right common carotid artery

Case 13.16



Case 13.16

A Anterior communicating artery (ACom)

B Left anterior cerebral artery (ACA)

C Right posterior cerebral artery (PCA)

D Basilar artery (BA)

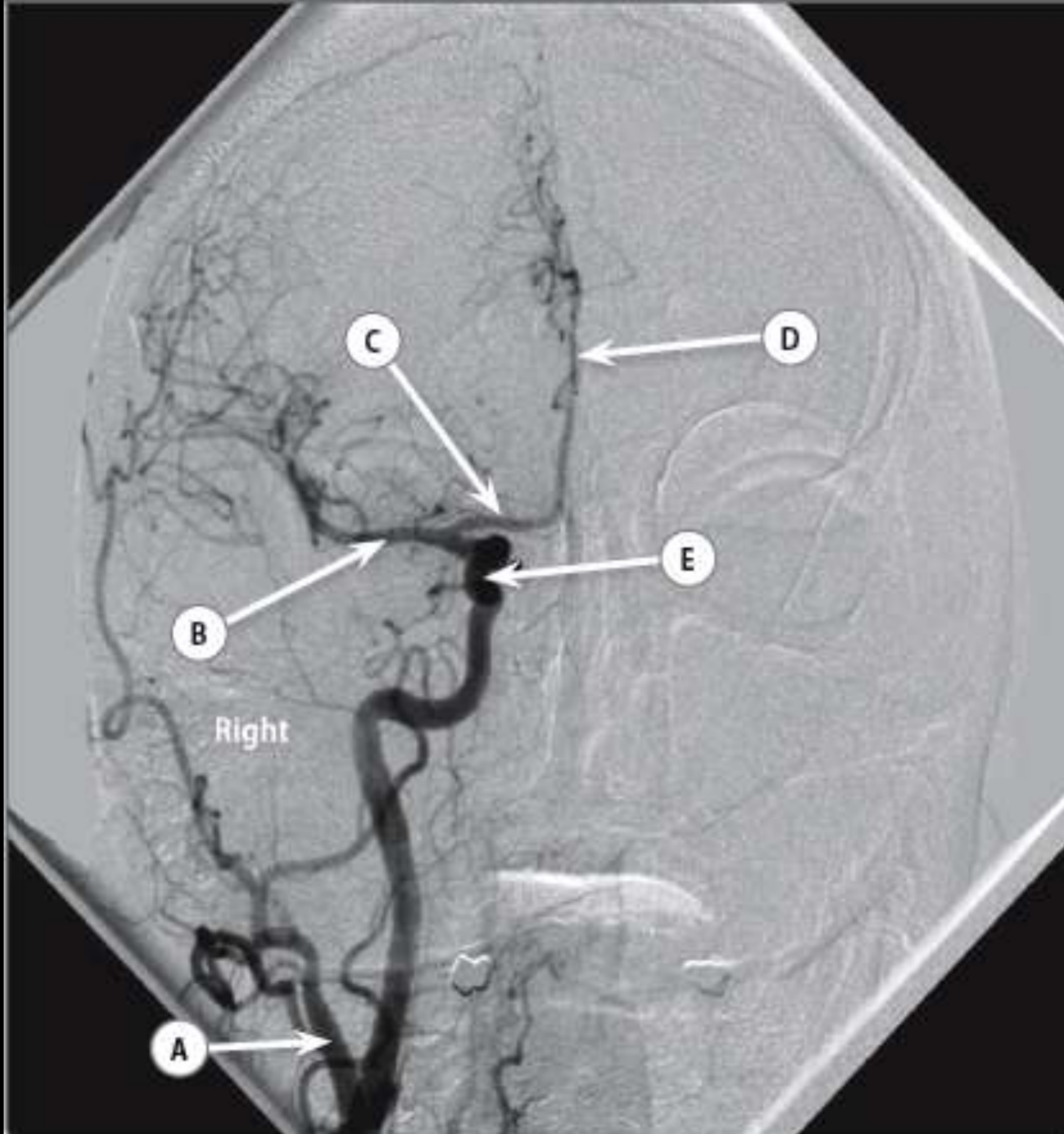
E Petrous portion of the left internal carotid artery (ICA)

The circle of Willis is an anastomotic circle between the anterior and posterior cerebral circulations. It is formed by branches of the ICA and BA and forms a satellite configuration in the suprasellar cistern.

The circle comprises the following paired arteries:

- ACA – ICA branches
- ACom – ACA branch
- ICAs
- PCA – BA branches
- Posterior communicating arteries – middle cerebral artery branches

Case 11.18



Case 11.18

A Right external carotid artery

B Right middle cerebral artery

C Right anterior cerebral artery

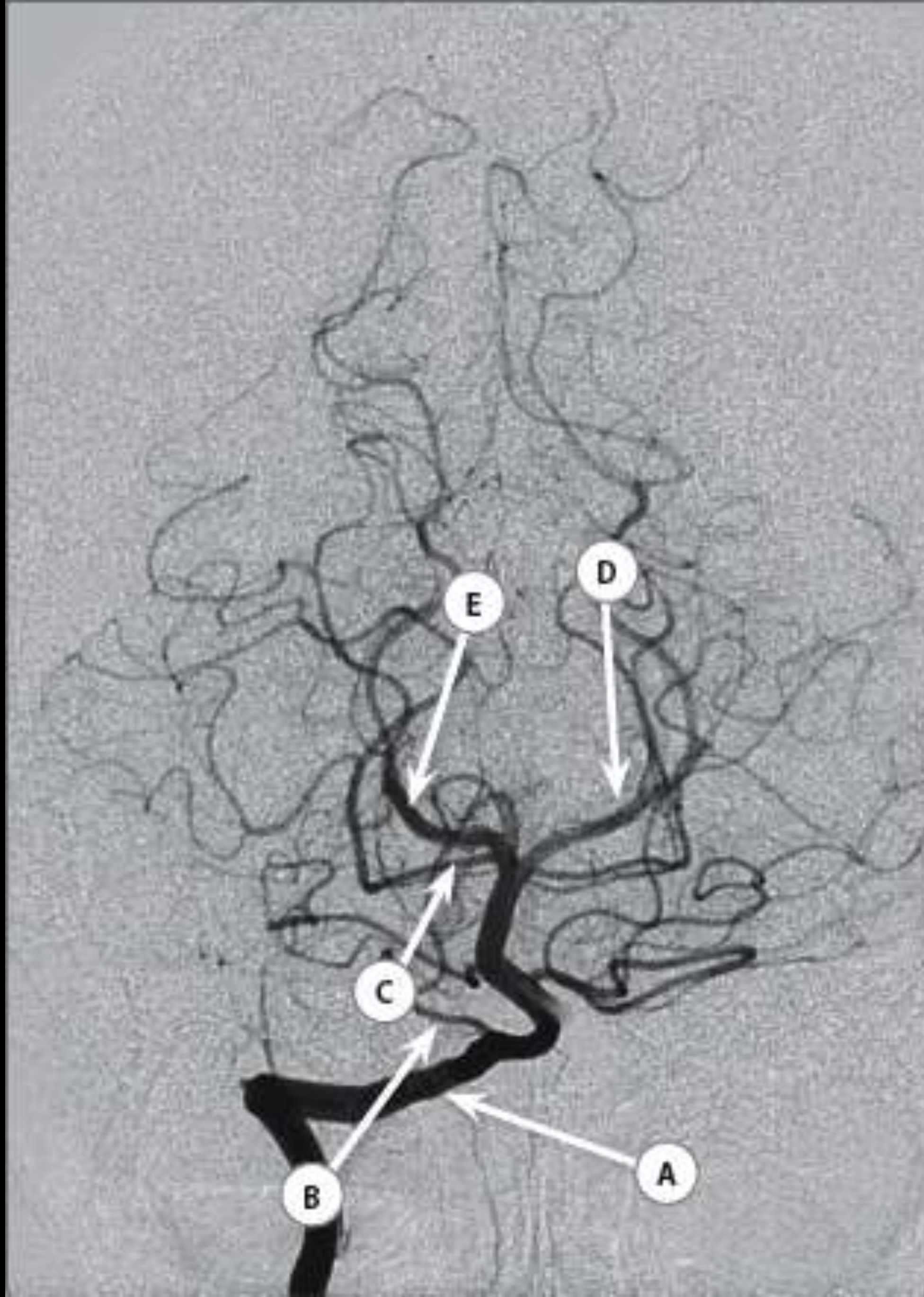
D Right pericallosal artery

E Cavernous portion of the right internal carotid artery

The intracranial portion of the internal carotid artery (ICA) gives off three major branches:

- **Anterior cerebral artery** (ACA) – a smaller terminal branch which runs anteromedially, close to the midline, on the medial surface of the hemisphere in the interhemispheric fissure. Both ACAs are linked by the anterior communicating artery
- **Middle cerebral artery** – the largest terminal branch which runs inferolaterally through the Sylvian fissure between the frontal and temporal lobes
- **Posterior communicating artery** – runs posteriorly and connects with the ipsilateral posterior cerebral artery, forming the posterior portion of the circle of Willis and connecting anterior and posterior circulations.

Case 8.9



Case 8.9

A Right vertebral artery

B Right posterior inferior cerebellar artery

C Right superior cerebellar artery

D Interpeduncular segment of the left posterior cerebral artery (PCA)

E Ambient segment of the right PCA

The first step in approaching a DSA angiogram is recognising a main vessel and then determining its branches. The vertebrobasilar circulation resembles a 'tree' on DSA angiography.

On the frontal projection, it looks like a 'tree on a windless day' (**Figure 8.1**), whereas on the lateral projection, it is shaped like a 'tree on a windy day' (see Figure 5.1, p. 242).

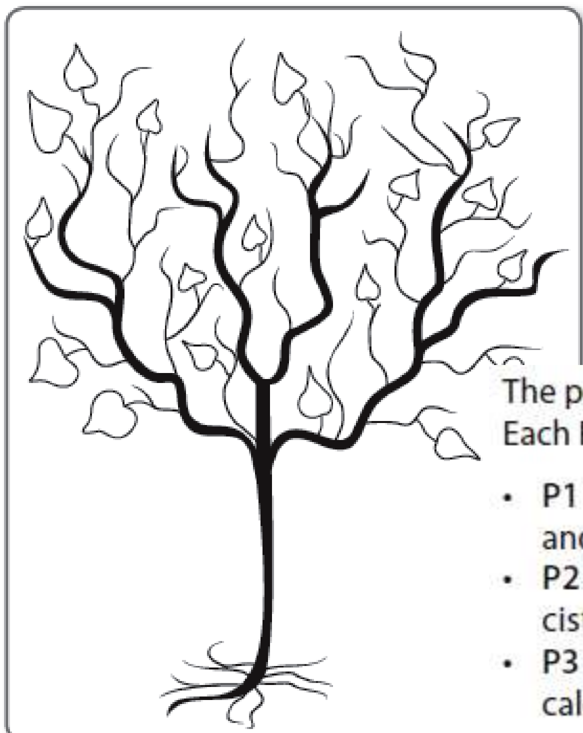
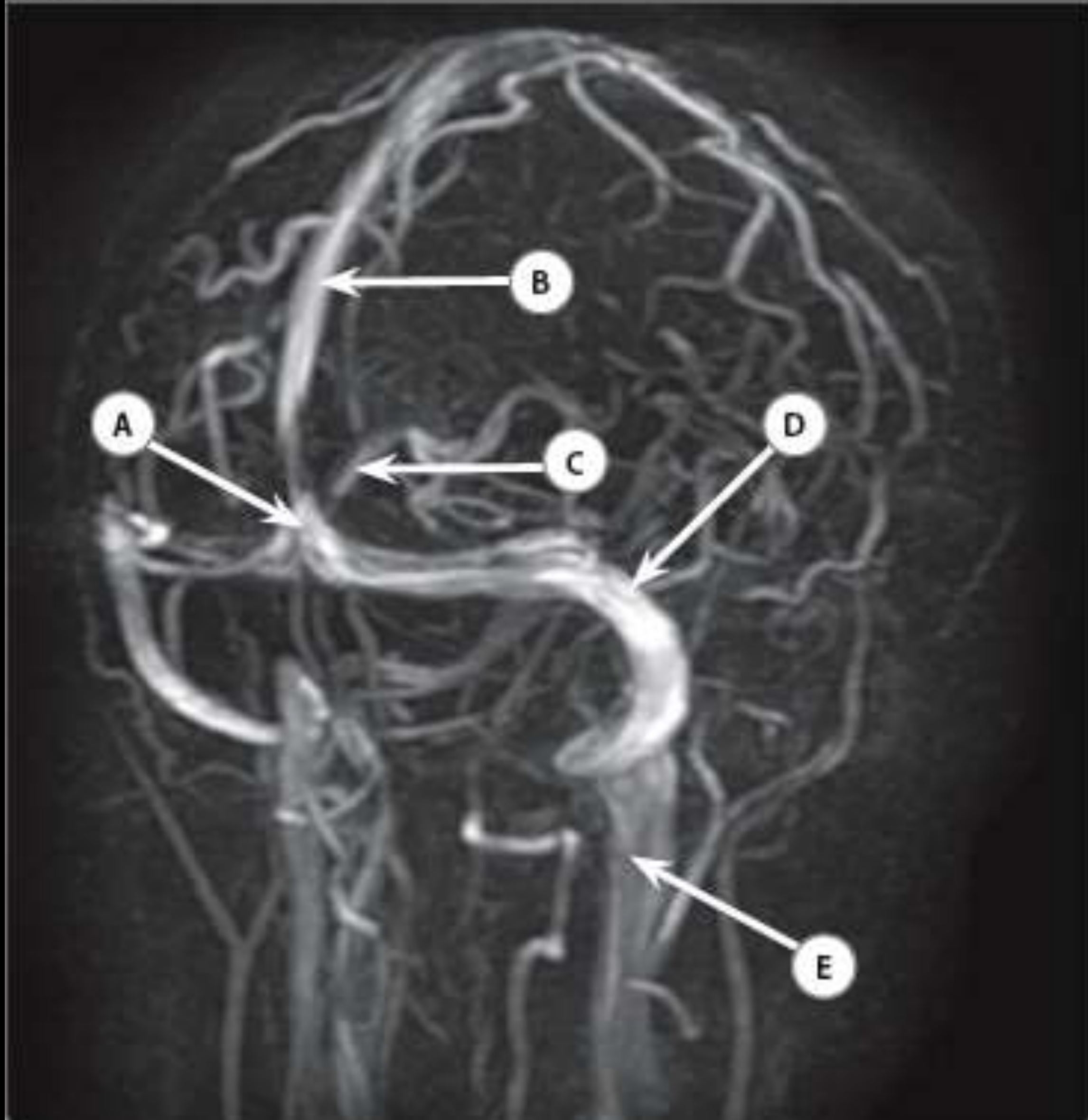


Figure 8.1 'Tree on a windless day'. resembling the vertebrobasilar circulation on frontal DSA angiography.

The posterior cerebral arteries (PCA) are the terminal branches of the basilar artery. Each PCA has three segments:

- **P1** – interpeduncular (pre-communicating) segment between basilar bifurcation and the origin of the posterior communicating artery
- **P2** – ambient segment, which runs around the brainstem in the ambient cistern
- **P3** – quadrigeminal segment, which extends from the quadrigeminal plate to the calcarine fissure.

Case 7.6



Case 7.6

A Confluence of the venous sinuses (torcular herophili)

B Superior sagittal sinus

C Straight sinus

D Right transverse sinus

E Right internal jugular vein

Blood from the deep cerebral veins drains centrally into the dural sinuses (the vascular channels lying between the layers of dura). The superior sagittal, straight and occipital sinuses meet at the venous confluence, also known as the torcular herophili. The venous confluence divides into two transverse sinuses which drain into the internal jugular veins via the sigmoid sinuses.

Question 6.10

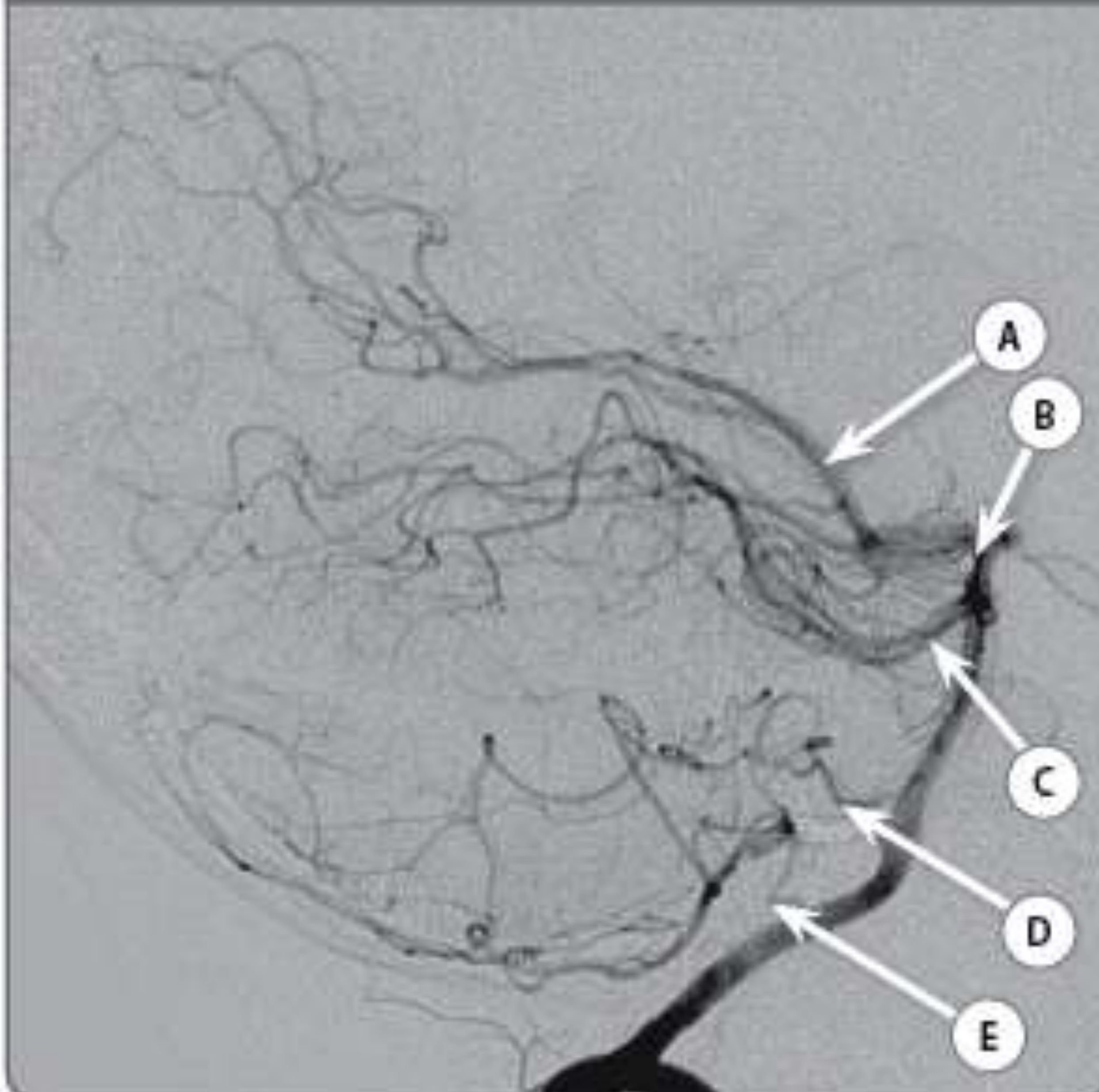
Name the structures labelled **A** to **E**.

6.10 Coronal MR angiogram of the neck

A Right internal carotid artery.
B Basilar artery.
C Left suprascapular artery.
D Left subclavian artery.
E Brachiocephalic artery.

The common carotid arteries bifurcate into the internal and external carotid arteries at approximately the C3 or C4 level. The internal carotid artery has no branches in the neck. The basilar artery supplies blood to the posterior part of the circle of Willis and arises from the confluence of the two vertebral arteries. The left subclavian artery is usually the third aortic arch branch (excluding the coronary arteries). The brachiocephalic artery is the first aortic arch branch.

Case 5.7



Case 5.7

A Posterior cerebral artery

B Basilar tip

C Superior cerebellar artery

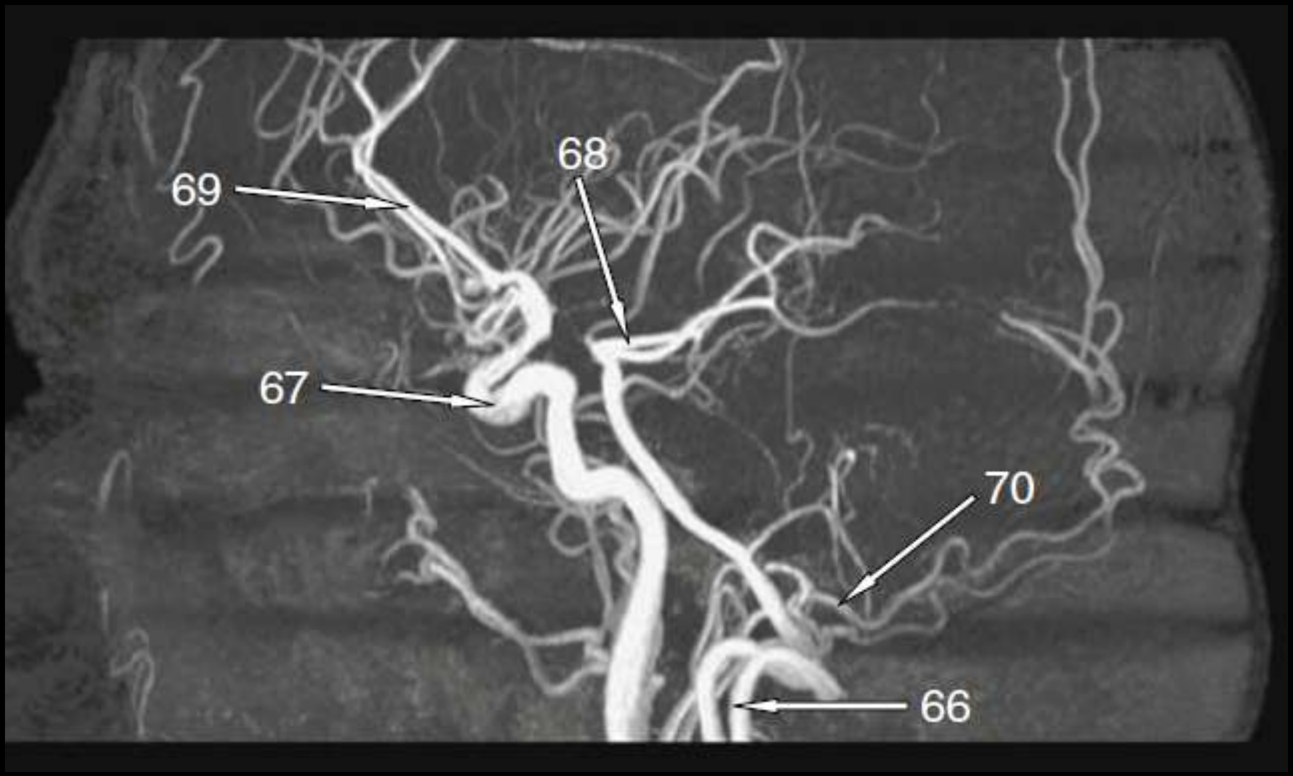
D Anterior inferior cerebellar artery

E Posterior inferior cerebellar artery

The vertebrobasilar circulation resembles a 'tree' on DSA angiography. On the frontal projection, it looks like a 'tree on a windless day' (see Figure 8.1), whereas on the lateral projection it is shaped like a 'tree on a windy day' (**Figure 5.1**).

Two vertebral arteries join to form a single basilar artery (BA) at the pontomedullary junction. The posterior inferior cerebral artery (PICA) – the largest branch of the vertebral artery – arises distally, just before the vertebral confluence. The BA gives off two large branches on each side: the anterior inferior (AICA) and superior cerebellar arteries (SCA).

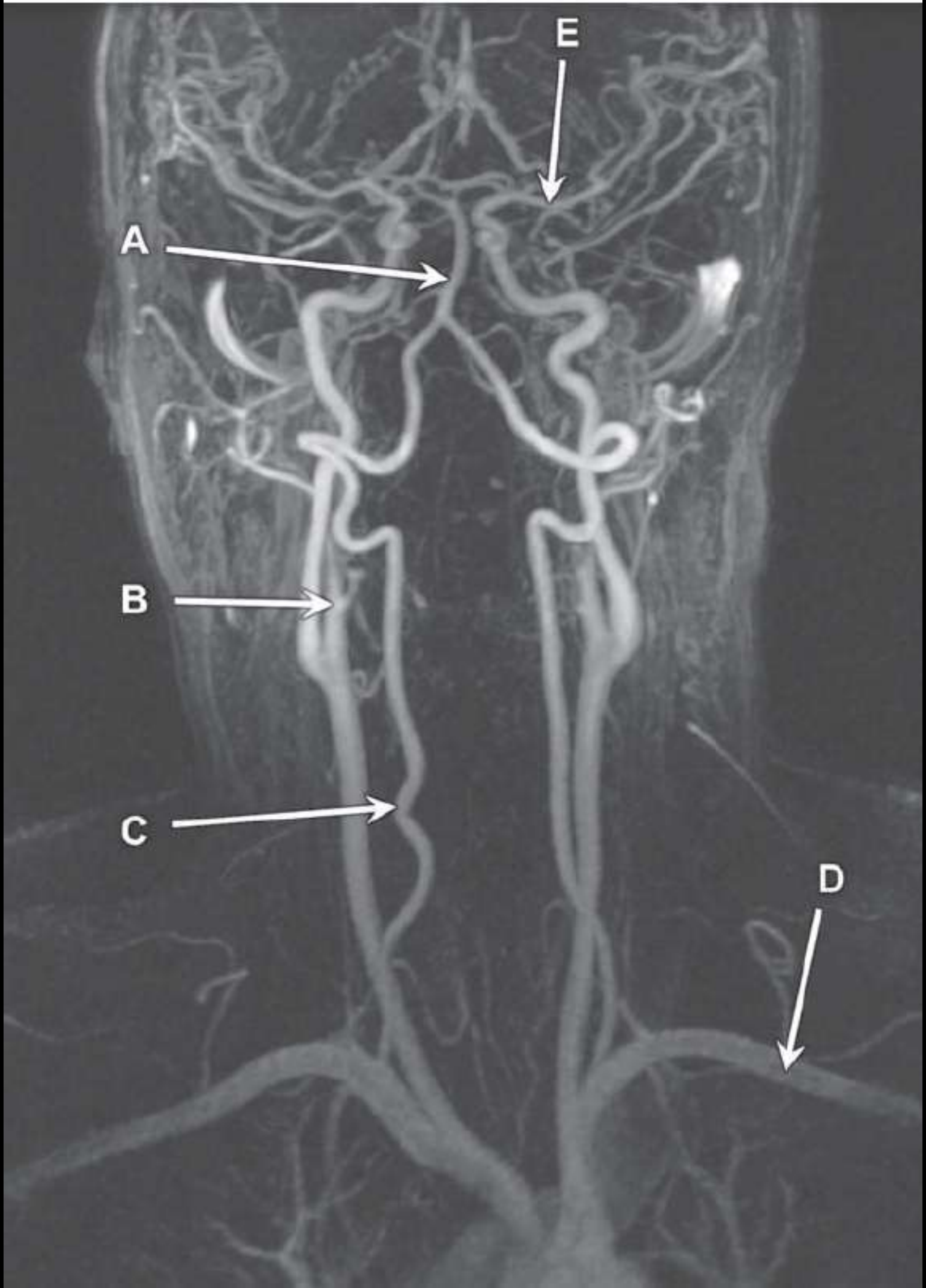
The posterior cerebral arteries (PCA) are terminal branches of the basilar artery.


68
69
67
70
66

MRA

66. Vertebral artery
67. Internal carotid artery (cavernous portion)
68. Posterior cerebral artery
69. Anterior cerebral artery
70. Posterior inferior cerebellar artery

The intracranial carotid artery has a very tortuous course; this may have a role in reducing the pulsating force to the brain. Its intracranial course has been divided into seven anatomical segments according to Bouthillier's classification.

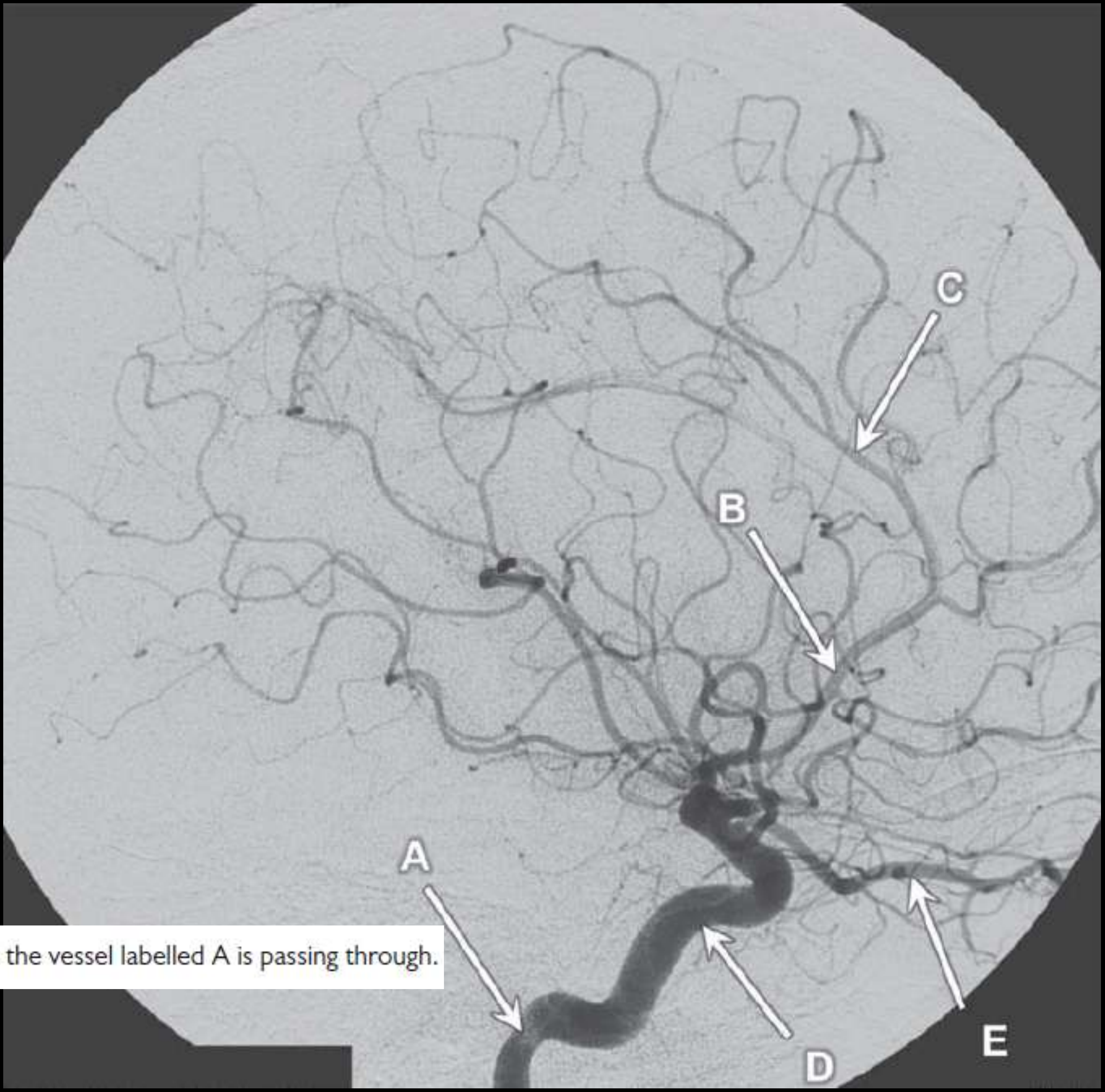

E
A
B
C
D

Case 11

MR angiogram. Neck vessels. AP view.

1. Basilar artery
2. Right external carotid artery
3. Right vertebral artery
4. Left subclavian artery
5. Left middle cerebral artery

The carotids can be confused because the 'external' carotids appear to branch medially. Follow the outer branch and you see that it becomes the middle cerebral artery so is the internal carotid artery.



1. Name bone that the vessel labelled A is passing through.

Case 5

Internal carotid angiogram. Lateral view

1. Petrous temporal bone
2. Anterior cerebral artery
3. Pericallosal artery
4. Internal carotid artery within the cavernous sinus
5. Ophthalmic artery

Question 2.4

2.4 MR angiogram of the circle of Willis

A Right anterior cerebral artery.
B Right middle cerebral artery.
C Right internal carotid artery.
D Right vertebral artery.
E Basilar artery.

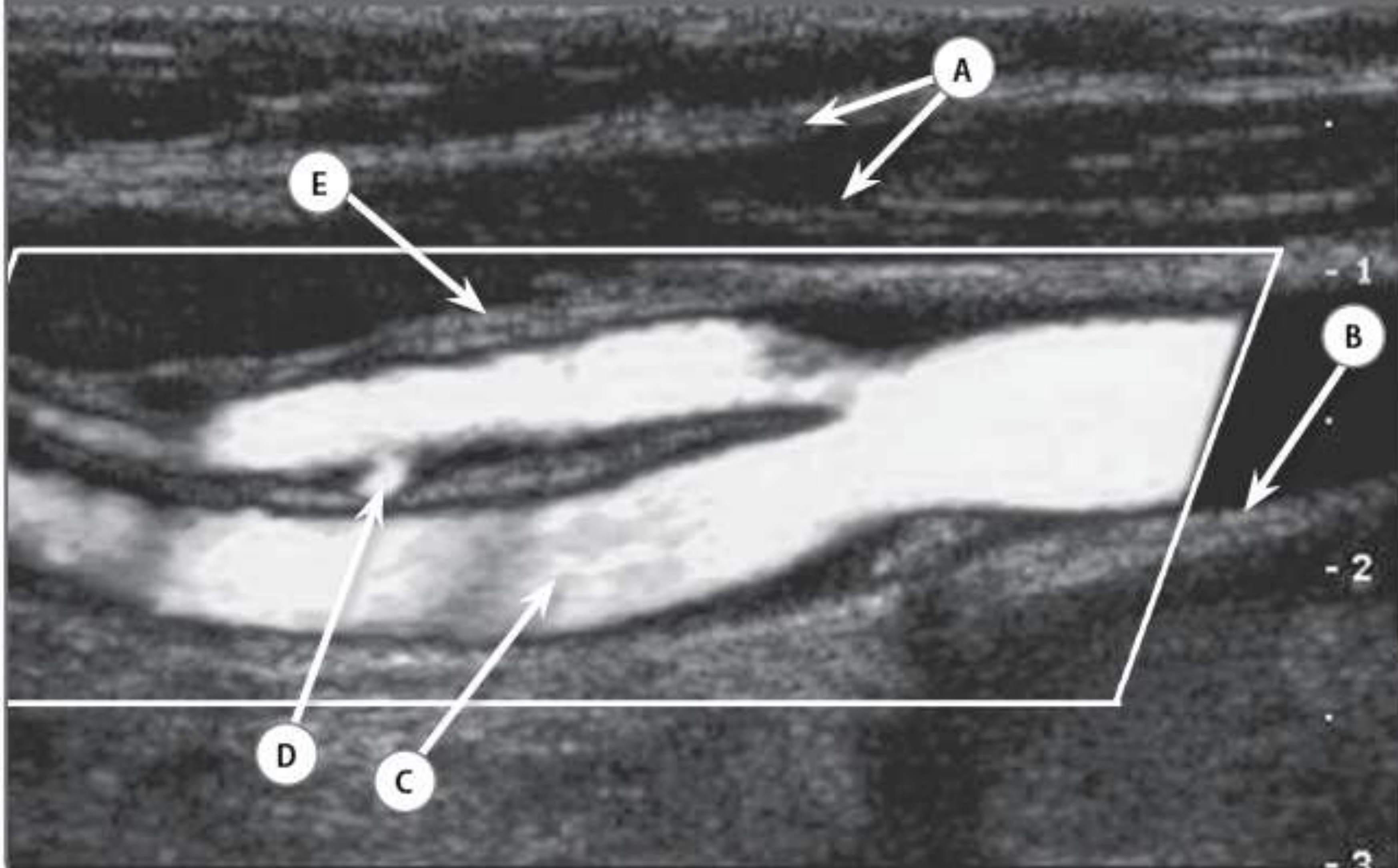
The circle of Willis is a pentagonal arterial circle and comprises of, from posterior to anterior:

- Posterior cerebral arteries, making the back wall.
- Posterior communicating arteries, making the posterior side walls.
- Internal carotid arteries, making the corners.
- Anterior cerebral arteries, making the anterior side walls.
- Anterior communicating artery, making the tip and connecting the anterior cerebral arteries.

The basilar artery, which is formed by the two vertebral arteries, divides into the posterior cerebral arteries and is not considered part of the circle.

For a diagram of the circle of Willis see Question 5.2.

Case 15.8



Case 15.8

A Sternocleidomastoid muscle fibres

B Intima of the common carotid artery

C Internal carotid artery

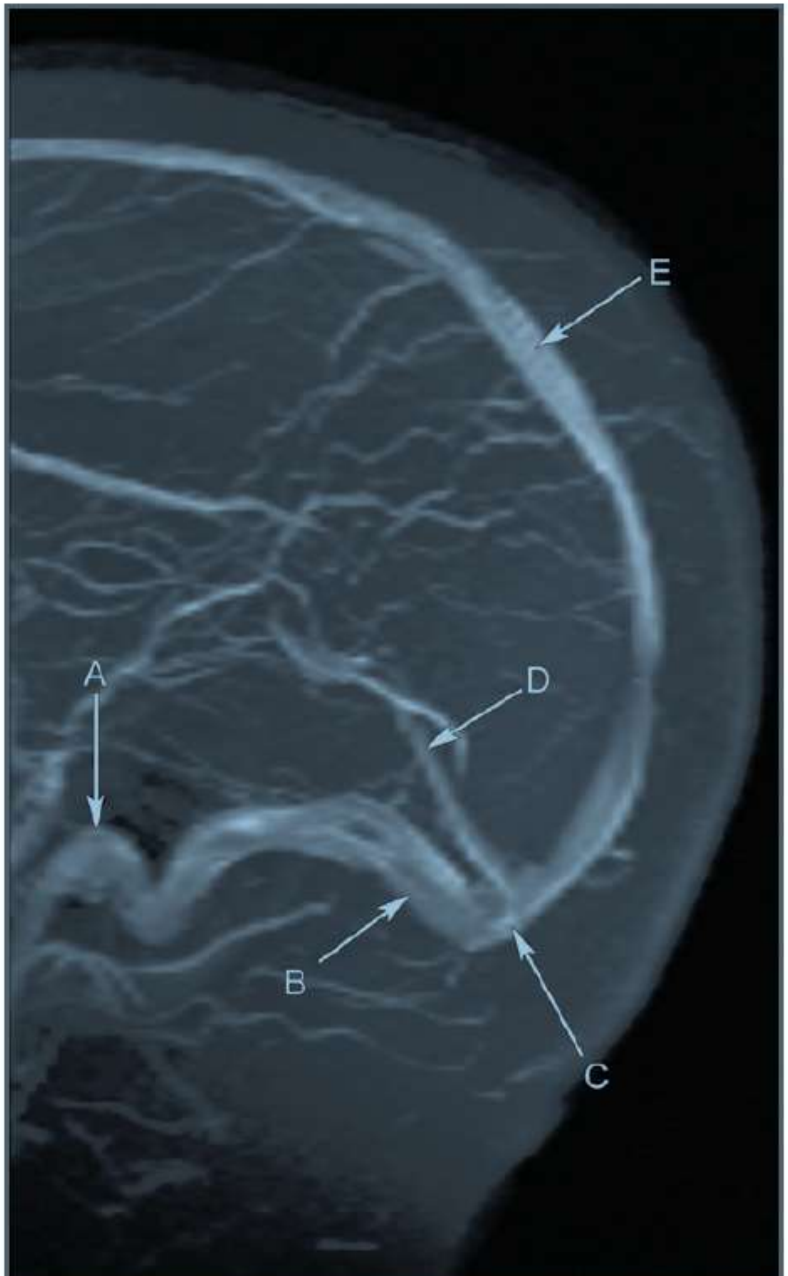
D Ascending pharyngeal artery

E Adventitia of the external carotid artery

Ultrasound examination of the carotid arteries is a non-invasive procedure used as a first line assessment of the severity of the carotid narrowing. This B-mode image is used for assessment of the morphology of the arterial lumen. The normal carotid artery produces two parallel echoes in B-mode imaging, which correspond to the internal and external layers of the wall, the intima and adventitia respectively. The hypoechoic stripe between these layers represents the media.

External carotid artery (ECA) gives off several branches in the neck, the second one being the ascending pharyngeal artery. Remember that the internal carotid artery lies deeper to the external carotid artery and does not give off any branches in the neck.

Question 3.5



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

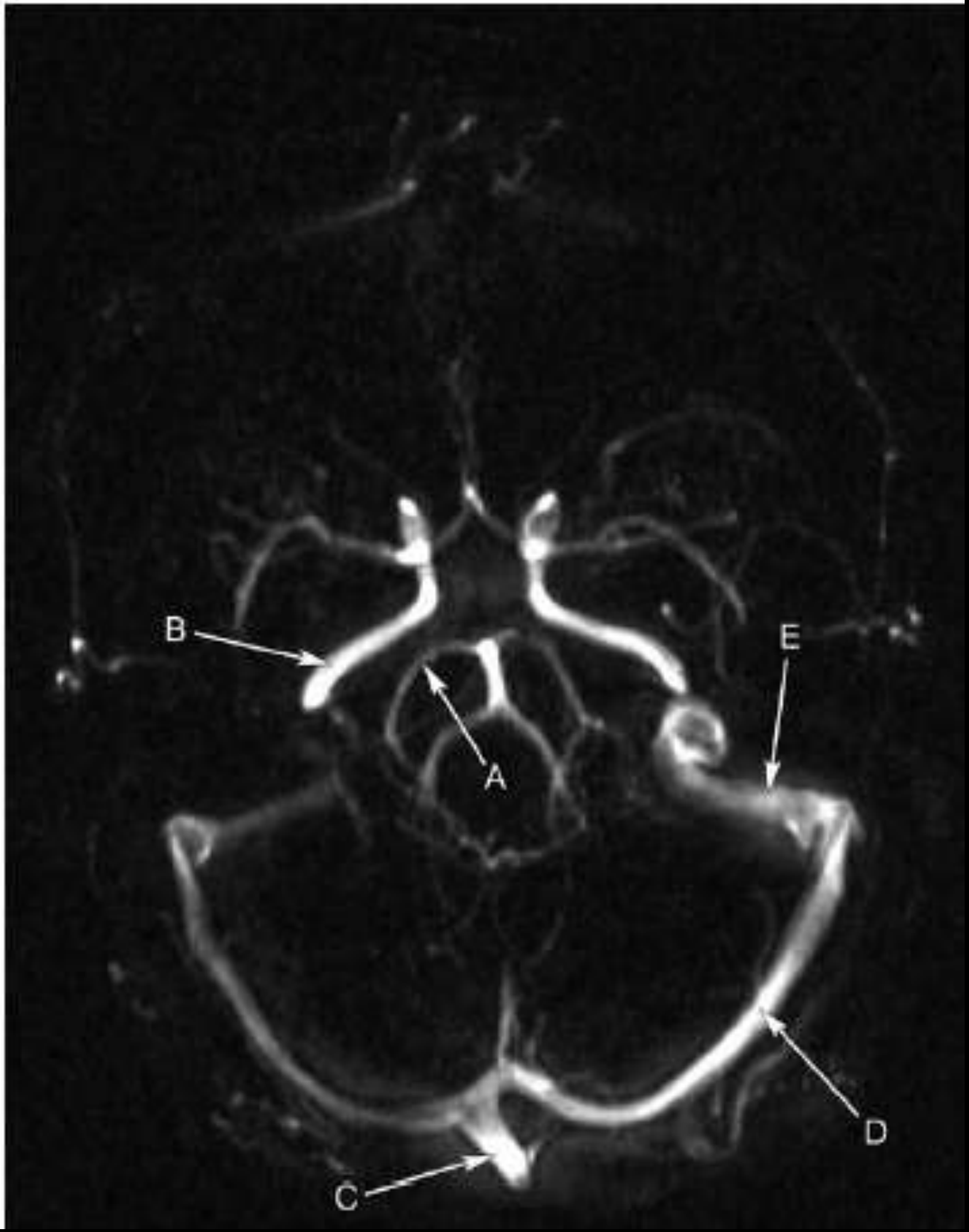
3.5 MRI venogram

A Sigmoid sinus.
B Transverse sinus.
C Confluence of the sinuses or torcular herophili.
D Straight sinus.
E Superior sagittal sinus.

The superior sagittal sinus runs from anterior to posterior of the brain, in the midline and between the two cerebral hemispheres, where it enters the confluence of the sinuses (torcular herophili) anterior to the internal occipital protuberance. The straight sinus is formed from the vein of Galen and the inferior sagittal sinus and is well demonstrated on this image, running from the centre of the brain where it drains into the confluence of the sinuses. The right and left transverse sinuses arise from the confluence and drain into respective tortuous sigmoid sinuses before draining into the internal jugular veins at the jugular foramen.

For a diagram as a further revision aid see Question 4.1

Question 4.1



4.1 MRV of the venous sinuses of the brain

A Right posterior cerebral artery.
B Right internal carotid artery.
C Superior sagittal sinus.
D Left transverse sinus.
E Left sigmoid sinus.

A diagram to aid remembering the sequence:

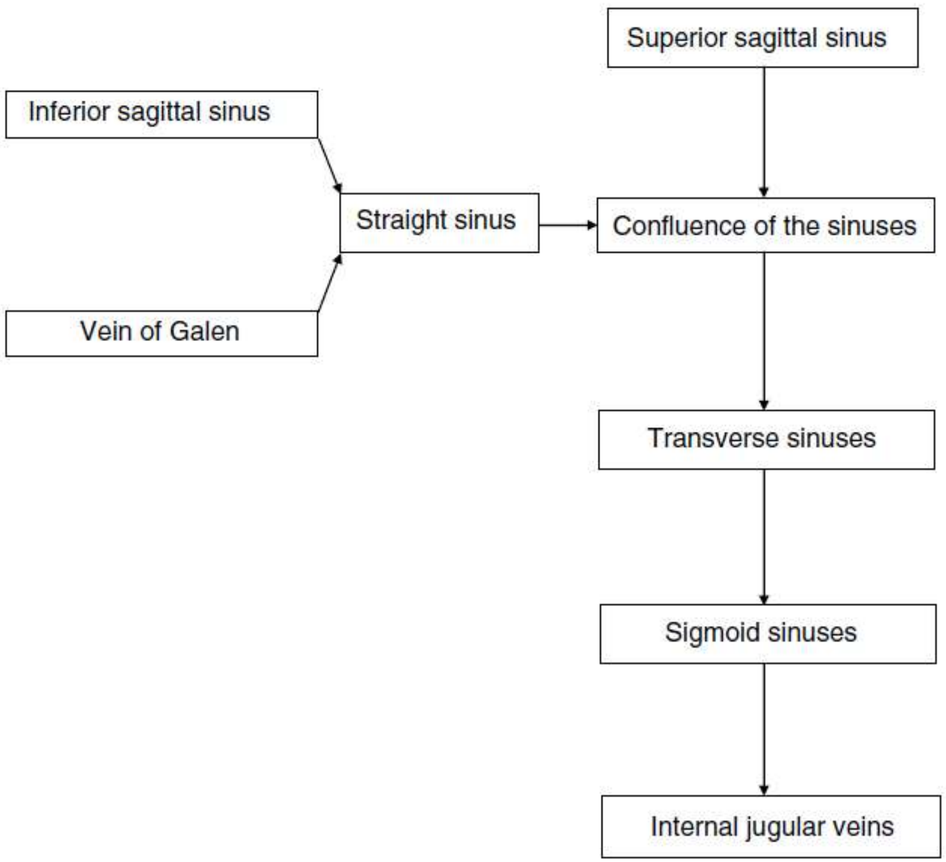


Figure 4.1 Sequence of venous sinuses of the brain

See Question 3.5 for a further description of the venous sinuses of the brain.

Question 7.2

7.2 MR angiogram of the neck

A Right vertebral artery.
B Right common carotid artery.
C Right internal thoracic artery.
D Left common carotid artery.
E Left vertebral artery.

The paired vertebral arteries are branches of the first part of the subclavian arteries and course through the transverse foramen of each cervical vertebra from C6 to C1. After C1, the vertebral arteries pass through the suboccipital triangle and enter the foramen magnum. Within the skull they converge to form the basilar artery at the base of the medulla oblongata. The internal thoracic arteries originate from the subclavian arteries and supply the anterior chest wall and breasts. They divide into the musculophrenic and superior epigastric arteries at the level of the sixth rib.

Question 7.9

7.9 Cerebral venogram

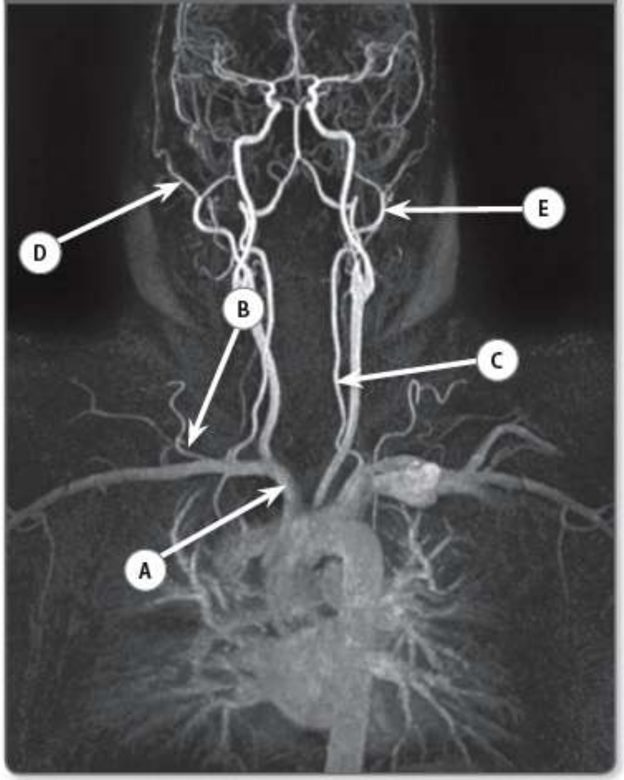
A Superior sagittal sinus.
B Confluence of sinuses (torcular herophili).
C Right transverse sinus.
D Right internal jugular vein.
E Left sigmoid sinus.

There is a complex and highly variable network of cerebral cortical veins that drain into the dural sinus system. These veins run in superficial paths along the cortical sulci to drain the cerebral cortex and white matter. Owing to their variability and complexity, most of these veins are not named. There are a few important cerebral cortical veins that can be consistently identified on imaging. Their anatomy and dominance is, again, highly variable.

Superficial middle cerebral vein (or superficial sylvian vein)	Passes along the sylvian fissure and drains into the sphenoparietal sinus Connects with the vein of Labbé and the vein of Trolard
Vein of Labbé	Anastomotic vein Crosses the temporal lobe Connects the superficial middle cerebral vein to the transverse sinus
Vein of Trolard	Anastomotic vein Connects the superficial middle cerebral vein to the superior sagittal sinus

For further relevant images and explanation of the cerebral venous system, please see Questions 3.5 and 4.1.

Case 2.14



Case 2.14

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 structure labelled D.	
E	Name the structure labelled E.	

Case 2.14

A Brachiocephalic (innominate) artery

B Right costocervical trunk

C Left vertebral artery

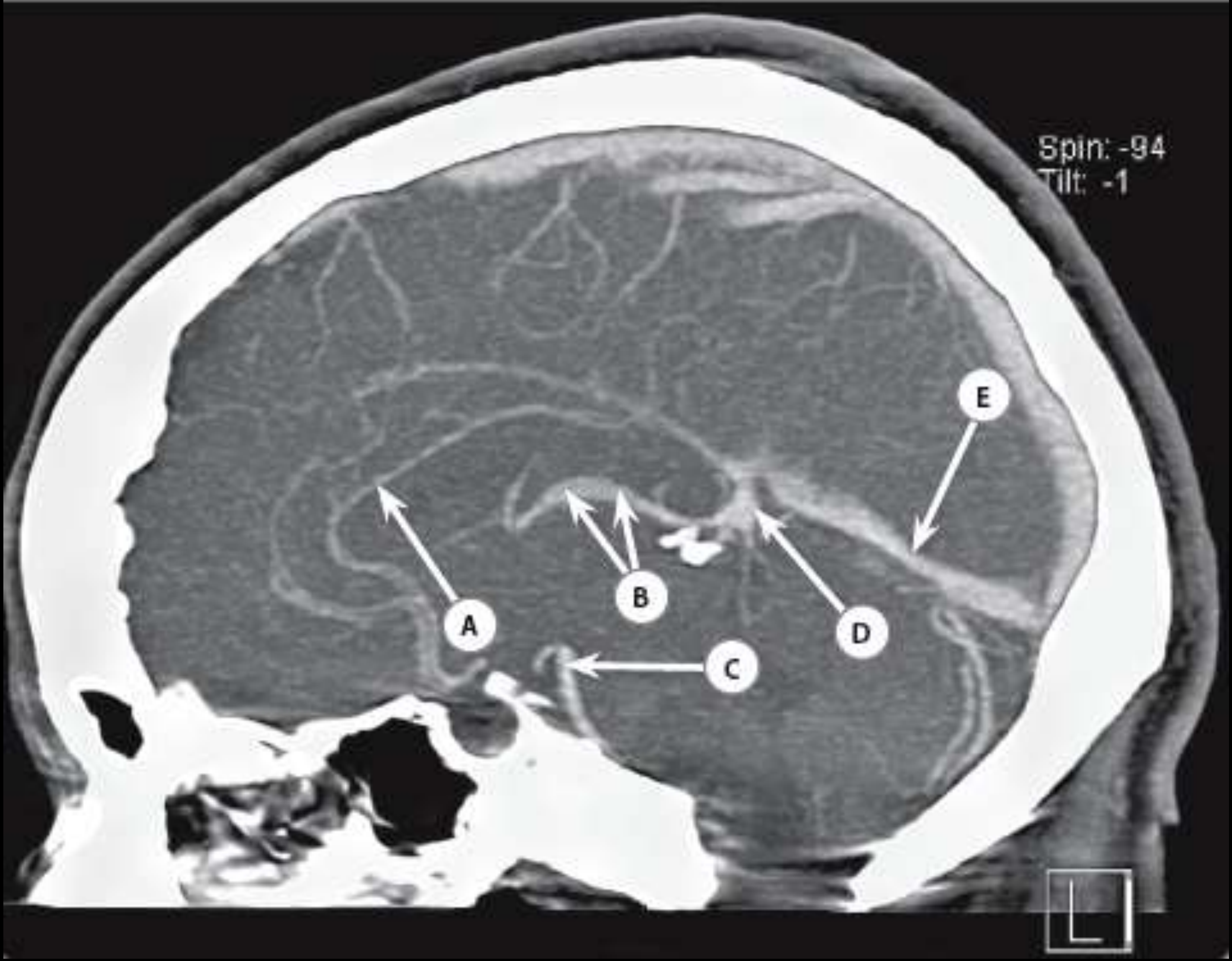
D Right superficial temporal artery

E Left external carotid artery

The costocervical trunk is a branch of the subclavian artery. This can be seen dividing into the deep cervical artery and the supreme intercostal artery. The superficial temporal artery is a terminal branch of the external carotid artery, the other being the maxillary artery.

On the current image, the right thyrocervical trunk is seen to arise adjacent to the right vertebral artery.

Case 10.14



Case 10.14

A Pericallosal artery

B Internal cerebral veins

C Basilar artery

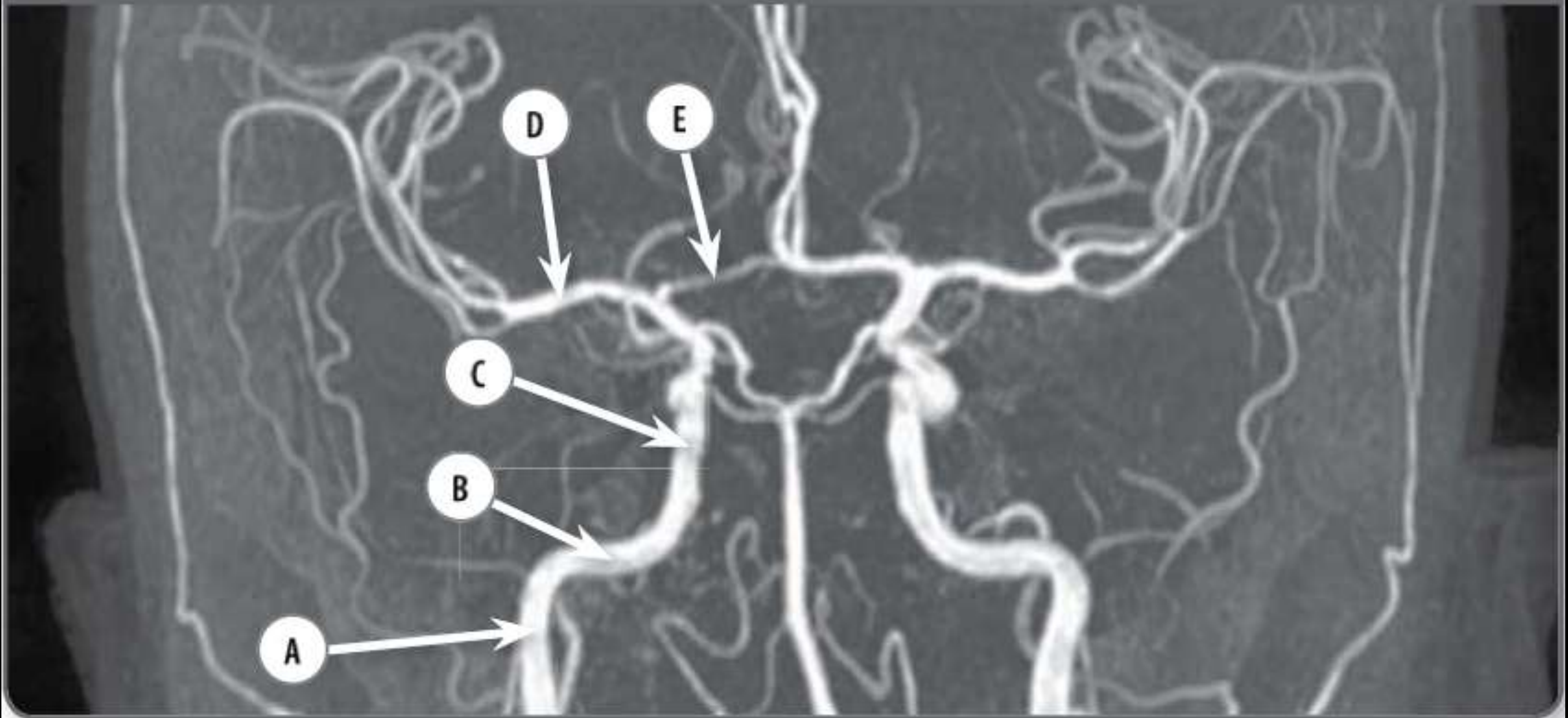
D Great vein of Galen

E Straight sinus

Paired internal cerebral veins join together in the quadrigeminal cistern along with the basal vein of Rosenthal to form the great vein of Galen (great cerebral vein). This is a short single midline vessel which lies under the splenium of the corpus callosum and drains into the straight sinus.

The inferior sagittal sinus lies in the free edge of the falx cerebri.

Case 1.13



Case 1.13

A Right internal carotid artery (cervical segment)

B Right internal carotid artery (petrous segment)

C Right internal carotid artery (cavernous segment)

D Right middle cerebral artery

E Right anterior cerebral artery

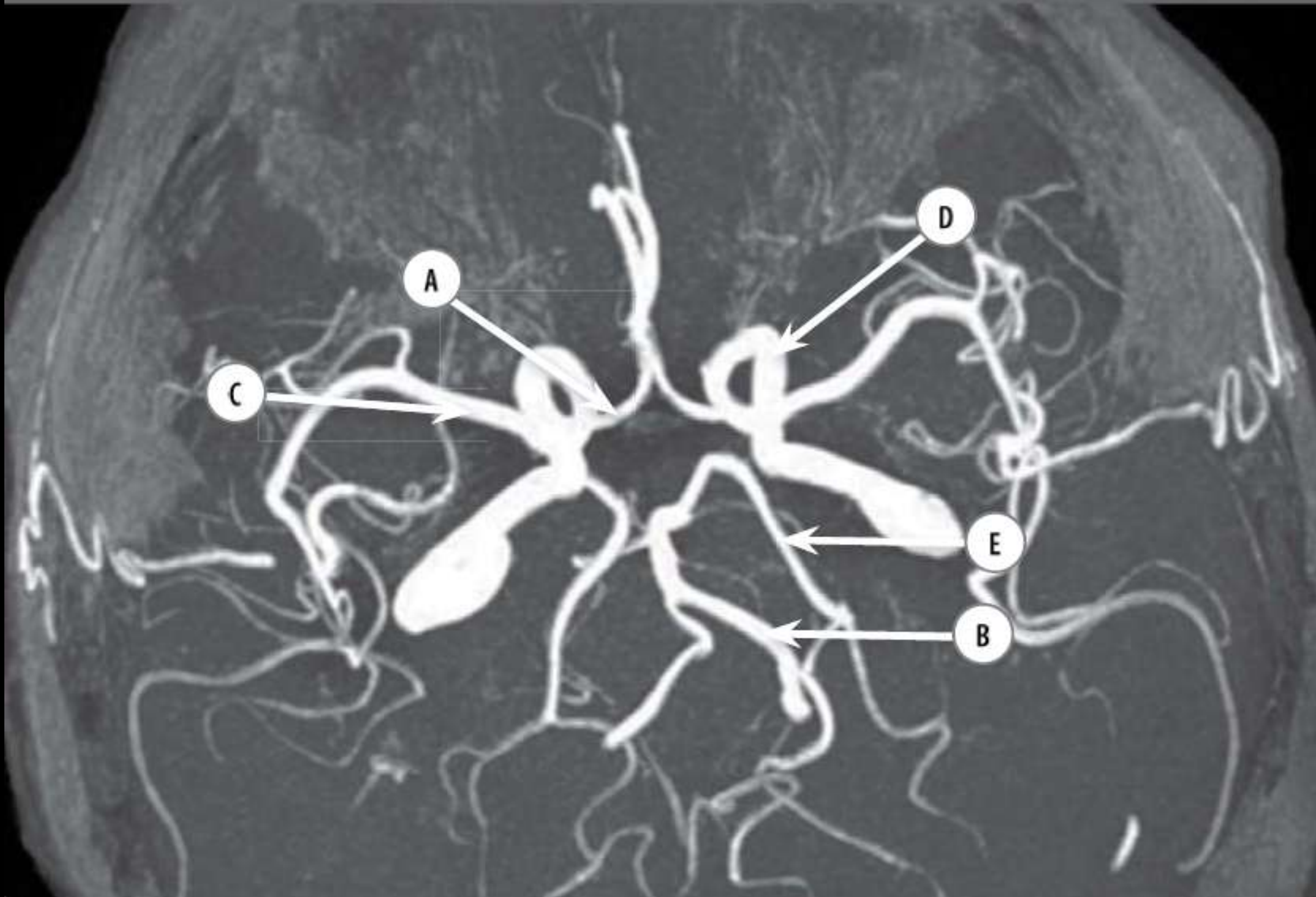
Magnetic resonance angiography – coronal view.

The internal carotid artery arises from the common carotid artery and lies posterolateral to the external carotid artery. No branches arise from the common carotid artery or the cervical segment of the internal carotid artery.

The internal carotid artery enters the skull through the carotid canal. That is where the petrous segment begins. The course here is anteromedial and horizontal as it can be seen in this image. The artery then turns superiorly and enters the cavernous sinus. At this point the cavernous segment begins. Note the siphon shape that the artery assumes in this segment. Emerging from the cavernous sinus the artery divides into its terminal branches: the anterior cerebral artery and the middle cerebral artery.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 36–40.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging. Edinburgh: Saunders, 2004: 80–87.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 50–57.

Case 1.14



Case 1.14

A Right anterior cerebral artery

B Left vertebral artery

C Right middle cerebral artery

D Left internal carotid artery

E Posterior cerebral artery

Magnetic resonance angiography – axial view.

The circle of Willis lies in the suprasellar cistern. It is formed by links between the internal carotid arteries and the vertebrobasilar system. The single anterior communicating artery links the two anterior cerebral arteries. There are two posterior communicating arteries, one on each side, that link the internal carotid artery with the vertebrobasilar system. The circle of Willis is not circular in shape but rather is star-shaped (**Figure 1.1**). It is complete in only a minority of individuals so do not be thrown by a missing branch.

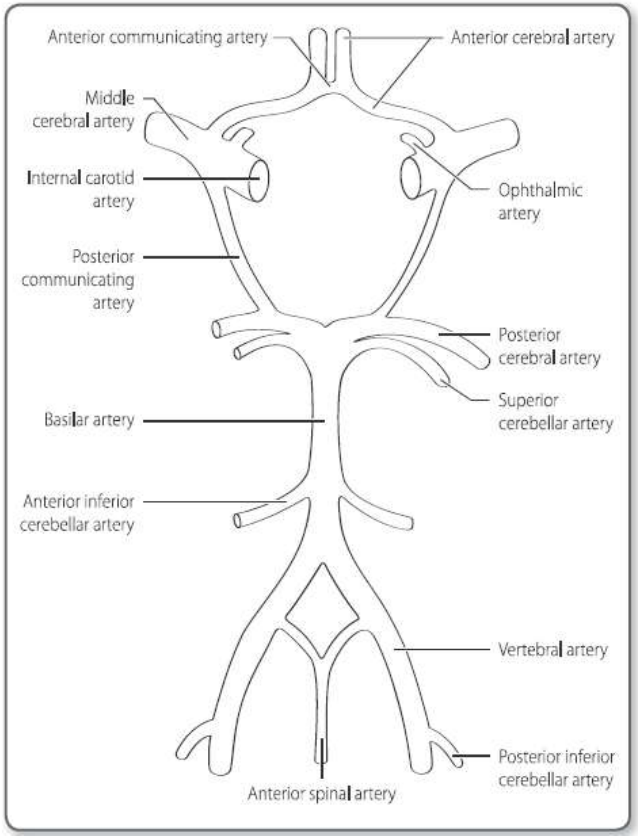
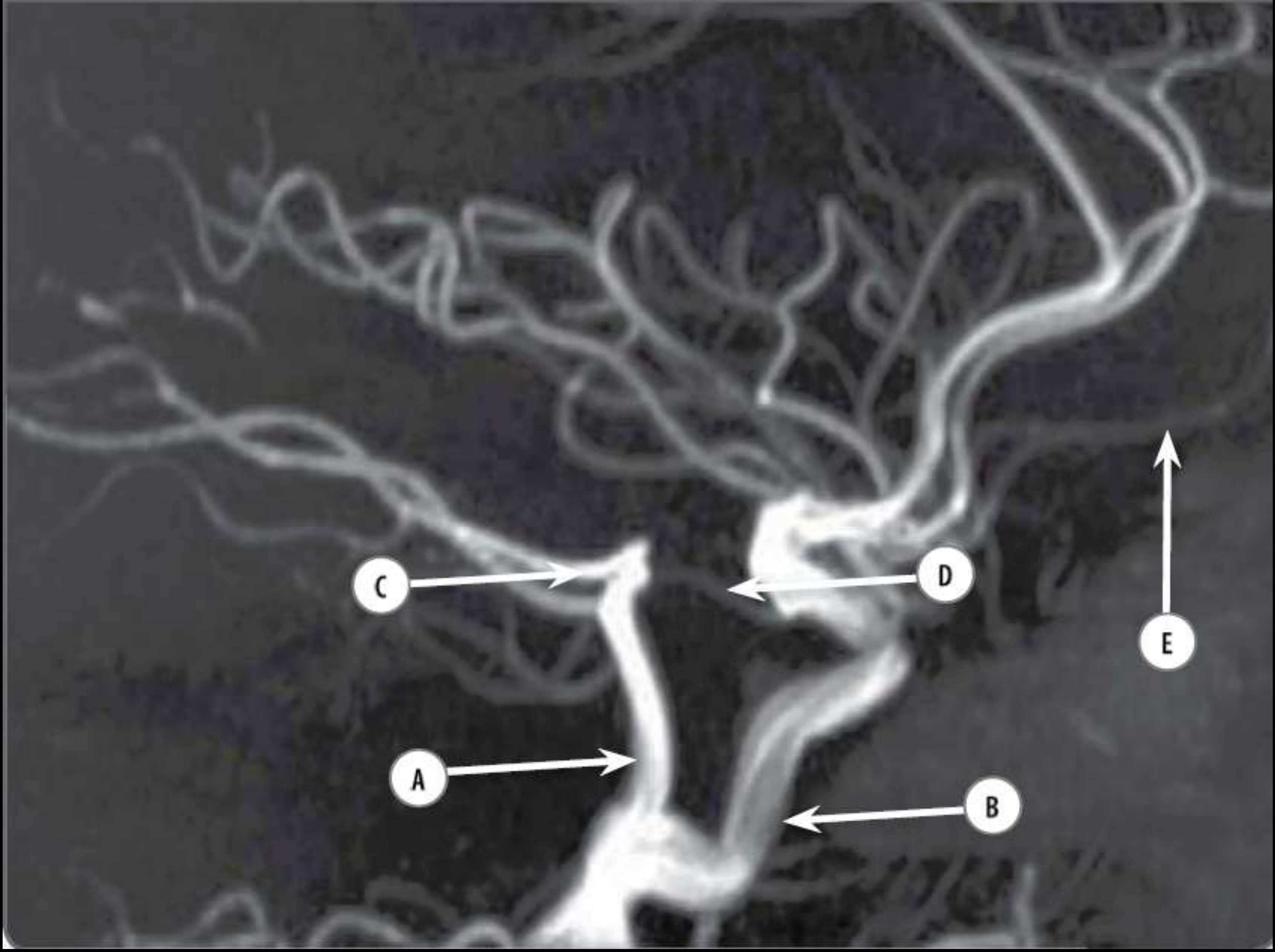


Figure 1.1 The circle of Willis.

Case 1.15



Case 1.15

- **A** Basilar artery
- **B** Internal carotid artery
- **C** Posterior cerebral artery
- **D** Posterior communicating artery
- **E** Ophthalmic artery

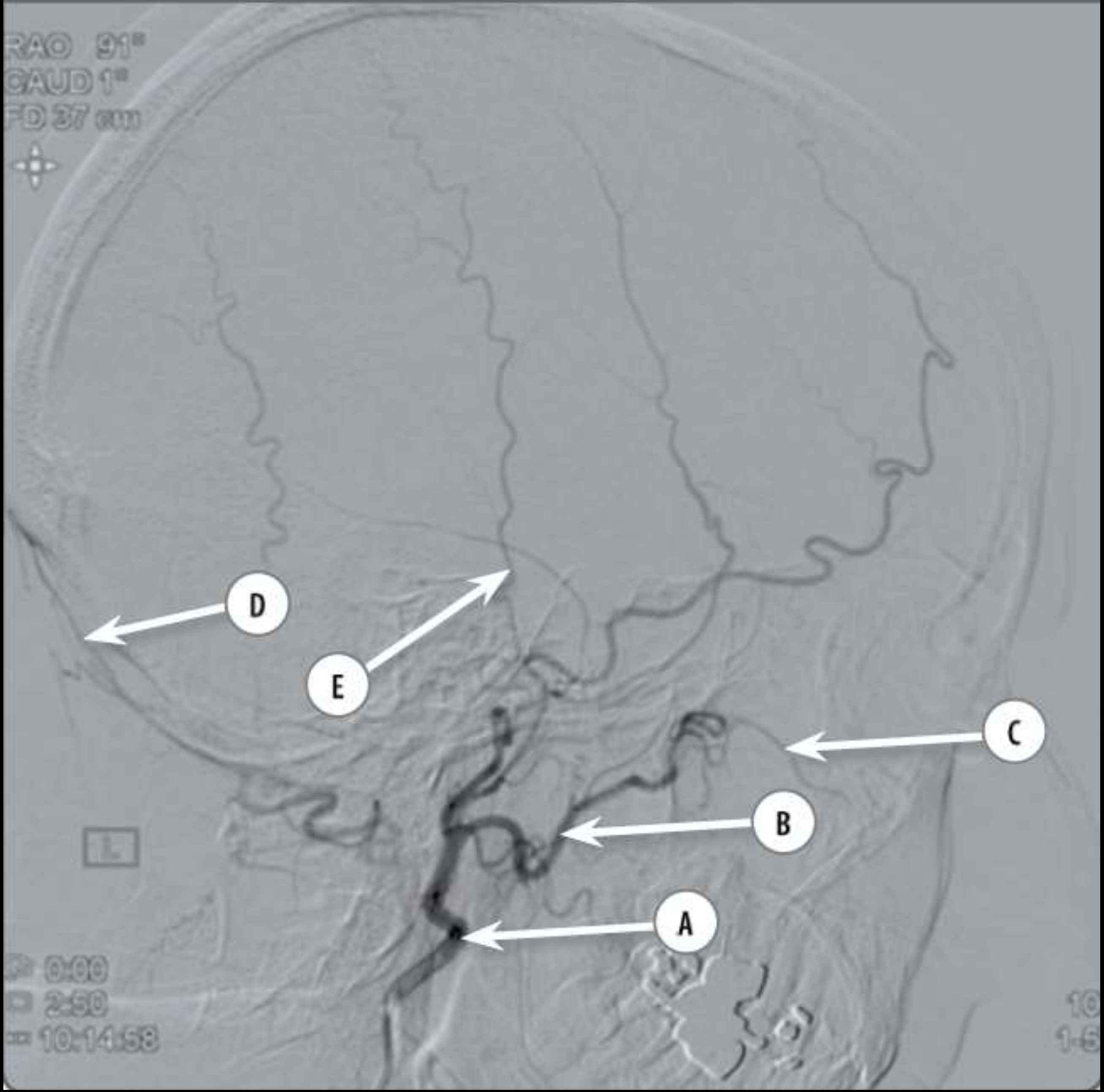
Magnetic resonance angiography – lateral view.

In this image we see the same vessels as in the previous two images but from the side. On lateral images such as this one and on some catheter angiograms, it is not possible to accurately determine laterality. If that is the case, simply name the vessel rather than guessing the side.

The ophthalmic artery is the first branch of the internal carotid artery distal to the cavernous sinus.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 36–40.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 80–87.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 50–57.

Case 1.40



and superficial temporal arteries. The other branches are the ascending pharyngeal, superior thyroid, lingual, facial, occipital and posterior auricular arteries (**Figure 1.10**)

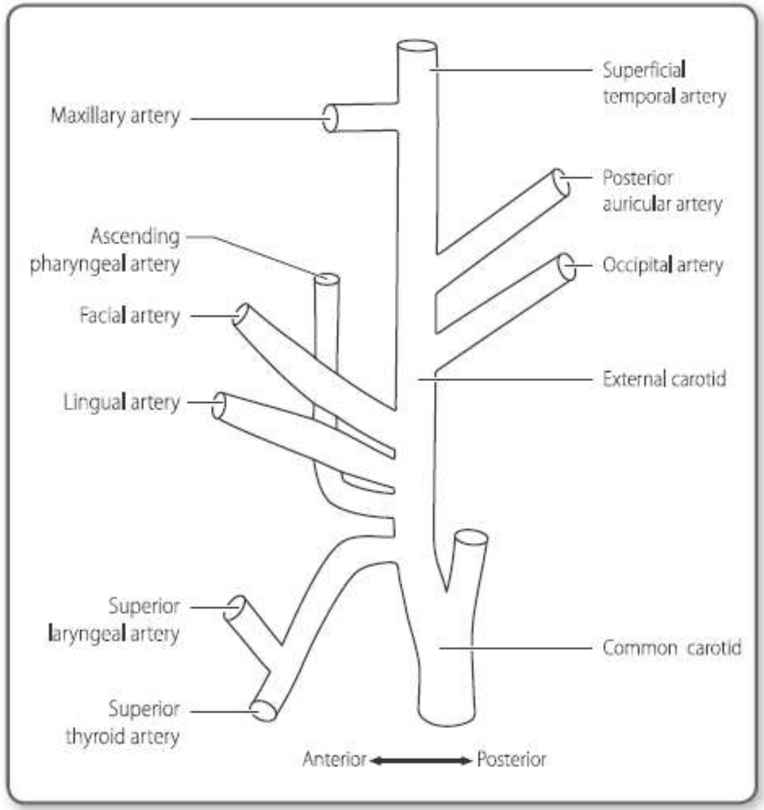


Figure 1.10 The external carotid artery and its branches.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 33.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 855.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 44.

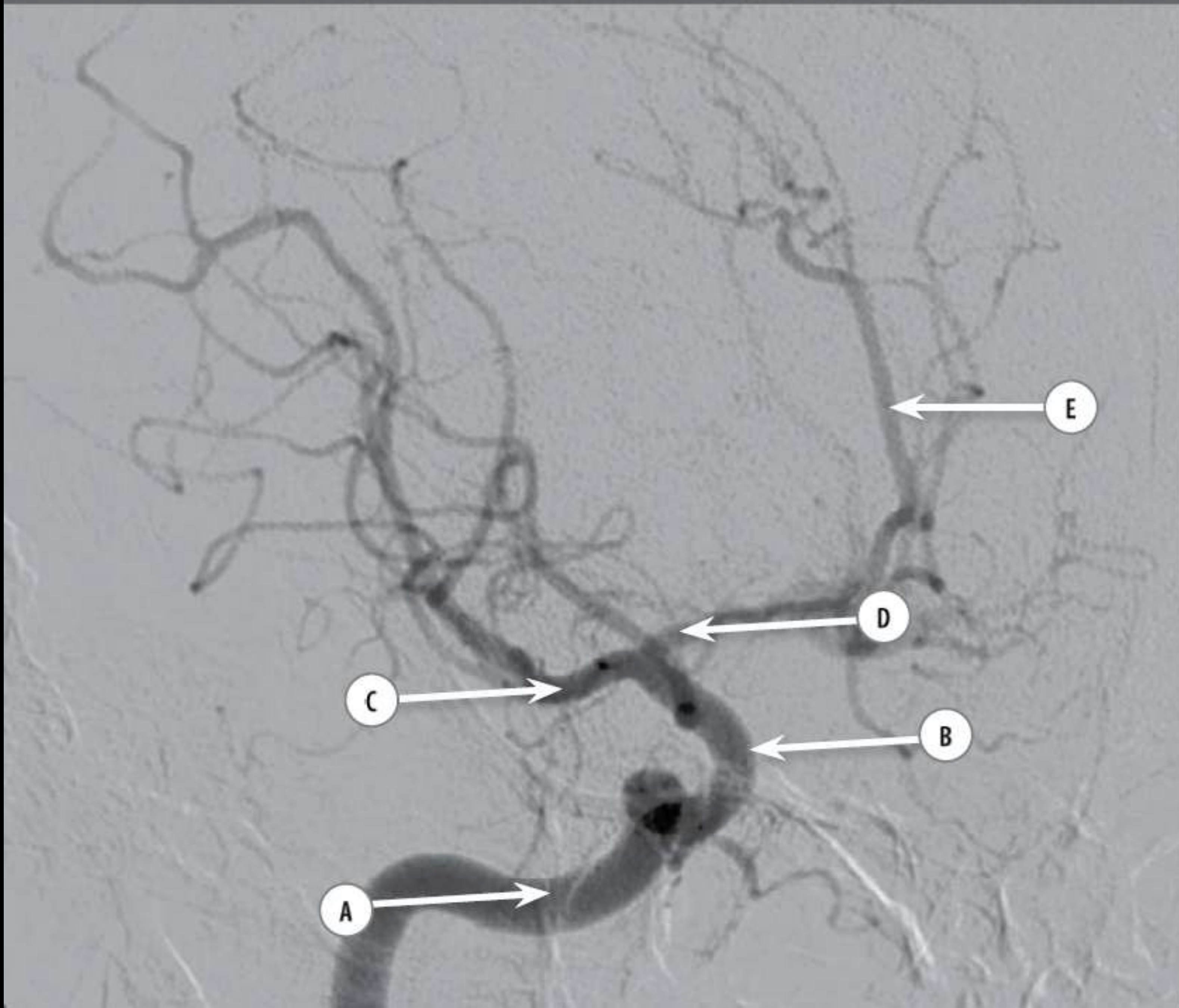
Case 1.40

- **A** External carotid arteries
- **B** Maxillary artery
- **C** Infraorbital artery
- **D** Occipital artery
- **E** Superficial temporal arteries

External carotid angiogram.

The common carotids bifurcate into the internal and external carotids at the level of C4. The internal carotids have no branches in the neck. The external carotid arteries supply much of the face and neck. They travel posterior and superiorly in the neck, through the substance of the parotid gland, before terminating into the maxillary

Case 1.16



Case 1.16

A Petrous part of the internal carotid artery

B Cavernous part of the internal carotid artery

C Middle cerebral artery

D Anterior cerebral artery (A1 segment)

E Pericallosal artery (A3 segment)

Catheter angiogram of the carotid artery.

Catheter angiography is used for diagnosis and treatment of vascular problems in the brain. This is an image from an angiogram of the carotid artery.

The internal carotid artery is the biggest vessel and has a characteristic shape. The different segments of the artery are seen in this image, including the terminal branches of the internal carotid artery: the anterior and middle cerebral arteries. The anterior cerebral artery arises from the internal carotid artery at the anterior perforated substance. It is divided into segments:

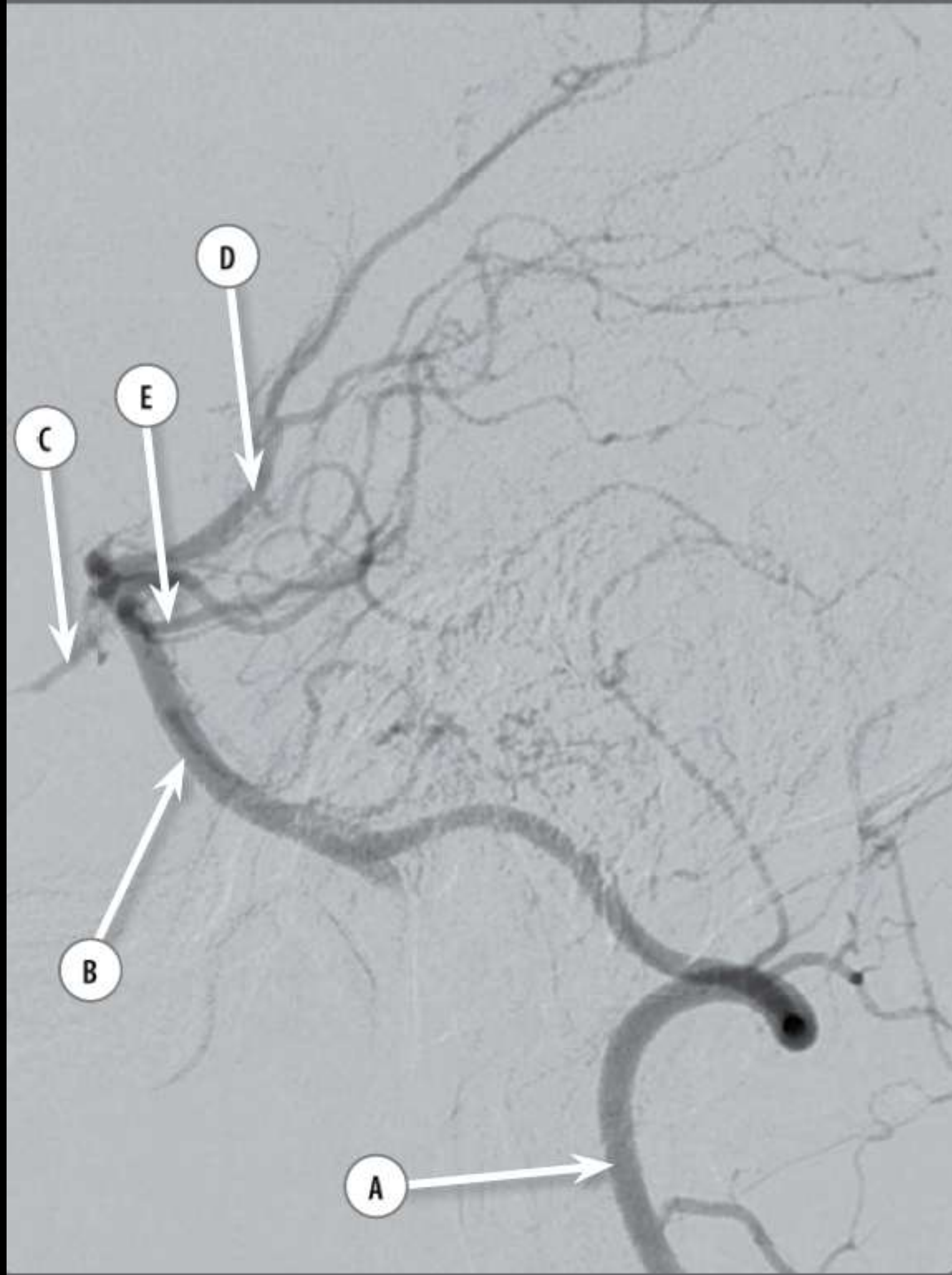
- A1 is the first segment and it extends from the origin to the level of the anterior communicating artery.
- A2 begins after the anterior communicating artery and continues to the bifurcation of the artery into its terminal branches.

Two branches are given off in A2:
- The orbital frontal artery is the first branch after the anterior communicating artery.
- The frontopolar artery arises distal to the orbital frontal, close to where the artery loops over the genu.

After the artery loops over the genu, it passes posteriorly on the superior surface of the corpus callosum. At this point it bifurcates into the callosal marginal and the pericallosal artery (which forms the A3 segment).

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 36–40.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 80–87.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999:

Case 1.17



Case 1.17

A Vertebral artery

B Basilar artery

C Posterior communicating artery

D Posterior cerebral artery

E Superior cerebellar artery

Catheter angiogram of the vertebral artery.

The vertebral arteries are the first branches of the subclavian arteries on each side. They ascend the neck within the foramina transversaria. They pass through the foramen magnum to enter the skull. At that point they pierce the dura and enter the subarachnoid space. The left and right vertebral arteries join to form the basilar artery at the level of the pontomedullary junction. The posterior inferior cerebellar arteries (PICA) arise from the vertebral arteries just before they join. The anterior inferior cerebellar arteries (AICA) and the superior cerebellar arteries arise from the basilar artery.

In this image we see the left vertebral artery entering the skull and continuing as the basilar artery after joining with the right vertebral artery. The terminal branches are labelled: the posterior cerebral arteries and the posterior communicating arteries. Just before the basilar artery splits into the terminal branches, it gives off the superior cerebellar artery.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 38.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 85.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 50–57.

Case 1.18

Case 1.18

A Superior sagittal sinus

B Straight sinus

C Confluence of sinuses (torcular herophili)

D Transverse sinus

E Sigmoid sinus

Magnetic resonance venogram.

The venous drainage of the brain (**Figure 1.2**) does not follow the arterial supply. The venous sinuses are low pressure veins within folds of dura. The superior sagittal sinus begins anteriorly and runs to the back in the midline to the internal occipital protuberance. Posteriorly the sinus turns to one side (usually the right) and continues as the transverse sinus.

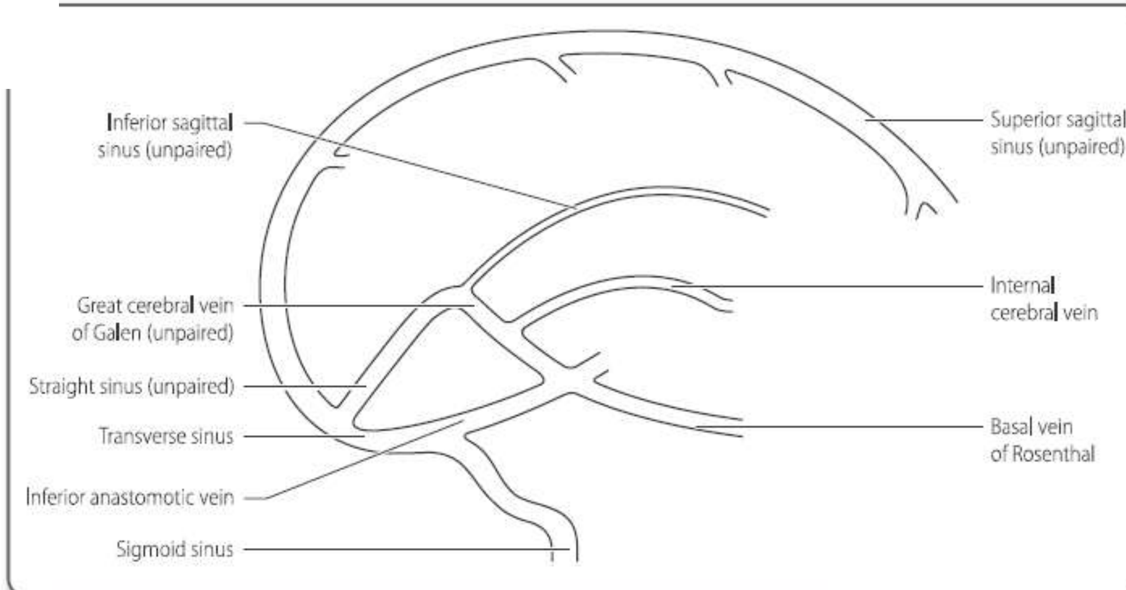
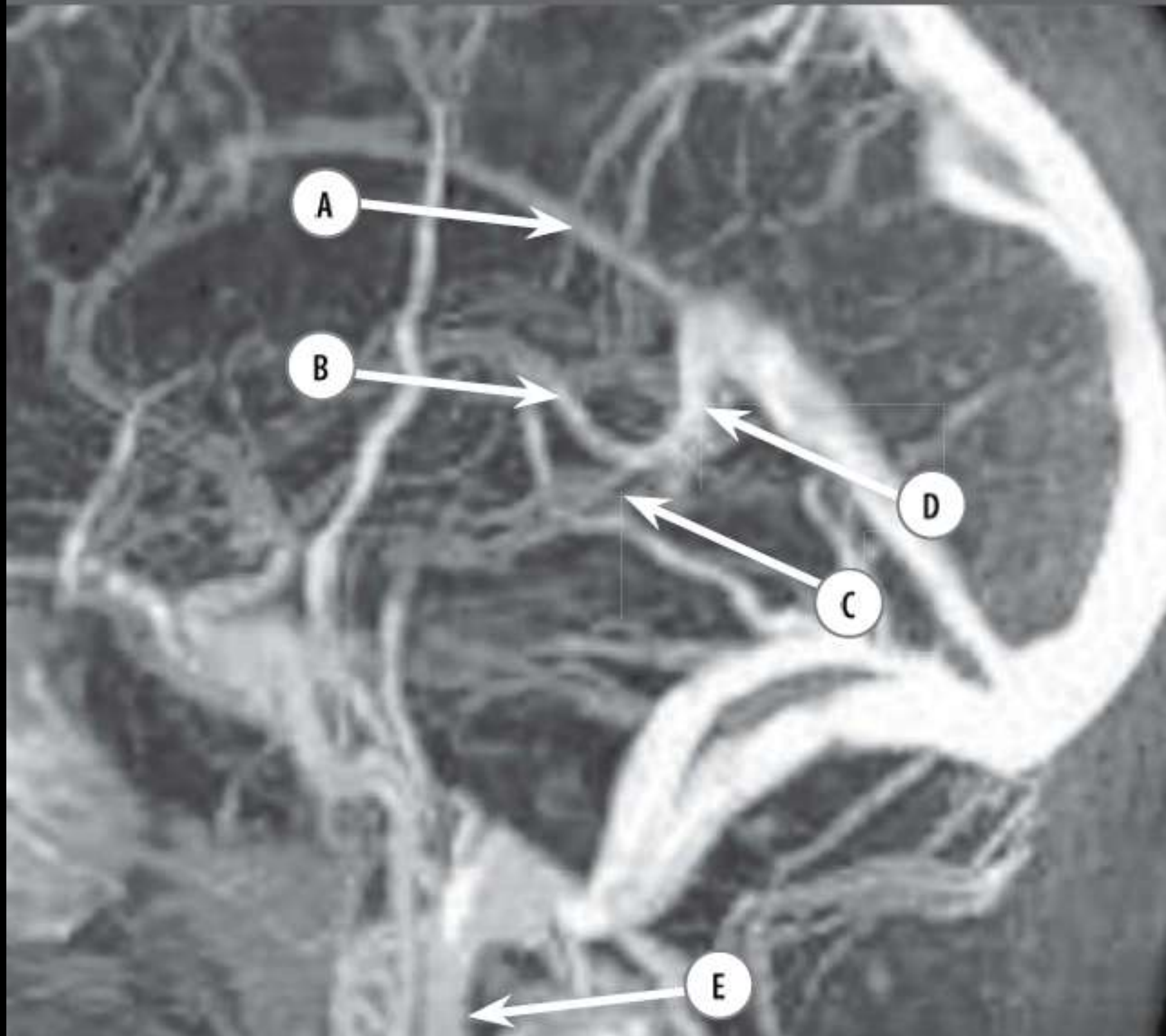


Figure 1.2 Venous drainage of the brain – lateral view.

The inferior sagittal sinus runs in the lower free edge of the falx cerebri. Posteriorly it joins the great cerebral vein to become the straight sinus. The straight sinus then runs posteriorly to meet the sagittal sinus at the confluence of sinuses (torcular herophili). The transverse sinuses run on either side to the mastoid bone where they turn inferiorly and become the sigmoid sinuses. The transverse and sigmoid sinuses together are known as the lateral sinus. The sigmoid sinus continues through the jugular foramen as the internal jugular vein.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 39–41.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 87–90.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 57–58.

Case 1.19



Case 1.19

A Inferior sagittal sinus

B Internal cerebral vein

C Basal vein of Rosenthal

D Great cerebral vein (of Galen)

Answers

E Internal jugular vein

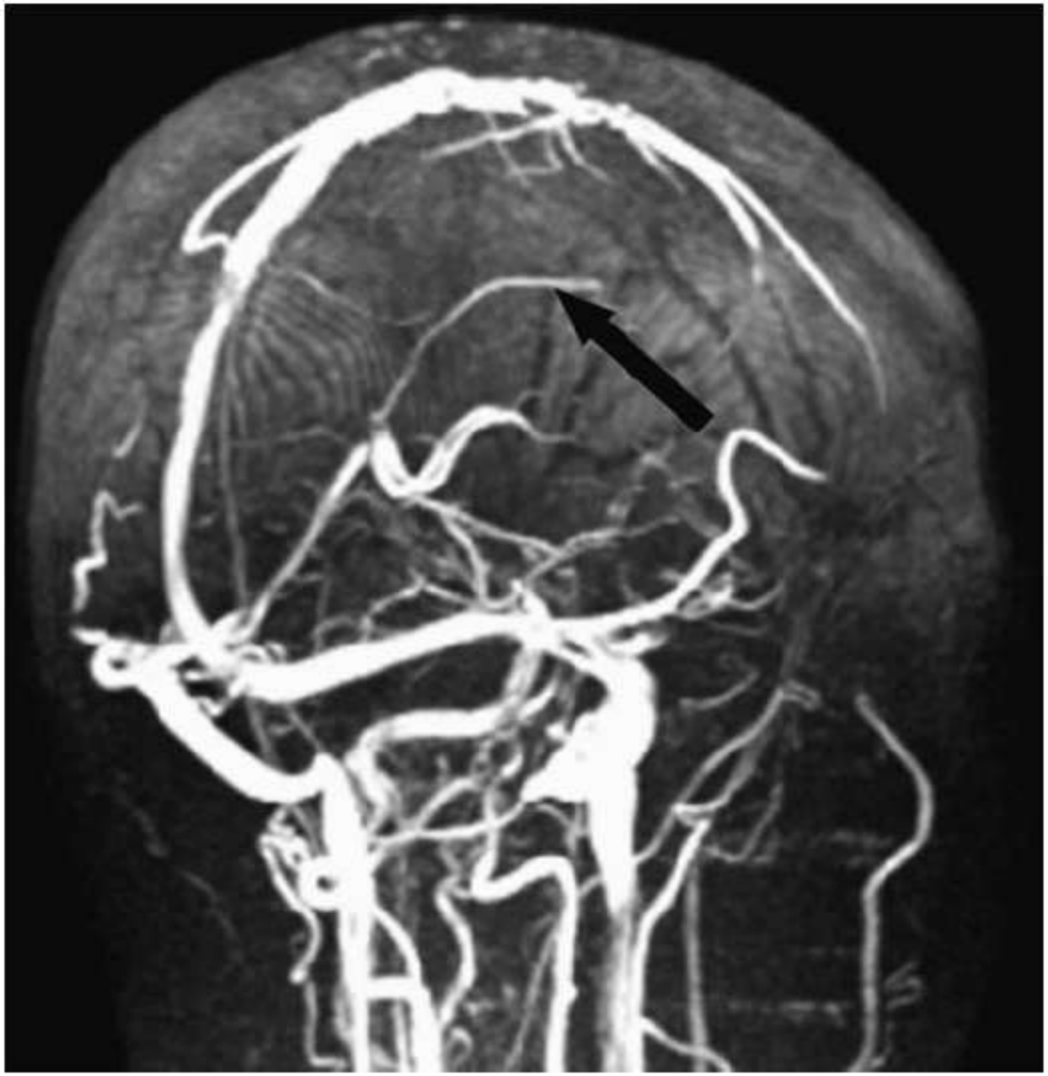
Magnetic resonance venogram.

The internal cerebral veins run in the roof of the third ventricle on each side and unite under the splenium of the corpus callosum, to form the great cerebral vein of Galen. This is a short vein that passes posterosuperiorly behind the splenium to drain in the anterior end of the straight sinus where it unites with the inferior sagittal sinus.

The basal veins of Rosenthal begin at the anterior perforated substance by the union of the anterior cerebral vein, the deep middle cerebral vein and the striate veins. The basal veins of Rosenthal pass around the midbrain on each side to join the great cerebral vein of Galen (**Figure 1.2**).

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 39–41.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 87–90.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 57–58.

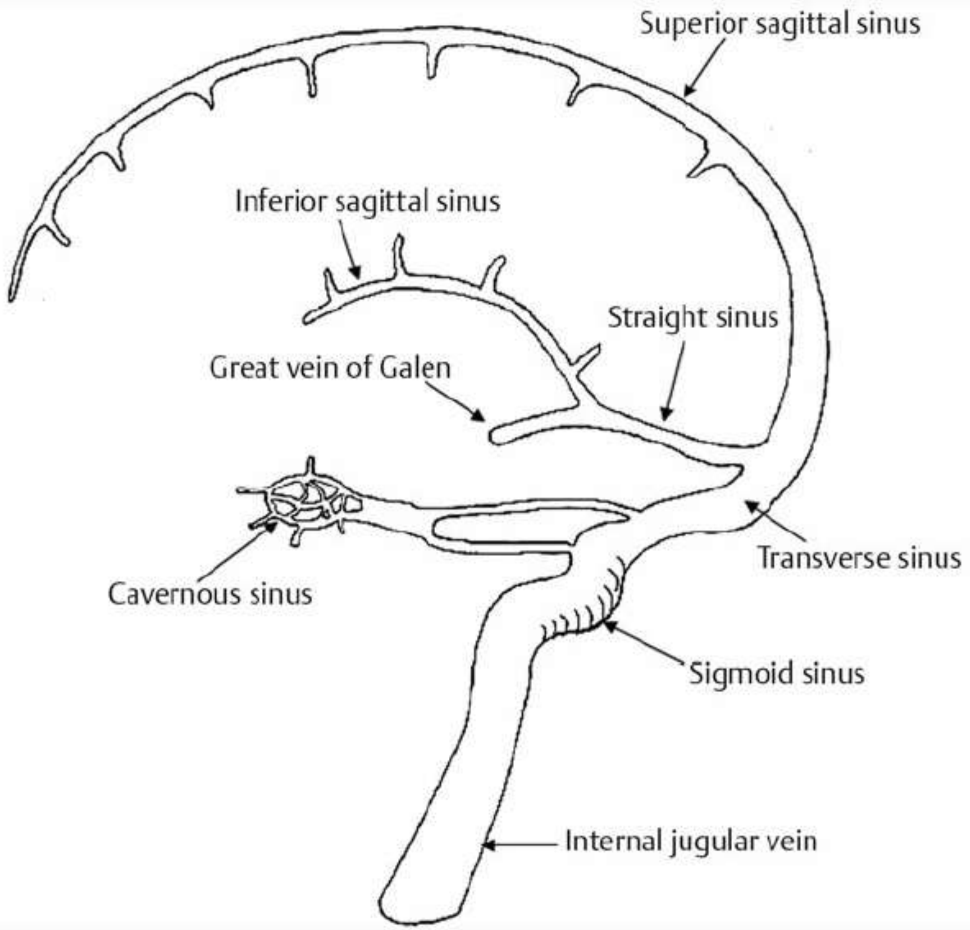
Question 12:



Question 12: MR venogram

Answer: Inferior sagittal sinus

- The inferior sagittal sinus runs along the inferior border of the falx cerebri.
- It drains into the straight sinus, as does the great cerebral vein of Galen.
- It can be distinguished from the great vein by the fact that it parallels the course of the superior sagittal sinus.
- The figure below shows the main dural venous sinuses.



CROSS-SECTIONAL

AXIAL

Case 1.32

Case 1.32

A Incisive canal

B Alveolar rim

C Right ramus of mandible

D Left medial pterygoid muscle

E Left masseter muscle

Axial CT of facial bones.

The incisive canals transmit the descending palatine artery and the nasopalatine nerve.

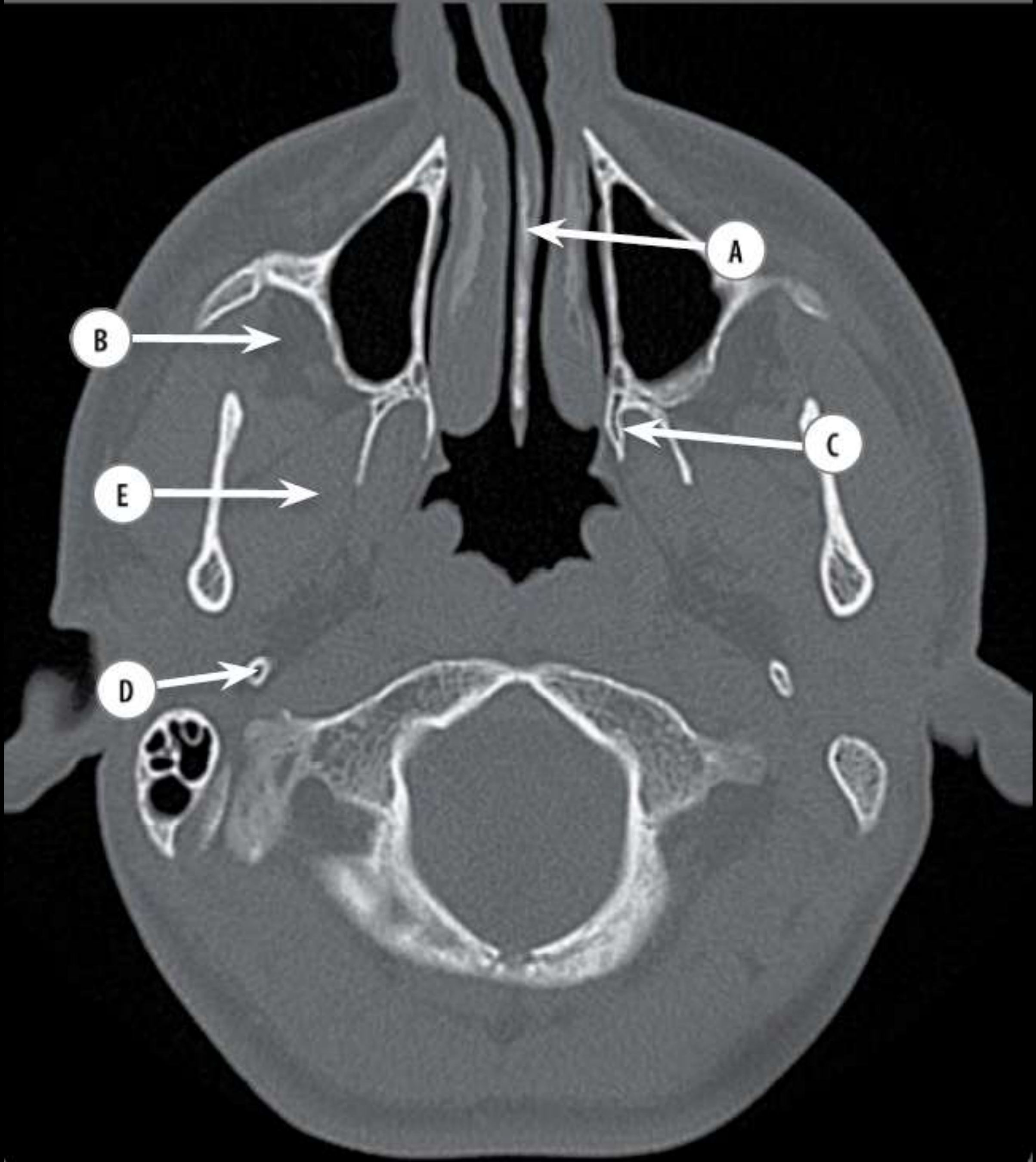
The lateral pterygoid muscle originates from the more lateral aspect of the lateral pterygoid plate. It inserts onto the neck of the mandible and disc of the temporomandibular joint where its main action is to protrude the jaw forward.

The medial pterygoid muscle originates from the more medial aspect of the lateral pterygoid plate to insert onto the ramus of the mandible. Its main action is to elevate the mandible.

The masseter muscle originates the zygomatic process of the maxilla and the zygomatic arch to insert onto the coronoid process and ramus of mandible. Its action is to elevate the mandible and occlude the teeth for chewing and biting (**Table 1.1**). Gravity also has a role in the depression (i.e. opening) of the mandible and protrusion occurs as a direct consequence of the opening of the mandible.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 8.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 919.

Case 1.33



Case 1.33

A Vomer

B Right infratemporal fossa

C Left medial pterygoid plate

D Right styloid process

E Right lateral pterygoid muscle

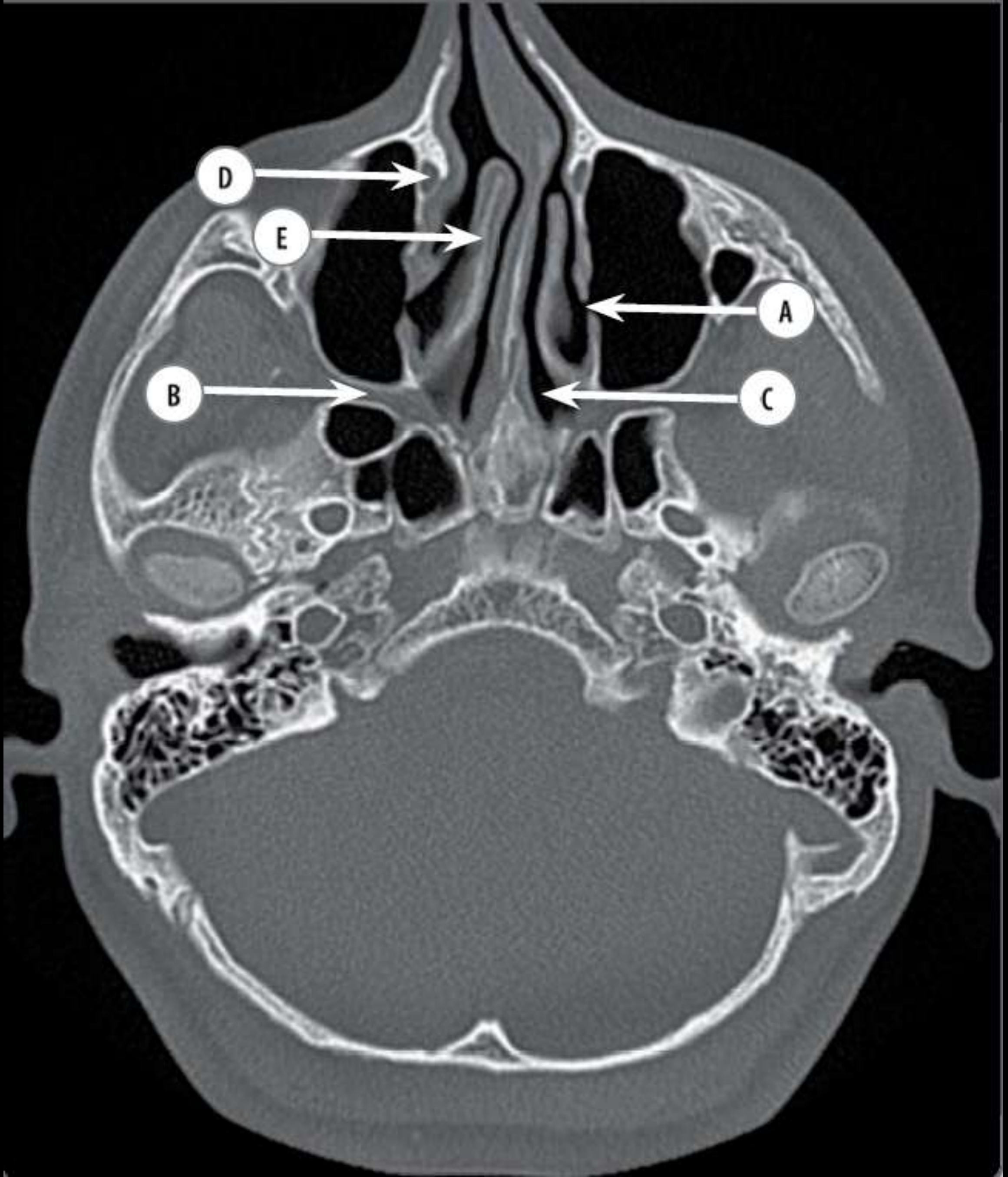
Axial CT of nares.

The infratemporal fossa is a space posterior to the maxilla, deep to the ramus of the mandible, and deep and inferior to the zygomatic arch. It contains the lateral and medial pterygoid muscles, the inferior part of the temporal muscle, the maxillary artery and the pterygoid venous plexus. It contains many nerves: mandibular, inferior alveolar, lingual, buccal and chorda tympani, as well as the otic ganglion.

The temporal styloid process is a projection from the inferior aspect of the temporal bone. It serves as an anchor point for many of the muscles of the tongue and larynx.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 8.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 919.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 34.

Case 1.34



Case 1.34

A Ostium of left maxillary antrum

B Right pterygopalatine fossa

C Left sphenopalatine foramen

D Right nasolacrimal duct

E Right middle turbinate (concha)

Axial CT of base of skull.

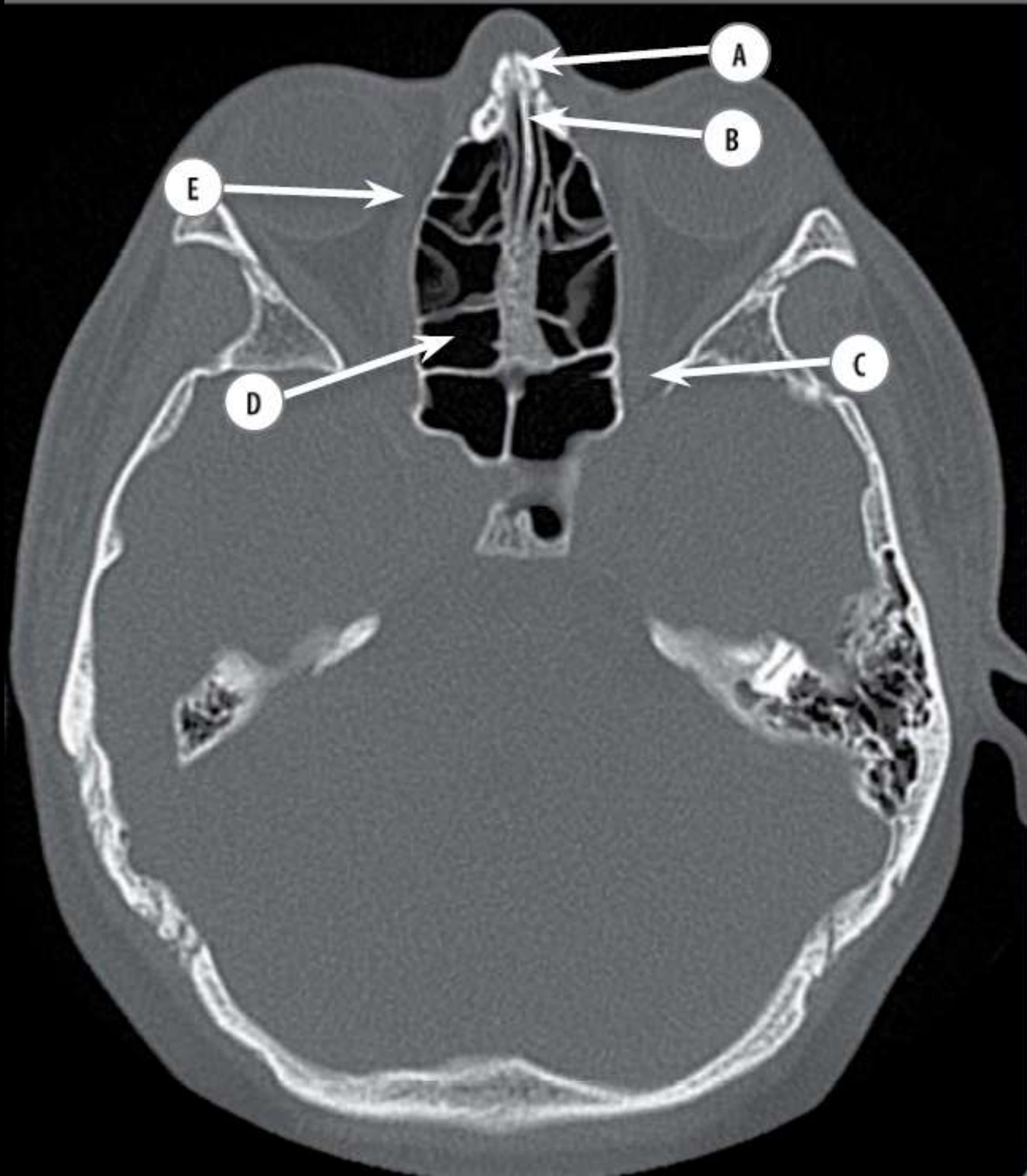
The maxillary antrum drains into the middle meatus of the nasal cavity via the maxillary ostium. The nasolacrimal duct conveys tears from the lacrimal apparatus into the inferior meatus of the nasal cavity.

The middle cranial fossa communicates with the pterygopalatine fossa via the foramen rotundum, which opens into it superiorly. The pterygopalatine fossa contains the V2 cranial nerve which enters the orbit through the inferior orbital fissure. It also contains the maxillary artery, the maxillary nerve, the nerve of the pterygoid canal, and the pterygopalatine ganglion.

The sphenopalatine foramen is a communication between the pterygopalatine fossa and the nasal cavity through the perpendicular plate of the palatine bone.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 9.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 35.

Case 1.35



Case 1.35

A Nasal bone

B Perpendicular plate of ethmoid bone

C Left superior orbital fissure

D Right posterior ethmoid air cell

E Right medial rectus

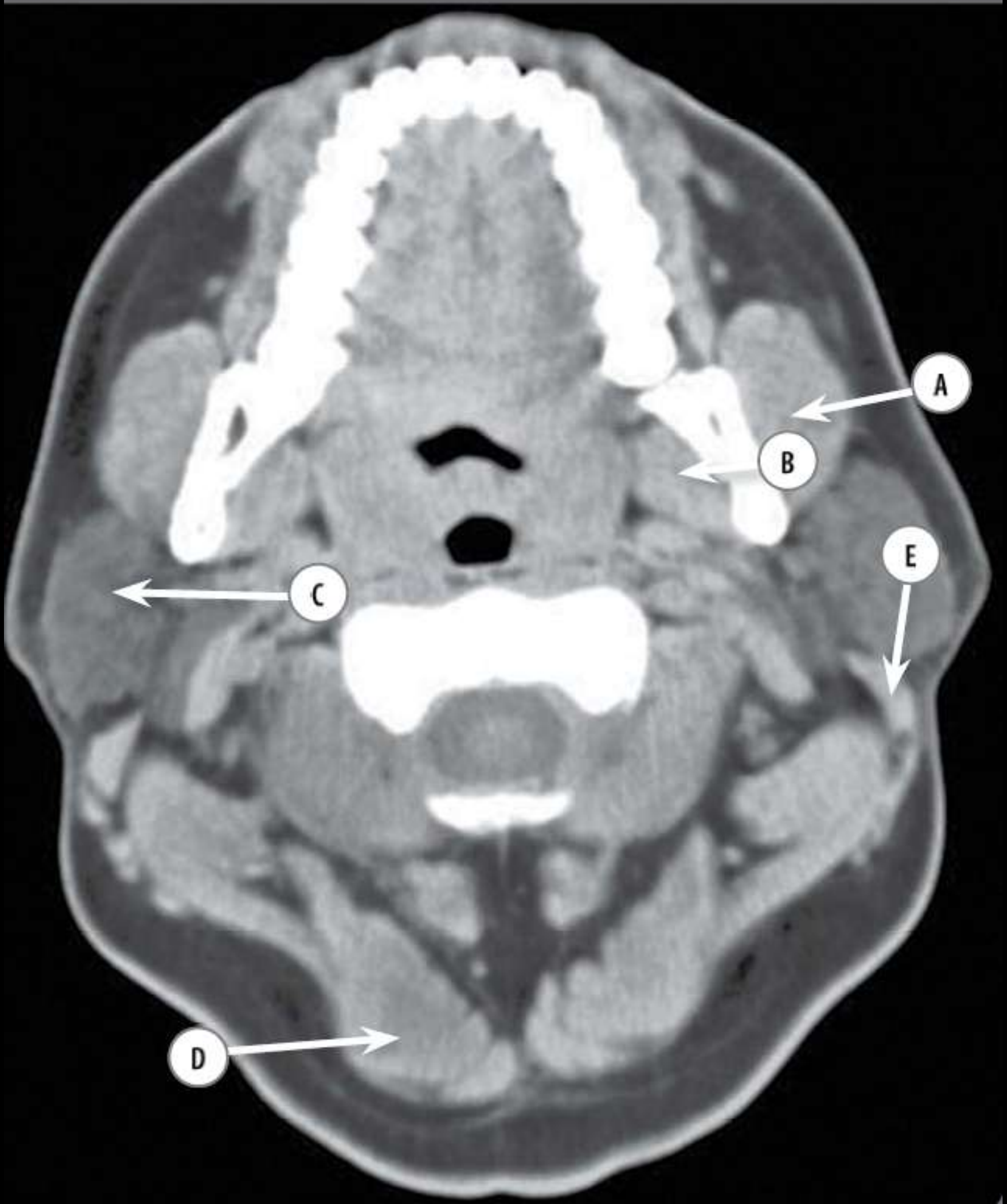
Axial CT at level of ethmoid sinus.

The perpendicular plate of the ethmoid bone descends down from the cribriform plate to form the superior part of the bony nasal septum. Above the cribriform plate, it continues as the crista galli.

The ethmoid air cells sit between the lateral walls of the nasal cavity and the medial walls of the orbits. Haller cells are infraorbital extensions of ethmoid air cells. Agger nasi cells are enlarged air cells located anteriorly towards the frontal bones.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 9.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 824.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 36.

Case 1.42



Case 1.42

A Left masseter

B Left medial pterygoid

C Right parotid gland

D Right semispinalis capitus

E Left sternocleidomastoid

Axial CT of soft tissues of the neck.

Sternocleidomastoid has two heads originating from the mastoid process of the temporal bone and the superior nuchal line of the occipital bone. The sternal head attaches to the manubriosternum, and the clavicular head attaches to the medial third of the clavicle. Acting together, they flex the neck. Acting individually, they rotate the head and neck. The two heads of the sternocleidomastoid divide the neck into the anterior and posterior triangles (**Table 1.2**).

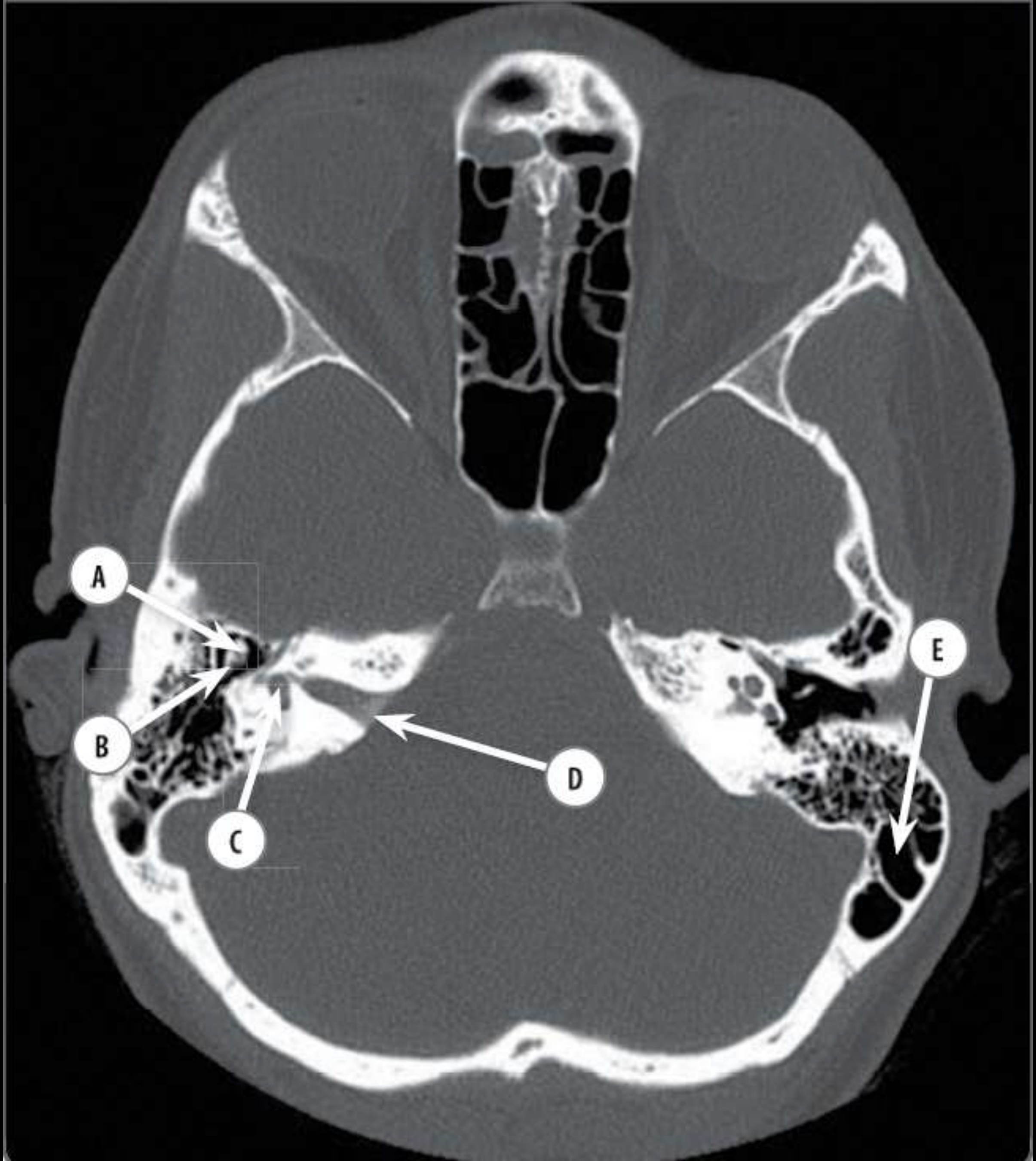
The transversospinal muscle group is one of the deep or intrinsic layers of back muscles, along with splenius and erector spinae muscles. Semispinalis is the most superficial of the transversospinal group, with the semispinalis capitis having the most superior attachment. It travels from the occipital bone to the cervical and transverse processes. It aids in maintaining posture and controlling movements of the vertebral column.

Table 1.2 The muscles of the neck

Muscle type	Muscles
Lateral	• Platysma • Sternocleidomastoid • Trapezius
Suprahyoid	• Mylohyoid • Geniohyoid • Stylohyoid • Digastric
Infrahyoid	• Sternohyoid • Omohyoid • Sternothyroid • Thyrohyoid

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 24.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 471, 1007.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 22.

Case 1.43



Case 1.43

A Right malleus

B Right incus

C Right vestibule

D Right internal auditory meatus

E Left mastoid air cells

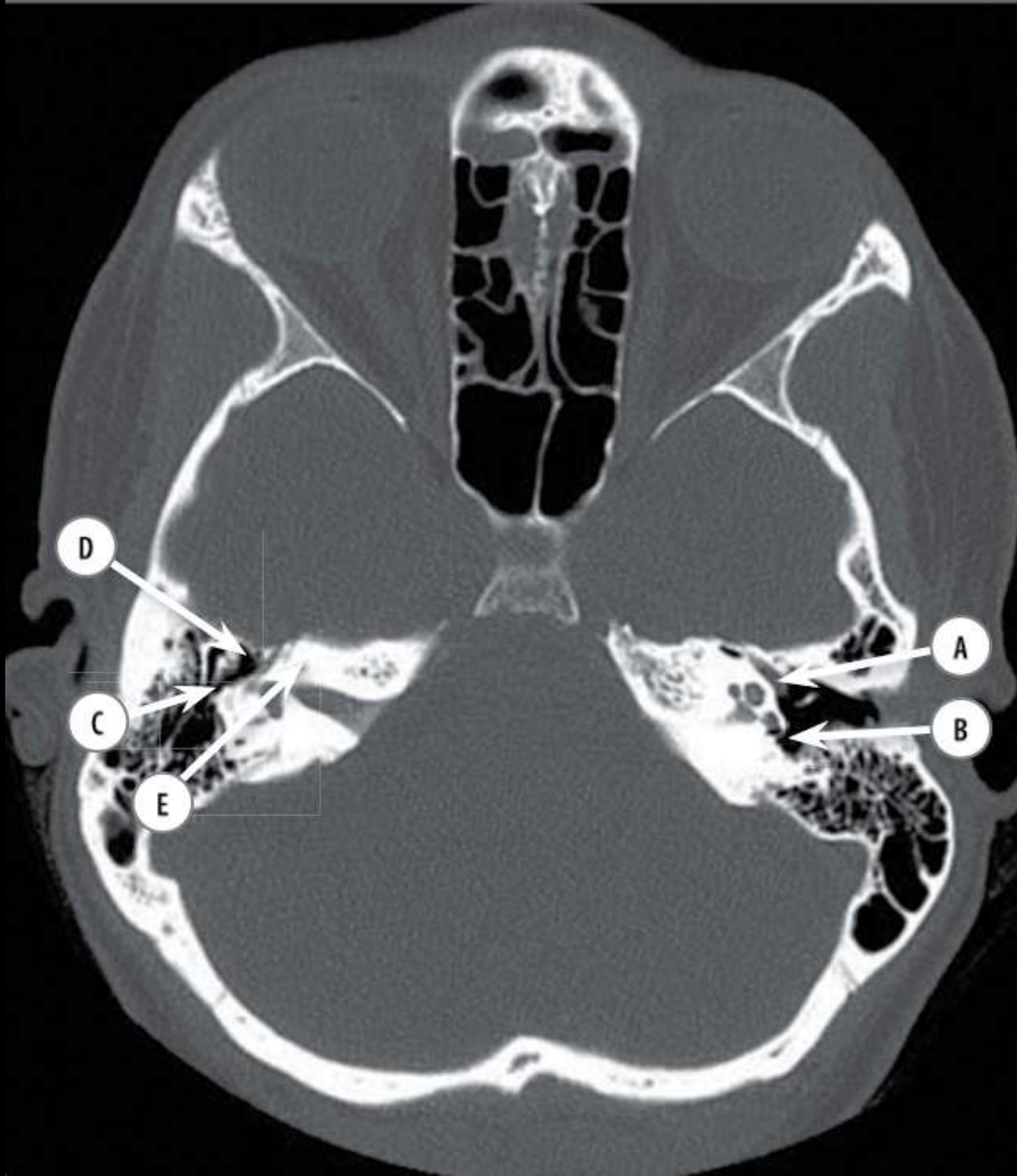
High-resolution axial CT of the temporal bone.

The ear has two functions: hearing and equilibrium. The function of the external ear is to collect and conduct sound to the tympanic membrane.

The tympanic membrane is the border between the external and middle ear. The middle ear is a cavity in the petrous temporal bone, consisting of the tympanic cavity just internal to the tympanic membrane, and an epitympanic recess/attic just superior to the membrane. The tympanic membrane is attached to the external auditory canal by a small spur of bone called the scutum.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 14.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 972.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 28–32.

Case 1.44



Case 1.44

A Left Eustachian tube

B Left oval window

C Right aditus ad antrum

D Right epitympanic recess/attic

E Right petrous temporal bone

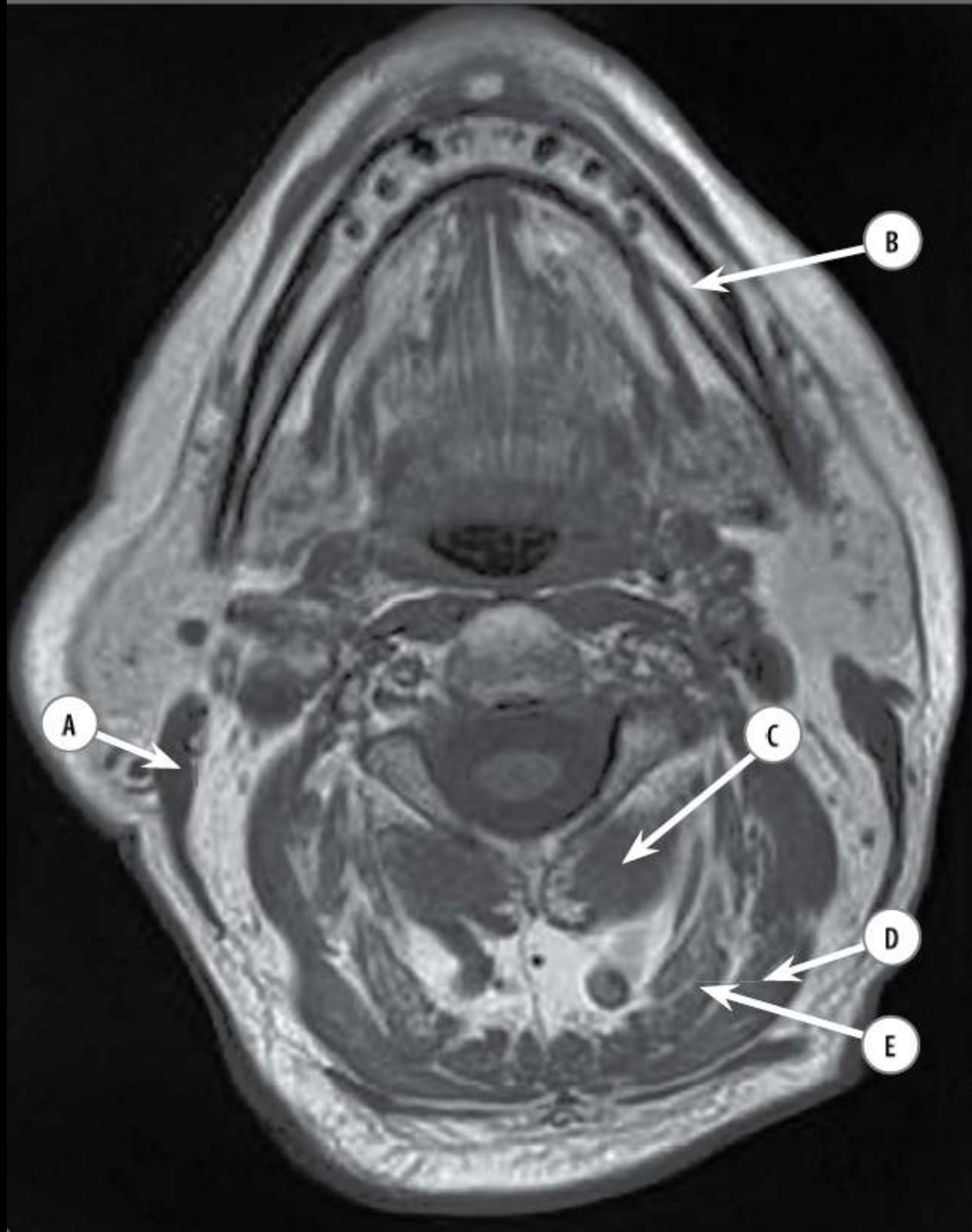
High-resolution axial CT of the temporal bone.

The tegmen tympani is a thin plate of bone forming the roof of the tympanic cavity and separating it from the middle cranial fossa and temporal lobe. A narrow posterior opening in the attic, the aditus to the mastoid antrum, communicates with the mastoid air cells, therefore acting as a route for the spread of infection. The floor of the cavity is a thin plate of bone separating it from the bulb of the jugular vein, and is continuous with the Eustachian tube, which runs into the lateral wall of the nasopharynx.

The medial wall is the lateral wall of the inner ear. There are prominences from the lateral semicircular canal (the arcuate eminence), and the initial/basal turn of the cochlea (the promontory).

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 14.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 972.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 28–32.

Case 1.47



Case 1.47

A Right sternocleidomastoid muscle

B Left ramus of the mandible

C Left inferior oblique muscle

D Right splenius capitis

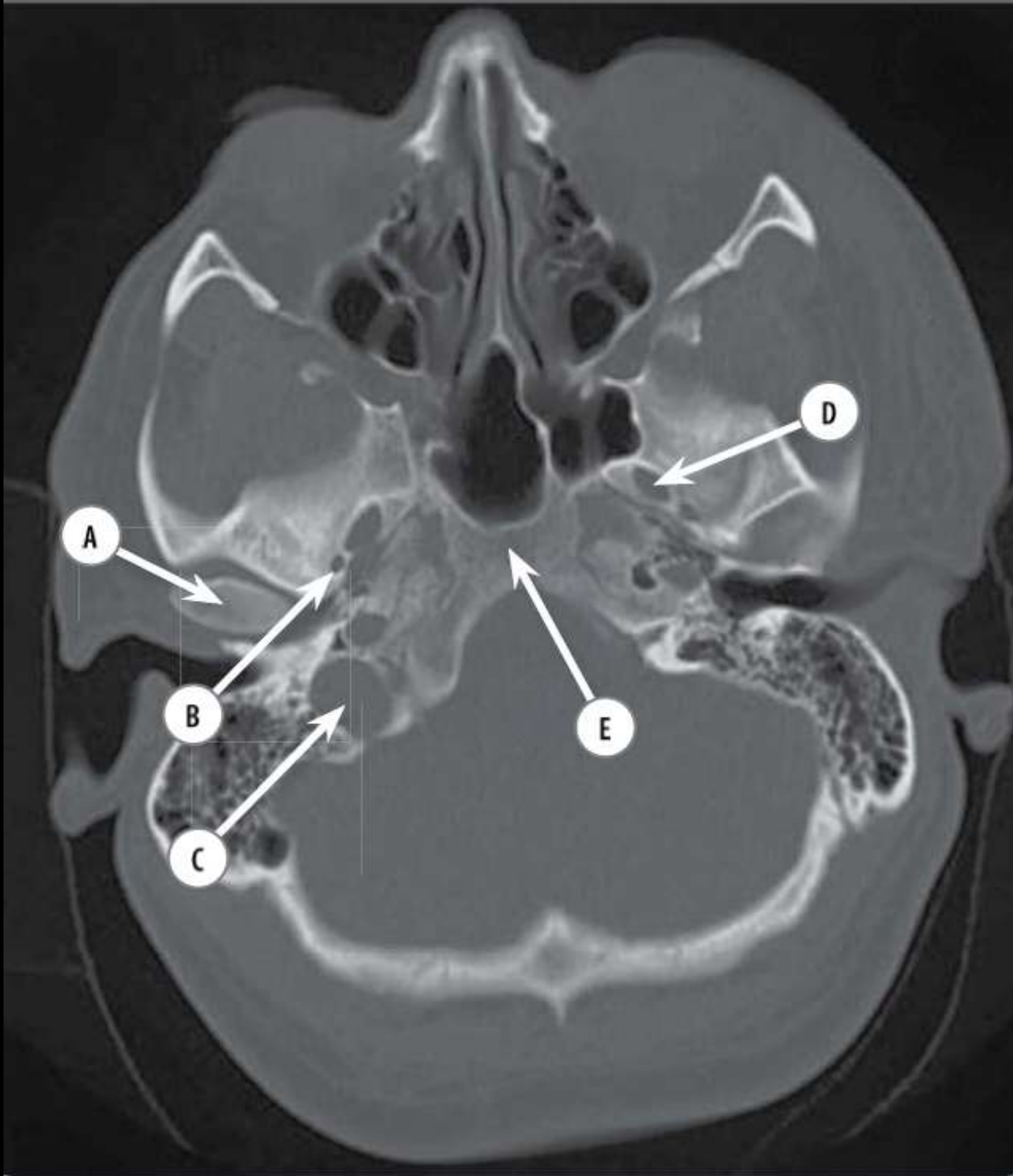
E Left semispinalis

Axial T1-weighted MRI at the level of the pharynx.

The orientation of the deep muscles of the neck is complex and best described diagrammatically (**Figure 1.12**).

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 26.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 475.

Case 1.54



Case 1.54

- A Right mandibular condyle
- B Right foramen spinosum
- C Right jugular foramen
- D Left foramen ovale
- E Clivus

Axial CT of the head.

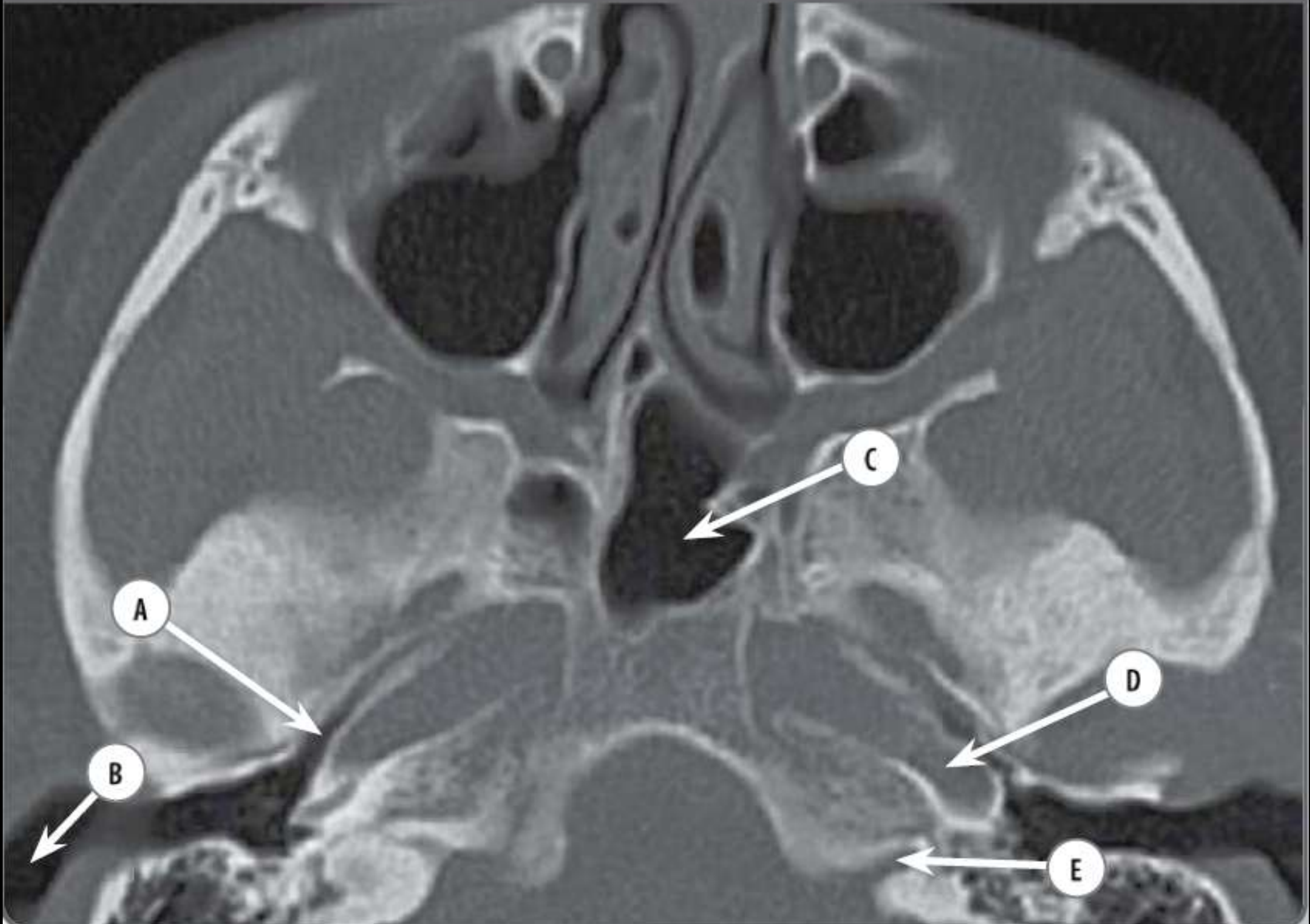
The foramen spinosum is a small foramen in the skull base. It is found posterolaterally to the foramen rotundum, and contains the middle meningeal artery on its path from the infratemporal fossa towards the middle cranial fossa.

The foramen ovale is a larger foramen, found in the greater wing of sphenoid, posterolateral to the foramen rotundum. It contains the third division of the fifth cranial nerve and the accessory meningeal artery as they pass between the middle cranial fossa and the infratemporal fossa.

At the junction of the occipital and petrous bones, posteriorly is found the jugular foramen. It has a course which runs inferomedially from the posterior cranial fossa, and it has a somewhat irregular, often asymmetrical shape. The jugular foramen can be divided into two compartments by a fibrocartilaginous band – the smaller anteromedial compartment is known as the pars nervosa, and the larger posteromedial compartment, the pars vascularis. The pars nervosa contains the inferior petrosal sinus (which drains into the internal jugular vein) and the 9th cranial nerve. The pars vascularis contains the jugular bulb, as well as the ascending occipital and pharyngeal arteries. The 10th and 11th cranial nerves are also found within the pars vascularis.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 8.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 94.

Case 1.56



Case 1.56

A Right Eustachian tube

B Right external acoustic canal

C Sphenoid sinus

D Left carotid canal

E Left internal acoustic canal

Axial CT of the head.

The carotid canal transmits the internal carotid artery on its course through the petrous bone. It is a circular opening, found just anterior to the jugular fossa, separated from it by a bony crest. It is separated from the inner ear, laterally, by the tympanic plate. The internal carotid takes a tortuous course, and the carotid canal has a vertical course at first, before turning at right angles to continue in a horizontal and medial direction, with the artery then entering the foramen lacerum.

The Eustachian or pharyngotympanic tube connects the lower part of the middle ear with the lateral wall of the nasopharynx. It provides a mechanism for equalising pressure across the tympanic membrane. At its proximal end, the Eustachian tube is bony, but as it continues over approximately 3.5 cm, it becomes cartilaginous.

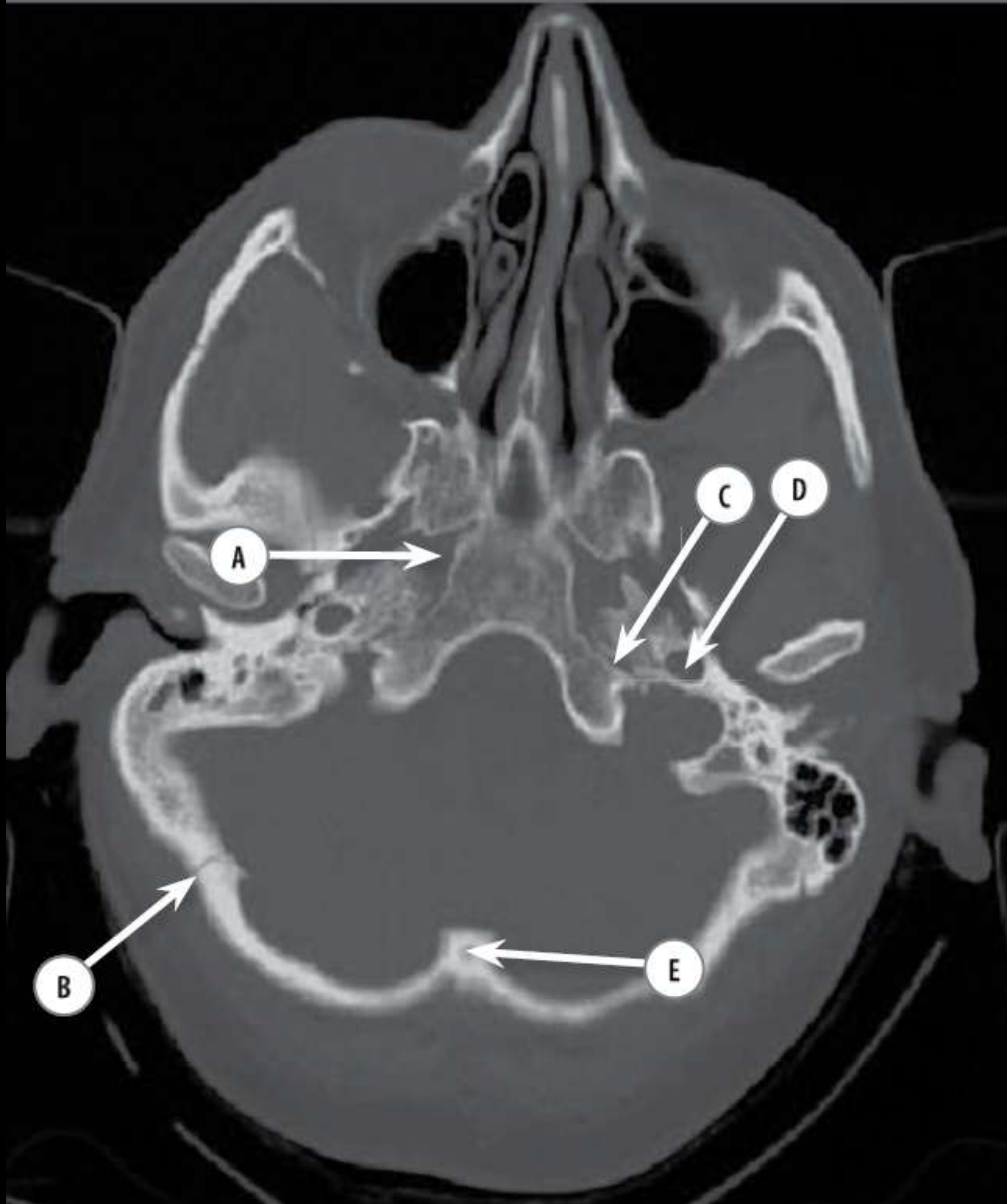
The internal auditory canal transmits the 7th (facial) and 8th (vestibulocochlear) cranial nerves as well as the labyrinthine artery from the posterior fossa. It is approximately 1cm in length, and runs a roughly horizontal course in the coronal plane. At the lateral end of the canal both nerves pass through the lamina cribrosa, after which the facial nerve continues through the facial canal and the vestibulocochlear nerve gives off branches to supply the cochlea and vestibule. The canal itself is divided into four quadrants by the crista falciformis, which runs horizontally, and the vertical crests. The posterior quadrants are occupied by the superior and inferior vestibular branches of the vestibulocochlear nerve. The anterosuperior compartment of the canal is occupied by the facial and intermediate nerves. The anteroinferior compartment is occupied by the cochlear branch of the vestibulocochlear nerve.

Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 91.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 8, 29.

Cunningham DJ, edited by Robinson A. Cunningham's textbook of anatomy. New York: William Wood and Company, 1898: 129.

Case 1.58



Case 1.58

A Right foramen lacerum

B Right lambdoid suture

C Left petro-occipital fissure

D Left carotid canal

E Internal occipital protuberance

Axial CT of the head.

The temporal bone is made up of four parts:

- **squamous:** forms part of the skull base and the lateral vault
- **petrous:** forms part of the skull base and contains the middle and inner ears
- **mastoid:** contains mastoid air cells within the mastoid process behind the ear
- **styloid process:** inferior projection.

The occipital bone makes up the posterior aspect of the skull vault, and continues anteriorly to form part of the skull base. It contains the foramen magnum, anterior to

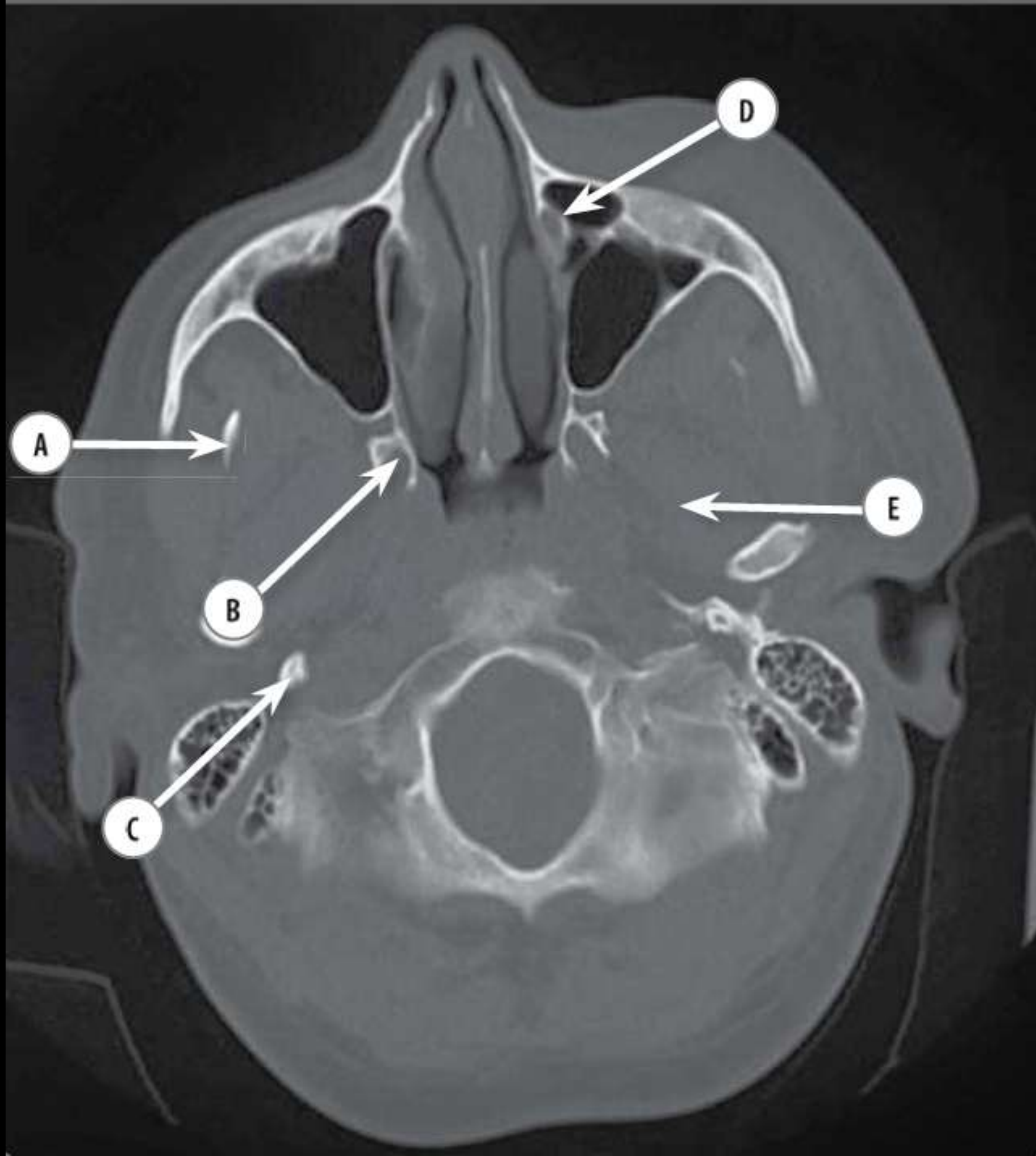
which it forms the clivus. This portion, anterior to the foramen magnum, is known as the basiocciput, and articulates with the sphenoid bone anteriorly, and the petrous temporal bone laterally. The petro-occipital fissure is found at the base of the petrous temporal bone and the clivus, and is continuous with the jugular foramen posteriorly.

The internal occipital protuberance is a bony prominence on the internal surface of the posterior cranial fossa in the midline, and marks a point of attachment of the tentorium cerebelli.

The foramen lacerum is a jagged bony canal found posteriorly and medial to the foramen ovale, between the petrous apex, the body of sphenoid and the basiocciput. The internal carotid artery traverses the superior part of the foramen lacerum; it contains only small veins and nerves.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 3.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 23.

Case 1.62



Case 1.62

A Right coronoid process of mandible

B Right pterygoid fossa

C Right styloid process

D Left nasolacrimal duct

E Left lateral pterygoid muscle

Axial CT of the head.

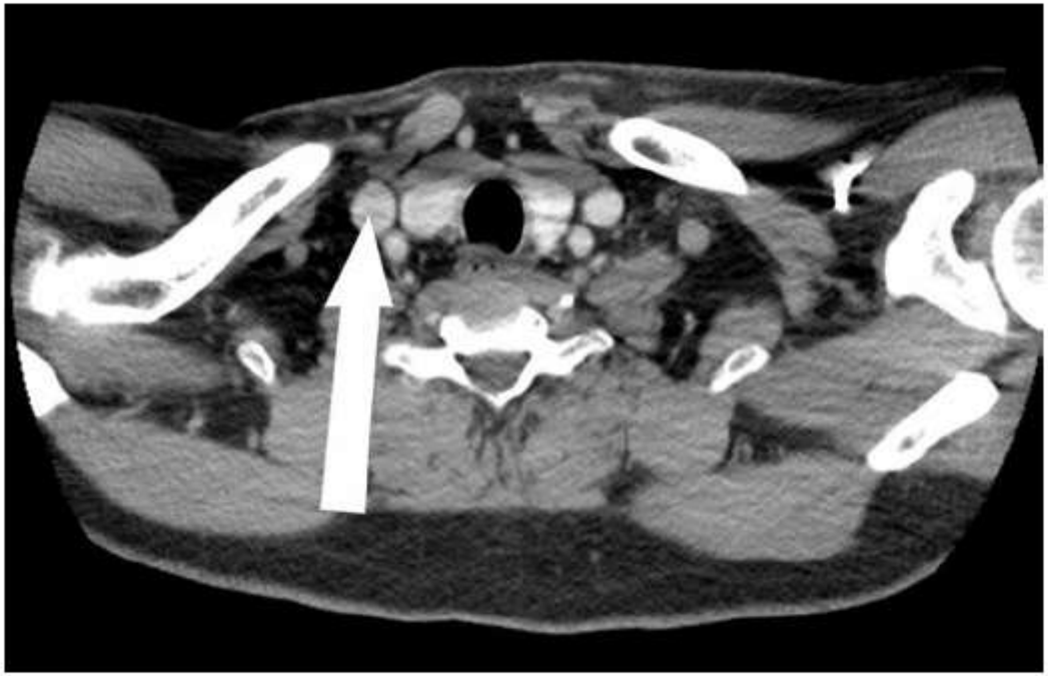
The lacrimal gland produces tears to lubricate the eye. These drain via the lacrimal punctae in the medial margins of each eyelid. They then pass through the superior and inferior lacrimal canaliculae. The canaliculae drain into the lacrimal sac, which is located in a depression in the medial wall of the bony orbit. From here, the lacrimal sac empties into the nasolacrimal duct. This duct passes through a bony canal to the inferior meatus in the nasal cavity.

The styloid process extends inferiorly from the base of the petrous temporal bone. The stylomastoid foramen is found posterior to the styloid process, with the facial nerve passing through it. The styloid process and the styloid muscles separate the nasopharynx anteromedially from the carotid sheath which is found posterolaterally.

Stylopharyngeus contributes to the inner layer of the pharyngeal muscles, and styloglossus runs anteriorly to act as an extrinsic muscle of the tongue. The stylohyoid ligament extends from the styloid process to the superior surface of the hyoid bone, and may sometimes be identified on lateral radiographs if it is calcified.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 20, 28.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 23, 30, 107.

Question 1:

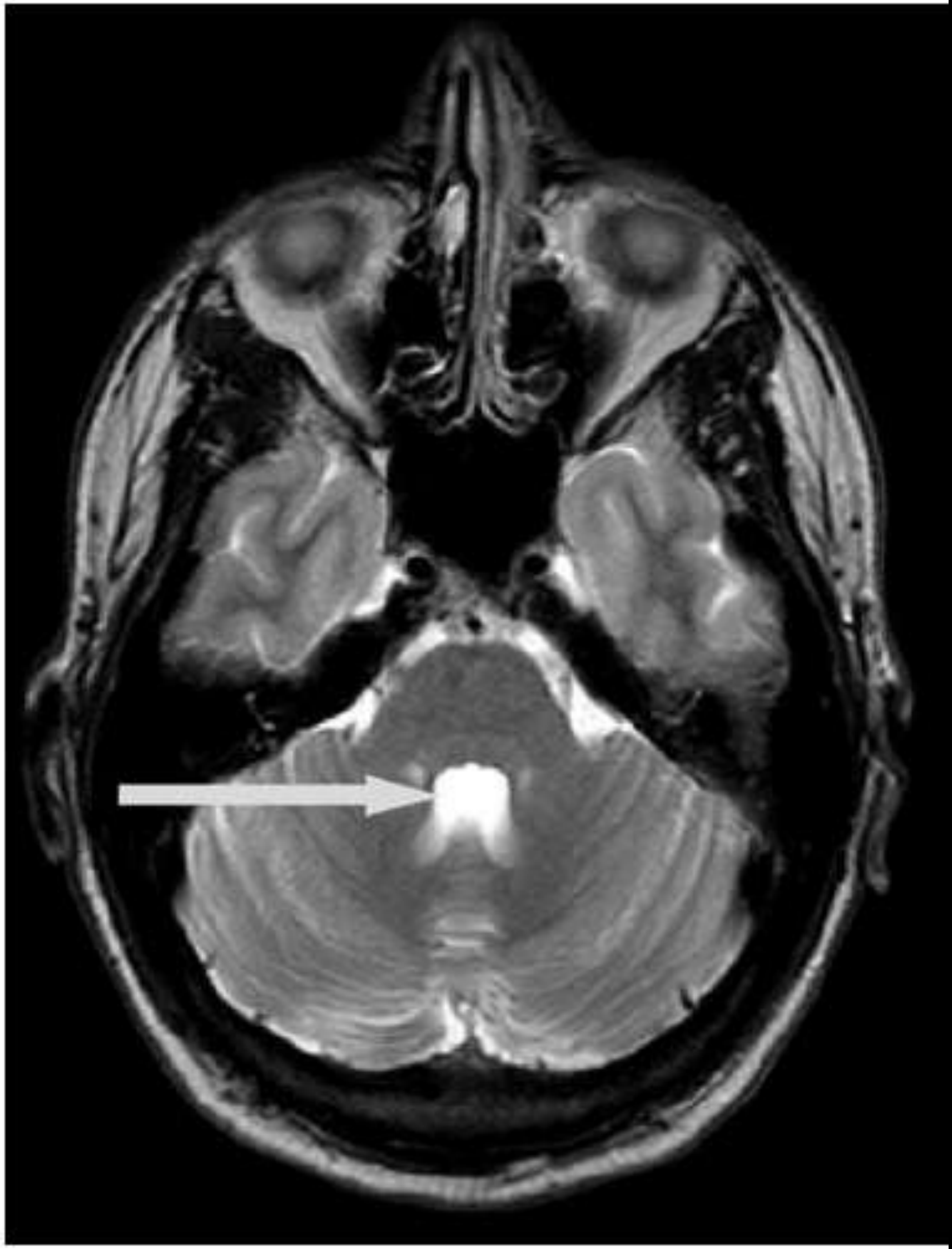


Question 1: Axial CT of the neck

Answer: Right internal jugular vein

- The internal jugular vein is a continuation of the sigmoid sinus and is formed at the jugular foramen.
- It joins the subclavian vein to become the brachiocephalic vein posterior to the medial aspect of the clavicle.
- The internal jugular vein travels within the carotid sheath along with the common carotid artery. The vein is usually lateral to the artery and larger in diameter.
- It is usual for the left and right jugular veins to be of different calibre, often even more marked than in this case.

Question 2:

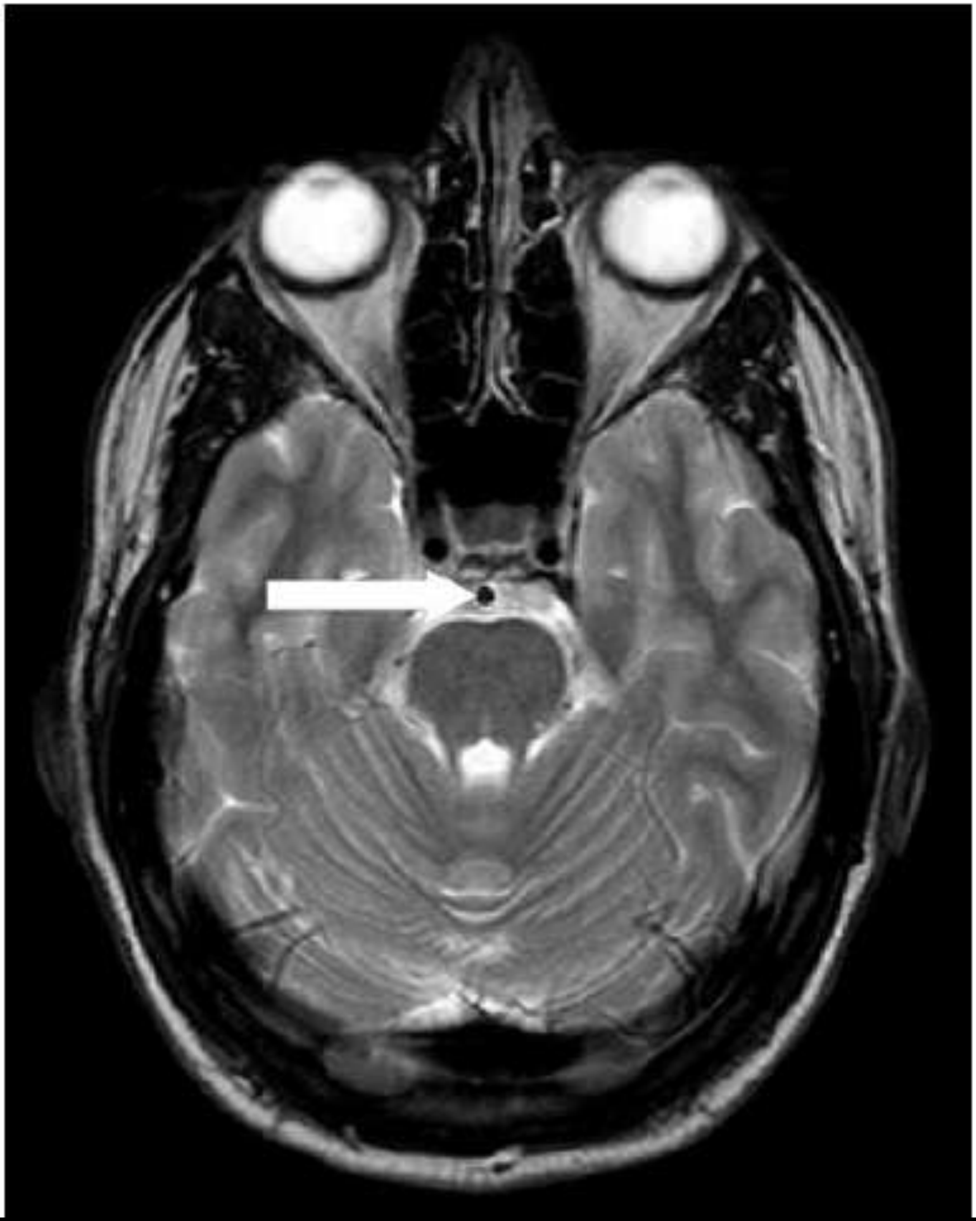


Question 2: Axial T2-weighted MRI of the brain

Answer: Fourth ventricle

- The fourth ventricle is a diamond-shaped structure that lies posterior to the pons.
- It is connected to the third ventricle superiorly via the aqueduct of Sylvius and to the central canal of the spinal cord inferiorly.
- It is also connected to the basal cisterns. One median aperture called the foramen of Magendie opens into the cisterna magna, whilst two lateral apertures called the foramina of Luschka open out into the cerebellopontine angle cisterns.

- **Question 5:**

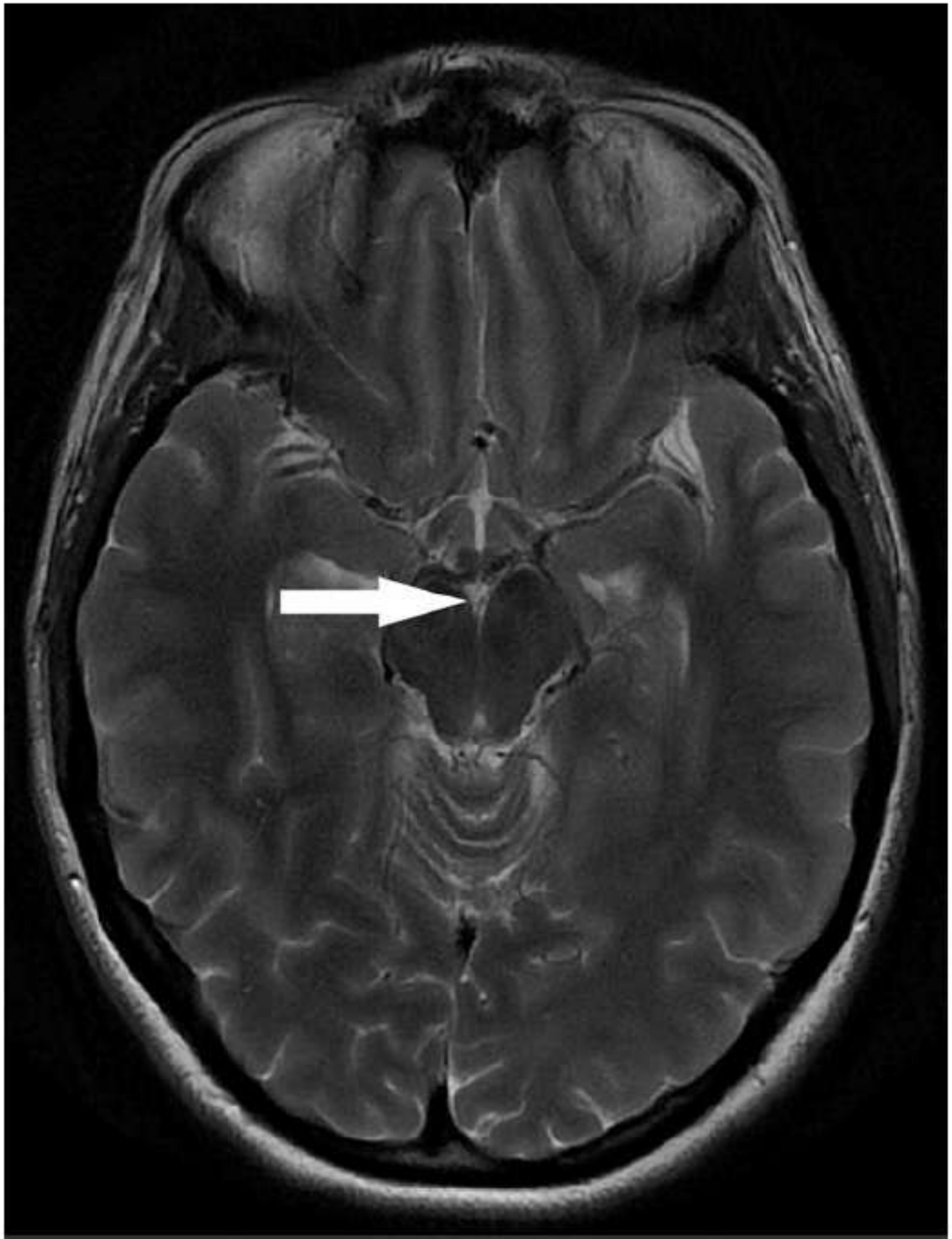


Question 5: Axial T2-weighted MRI of the brain

Answer: Basilar artery

- The basilar artery is a single vessel in the midline and is part of the posterior circulation.
- It lies posterior to the dorsum sellae and clivus and anterior to the pons.
- It arises from the paired vertebral arteries at the base of the pons.
- It gives off the following paired branches:
  - Anterior inferior cerebellar artery
  - Labyrinthine artery (variable)
  - Pontine artery
  - Superior cerebellar artery
- The basilar artery terminates at the paired posterior cerebral arteries.

Question 8:

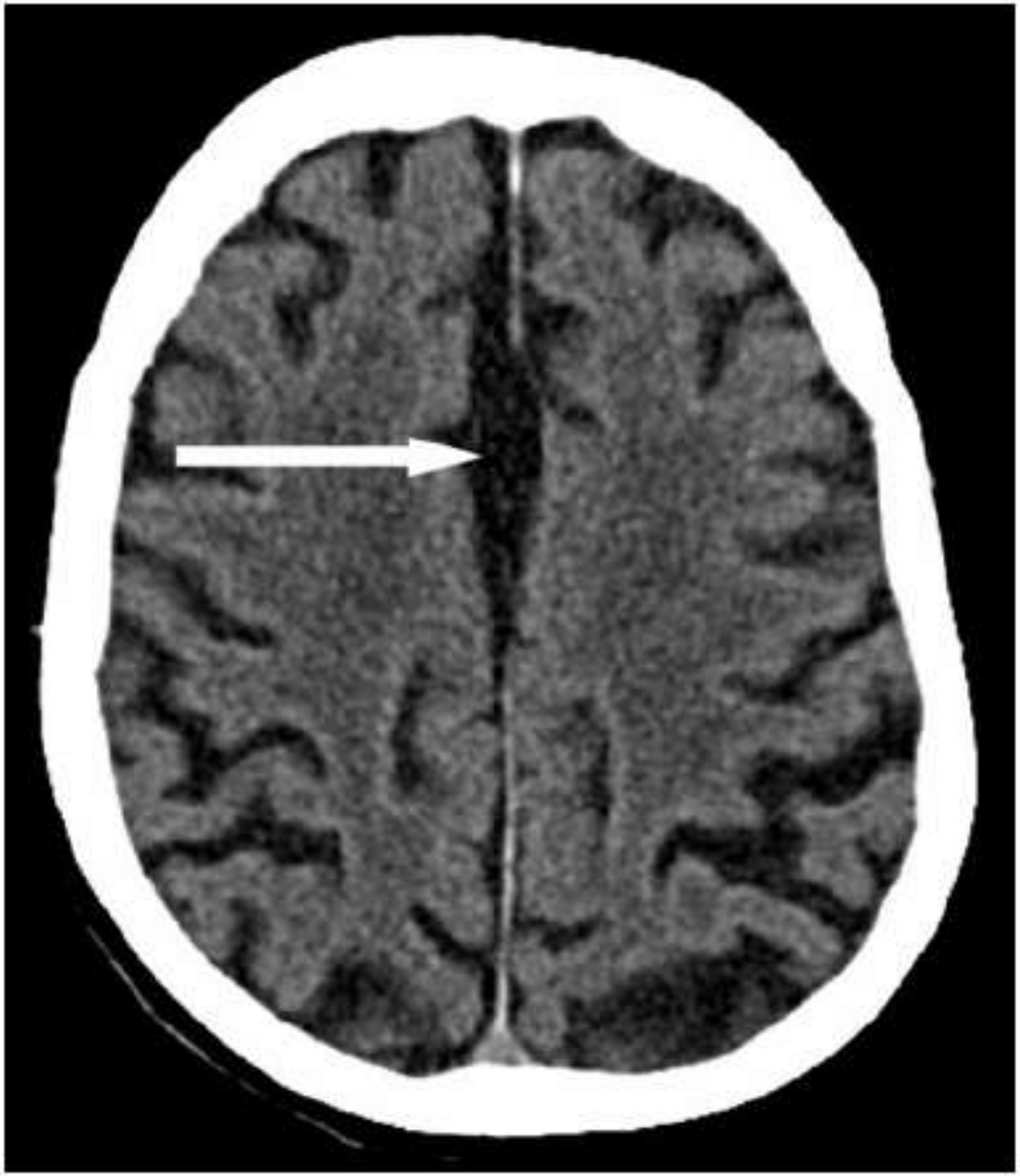


Question 8: Axial T2-weighted MRI of the brain

Answer: Interpeduncular cistern

- This portion of the brainstem is the midbrain, which somewhat resembles the head of Mickey Mouse.
- Between the cerebral peduncles (which are the ears of Mickey Mouse) lies the interpeduncular fossa. The interpeduncular cistern is located within the interpeduncular fossa.
- It lies posterior to the optic chiasm.

- **Question 14:**

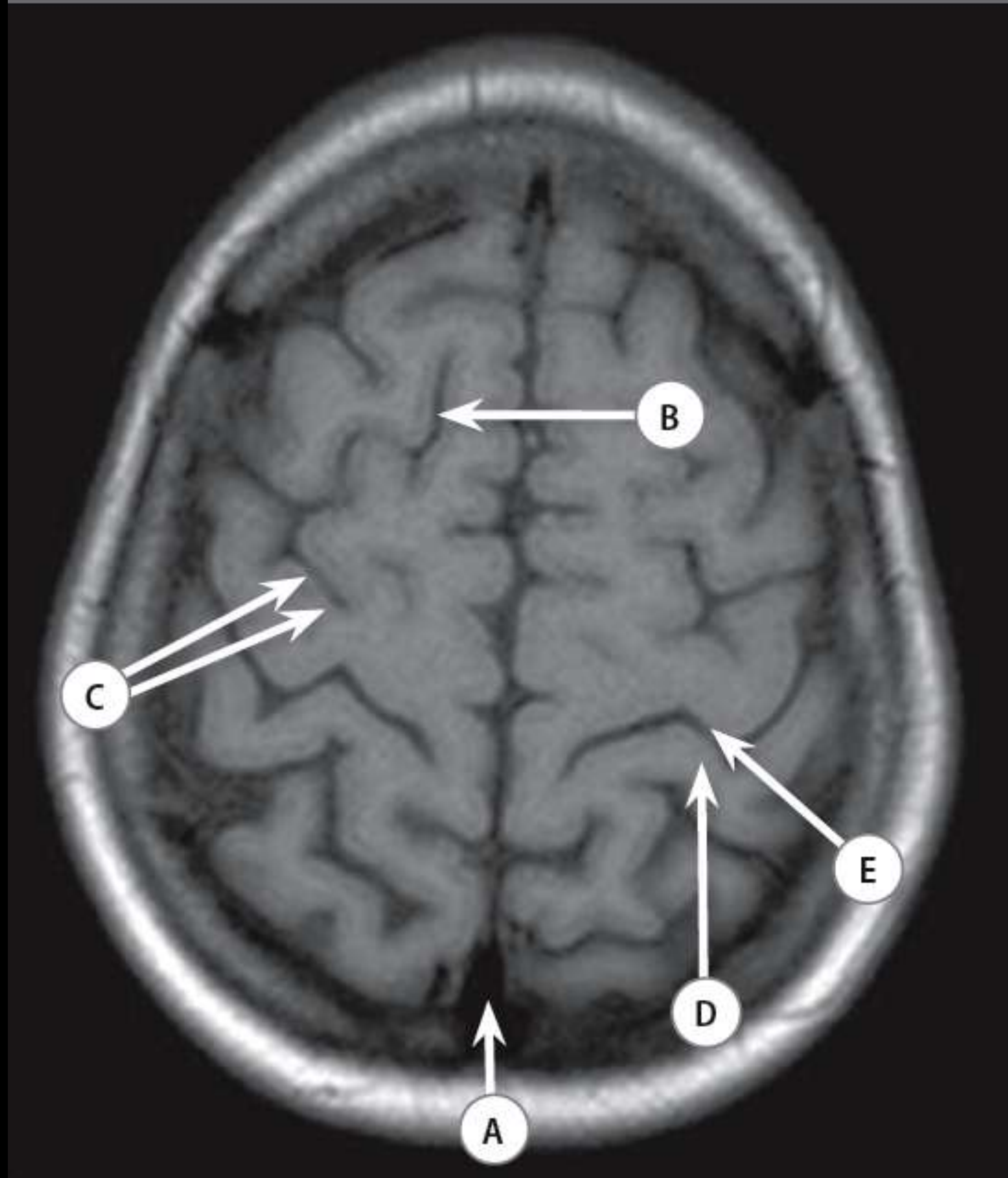


Question 14: Axial CT of the brain

Answer: Interhemispheric fissure

- An interhemispheric fissure is a deep groove running from anterior to posterior in the midline that separates the left and right cerebral hemispheres.
- The falx cerebri runs through the fissure as shown in the image.

Case 5.11



Case 5.11

A Superior sagittal sinus

B Right superior frontal sulcus

C Right precentral sulcus

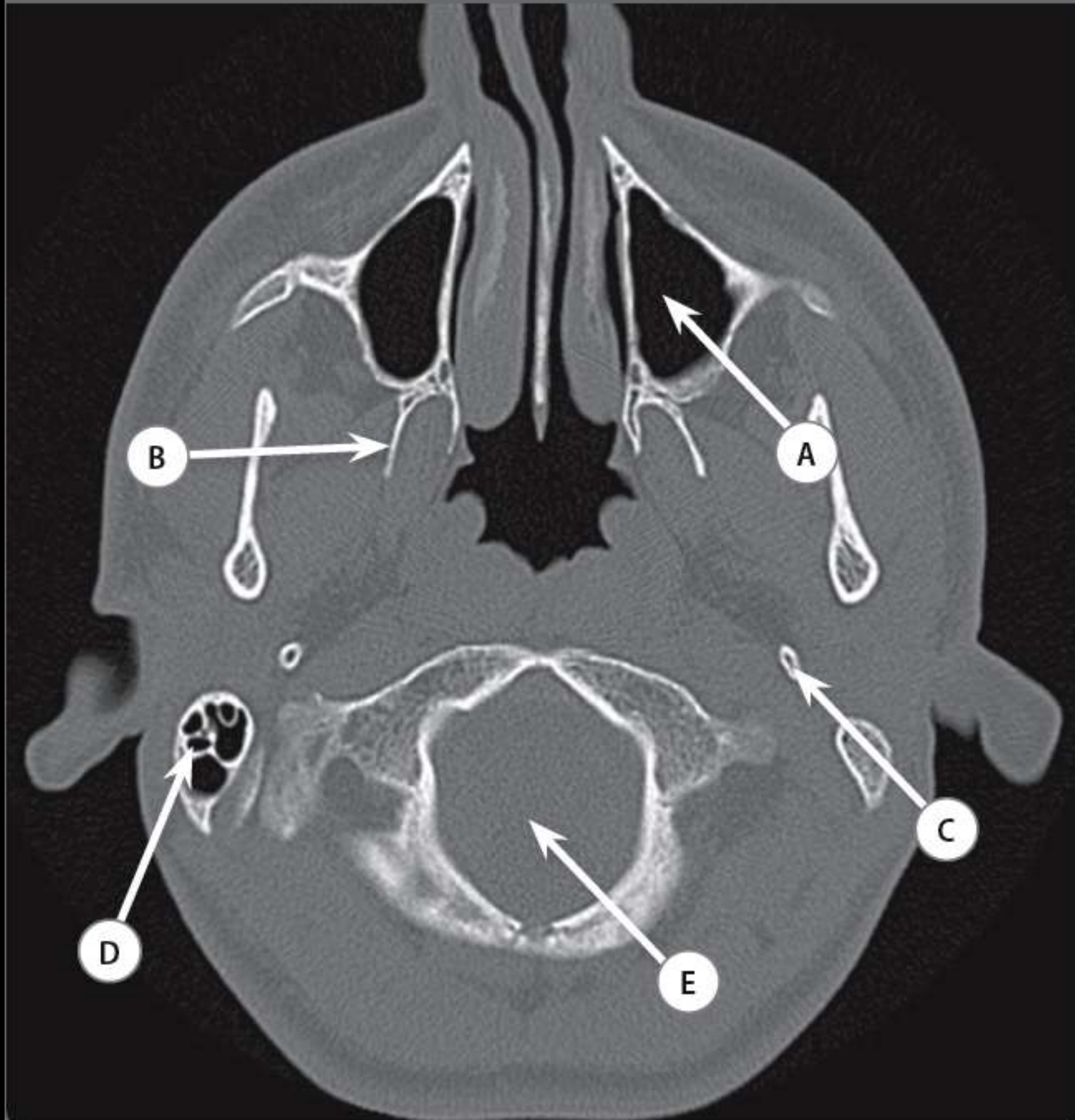
D Left postcentral gyrus

E Left central sulcus

Axial MRI of the central sulcus.

For further discussion see Chapter 1, Case 1.6

Case 6.19



Case 6.19

A Left maxillary antrum

B Right lateral pterygoid plate

C Left styloid process

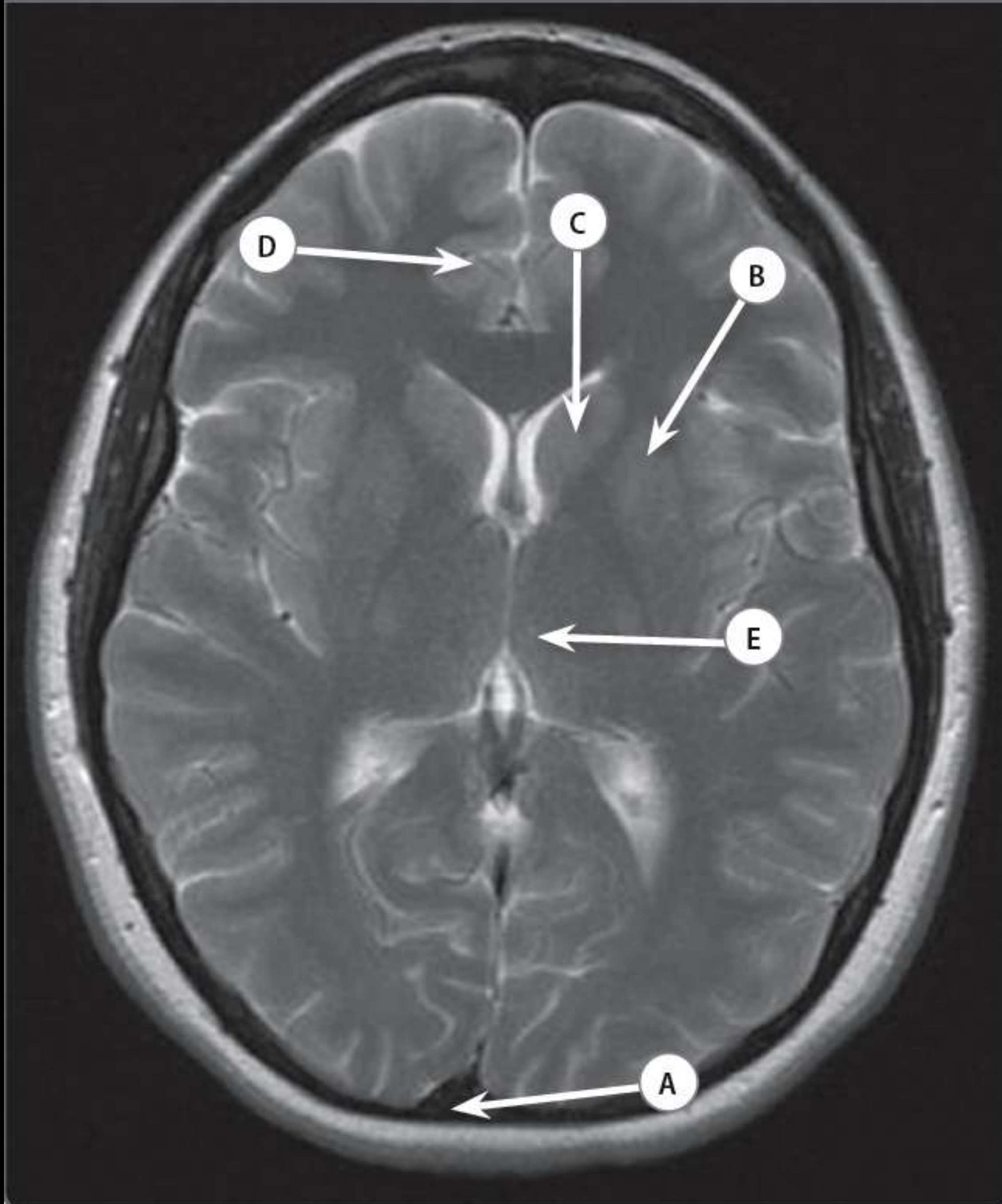
D Right mastoid air cells

E Foramen magnum

Axial CT of the head.

For further discussion see Chapter 1, Cases 1.32–1.38.

Case 6.14



Case 6.14

A Superior sagittal sinus

B Left lentiform nucleus

C Head of left caudate

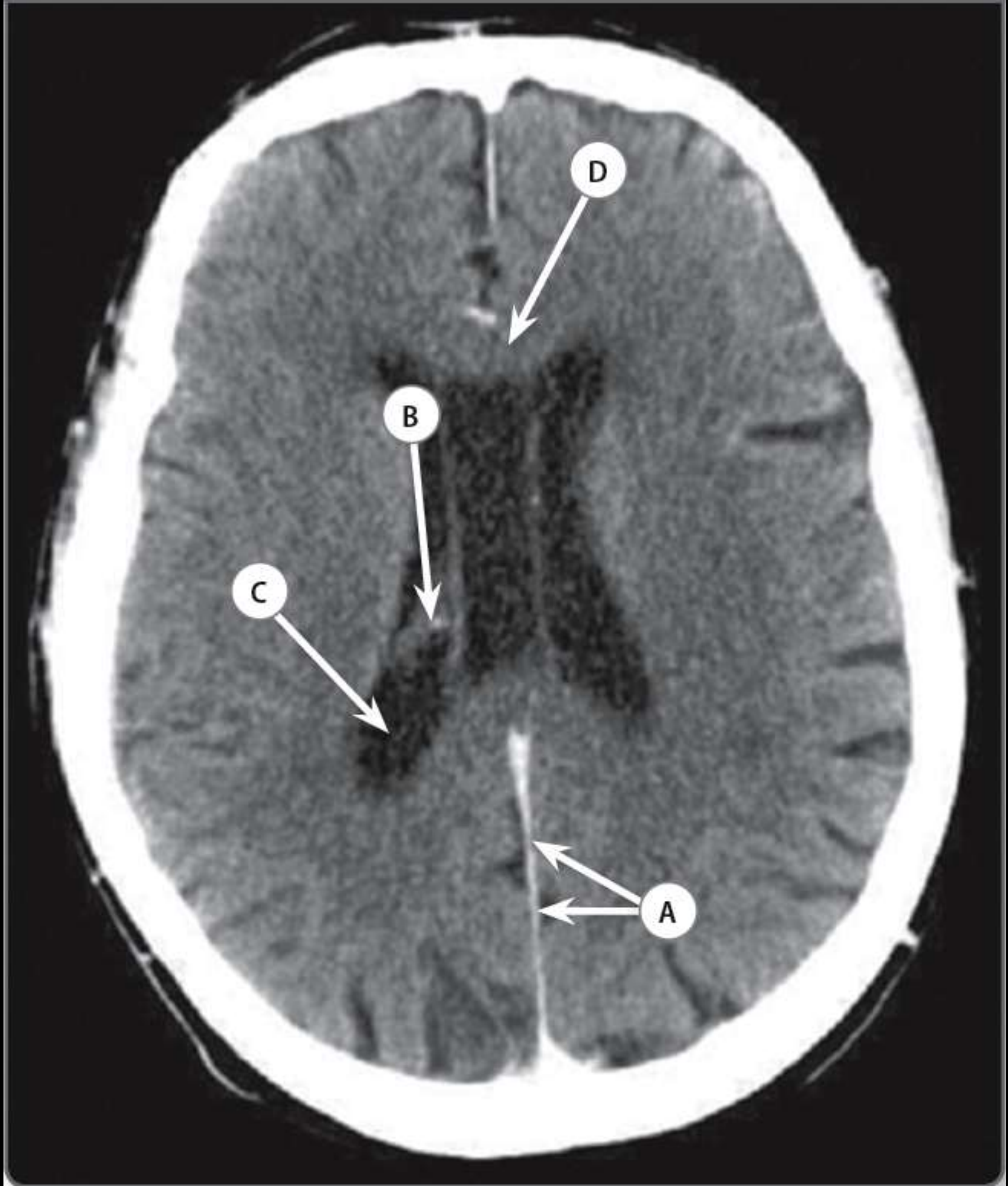
D Right cingulate gyrus

E Left thalamus

Axial CT of the brain at the level of the basal ganglia.

For further discussion see Chapter 1, Cases 1.7–1.9.

Case 6.11



Case 6.11

A Falx cerebri

B Choroid plexus in the right lateral ventricle

C Occipital horn of the right lateral ventricle

D Genu of the corpus callosum

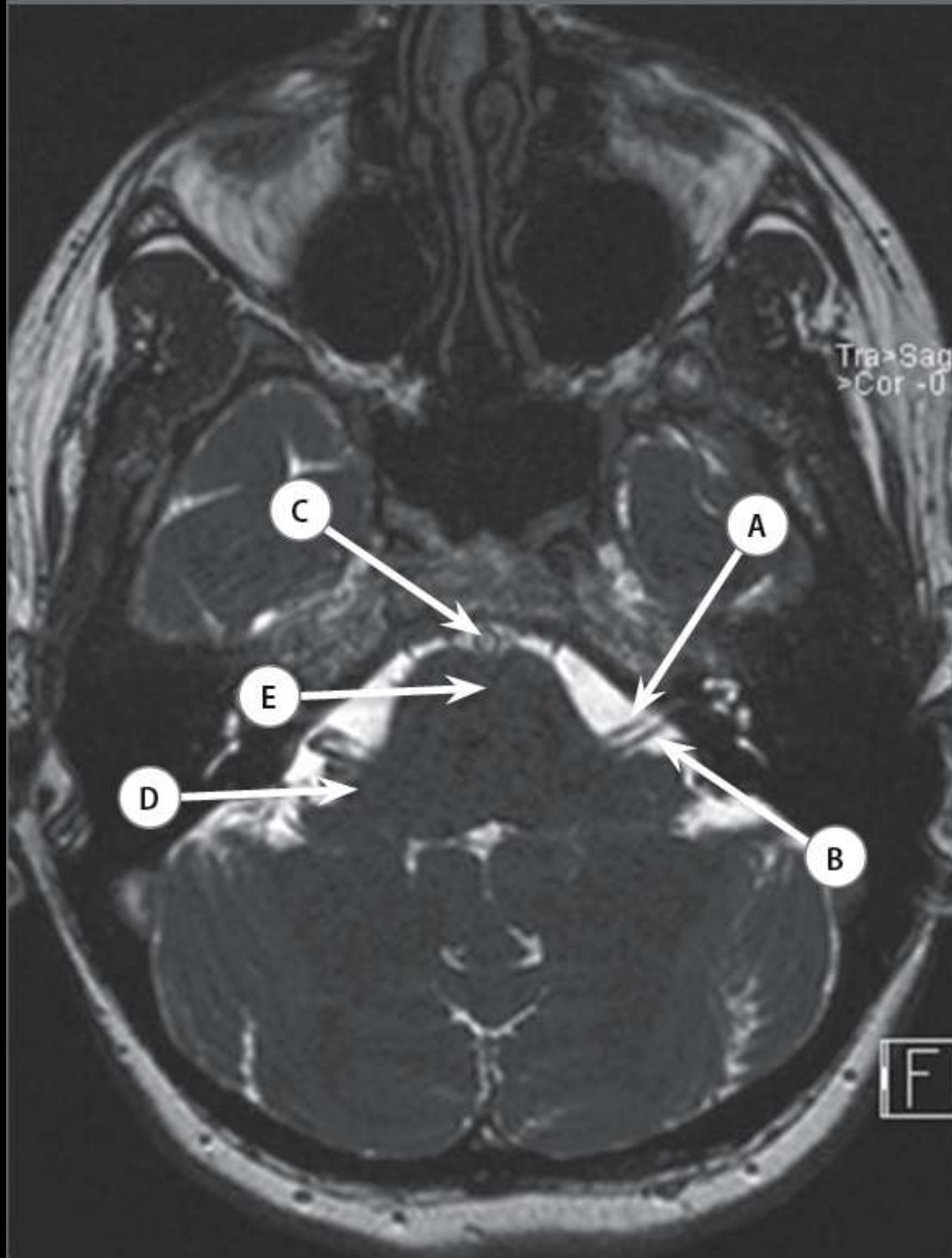
E Cavum septum pellucidum

Axial CT of the brain.

Cavum septum pellucidum is a variant of the septum pellucidum where there is a separation between the septal laminae.

For further discussion see Chapter 1, Cases 1.7–1.9.

Case 6.7



Case 6.7

A Left facial nerve

B Left vestibulocochlear nerve

C Basilar artery

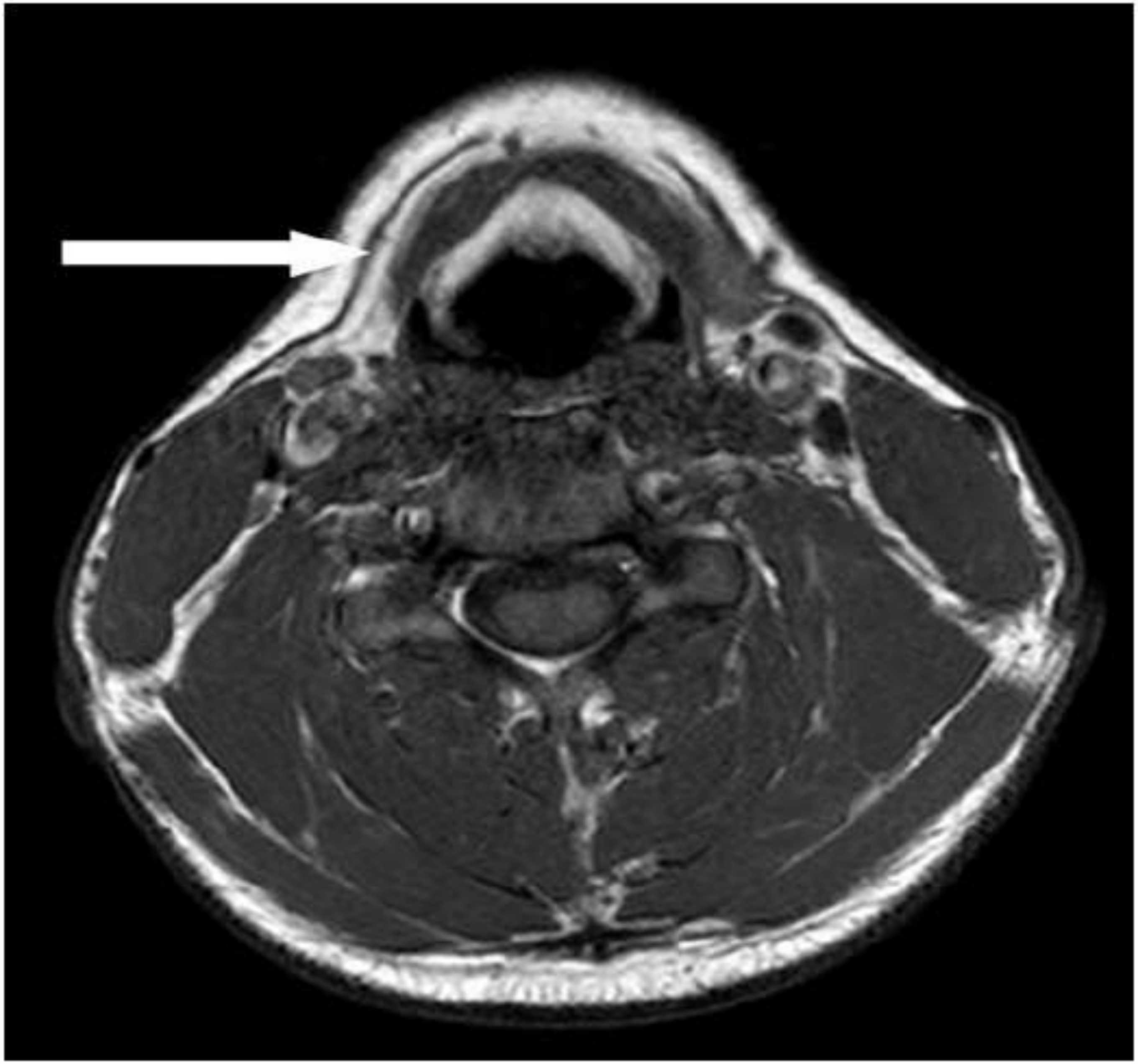
D Right middle cerebellar peduncle

E Pons

Axial T2-weighted MRI of the cerebropontine angle.

For further discussion see Chapter 1, Cases 1.1–1.19.

Question 50:

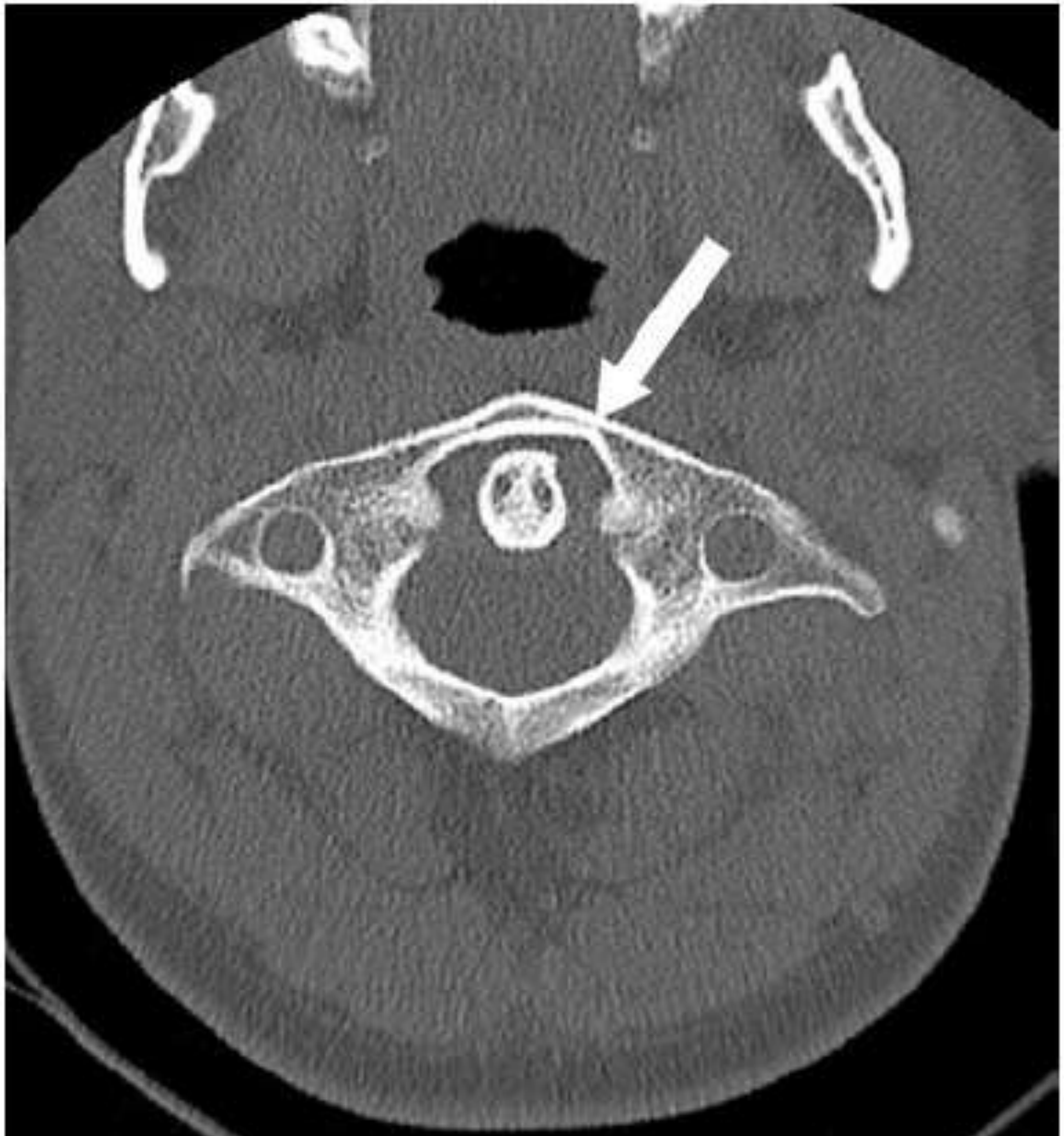


Question 50: Axial T1-weighted MRI of the neck

Answer: Right platysma muscle

- The platysma is a broad but thin sheet of muscle that is derived from the fascia of the pectoralis major muscle and the deltoid muscle.
- It inserts onto the body of the mandible and onto the skin of the lower face.
- In humans, it is a muscle of facial expression; in horses, it is more developed and its contractions act to repel insects.
- It is the most superficial muscle in the anterior portion of the neck.
- The name is derived from the Greek word *platus*, which means wide.

Question 21:

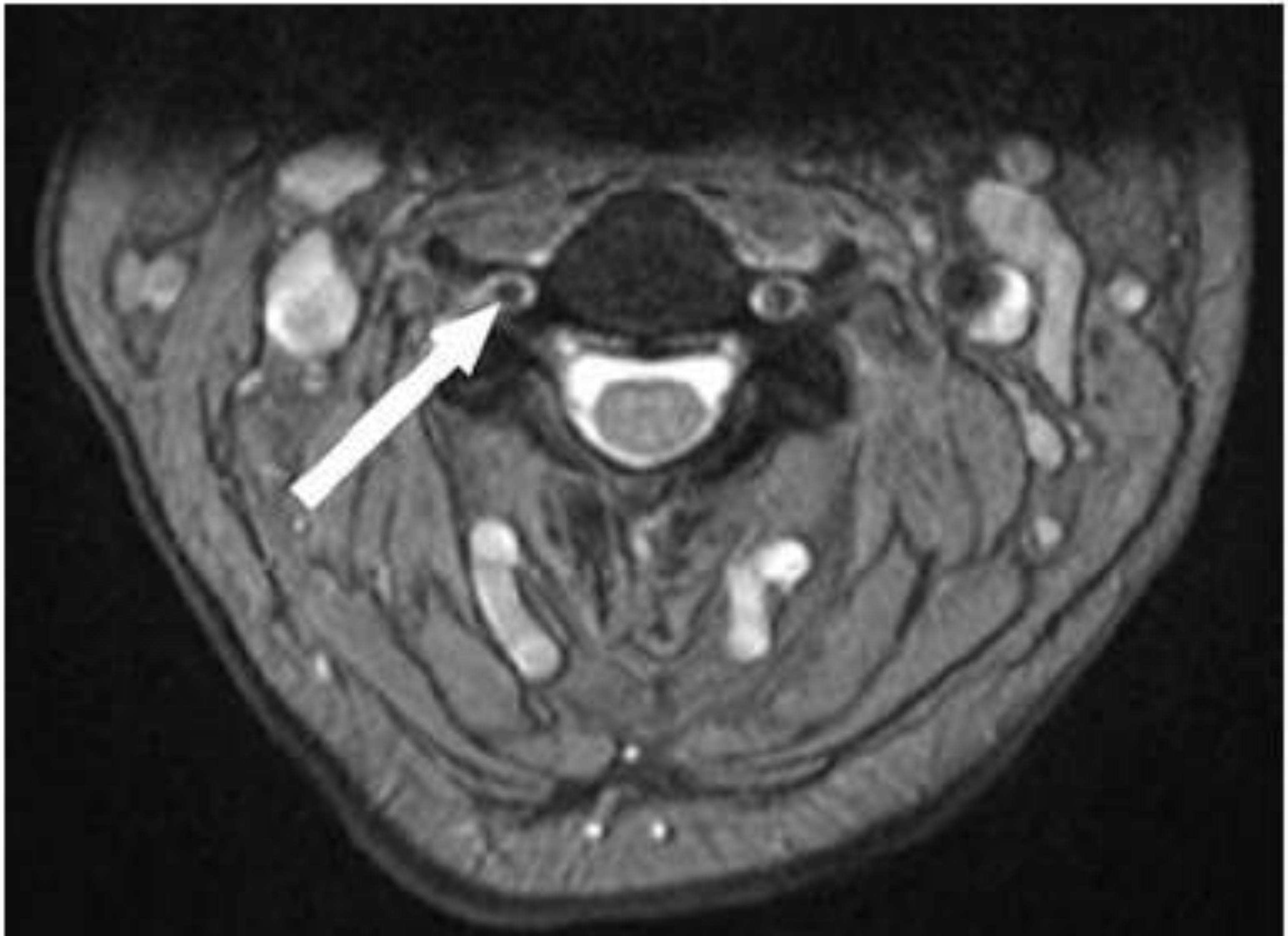


Question 21: Axial CT of the neck

Answer: Anterior arch of the atlas (C1)

- Unlike other vertebrae, the atlas does not have a body. It is shaped like a ring with lateral masses on either side.
- Each lateral mass has superior and inferior facets for articulation with the occiput at the atlanto-occipital joint and axis (C2) at the atlantoaxial joint.
- The anterior arch has a tubercle on the anterior surface and a posterior facet that articulates with the odontoid process.
- A pair of vertebral arteries exit from the foramen transversarium and form grooves on the posterior arch as it passes alongside the lateral masses before entering the foramen magnum.

- Question 22:

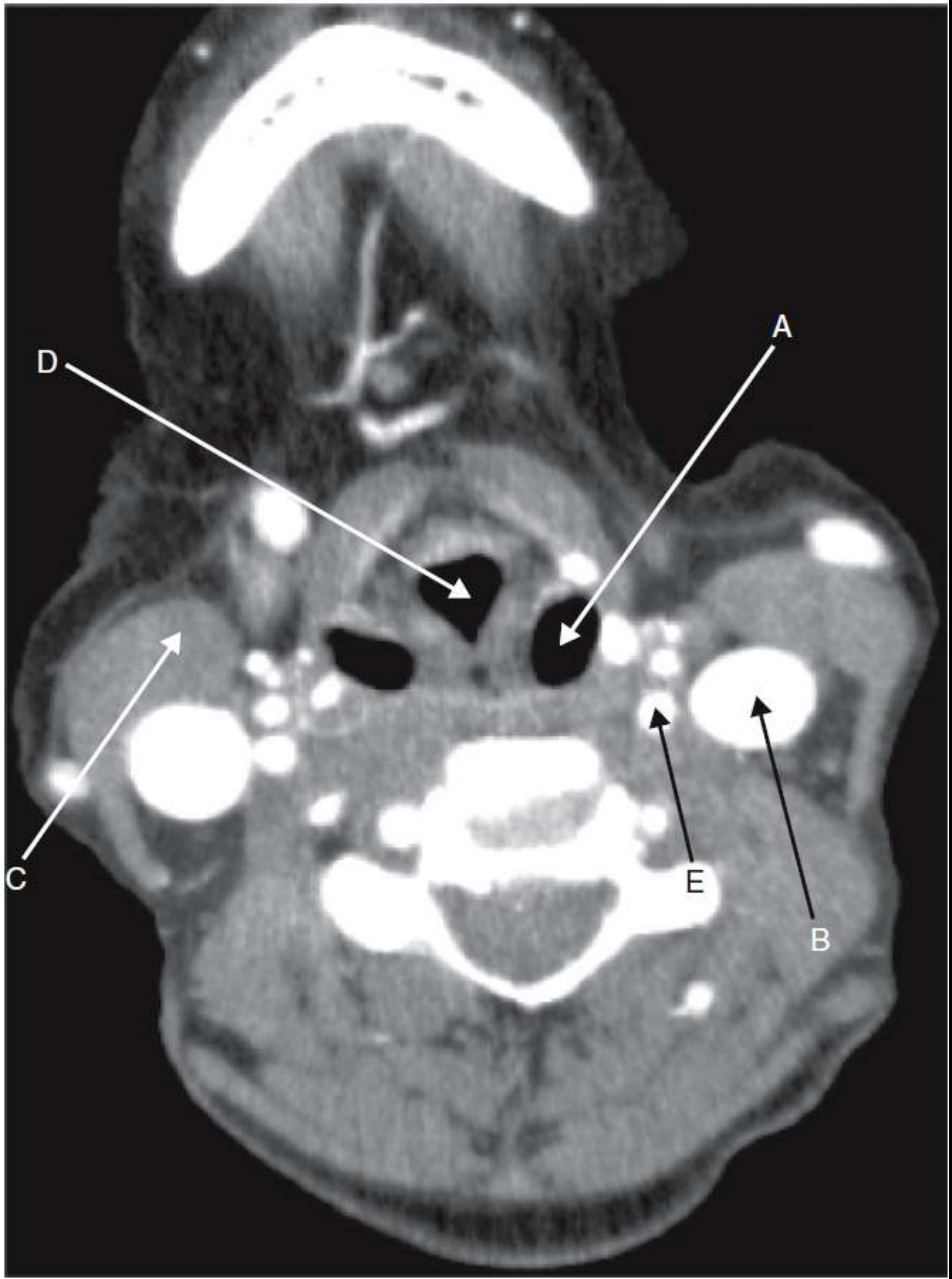


Question 22: T2-weighted axial MRI of the neck

Answer: Right vertebral artery

- The vertebral arteries originate from the subclavian arteries and ascend through the foramen transversarium from the level of C6.
- They enter the foramen magnum and join at the base of the medulla oblongata to form the basilar artery.

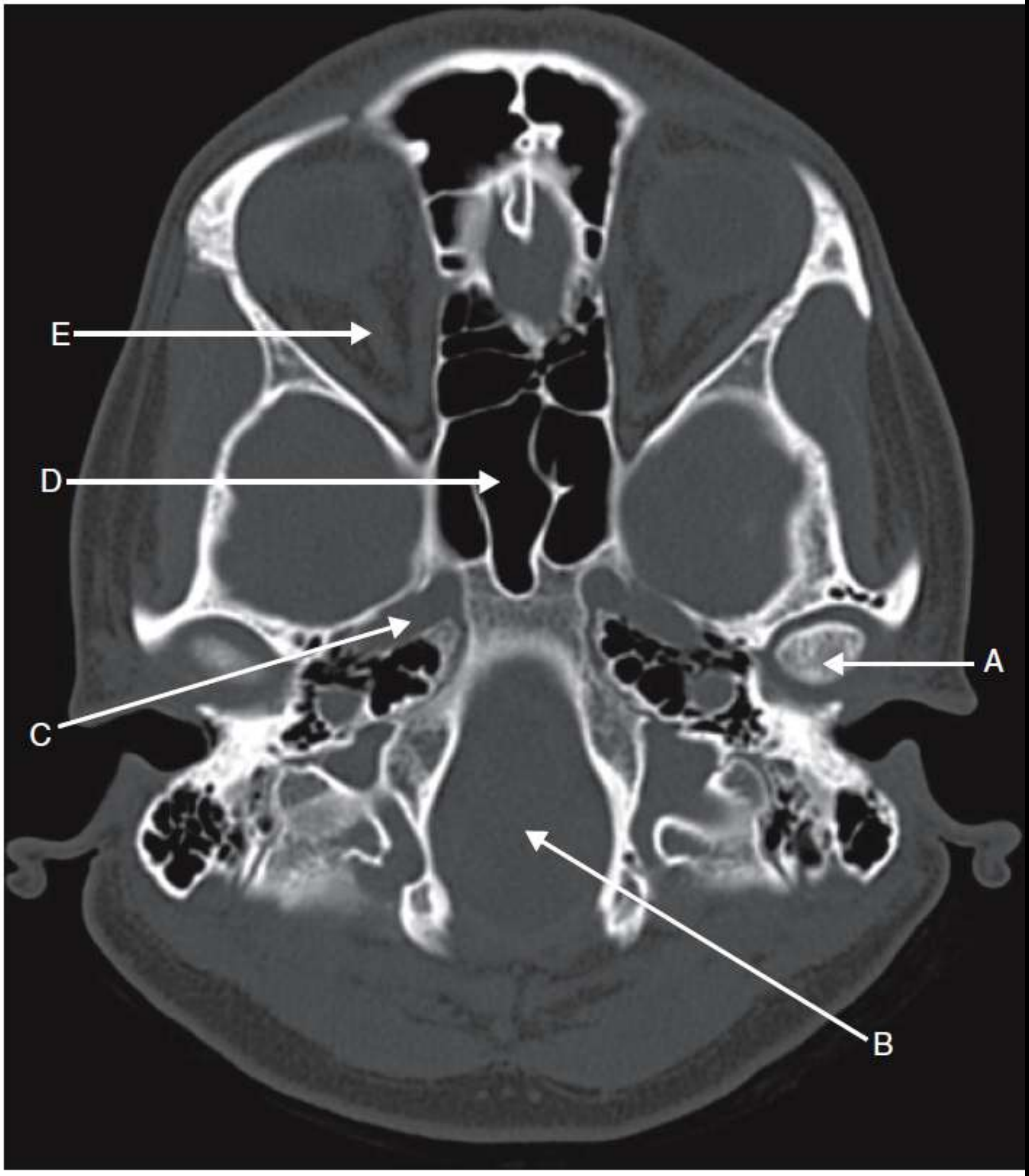
Case 7.4



7.4 Axial enhanced CT neck

(a) Air in the left piriform fossa. This is part of the hypopharynx.
(b) Left internal jugular vein. The anterior branch of the retromandibular vein joins the facial vein to form the internal jugular vein.
(c) Right sternocleidomastoid muscle. The superior attachment is the mastoid process of the temporal bone. The inferior attachments are to the manubrium and the clavicle.
(d) Air in the supraglottic larynx. The supraglottic larynx consists of the false cords and aryepiglottic folds.
(e) Left internal carotid artery. This gives off two small branches in the petrous region – the caroticotympanic artery to the ear drum and the pterygoid artery to the pterygoid canal and plate. There are further small branches which come off in the cavernous region.

Case 7.7



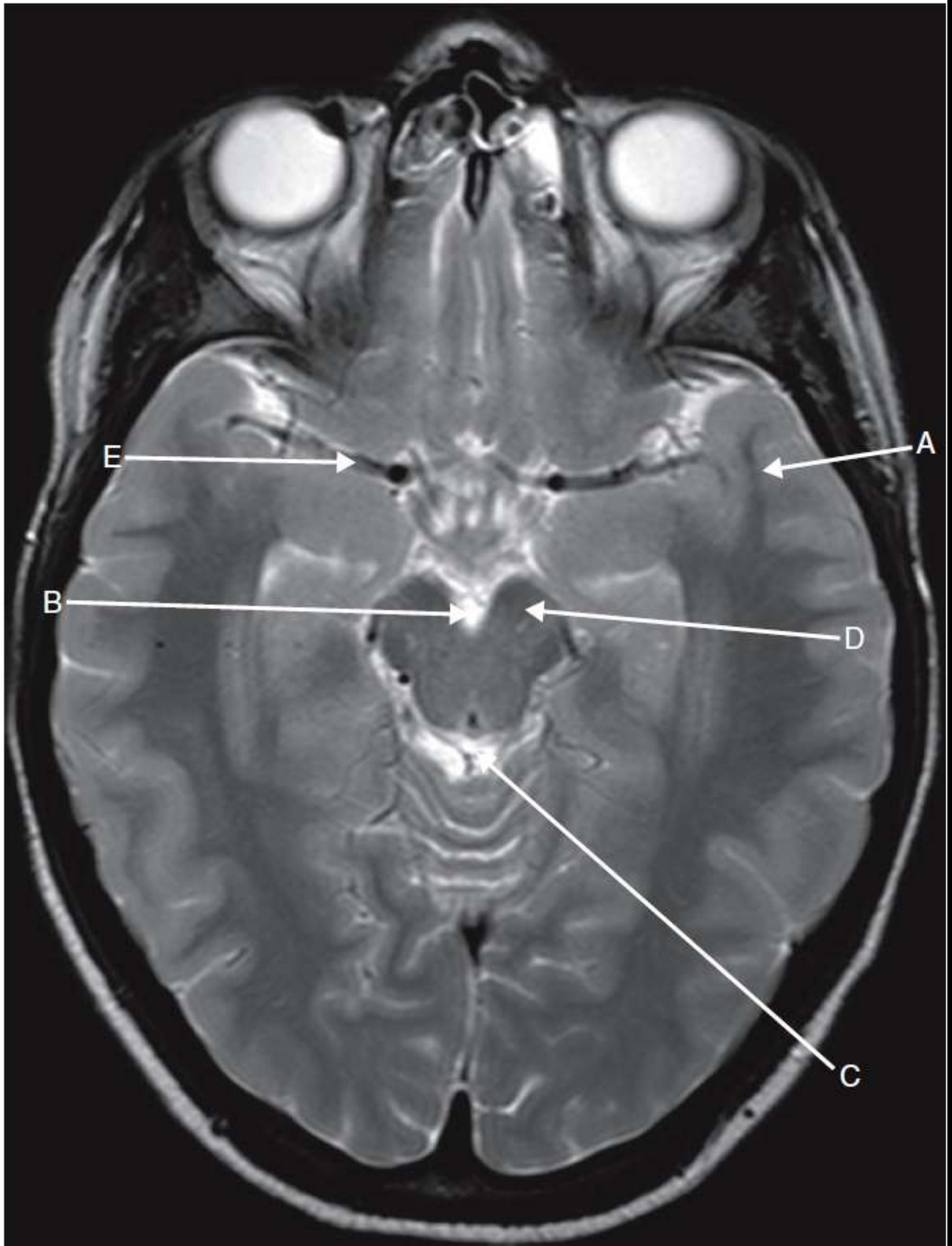
7.7 Axial CT skull base (bone windows)

(a) Left head (condyle) of mandible.
(b) Foramen magnum. With raised intracranial pressure from any aetiology (traumatic, neoplastic, ischaemic) the cerebellar tonsils can descend through the foramen magnum which is known as tonsillar herniation. This causes compression of the cardiac and respiratory centres within the brainstem and thereby death. This is best appreciated on sagittal MR though can be suspected on CT. Other possible brain herniations include:

1. transtentorial (or uncal) herniation where the medial aspect of the temporal lobe (uncus) herniates inferior to the tentorium cerebelli
2. subfalcine herniation where a frontal lobe crosses the midline and passes beneath the falx cerebri (midline shift).

(c) Right carotid canal. Part of the petrous apex of the temporal bone.
(d) Sphenoid sinus. There are varying degrees of pneumatization of the sphenoid sinus in individuals. The sphenoid sinuses drain into the sphenoethmoidal recesses, either side of the nasal septum.
(e) Right optic nerve.

Case 7.10



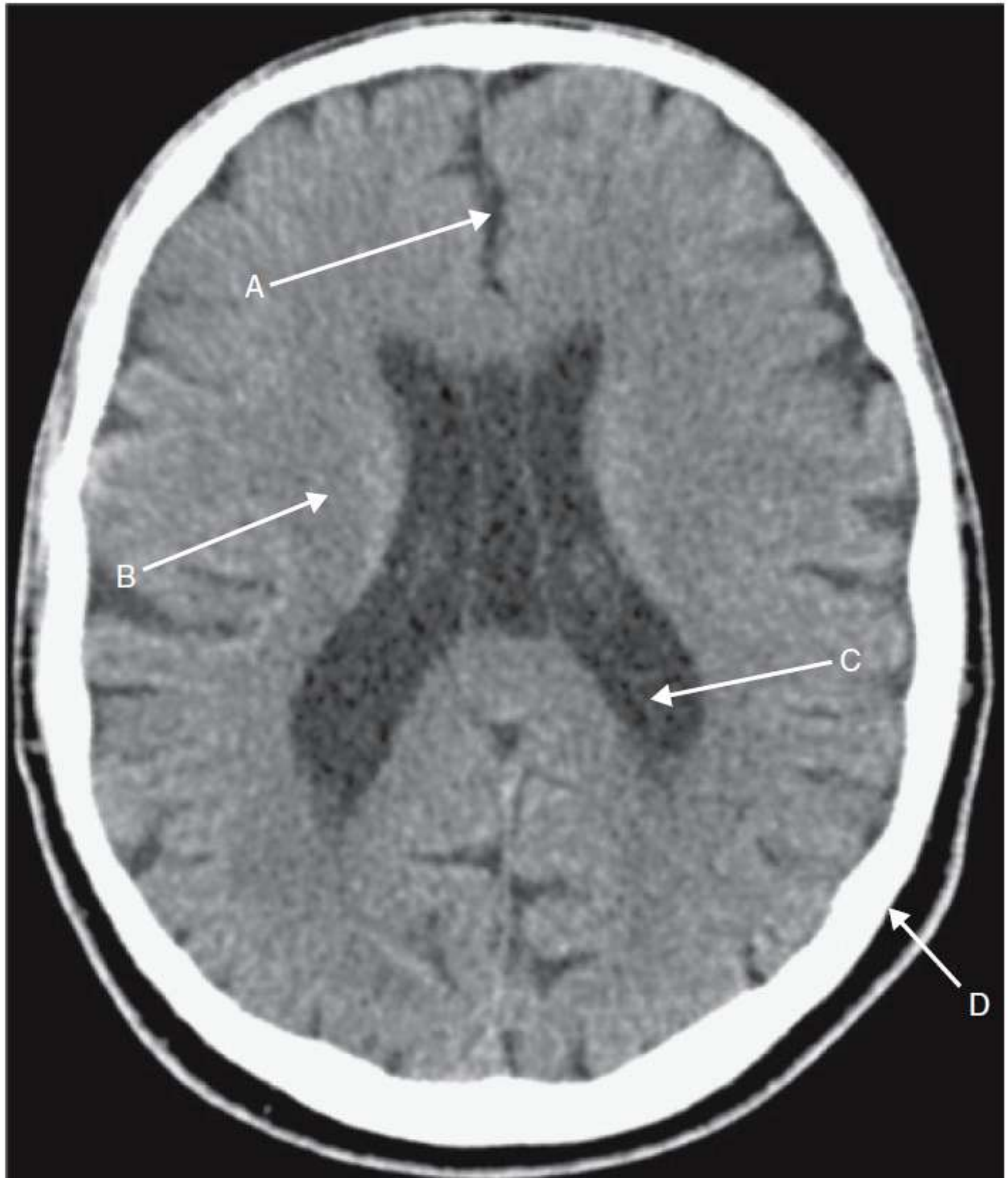
7.10 Axial T2-weighted MR brain

(a) Left temporal lobe.
(b) Interpedicular cistern.
(c) Quadrigeminal cistern.
(d) Left cerebral peduncle.
(e) Right middle cerebral artery (MCA). The arrow points at the horizontal or M1 segment of the MCA. This gives off a number of lenticulostriate arteries which perfuse

the lateral basal ganglia. At the insula, the artery turns into the Sylvian fissure (M2 segment) giving off a number of insular branches. The branches emerge form the lateral aspect of the Sylvian fissure extending anteriorly and posteriorly over the frontal, parietal and temporal lobes (M3 segment).

In acute stroke thrombus can be seen within the MCA. On CT, this is called the hyperdense MCA sign if the thrombus is in the M1 segment, and if it is in the M2 segment as the hyperdense MCA dot sign.

Case 7.16

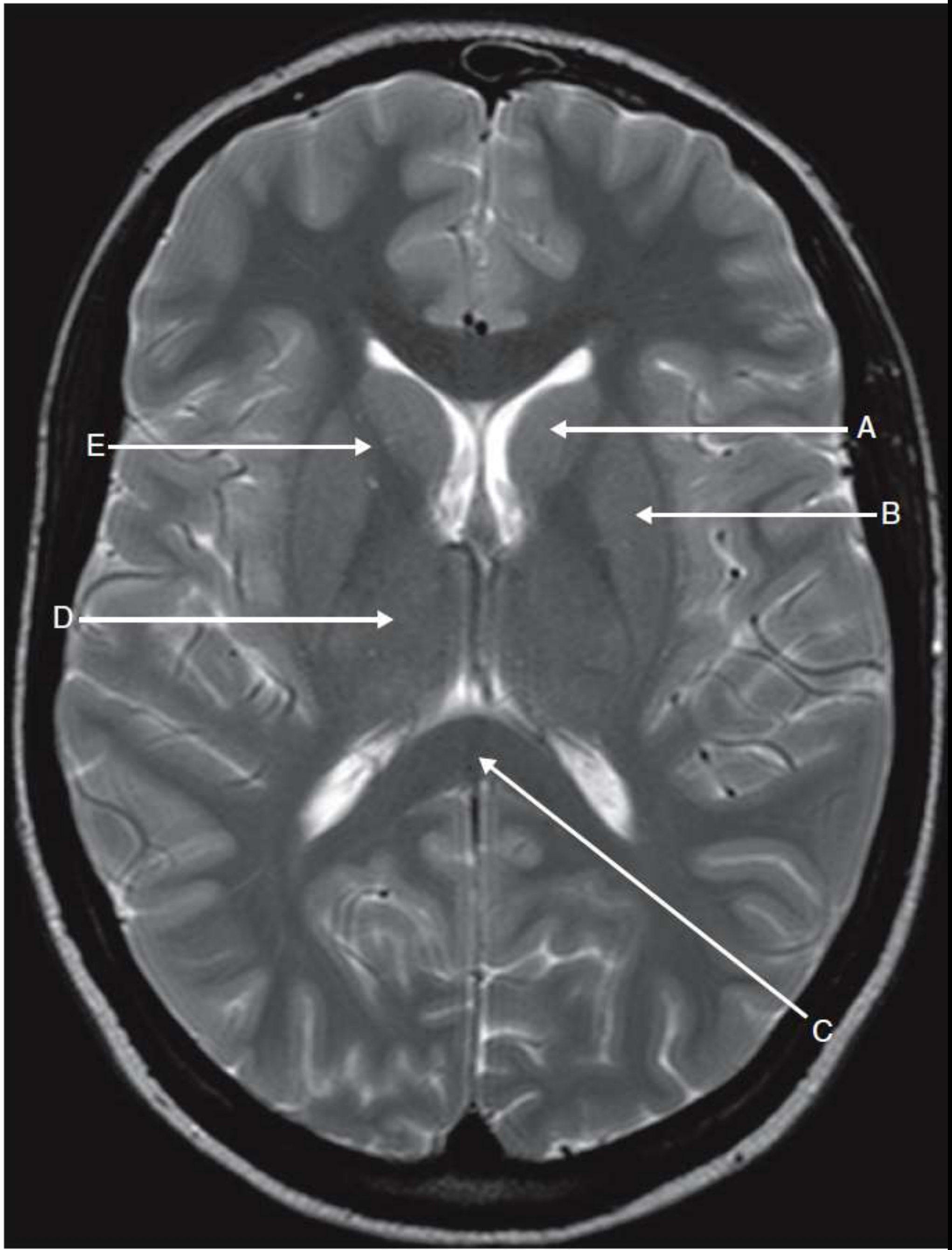


(e)	Which normal variant is present on this image?

7.16 Axial unenhanced brain CT

(a) Falx cerebri.
(b) Left corona radiata.
(c) Posterior horn of the left lateral ventricle.
(d) Left parietal bone.
(e) Cavum vergae. This is a normal variant similar to cavum septum pellucidum except in this case the separation of the septum pellucidum leaflets extends back to the splenium of the corpus callosum.

Case 8.8



8.8 Axial T2-weighted MR image of the brain

(a) Left caudate nucleus.
(b) Left lentiform nucleus. This consists of two components – the lateral putamen and medial globus pallidus.

Together the lentiform and caudate nuclei are known as the corpus striatum. They are part of the extrapyramidal system of the motor system, involved in the coordination of reflexes and posture.

(c) Splenium of the corpus callosum. The corpus callosum connects both cerebral hemispheres. The splenium is the bulky posterior part, anterior to which lies the body, genu and rostrum respectively.
(d) Right thalamus.
(e) Anterior limb of the right internal capsule.

A
B
C
D
E

Q8 Answers

a Foramen rotundum
b Foramen ovale
c Foramen spinosum
d Condylar process of the mandible
e Frontal process of the zygoma

CT with bone windows at level of skull base, axial section

The skull base is generally symmetrical across the midline sagittal plane and its many foramina are clearly visible on CT. On each side, the foramen rotundum (more rounded appearance than foramen ovale) transmits the second (maxillary) branch of the trigeminal nerve (CN V). Postero-lateral to this, the foramen ovale transmits the third (mandibular) division of the trigeminal nerve. Immediately postero-lateral again sits the foramen spinosum; this allows passage of the middle meningeal artery (a branch of the maxillary artery).

A
B
C
D
E

Q9 Answers

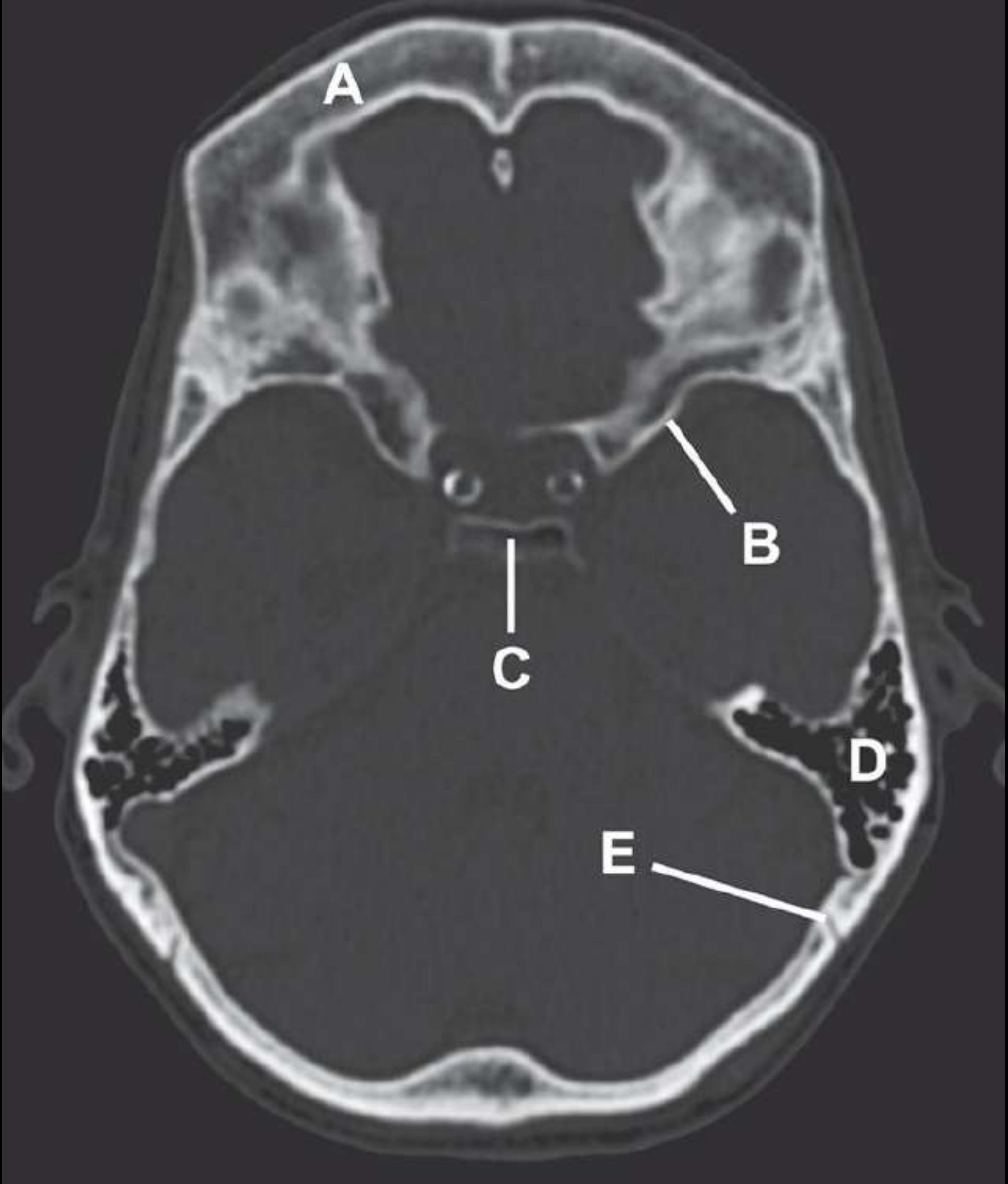
a Clivus
b Carotid canal
c Jugular foramen
d Foramen magnum
e Hypoglossal nerve

CT with bone windows at level of skull base, axial section

The clivus represents the posterior aspect of the sphenoid bone and forms part of the anterior wall of the posterior cranial fossa. The pons sits immediately posterior to the clivus.

The carotid artery takes a tortuous course through the skull base; it enters the skull via the carotid canal traversing the foramen lacerum (seen on this image just medial to the carotid canal as a ragged opening) to enter the cranial cavity. Immediately thereafter, the carotid artery enters the venous cavernous sinus where it makes several turns before entering the subarachnoid space to divide into its terminal branches.

In addition to the jugular vein, the jugular foramen transmits cranial nerves IX (glossopharyngeal), X (vagus) and XI (accessory). The hypoglossal canal lies medial to and below the jugular foramen and transmits the hypoglossal nerve (CN XII). The foramen magnum is the major and only unpaired opening in the cranial floor and allows the medulla to continue caudally as the spinal cord. In addition, the vertebral arteries enter the skull via this route along with the spinal root of CN XI.


A
B
C
D
E

Q10 Answers

a Frontal bone
b Lesser wing of sphenoid
c Dorsum sellae
d Mastoid air cells
e Lambdoidal suture

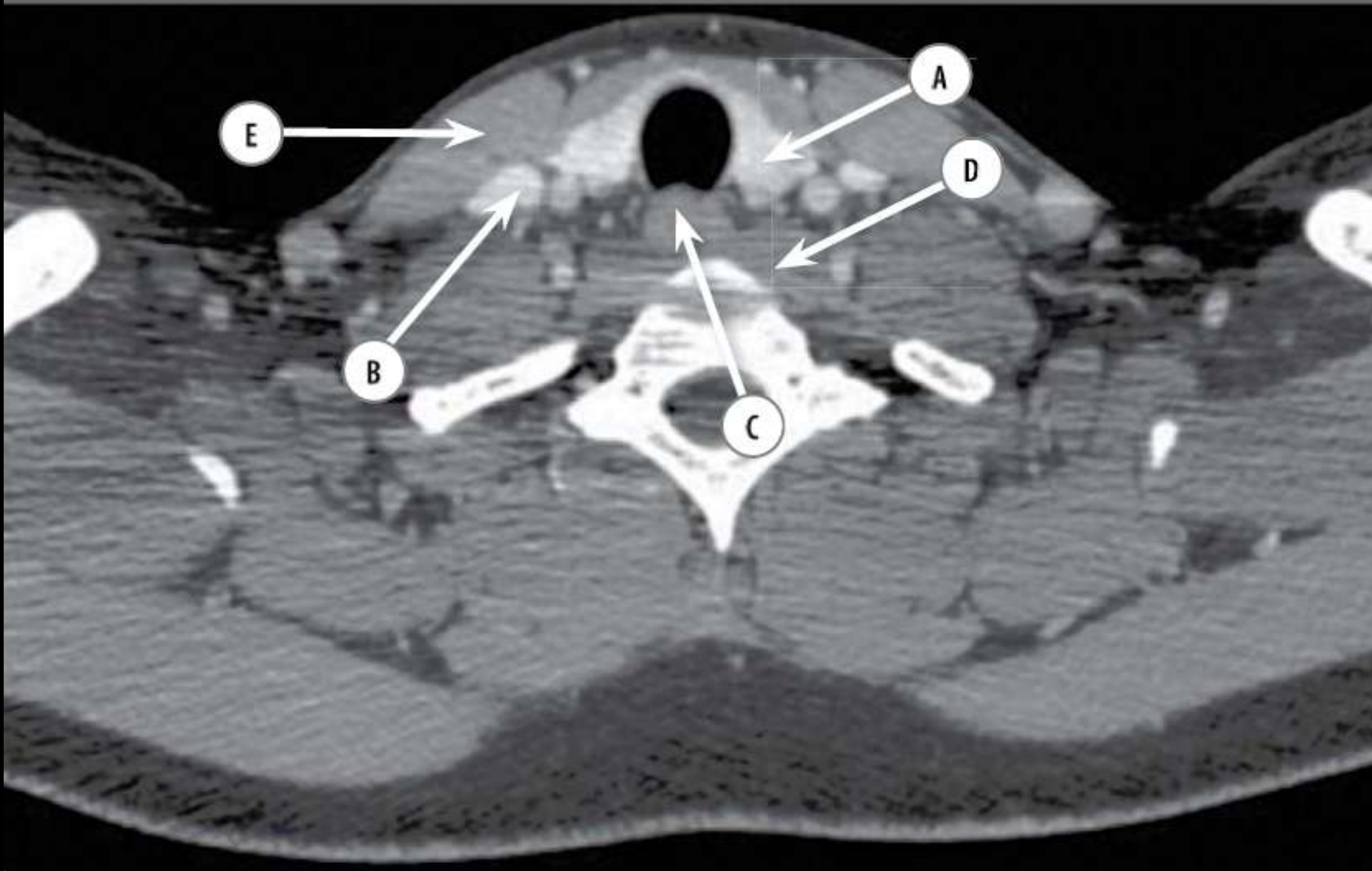
CT with bone windows showing cranial fossae, axial section

The cranium is divided into three fossae which are arranged in a stepwise fashion from front to back. The anterior cranial fossa, containing the frontal lobes of the cerebral hemispheres, is at the highest level and lies between the frontal bones anteriorly and the sphenoid ridge (formed by the lesser wing of sphenoid) posteriorly. The base of the anterior cranial fossa is predominantly formed by the orbital plates of the frontal bones separating the frontal lobes of the brain from the orbits. In the midline the perforated cribriform plates of the ethmoid bone enable olfactory nerve fibres to pass from the nasal cavity to the olfactory bulbs. The floor of the middle cranial fossa is formed anteriorly by the greater wing of sphenoid and posteriorly by the petrous part of the temporal bone; the petrous ridge defines its posterior limit. The middle cranial fossa supports the anterior aspect of the temporal lobes. The posterior cranial fossa is formed largely by the occipital bone and contains the cerebellum.

The dorsum sellae is the posterior part of the bony cavity formed to house the pituitary gland and arises from the body of the sphenoid bone.

It is important to recognize the various skull sutures and their normal locations as fractures can have similar appearances.

Case 1.46



Case 1.46

A Left lobe of the thyroid

B Right internal jugular vein

C Oesophagus

D Prevertebral muscles

E Right sternocleidomastoid

Soft tissue axial CT through the neck at the level of the thyroid.

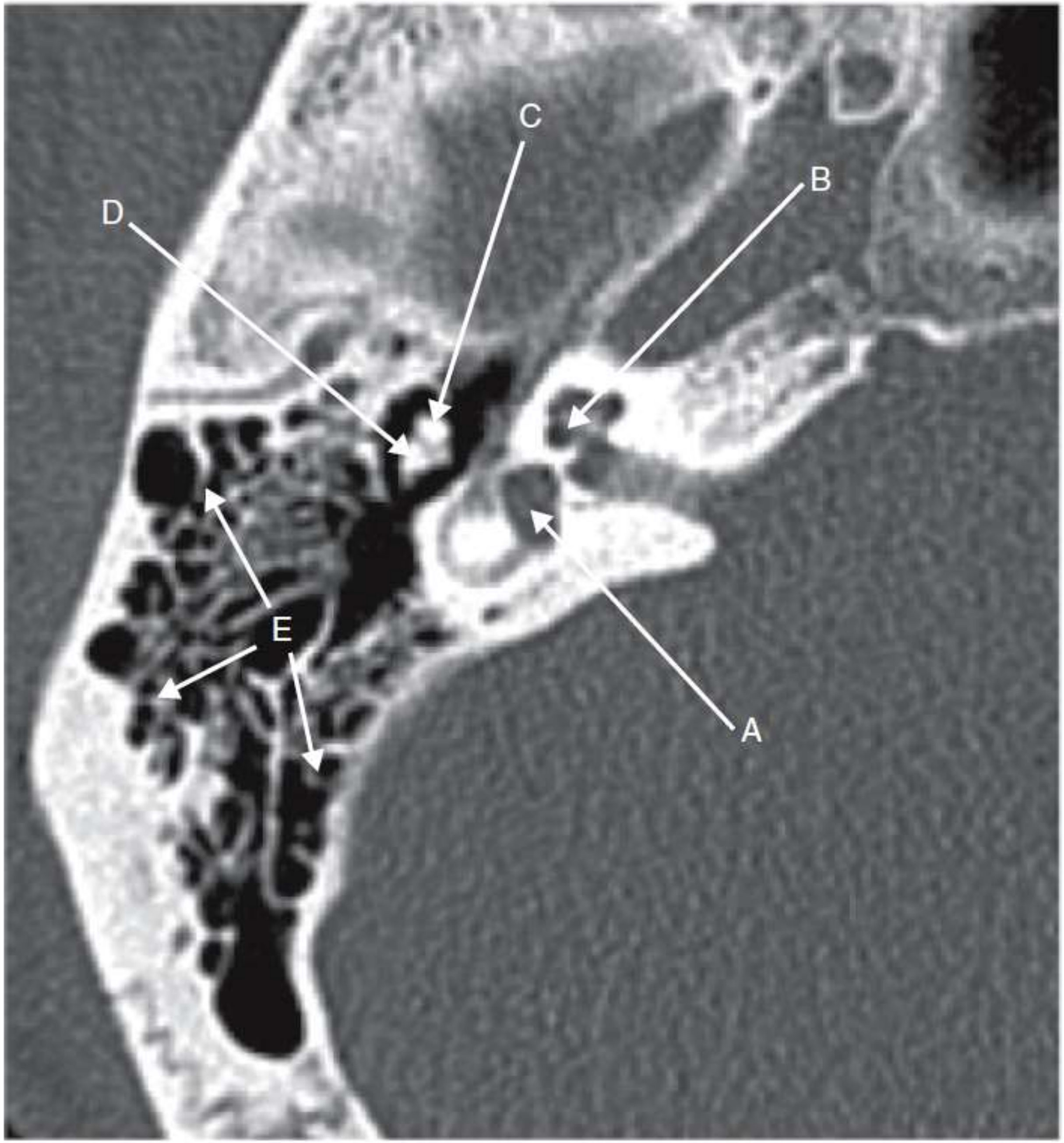
The thyroid is relatively high attenuating on CT due to its high iodine content. The sternocleidomastoid is seen as a large muscular structure anteriorly. The internal jugular vein is posterior to the thyroid, and wider and more irregular than the more medial common carotid artery. The oesophagus is usually collapsed behind the trachea. The prevertebral muscles lie in the floor of the anterior and posterior triangles of the neck. They lie deep to the prevertebral fascia, and anterior to the vertebral bodies. They can be split into anterior and lateral groups (**Table 1.3**).

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 1005.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 42–43.

Table 1.3 The prevertebral muscles

Muscle type	Muscles
Anterior	• Longus colli • Longus capitis • Rectus capitis • Rectus capitis lateralis
Lateral	• Splenius capitis • Levator scapulae • Posterior scalene • Middle scalene • Anterior scalene

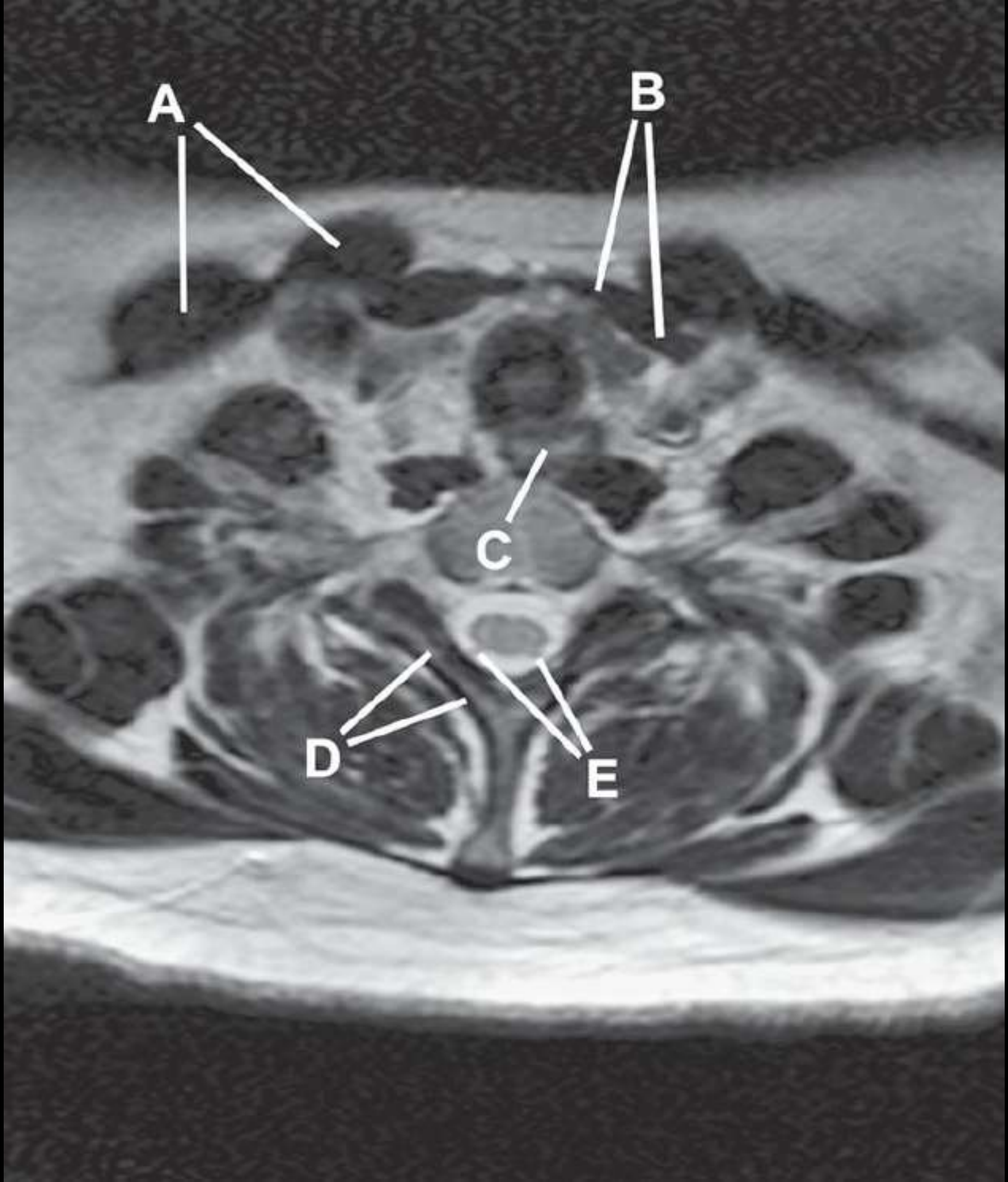
Case 8.3



8.3 HRCT right inner ear

(a) Right vestibule. This communicates posteriorly with the three semicircular canals and anteriorly with the cochlear.

(b) Right cochlear. This contains the cell bodies of the cochlear nerve within the modiolus.
(c) Right head of malleus. The handle of the malleus is attached to the tympanic membrane whilst the head articulates with the body of the incus.
(d) Right body of incus. The body of the incus articulates with the malleus at the incudomallear joint. The long process of the incus articulates with the head of the stapes.
(e) Right mastoid air cells. These communicate with the attic via the aditus ad antrum.


A
B
C
D
E

Q15 Answers

- **a** Sternal and clavicular heads of sternocleidomastoid muscle
- **b** Sternothryoid and sternohyoid muscles (strap muscles)
- **c** Oesophagus
- **d** Lamina
- **e** Dorsal roots/ dorsal root ganglia of cervical cord

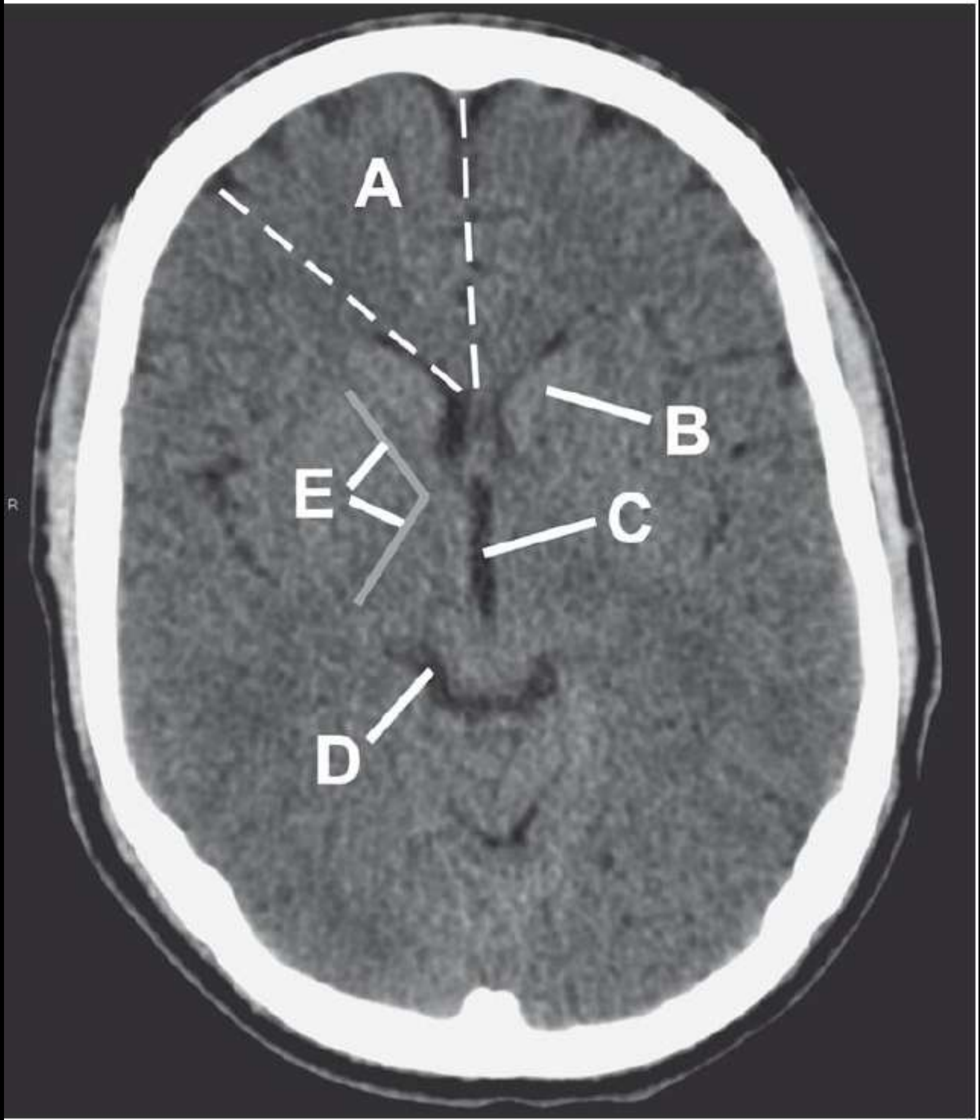
T2W MRI at root of neck, axial section

The sternocleidomastoid (SCM) muscle has, as the name suggests, a sternal and clavicular head. Medial to the SCM lie the strap muscles. These are named by their attachments; the sternothyroid lies deep to the sternohyoid. The strap muscles depress the hyoid and larynx.

Each spinal nerve is formed from dorsal and ventral nerve roots which combine as they leave the vertebral canal. The dorsal nerve root is sensory and its nerve cell bodies are contained within the dorsal root ganglion. The ventral nerve roots are motor and have their ganglia within the spinal cord. After leaving the vertebral canal, a spinal nerve almost immediately divides into dorsal and ventral rami which supply the posterior and anterior parts of the body, respectively.

Q12

a Name the artery which supplies the vascular territory indicated by 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, which has been highlighted with a grey line



Q12 Answers

a Anterior cerebral artery
b Head of the caudate
c Third ventricle
d Ambient cistern
e Internal capsule

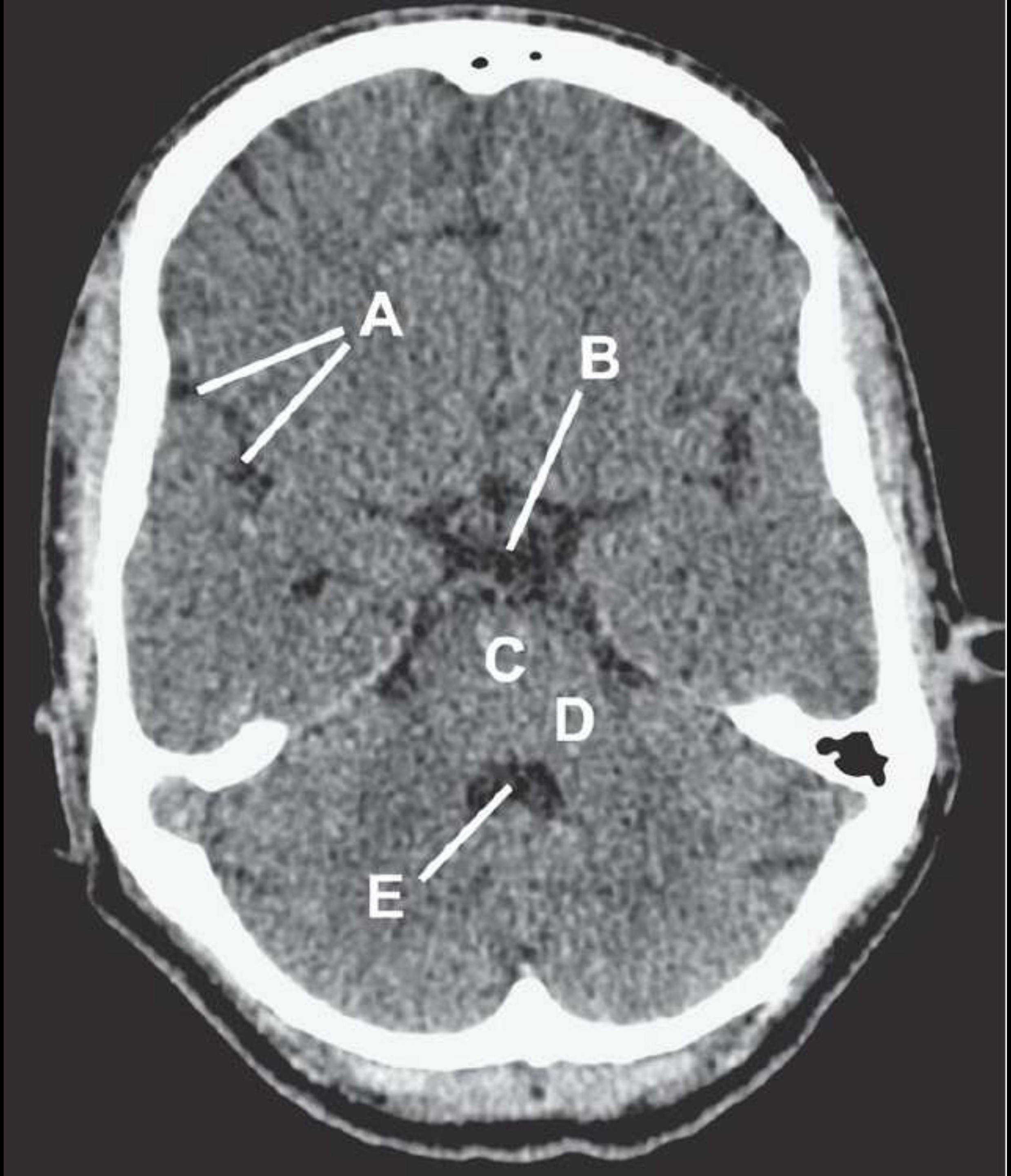
CT brain scan, axial section at the level of the third ventricle

Vascular territories of the brain are best demonstrated diagrammatically; an in-depth description is beyond the scope of this text.

The caudate nucleus is a long thin structure with a head, body and tail. Its cours is compliant with that of the lateral ventricle. The caudate is composed of grey matter and is considered one of the basal ganglia which as a group are concerned with movement as part of the extra-pyramidal system.

Cerebrospinal fluid (CSF) is produced through ultrafiltration of blood plasma b choroid plexus; most is produced in the lateral ventricles. CSF flows from the latera ventricles to the midline third ventricle through the interventricular foramina (of Monro); from here it passes through the midbrain via the cerebral aqueduct to the fourth ventricle posteriorly. Once in the fourth ventricle, CSF will pass either to the sub-arachnoid space (predominantly) via the medial and lateral apertures of Magendie and Luschka, respectively, or in a caudal direction through the central canal of the spinal cord. The named ventricles and several subarachnoid cisterns ar visible on CT. The ambient cisterns extend around both sides of the midbrain and communicate posteriorly with the quadrigeminal cistern. The posterior cerebral arteries pass through the ambient cisterns.

The internal capsule represents white matter tracts connecting the cerebral cortices with the brainstem and spinal cord. The anterior and posterior limbs meet at the genu (meaning knee) and form a V shape which is visible on axial CT slices. Both primary motor and sensory pathways for the entire body are concentrated in the anterior two thirds of the posterior limb; the upper body is represented anteriorly towards the genu while the lower body is represented more posteriorly.


A
B
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Q13 Answers

- **a** Sylvian fissure
- **b** Pontine/interpeduncular cistern
- **c** Pons
- **d** Middle cerebellar peduncle
- **e** Fourth ventricle

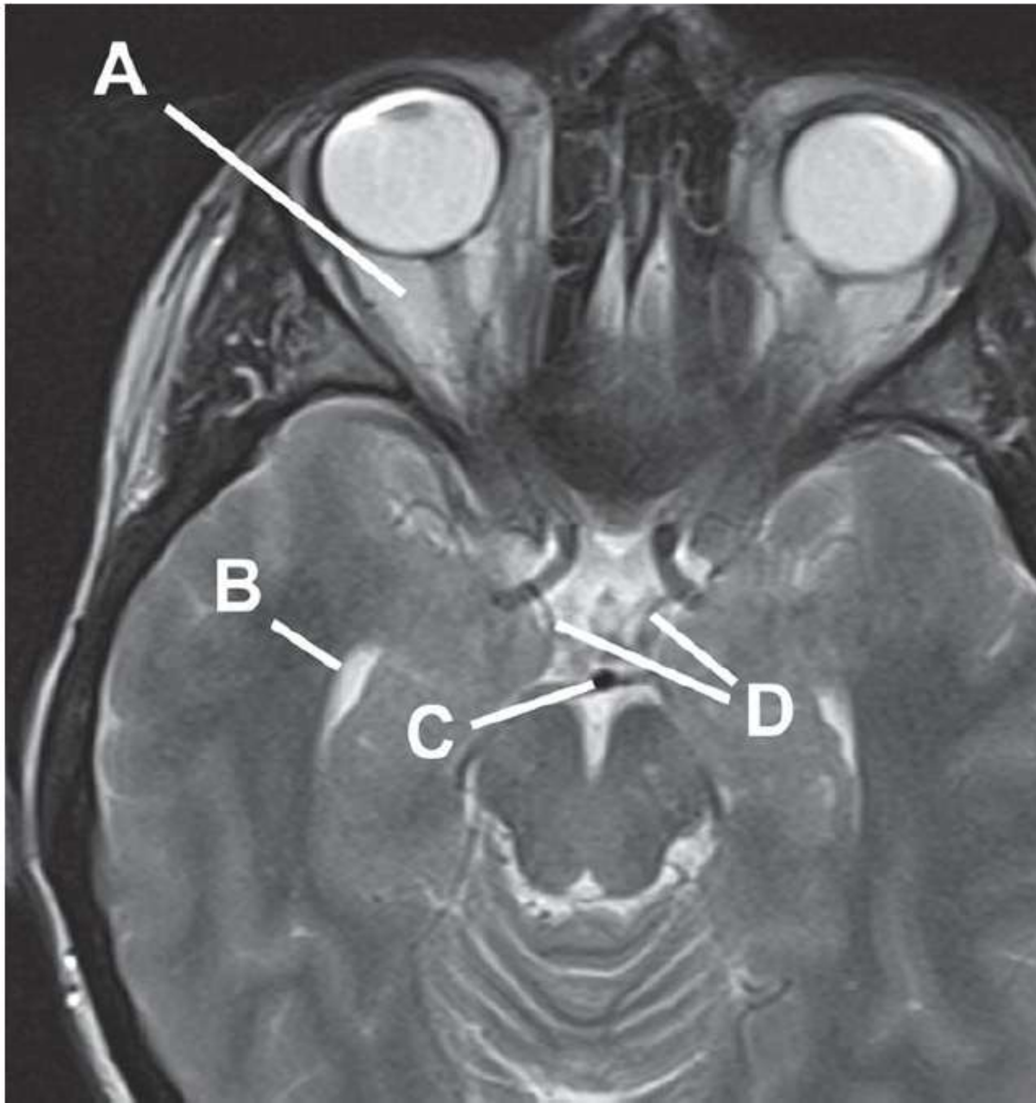
Contrast enhanced CT head, axial section at the level of the fourth ventricle

The sylvian fissure (or lateral sulcus) separates the frontal and temporal lobes and contains branches of the middle cerebral artery. The pontine cistern is continuous with the interpeduncular cistern above and the foramen magnum below and contains the basilar artery. Due to the angulation of this CT image (parallel with skull base) the CSF space shown contains elements of both pontine and interpeduncular cisterns.

The pons is recognizable by its anterior bulge ('pot belly' appearance when seen in sagittal section) and by the largest of the cerebellar peduncles (middle) connecting it posteriorly with the cerebellum (also forming the lateral walls of the fourth ventricle).

Q16

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C
d Name the structures labelled D
e Name the part of the brainstem demonstrated on this slice



Q16 Answers

a Intra-conal fat
b Temporal (inferior) horn of the right lateral ventricle
c Basilar artery
d Posterior communicating arteries
e Midbrain

T2W MRI of head, axial section

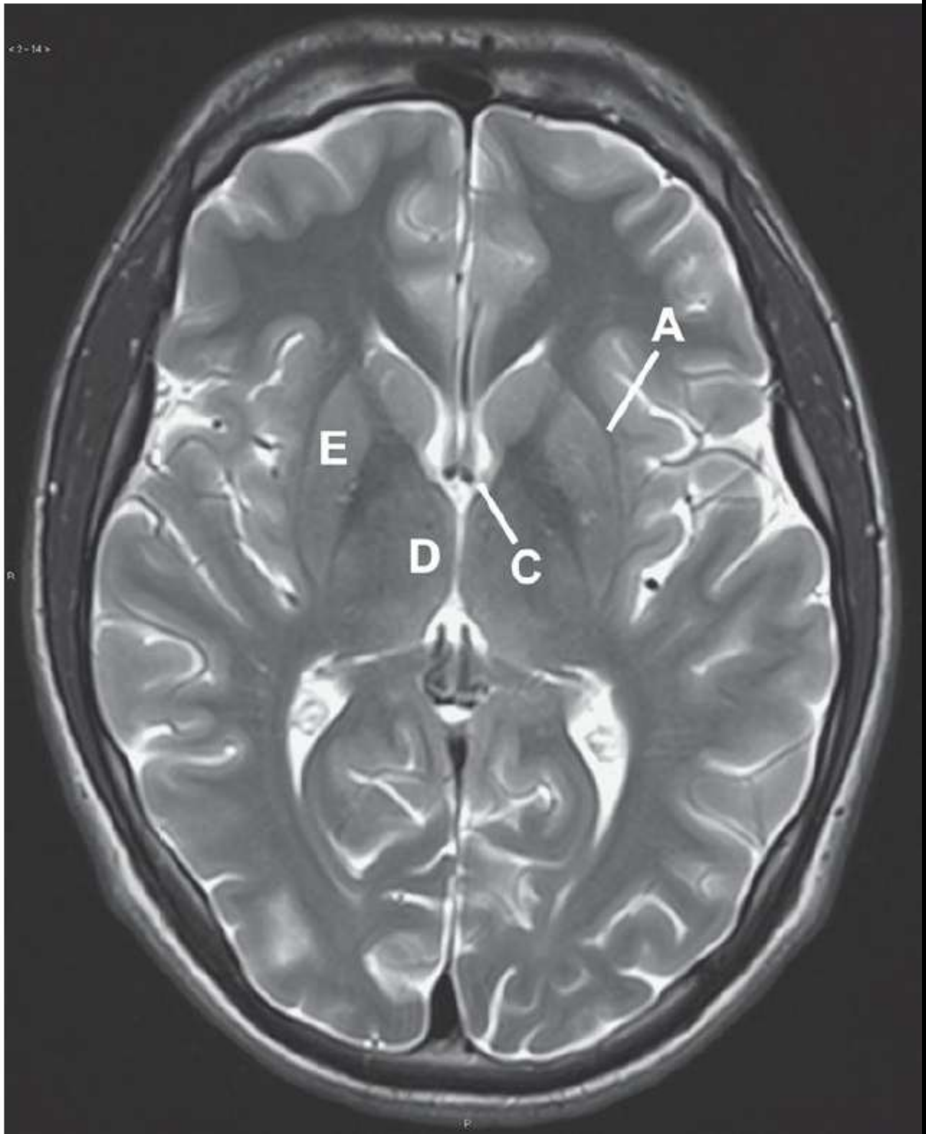
The extra-ocular muscles are arranged as a cone; this configuration is used to define intra and extra-conal compartments within the orbit.

The circle of Willis supplies arterial blood to the brain and is formed when the basilar and the right and left internal carotid arteries divide at the base of the brain. The basilar divides to form right and left posterior cerebral arteries, while each internal carotid divides to form an anterior and a middle cerebral artery. Posterior communicating arteries link the posterior and middle cerebral vessels bilaterally while the anterior communicating artery completes the circle (of Willis) by connecting the two anterior cerebral arteries. This configuration of anastomoses between the anterior and posterior arterial blood supplies to the brain provides the potential for collateral flow if part of the circulation is compromised.

The midbrain can be recognized in axial cross section by identification of the two cerebral peduncles anteriorly which are separated by the interpeduncular cistern. Posteriorly the midbrain has four rounded prominences, the superior and inferior colliculi (also known as the corpora quadrigemini).

Q19

a Name the structure labelled A
b Name the two structures situated between A and the insular cortex
c Name the CSF channel labelled C
d Name the structure labelled D
e Name the structure labelled E and its two constituent parts

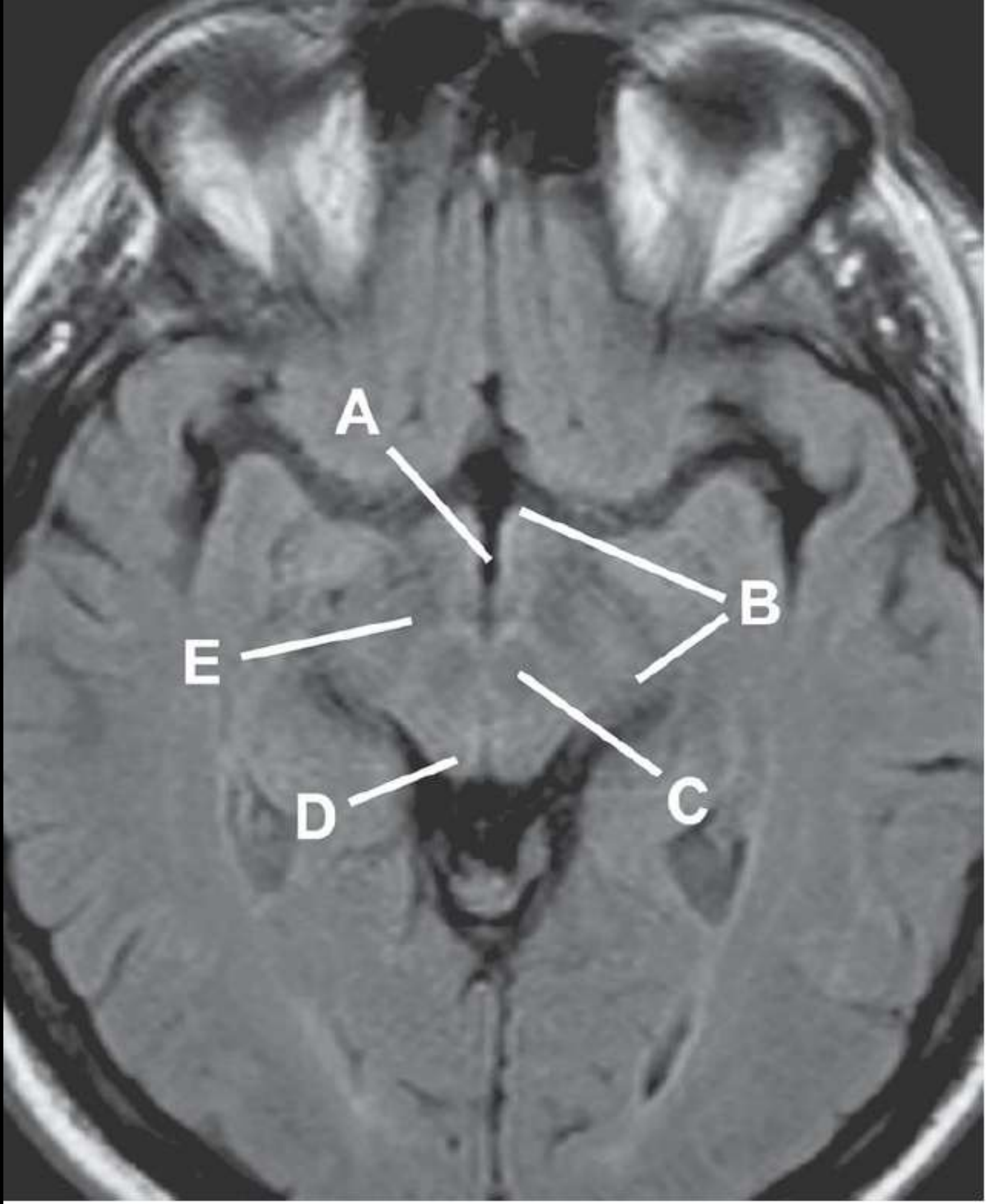


Q19 Answers

a External capsule
b Claustrum and extreme capsule
c Foramen of Monro
d Thalamus
e Lentiform nucleus composed of globus pallidus and putamen

T2W MRI of brain at level of third ventricle, axial section

The internal capsule is a white matter tract and forms a V-shape on axial section with the point directed towards the midline. Medial to the anterior limb of this V is the head of the caudate nucleus while the thalamus lies medial to the posterior limb and lateral to the third ventricle. Lateral to the internal capsule on this view is the lentiform nucleus. Like the caudate nucleus, the lentiform nucleus is one of the paired basal ganglia which as a group are functionally involved with movement. The lentiform is lens-shaped when viewed on axial section, hence the name. The constituent parts of the lentiform nucleus are (from medial to lateral) globus pallidus and putamen. The external capsule is a further white matter tract lying lateral to the lentiform nucleus. Lateral to the external capsule, in order, are the claustrum (further paired basal ganglia), the extreme capsule and finally the insular cortex.


A
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C
D

Q22 Answers

a Interpeduncular cistern
b Crus cerebri
c Red nucleus
d Superior colliculus
e Substantia nigra

T1W MRI at level of midbrain, axial section

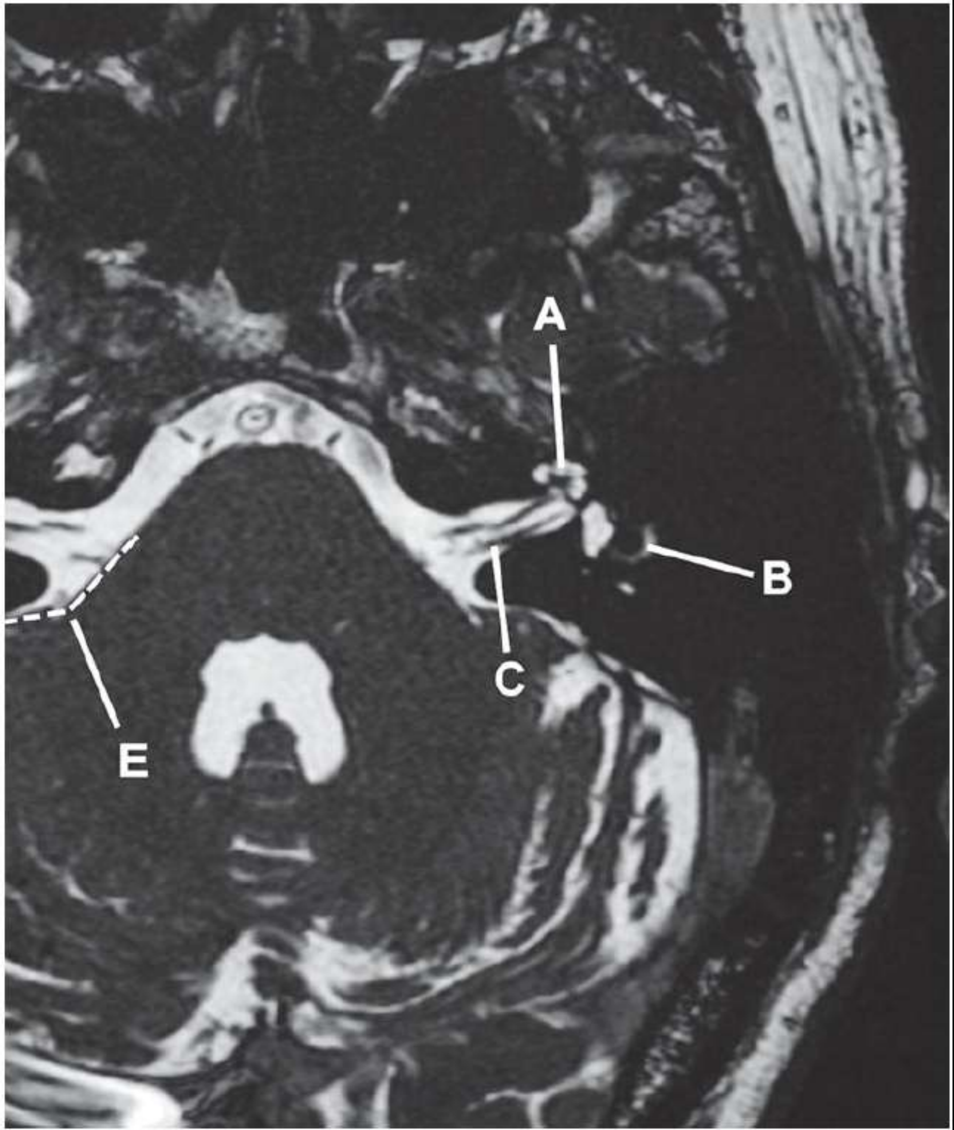
The crus cerebri are white matter tracts that run from the internal capsule to the pons over the antero-lateral aspect of the midbrain. The cerebral peduncle is the whole of the midbrain excluding the tectum (superior and inferior colliculi). A CSF cleft is formed between the paired cerebral peduncles anteriorly known as the interpeduncular cistern; occult subarachnoid haemorrhage can sometimes be found here.

The red nuclei and substantia nigra are both concerned with motor function; the substantia nigra is considered one of the basal ganglia. The red nuclei are usually found at the level of the superior colliculi.

The cerebral aqueduct (of Sylvius) may be seen on an axial section of midbrain between the red nuclei and superior colliculus as an area of CSF signal intensity (this is just visible on the image provided).

Q24

- **a** Name the structure labelled A
- **b** Name the structure labelled B
- **c** Name the structure labelled C
- **d** Name the CSF filled space containing C in this image
- **e** Name the structure outlined and labelled E



Q24 Answers

a Cochlea
b Lateral (or horizontal) semicircular canal
c Vestibular nerve (superior or inferior)
d Internal auditory meatus
e Cerebello-pontine angle

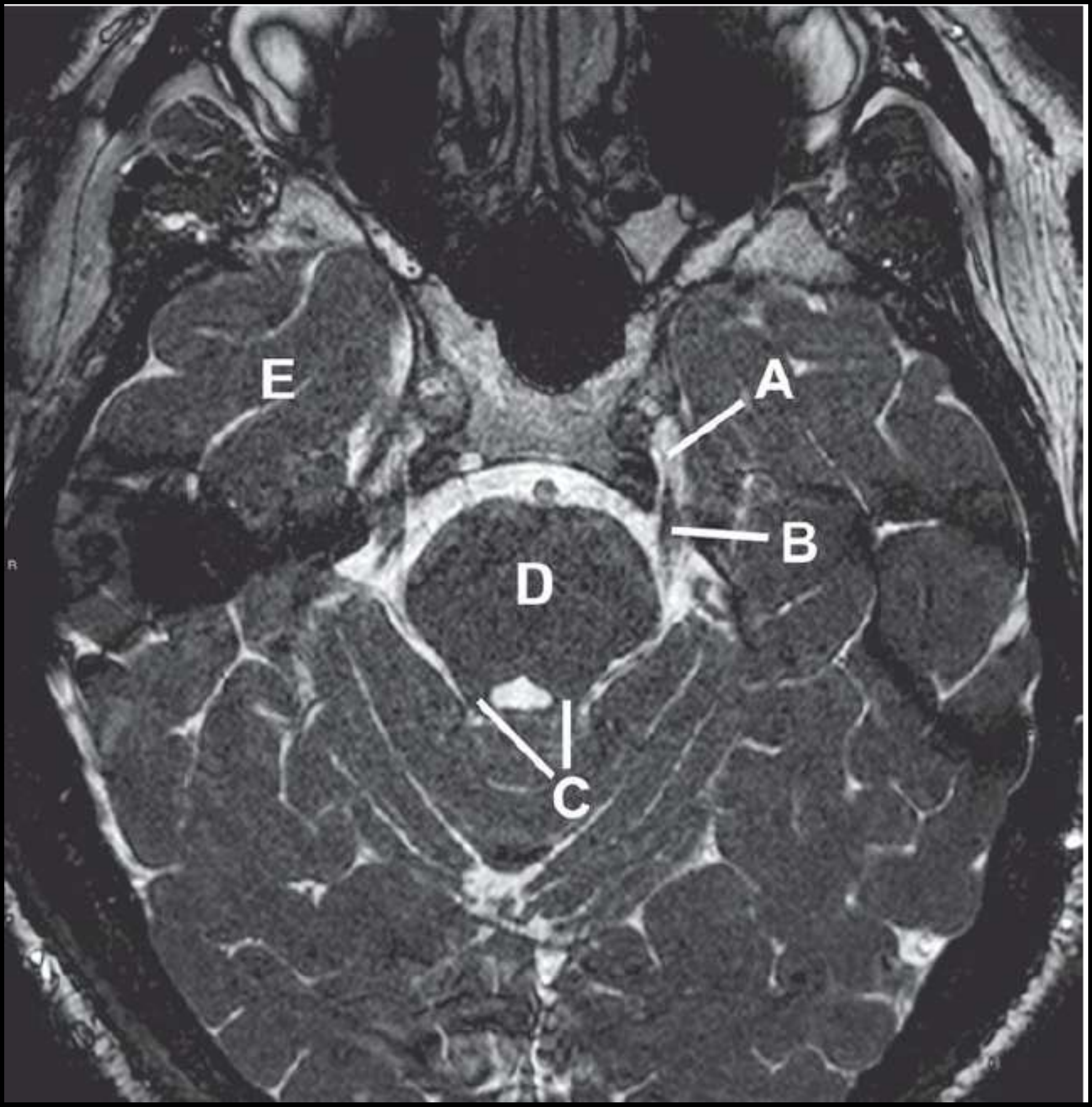
T2W MRI of middle ear structures, zoomed up high resolution axial section

Structures in the internal auditory meatus (IAM) can be well visualized on high resolution T2W MRI scans (using IAM specific sequences, e.g. CISS (constructive interface in steady state).

Four nerves run through the IAM and depending on the level of the axial section are usually visualized as two superior and two inferior nerves running in parallel. With a more superiorly orientated section, the facial nerve is seen anterior to the superior division of the vestibular nerve (CN VII and one of the three branches of CN VIII, respectively). With a slightly inferiorly orientated section the cochlear nerve is seen anterior to the inferior division of the vestibular nerve (both branches of CN VIII, the vestibulocochlear nerve). This orientation may be difficult to appreciate on axial section as the superior and inferior nerves lie very close together (the two anterior nerves seem to cross over on the image provided). For identification purposes, remember that the vestibular nerves lie posterior to th facial and cochlear nerves. To ease orientation and identification of the individual nerves, images can be reformatted and viewed in an oblique sagittal section. In this scenario the nerves are orientated as the four corners of a square.

The cochlea lie antero-medial to the semicircular canals within the petrous portion of the temporal bone.

There are three semicircular canals; anterior, posterior and lateral. The lateral (or horizontal) canal is orientated in-plane with an axial section; the other two are orientated vertically with respect to the horizontal canal and at 90 degrees to one another. The posterior canal runs in parallel with the petrous ridge, while the anterior canal lies at 90 degrees to the petrous ridge.



E
A
B
D
C
R

Q25 Answers

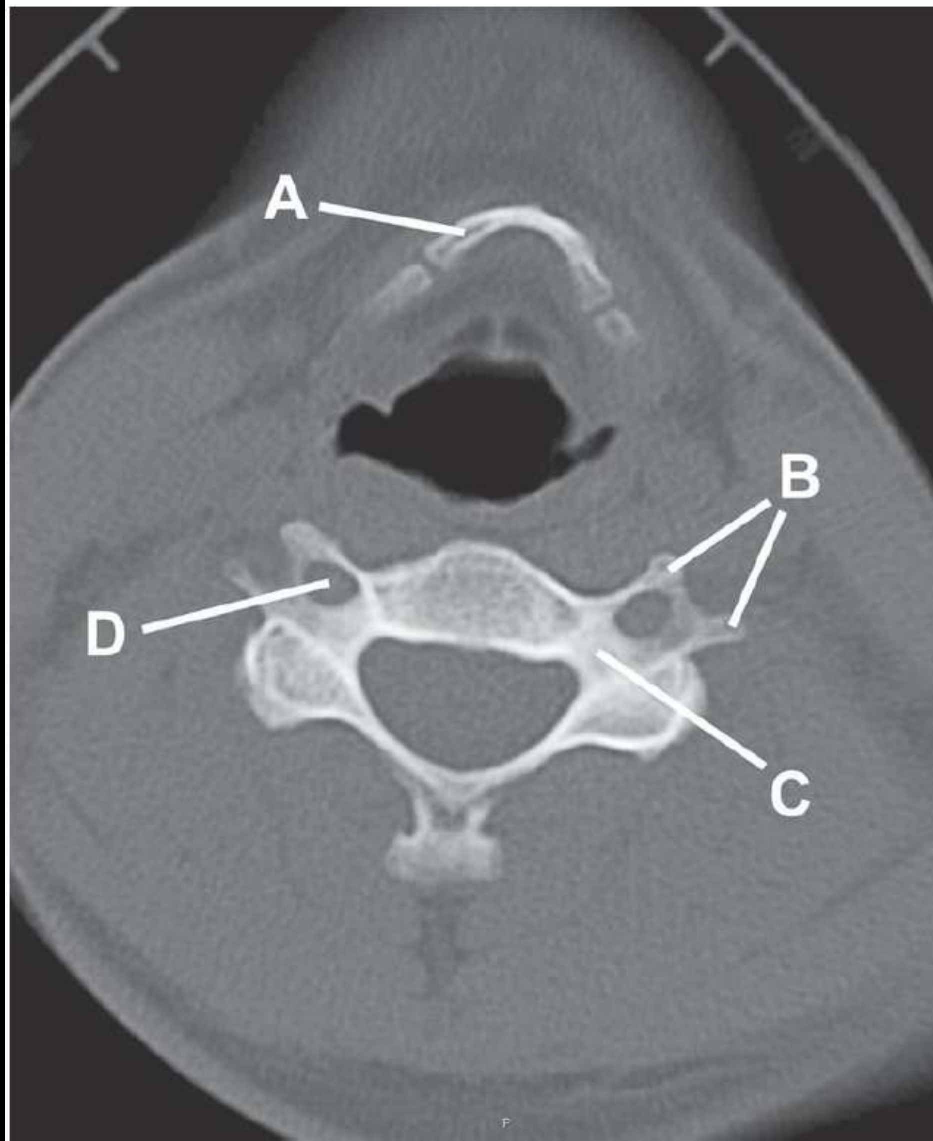
a Meckel's cave
b Trigeminal nerve
c Superior cerebellar peduncles
d Pons
e Anterior temporal lobe

The trigeminal nerve (CN V) arises from the pons and passes anteriorly into Meckel's cave where it forms the trigeminal ganglion. Meckel's cave is a CSF filled space lined by dura which lies postero-lateral to the cavernous sinus on the antero-medial aspect of the petrous temporal bone.

The superior cerebellar peduncles arise from the midbrain but run infero-posterioly and are therefore visualized on this oblique view through the upper pons.

Q30

- **a** Name the structure labelled A
- **b** Name the structures labelled B
- **c** Name the structure labelled C
- **d** Name the major structure that travels through the foramen labelled D
- **e** Name the vertebral level demonstrated



Q30 Answers

a Body of hyoid bone
b Tubercles (anterior and posterior) of left transverse process
c Pedicle
d Vertebral artery
e C3

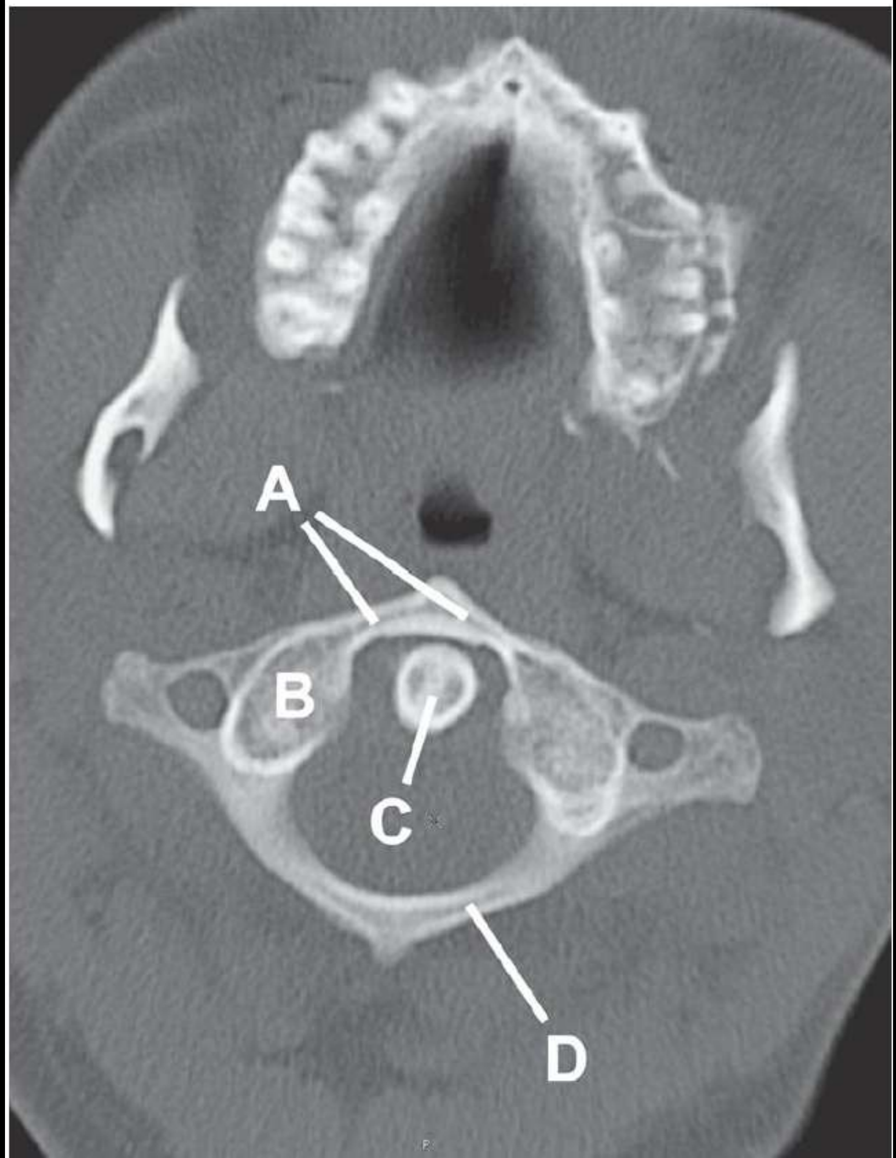
CT of neck with bone windows at level of hyoid and C3 vertebra, axial section

The hyoid bone has a body which curves in the midline and two greater horns which articulate laterally with the body. The stylohyoid ligaments attach to the lesser horns (not shown) of the hyoid. The hyoid lies at the C3 vertebral level.

A typical cervical vertebra is shown (C3). The major differences between cervical and other vertebrae are the inclusion of formina in the transverse processes and also the existence of anterior and posterior tubercles arising from the transverse processes. The transverse foramina allow transmission of the vertebral arteries to the skull; these are usually accompanied by veins and sympathetic nerves.

Q31

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 which holds C against A



Q31 Answers

a Anterior arch of C1
b Lateral mass of C1
c Dens
d Posterior arch of C1 (neural arch)
e Transverse ligament of C1

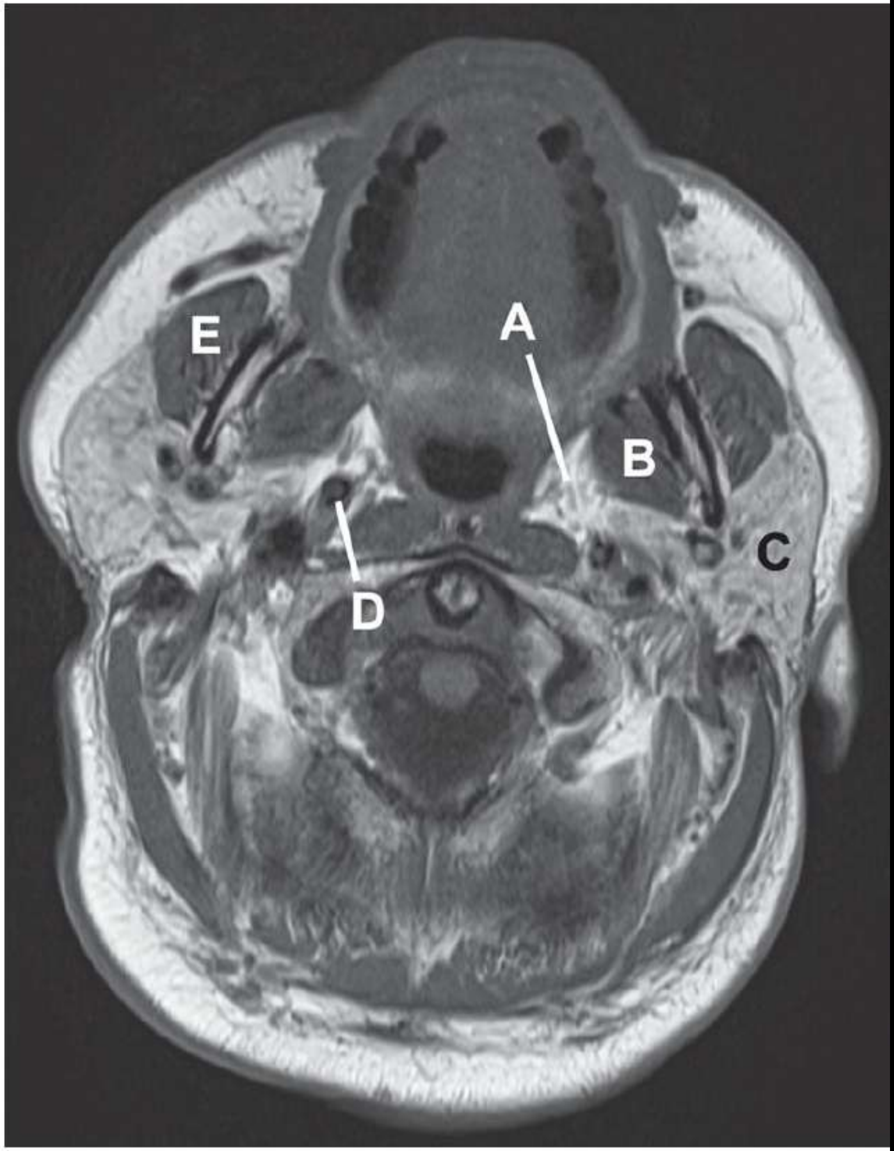
CT of neck with bone windows at level of C1 vertebra, axial section

The first cervical vertebra is also known as the atlas as it 'holds up' the skull. The atlas is unusual by virtue of not having a vertebral body (the body has become detached from C1 and has fused with the body of C2 to form the dens); it is composed of two lateral masses and an anterior and a posterior arch. Note that the posterior arch is not considered to be composed of right and left lamina as in other vertebrae.

The dens is a superior projection of C2 which enables rotation of C1 on C2 (therefore termed the axis vertebra). The dens is held in place by a strong transverse ligament known as the transverse ligament of the atlas. This ligament is continuous with two vertical bands of connective tissue joining the occipital bone superiorly and the body of C2 inferiorly. Collectively these three ligaments form a cross over the posterior aspect of the dens known as the cruciform ligament.

Q36

a Name the structure labelled A
b Name the structure labelled B
c Name the three major structures which pass through the gland labelled C
d Name the structure labelled D
e Name the structure labelled E



Q36 Answers

a Parapharyngeal space
b Medial pterygoid muscle
c The facial nerve, external carotid artery and retromandibular vein pass through the parotid gland
d Internal carotid artery
e Masseter muscle

T1W MRI of neck at level of parotid glands, axial section

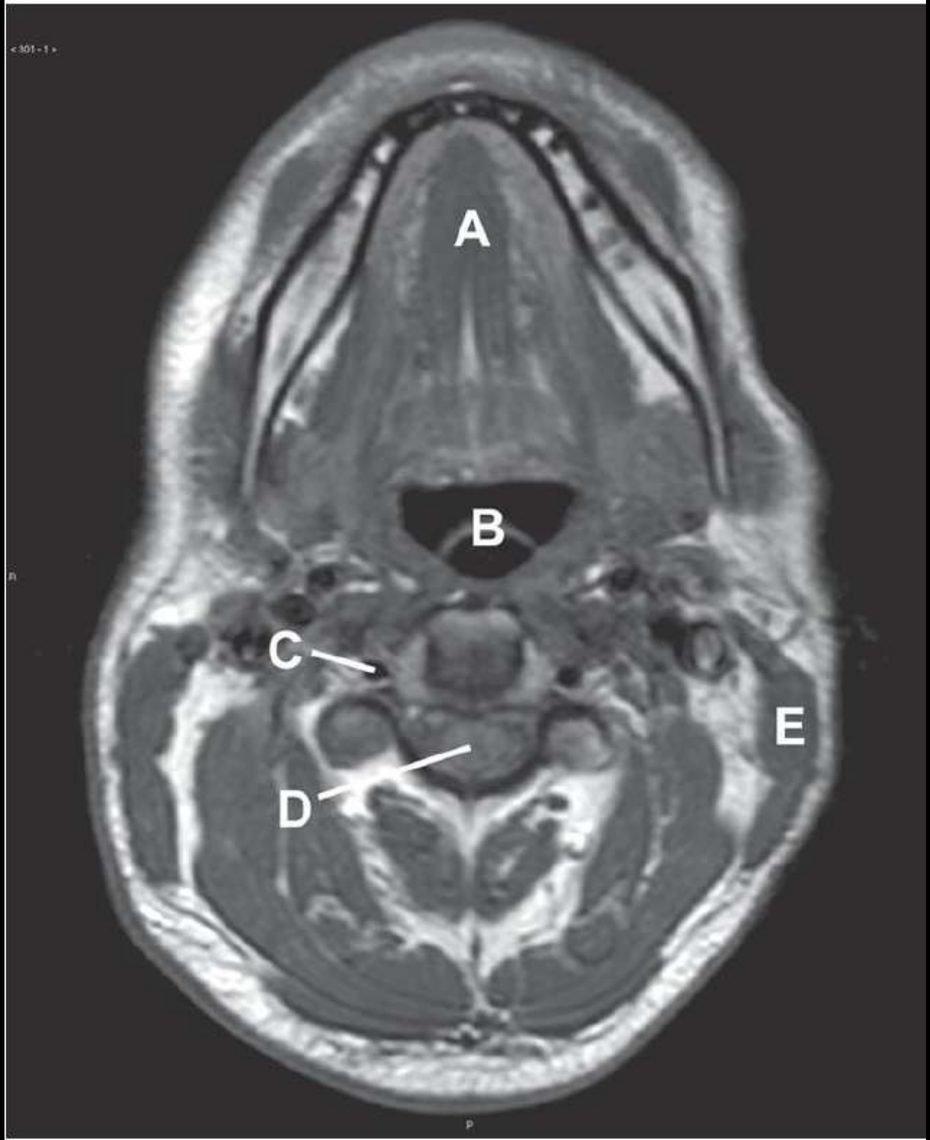
The parapharyngeal space is a triangular fatty filled area situated lateral to the pharynx and anterior to the major blood vessels for the head. It is important to recognize this area because it can be readily displaced and/or infiltrated by disease.

There are four muscles of mastication and these all attach to the mandible. Only the masseter muscle lies lateral to the mandible. The medial and lateral pterygoid muscles are so named because of their origin medial and lateral to the lateral pterygoid plate (an inferior process of the sphenoid bone). The medial pterygoid attaches distally to the medial aspect of the mandibular ramus, while the lateral pterygoid attaches to the neck of the mandible. The fourth muscle of mastication is the temporalis.

The parotid gland is the largest of the three paired salivary glands and sits between the ramus of the mandible and the mastoid process and extends down to the angle of the mandible with both a deep and a superficial lobe. The facial nerve (CN VII) divides into its terminal branches within the parotid gland, therefore disease within the parotid can lead to ipsilateral facial palsy (lower motor neurone). The other major structures which can be seen passing through the parotid gland are the external carotid artery and the retromandibular vein (formed from the union of superficial temporal and maxillary veins).

Q37

a Name the cranial nerve that supplies motor function to 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



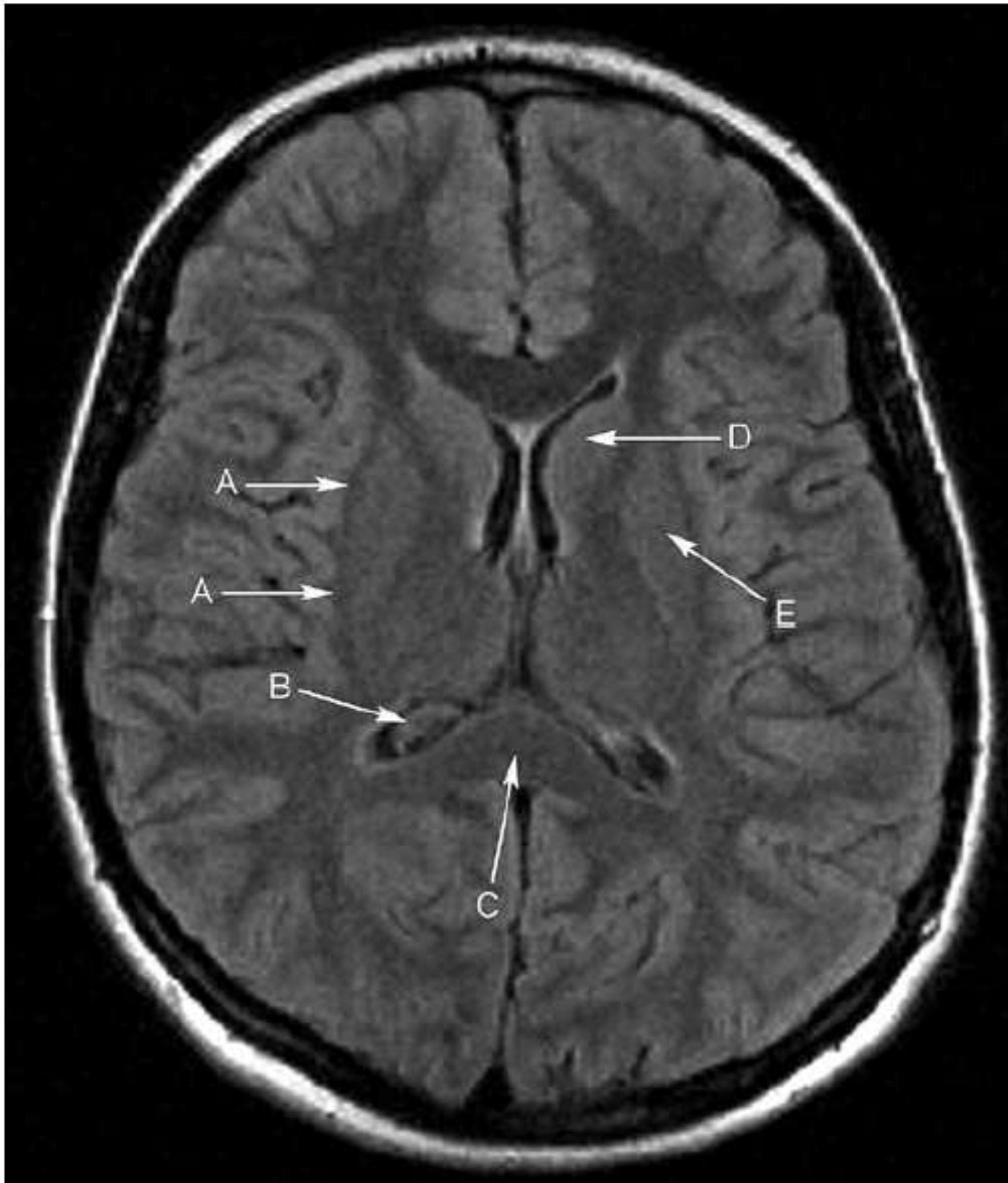
Q37 Answers

- a Hypoglossal nerve (CN XII)
- b Epiglottis within oropharynx
- c Vertebral artery
- d Upper cervical spinal cord
- e Sternocleidomastoid muscle

T1W MRI through neck at level of C2/3, axial section

Immediately posterior to the tongue is the oropharynx. This channel provides combined passage for both the foods we eat and the air we breathe. At rest the oropharynx is open to both the oesophagus and the trachea simultaneously. As a food bolus is propelled backwards by the muscular action of the tongue, the swallowing reflex is instigated. The hyoid bone rises in the midline bringing the epiglottis down over the laryngeal opening. Constriction of the pharyngeal muscles forces the food inferiorly where it is directed into the oesophagus.

Question 8.2

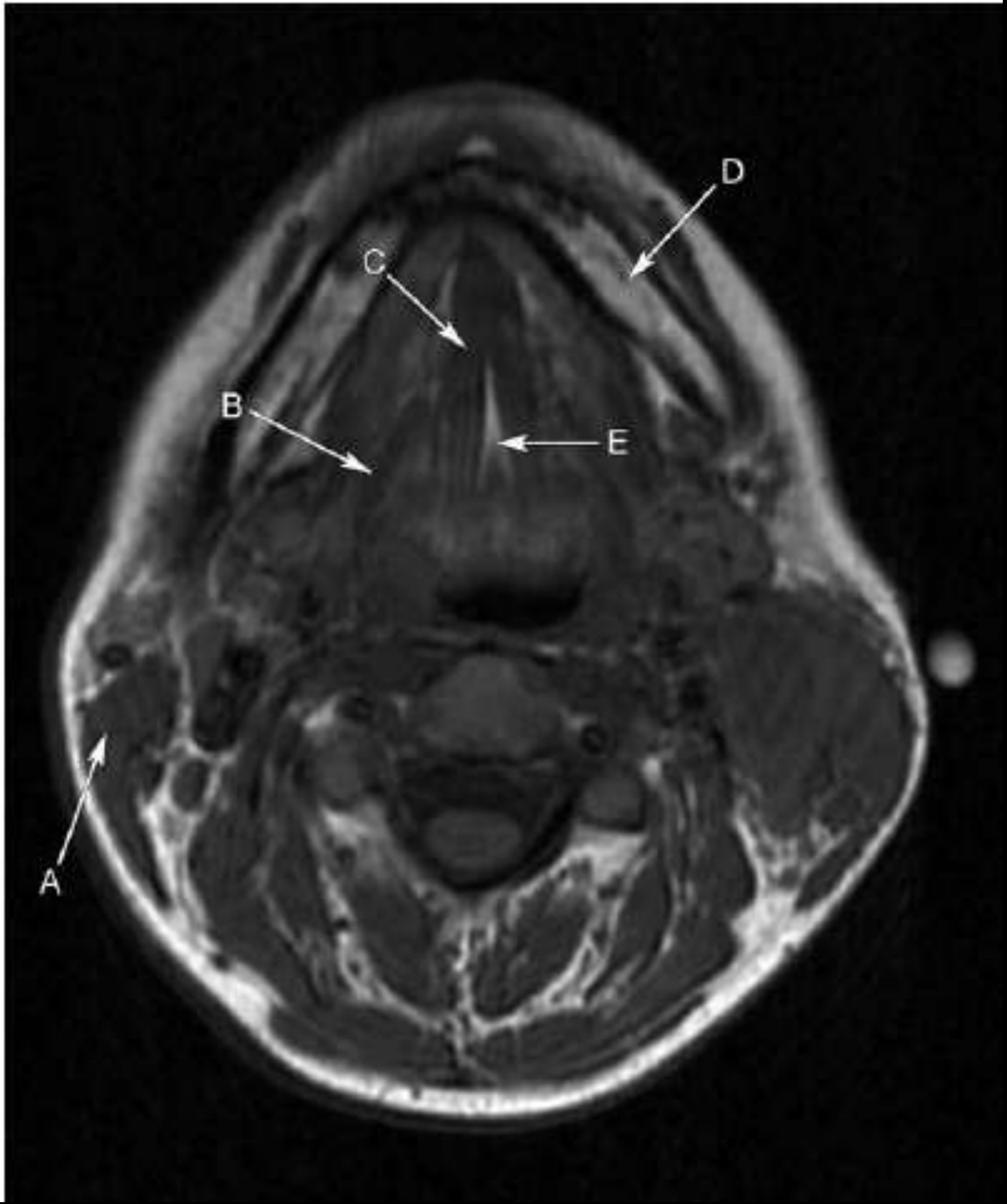


8.2 Axial T2 FLAIR MRI of the brain

A Right external capsule.
B Choroid plexus in the right lateral ventricle.
C Splenium of the corpus callosum.
D Left caudate nucleus (head).
E Left lentiform nucleus.

The external capsule is a collection of white matter tracts seen lateral to the lentiform nucleus of each hemisphere. The lentiform nucleus (named after its shape) consists of two parts – globus pallidus (medial) and putamen (lateral). The caudate nucleus is C-shaped and consists of a head, body and tail. The head of the caudate nucleus forms part of the floor and wall of the anterior horn of the lateral ventricle. The caudate nucleus is separated from the lentiform nucleus by the anterior limb of the internal capsule.

Question 9.3



9.3 Axial T1 MRI of the neck

A Right sternocleidomastoid muscle.
B Right hyoglossus muscle.
C Right genioglossus muscle.
D Body of left mandible.
E Lingual septum.

The hyoglossus muscle runs from the hyoid bone vertically upwards to the side of the tongue (between the styloglossus and the longitudinalis inferior). It acts to depress and retract the tongue.

The genioglossus muscle passes from the mental spine of the mandible to the hyoid bone and dorsum of the tongue. It acts to depress and protrude the tongue.

Both of these muscles are innervated by the hypoglossal nerve (CN XII).

Question 9.4

9.4 Axial T1 MRI of the neck

A Right temporalis muscle.
B Right levator veli palatini muscle.
C Right vertebral artery.
D Left masseter.
E Left lateral pterygoid muscle.

The temporalis, medial pterygoid, lateral pterygoid and masseter muscles are the four muscles of mastication. They are all innervated by the mandibular branch of the trigeminal nerve (CN V^3). The temporalis muscle runs from the temporal fossa to the coronoid process of the mandible. The lateral pterygoid runs from the infratemporal surface of the sphenoid bone (upper head) and the lateral surface of the lateral pterygoid plate (lower head) to the pterygoid fovea below the mandibular condyle. The masseter muscle runs from the zygomatic arch to the angle of the mandible.

The levator veli palatine muscle acts to elevate and retract the soft palate and is supplied primarily by the vagus nerve (CN X).

Question 9.5

9.5 Axial CT of the orbits

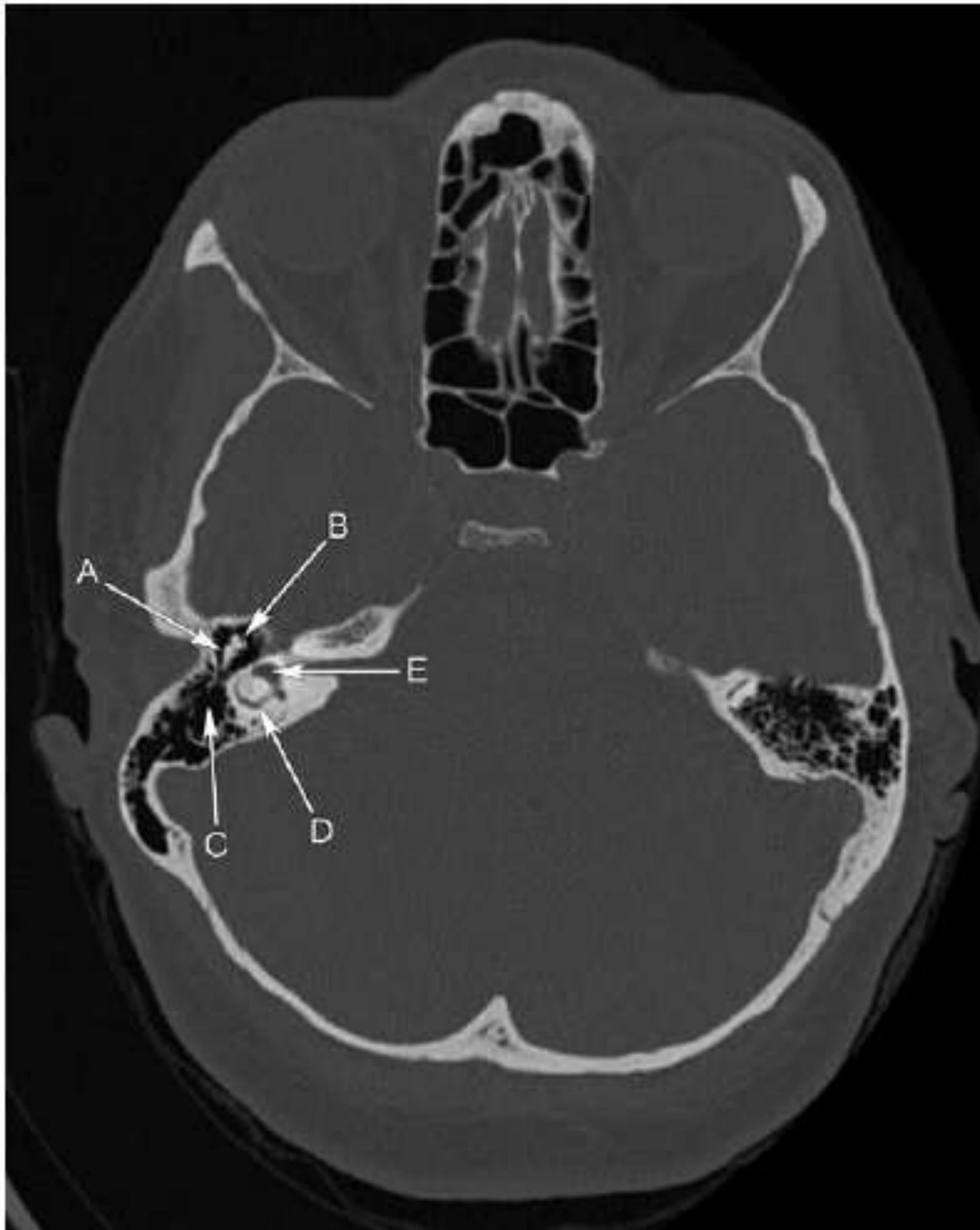
A Right lens.
B Right cornea.
C Right anterior clinoid process.
D Inferior pole of the left lacrimal gland.
E Right intraconal fat.

The cornea is the transparent structure at the front of the eye overlying the iris, pupil and lens. It has no blood supply. The aqueous humour is a thick watery substance containing amino acids that lies in between the cornea and the lens. A disruption of its normal circulation can lead to glaucoma.

The orbital septum is a membranous fascia, which acts as the anterior boundary to the orbit. It lies between the orbital rim and the tarsus, making up the fibrous component of the eyelids.

The lacrimal gland is a bilobed gland lying in the superotemporal orbit within the lacrimal fossa.

Question 9.10



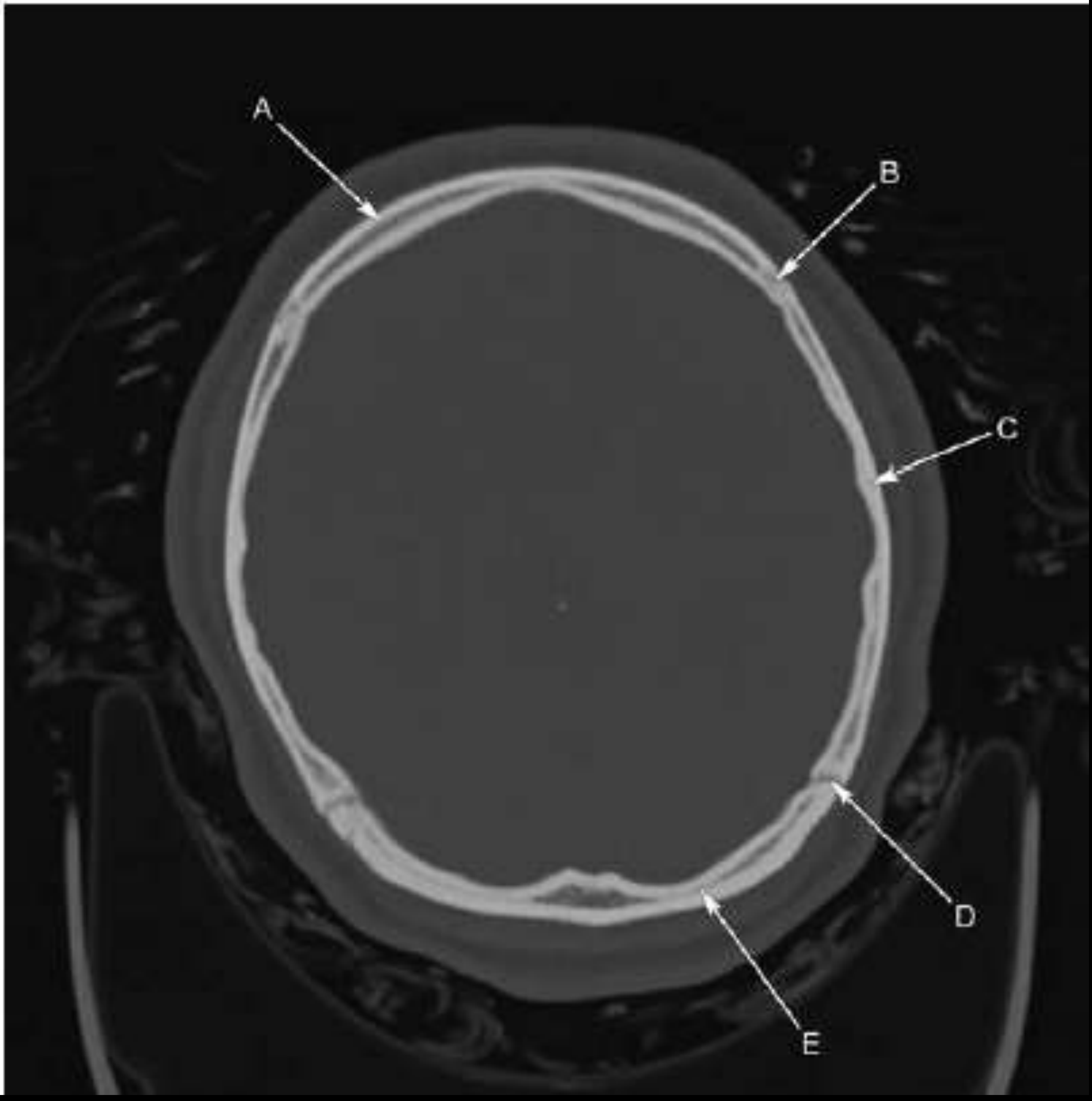
9.10 Axial CT of the auditory canal

A Right incus.
B Right malleus.
C Right mastoid air cells.
D Right semicircular canal.
E Right vestibule.

The middle ear is a cavity in the petrous bone between the tympanic membrane and the inner ear. The upper part of the cavity is known as the attic and it communicates with the mastoid air cells through a posterior opening known as the aditus ad antrum. Three bony ossicles traverse the middle ear cavity – the malleus, incus and stapes. They are connected via synovial joints. On axial CT the appearance of the incus and malleus is sometimes described as an 'ice cream cone', with the malleus being the 'ice-cream' on top of the incus' 'cone'.

The bony labyrinth lies within the inner ear and consists of the vestibule, cochlear and three semicircular canals.

Question 10.2



10.2 Axial CT of the skull

A Frontal bone.
B Left coronal suture.
C Left parietal bone.
D Left lambdoid suture.
E Occipital bone.

The skull is composed of 22 bones, each of which is joined together by sutures (fibrous joints which permit a minute amount of movement). Eight of these bones make up the skull vault, which forms a protective covering for the brain. These are:

- Two parietal bones.
- Two temporal bones.
- One frontal bone.
- One occipital bone.
- One sphenoid bone.
- One ethmoid bone.

The frontal bone articulates with the paired parietal bones via the coronal suture and forms the forehead as well as the roof and the lateral walls of the orbits. The paired parietal bones articulate with each other via the sagittal suture, with the frontal bone via the coronal suture and with the occipital bone via the lambdoid suture.

Question 10.3

10.3 Axial T2 MRI of the brain

A Vestibulocochlear nerve (CN VIII).
B Facial nerve (CN VII).

C Left Meckel's cave.
D Right vestibule.
E Right semicircular canal.

The internal auditory meatus (IAM) is a short channel through the petrous temporal bone, which provides a passage from the posterior cranial fossa to the auditory apparatus. The contents of the IAM include the vestibulocochlear nerve (CN VIII), facial nerve (CN VII) and the labyrinthine artery. Bill's bar is a vertical bony ridge, which divides the IAM into an anterior and posterior component. The falciform crescent (or transverse crest) is a horizontal ridge, which divides the IAM into superior and inferior components.

The vestibulocochlear nerve is divided into the cochlear nerve and the vestibular nerve. The vestibular nerve is further subdivided into superior and inferior branches. The facial nerve has a motor component and a sensory component (nervus intermedius). The following schematic shows the arrangement of the nerves within a cross-section of the IAM.

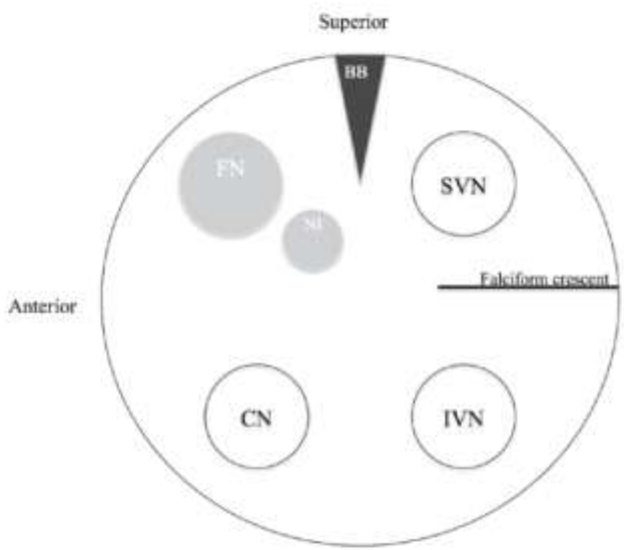
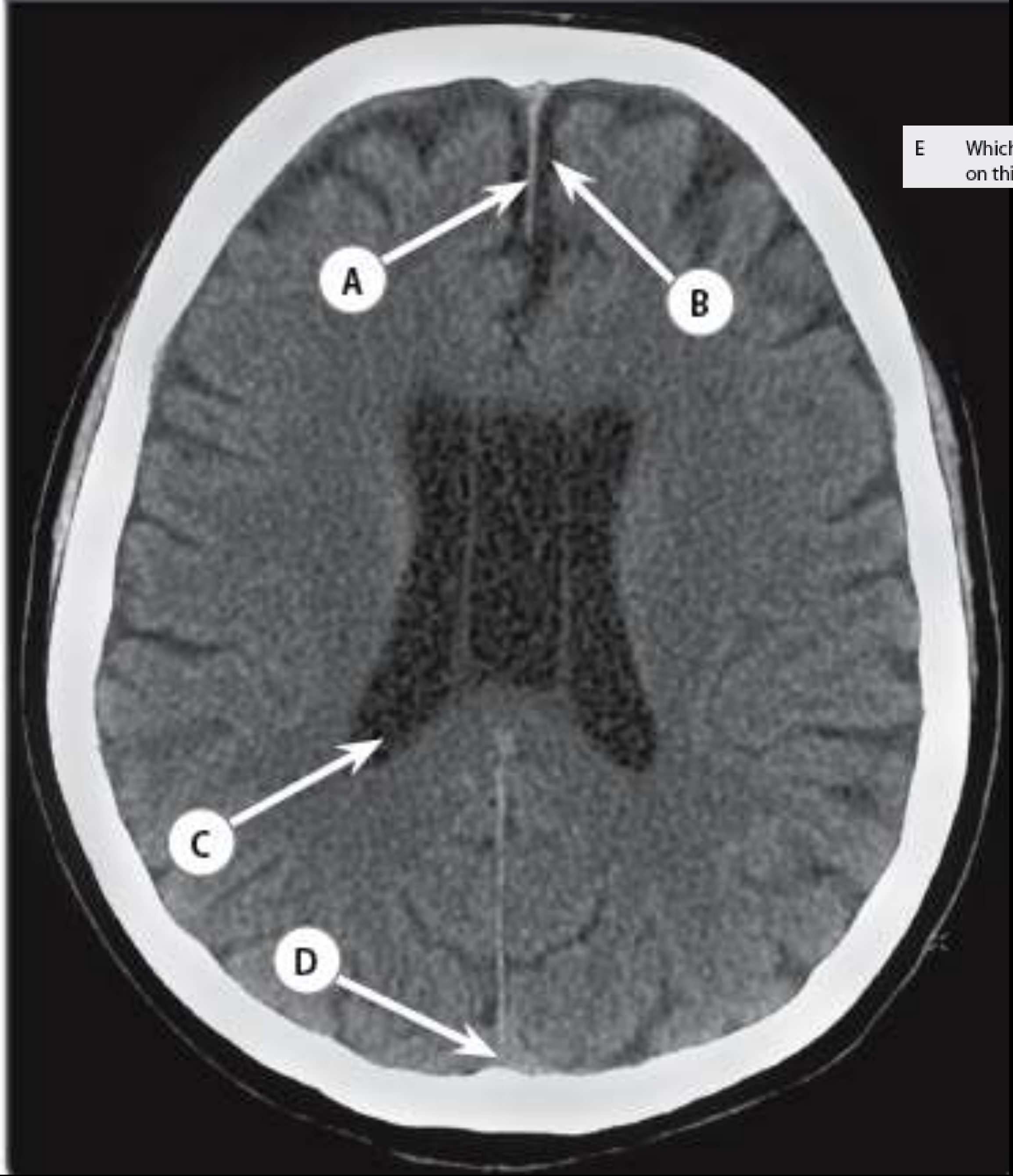


Figure 10.1 Cross-section of the internal auditory meatus: FN = facial nerve motor branch; NI = nervus intermedius (facial nerve sensory branch); CN = cochlear nerve; SVN = superior vestibular nerve (branch of vestibulocochlear nerve); IVN = inferior vestibular nerve (branch of vestibulocochlear nerve); BB = Bill's bar. A useful way to remember the positions of the nerves is '7-up, Coke Down', which refers to the facial nerve (7th nerve) and the Cochlear nerve.

Case 1.14



E Which anatomical variant is present on this image?

Case 1.14

A Falx cerebri

B Interhemispheric fissure

C Occipital horn of the right lateral ventricle

D Superior sagittal sinus

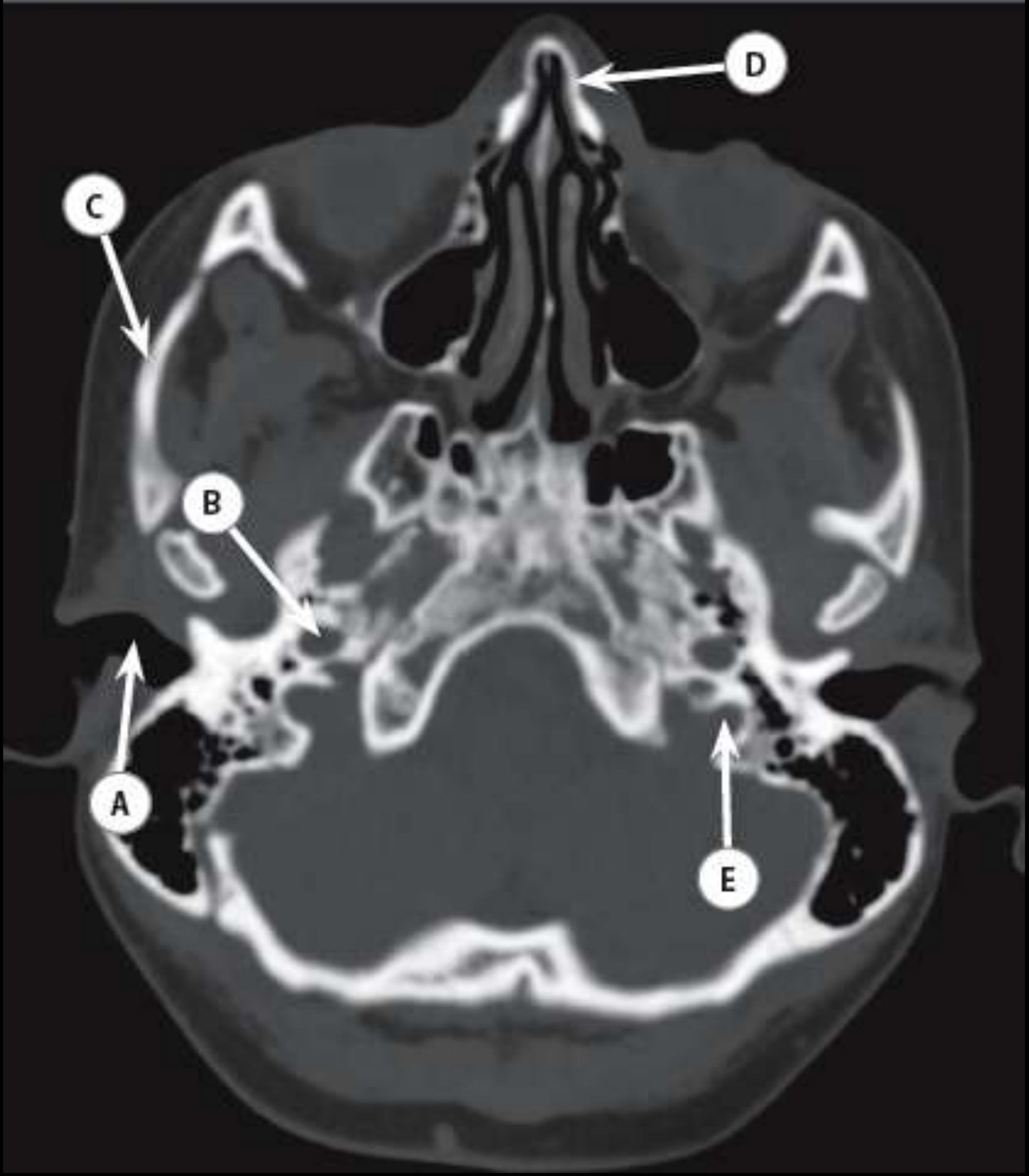
E Cavum septum pellucidum et vergae

Septum pellucidum separates the anterior horns and bodies of the lateral ventricles. It consists of two laminae which attach anteriorly to the corpus callosum and posteriorly to the fornix.

In neonates, there is a narrow cavity between the laminae which does not communicate with the subarachnoid space, called cavum septum pellucidum (CSP). Over 85% of them fuse by 3–6 months of age. In the remaining 15%, the CSP persists as a normal anatomical variant.

Cavum septum pellucidum et vergae is a variant of CSP in which it continues posteriorly, inferior to the splenium and superior fornix.

Case 1.18



Case 1.18

A Right external auditory canal

B Right carotid canal

C Right zygomatic arch

D Left nasal bone

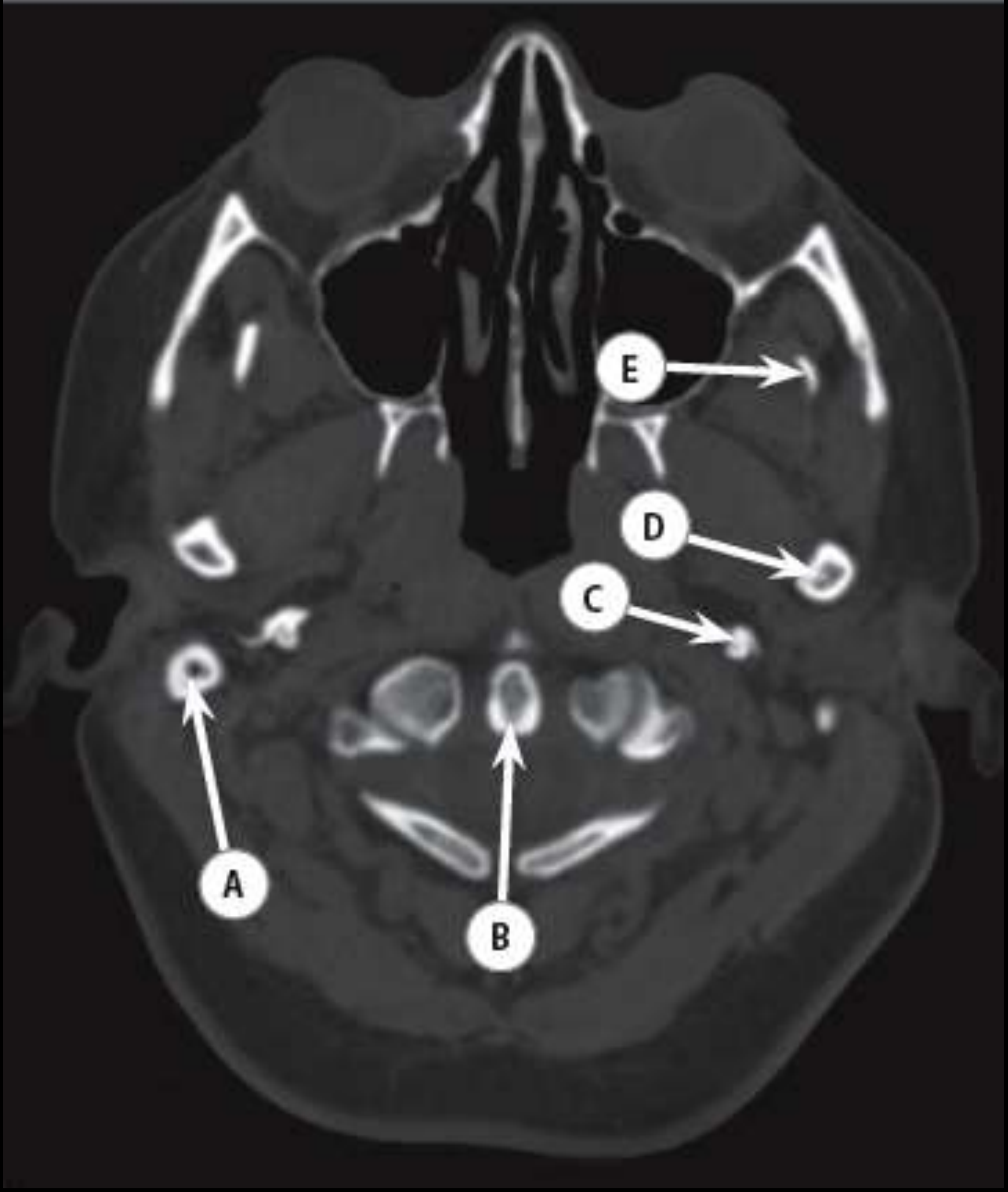
E Left jugular foramen

The petrous portion of the temporal bone contains two important foramina:

The jugular foramen lies inferior to the middle ear cavity and posterior to the carotid canal. It transmits the jugular vein and glossopharyngeal (CN IX), vagus (CN X) and accessory (CN XI) cranial nerves. Jugular foramina often differ in size, with the right usually larger than the left.

The carotid canal lies anteromedial to the jugular foramen in the petrous apex. It transmits the internal carotid artery from the neck to the cranium.

Case 2.11



Case 2.11

A Right mastoid process

B Odontoid process of axis (C2)

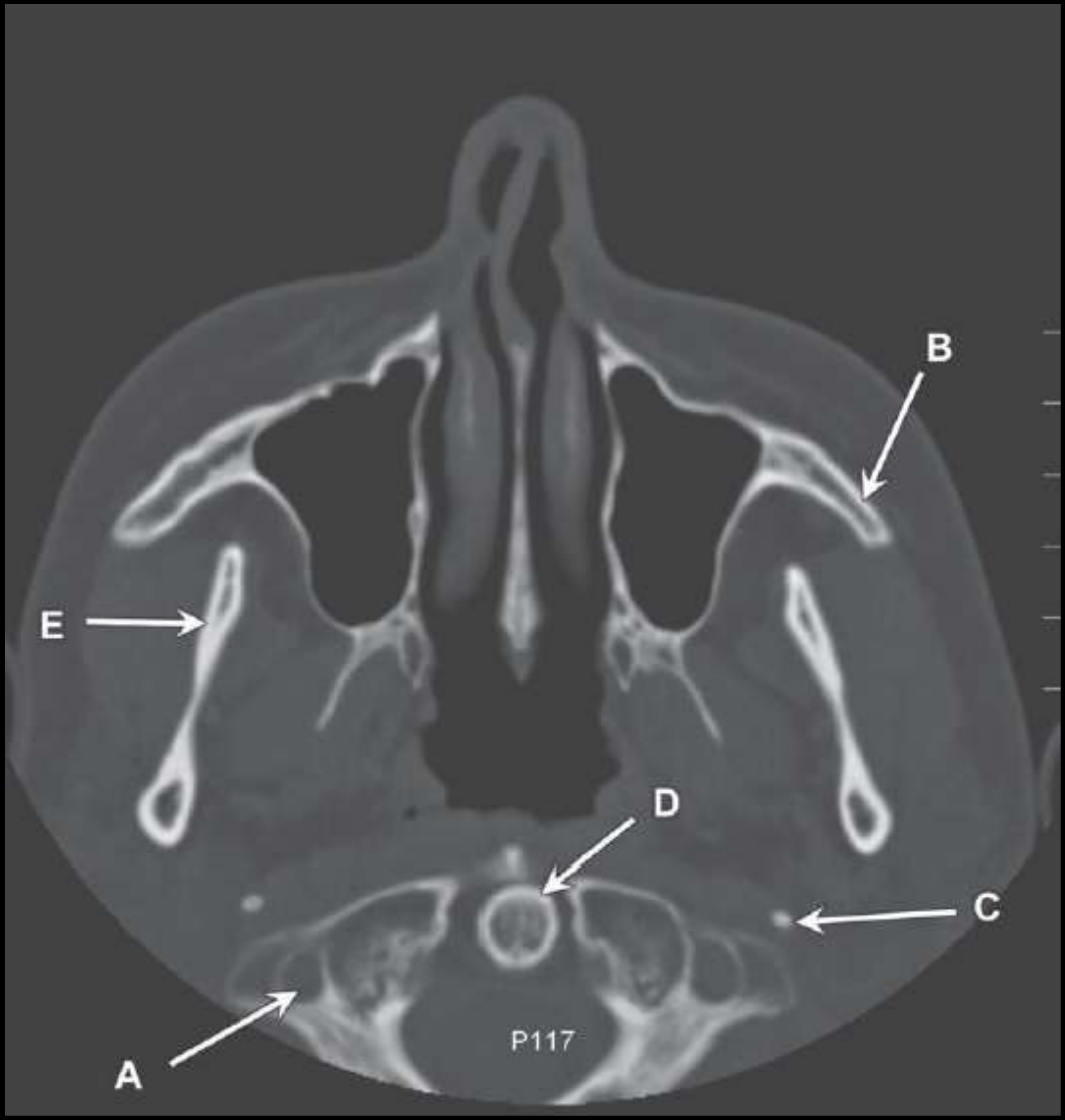
C Left styloid process of the temporal bone

D Left condylar process of the mandible

E Left coronoid process of the mandible

The bony processes of the skull and facial bones serve as anchor points for muscular and ligamentous attachments. The following are visible at the level of the cranio-cervical junction:

- **Mastoid process** – conical projection of the mastoid portion of the temporal bone. It serves as an insertion for sternocleidomastoid, splenius capitis and longissimus capitis muscles.
- **Styloid process** – arises from the inferior surface of the temporal bone. The point of insertion for styloglossus, stylohyoid and stylopharyngeus muscles.
- **Condylar process** – posterior process of the mandible forming the temporomandibular joint. It contains a small tubercle superiorly for the temporomandibular ligament attachment.
- **Coronoid process** – projection from the mandible. The point of insertion for the temporalis muscle.
- **Odontoid process** – superior protuberance of the axis, articulating with the anterior arch of the atlas. Its apex serves as an attachment point for the apical odontoid ligament and the alar ligaments.


B
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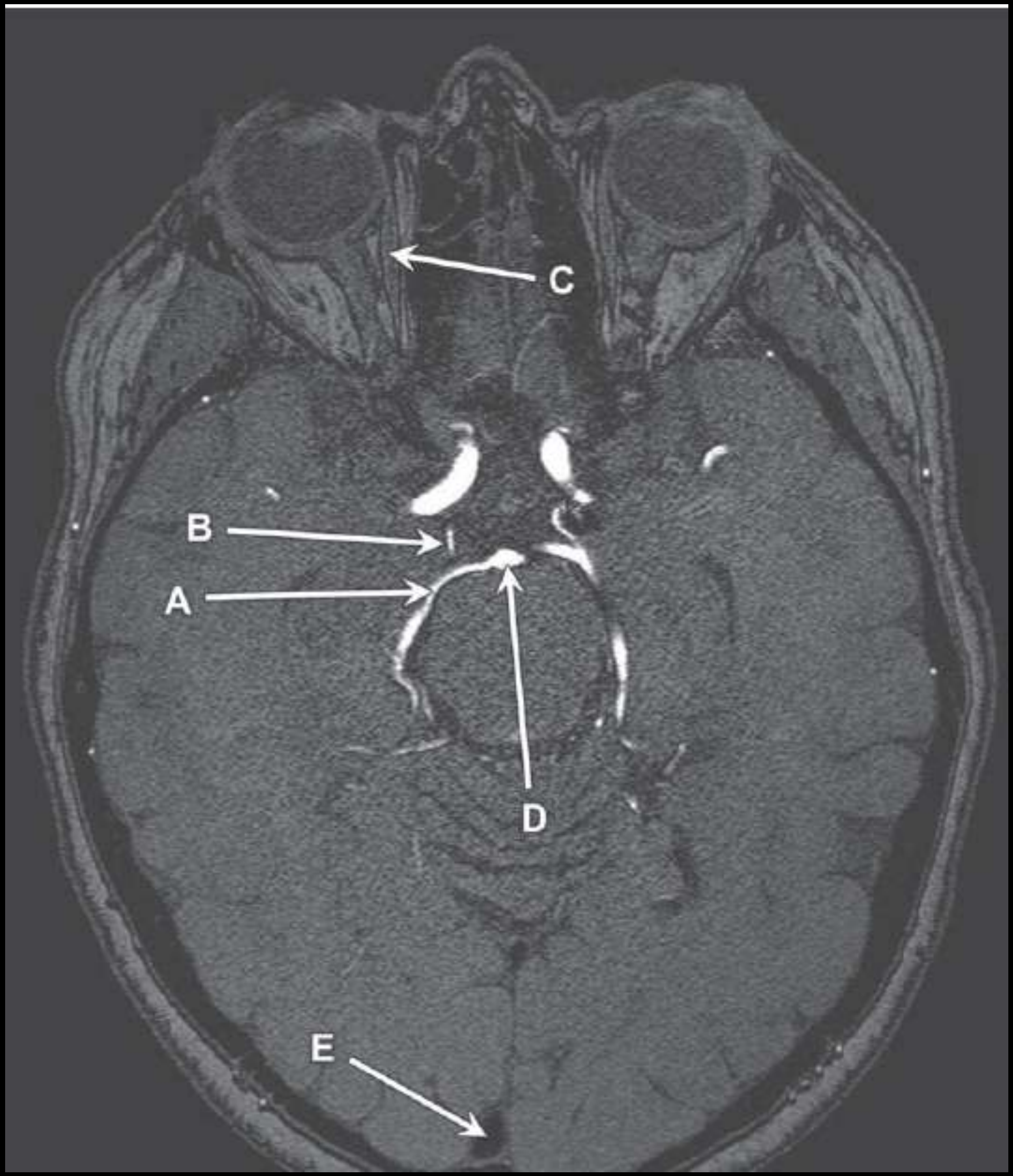
Case 7

CT facial bones. Axial section.

1. Right foramen transversarium (of C1 vertebra)
2. Left zygomatic bone (zygomatic process)
3. Left styloid process
4. Dens (odontoid process of the C2 vertebra)
5. Right mandibular ramus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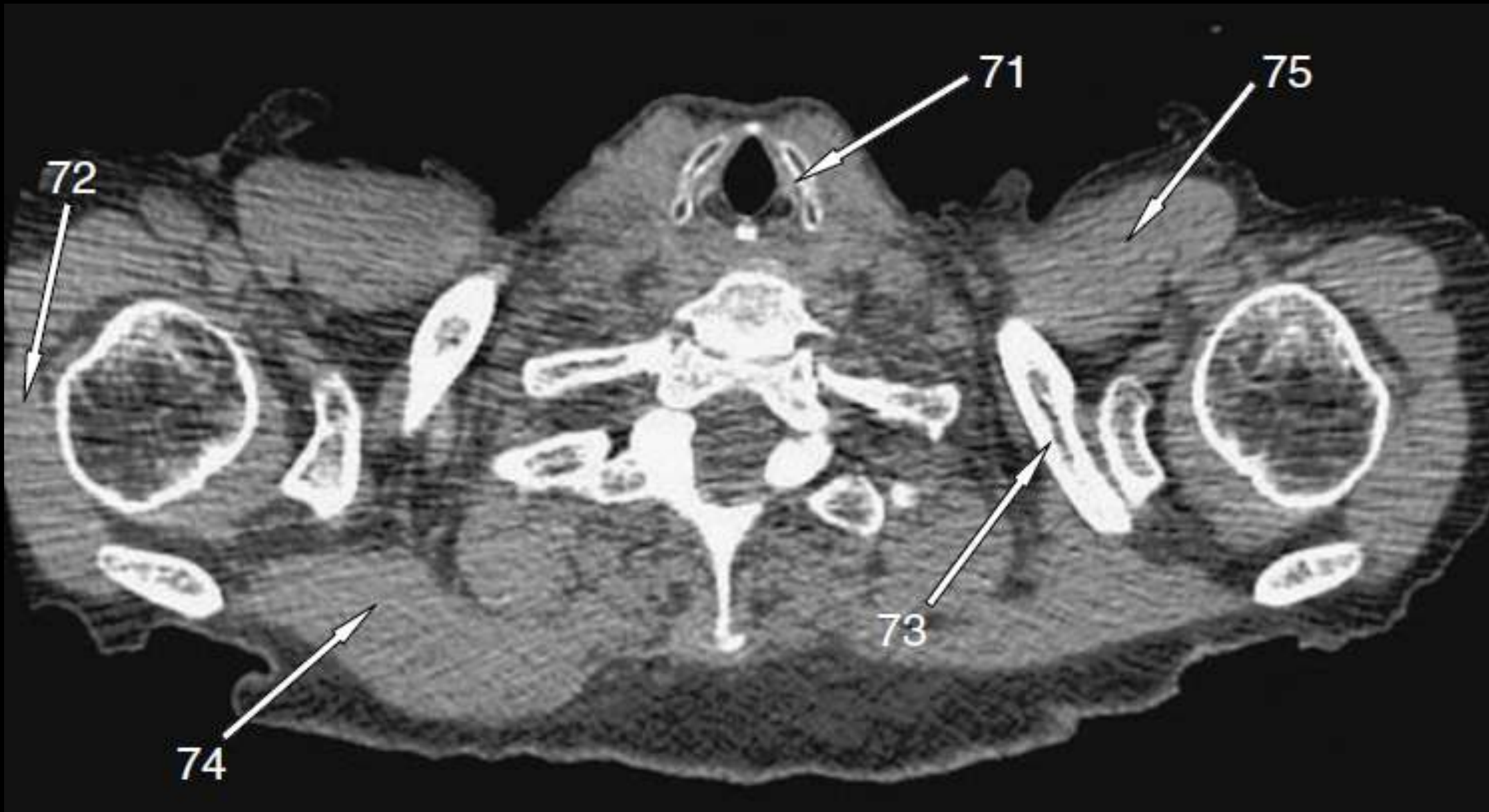
Case 4

MR-angio. Circle of Willis.

1. Right posterior cerebral artery
2. Right posterior communicating artery
3. Right medial rectus muscle
4. Basilar artery
5. Superior sagittal sinus

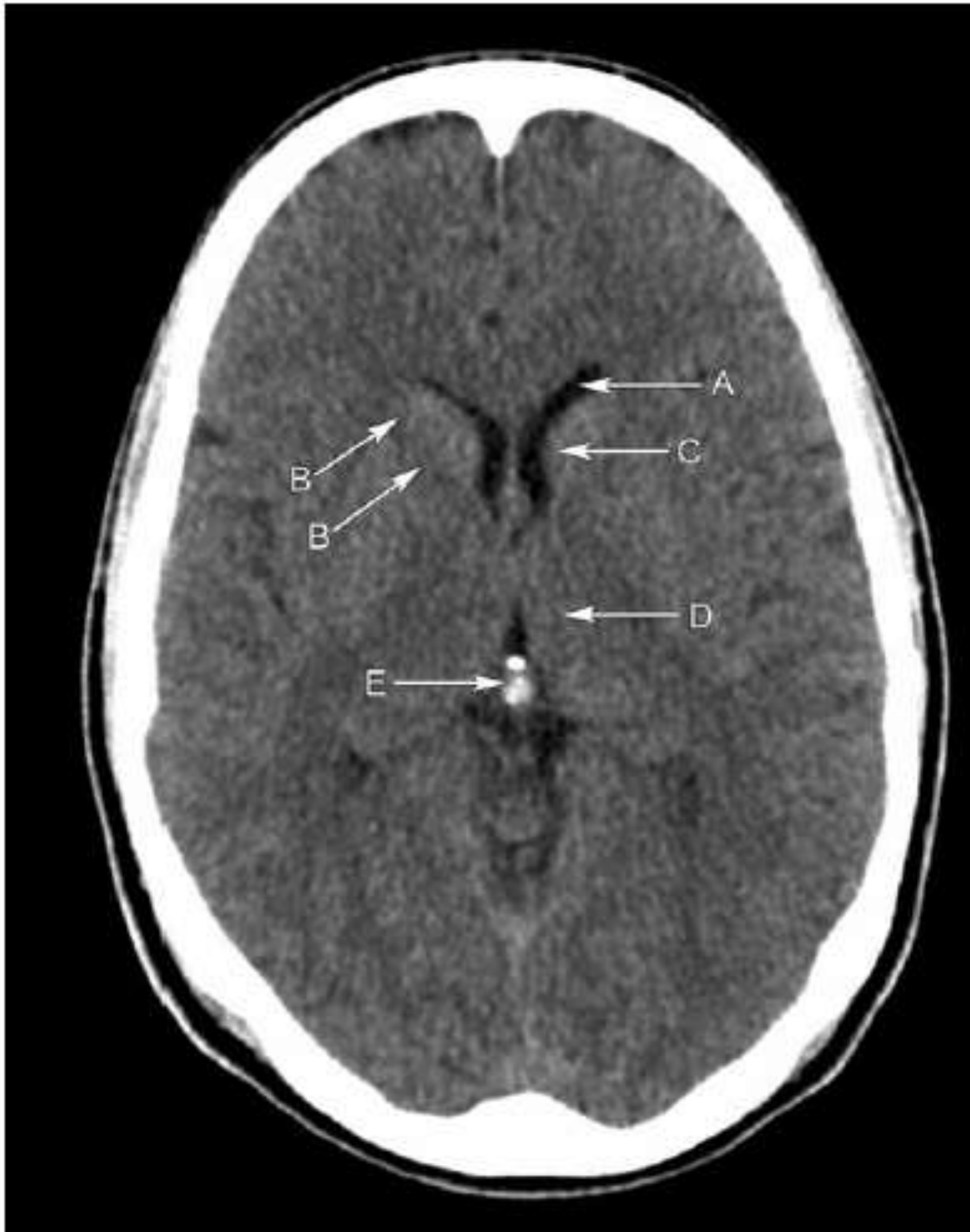

71
75
72
73
74

CT Neck

71. Thyroid cartilage
72. Right deltoid
73. Left clavicle
74. Right trapezius muscle
75. Left pectoralis major muscle

This axial CT is taken with the arms raised above the head.

Question 1.1

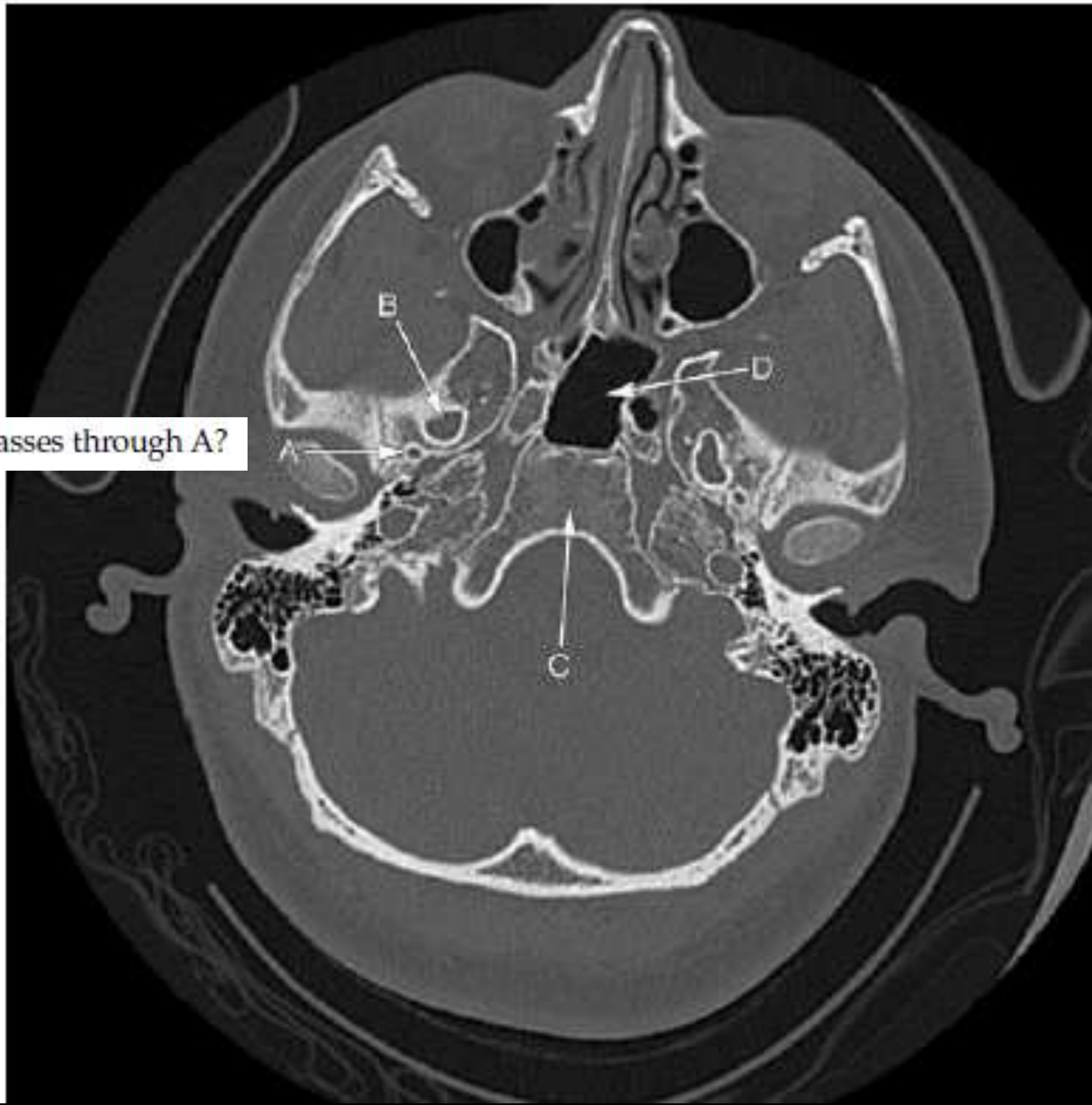


1.1 Axial CT scan of the brain

A Frontal horn of the left lateral ventricle.
B Anterior limb of the right internal capsule.
C Head of the left caudate nucleus.
D Left thalamic nucleus.
E Pineal gland.

The heads of the caudate nuclei are located in the concavities of the frontal horns of the lateral ventricles. The internal capsule lies lateral to the caudate nucleus and is split into anterior and posterior limbs. The anterior limb is located between the caudate nucleus and the globus pallidus of the lentiform nucleus. There are two thalami, which are located lateral to the third ventricle and medially to the posterior limb of the internal capsule. The pineal gland is a midline structure located posterior to the third ventricle and is often calcified.

Question 1.5



E What artery passes through A?

1.5 Axial CT of the base of the skull

A Right foramen spinosum.
B Right foramen ovale.
C Clivus.
D Sphenoid sinus.
E Right middle meningeal artery.

The foramen spinosum transmits the middle meningeal artery. The foramen ovale transmits the mandibular division (CN V^3) of the trigeminal nerve and the accessory meningeal artery. The sphenoid sinuses are a pair of sinuses whose relations are as follows:

Anteriorly	Ethmoid air cells
Posteriorly	Clivus
Superiorly	Sella turcica
Inferiorly	Nasopharynx
Laterally	Cavernous sinus

The base of the skull and the contents of the foramina are a common exam topic and the following table should be learnt:

Foramina	Contents
Foramen ovale	Mandibular division of the trigeminal nerve (CN V^3) Accessory meningeal artery
Carotid canal	Internal carotid artery Sympathetic plexus
Jugular foramen	Internal jugular vein Glossopharyngeal nerve (CN IX) Vagus nerve (CN X) Accessory nerve (CN XI)
Stylomastoid foramen	Facial nerve (CN VII) Stylomastoid artery
Foramen spinosum	Middle meningeal artery and vein
Foramen lacerum	Internal carotid artery
Foramen magnum	Medulla and surrounding meninges Spinal roots of the accessory nerve Anterior and posterior spinal and vertebral arteries


85
81
82
83
84

MRI Head

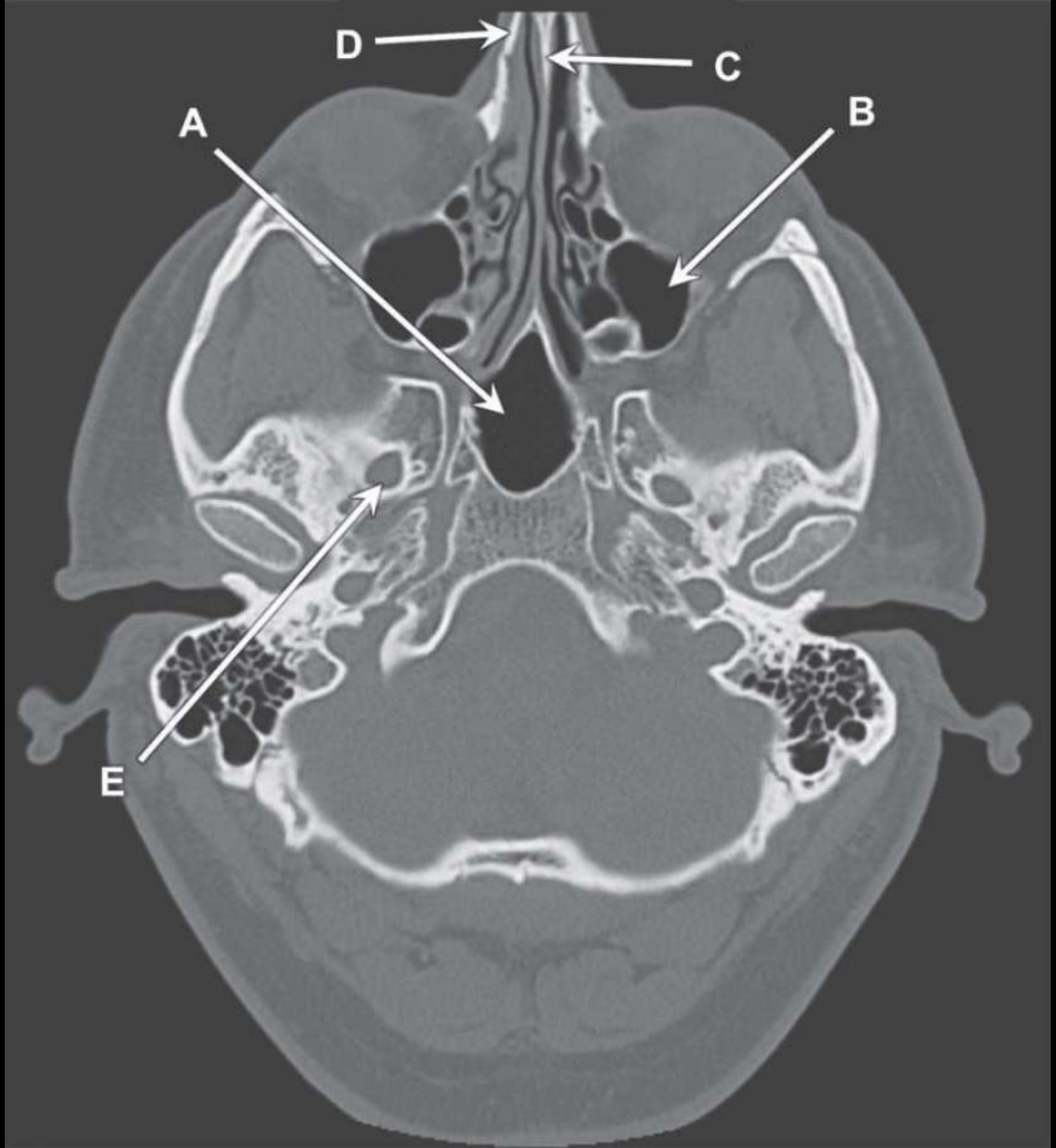
81. Right middle cerebral artery
82. Right cerebral peduncle
83. Aqueduct of Sylvius
84. Straight sinus
85. Crista galli

Name the normal variant

CT Head

Cavum vergae

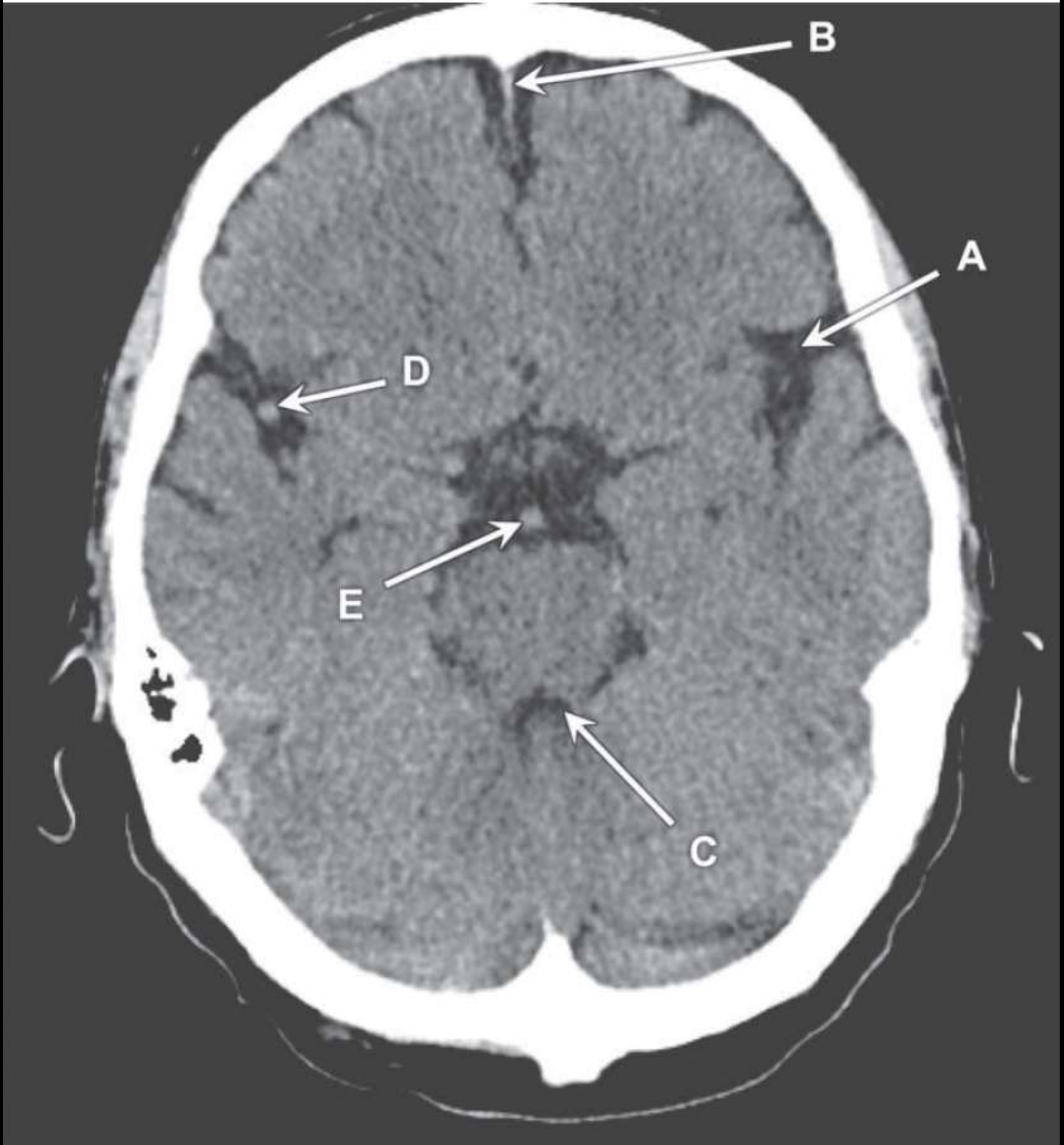
A cavum septum pellucidum separates the frontal horns of the lateral ventricles, anterior to the foramina of Monro. A cavum vergae cannot exist without a cavum septum pellucidum but extends posterior to the splenium of the corpus callosum.


D
C
A
B
E

Case 11

CT head. Axial section.

1. Sphenoid sinus
2. Left maxillary sinus
3. Nasal septum
4. Right nasal bone
5. Right foramen ovale

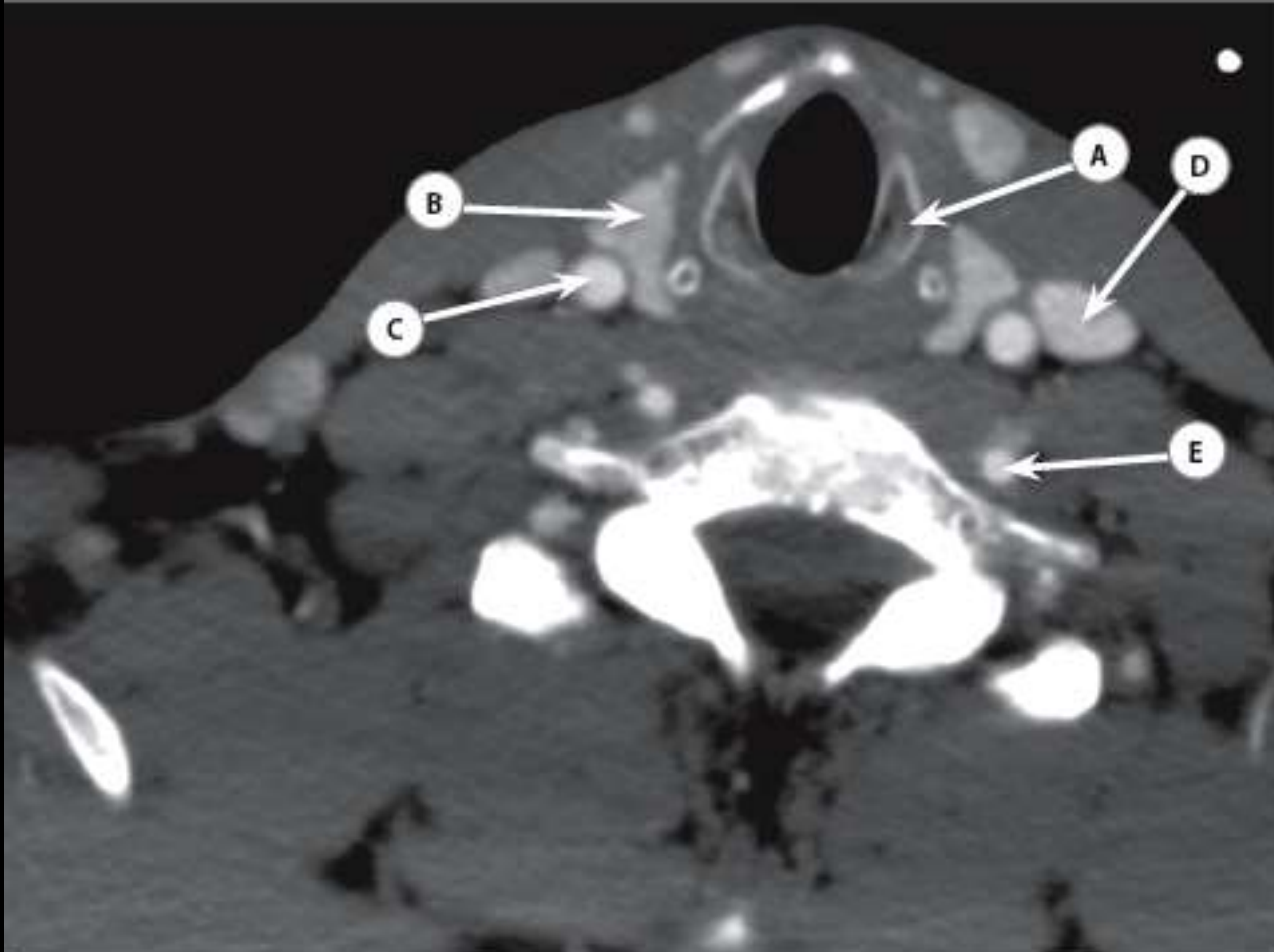

B
A
D
E
C

Case 14

CT head. Axial section.

1. Left Sylvian fissure
2. Falx cerebri (anterior part)
3. Fourth ventricle
4. Right middle cerebral artery
5. Basilar artery

Case 8.10



Case 8.10

A Cricoid cartilage of larynx

B Right lobe of thyroid gland

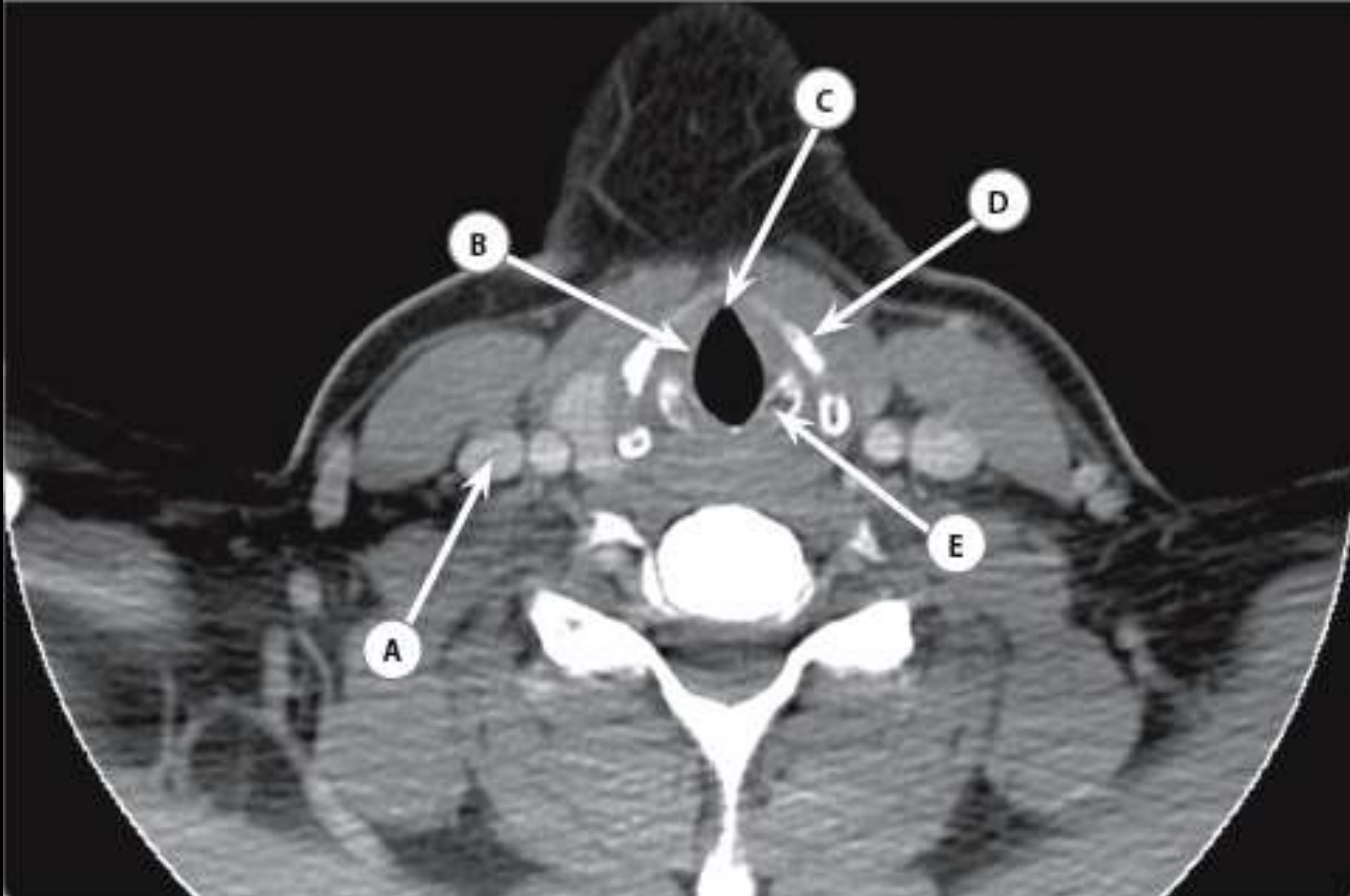
C Right common carotid artery

D Left internal jugular vein

E Left vertebral artery

The thyroid and cricoid cartilages are parts of the larynx. The thyroid gland is high attenuation on CT due to its high iodine content. The vertebral arteries can be identified by their paired prevertebral locations. The common carotid arteries usually bifurcate at the upper end of the thyroid cartilage (C4 level) into internal and external carotid arteries.

Case 6.18



Case 6.18

A Right internal jugular vein

B Right true vocal cord

C Anterior commissure

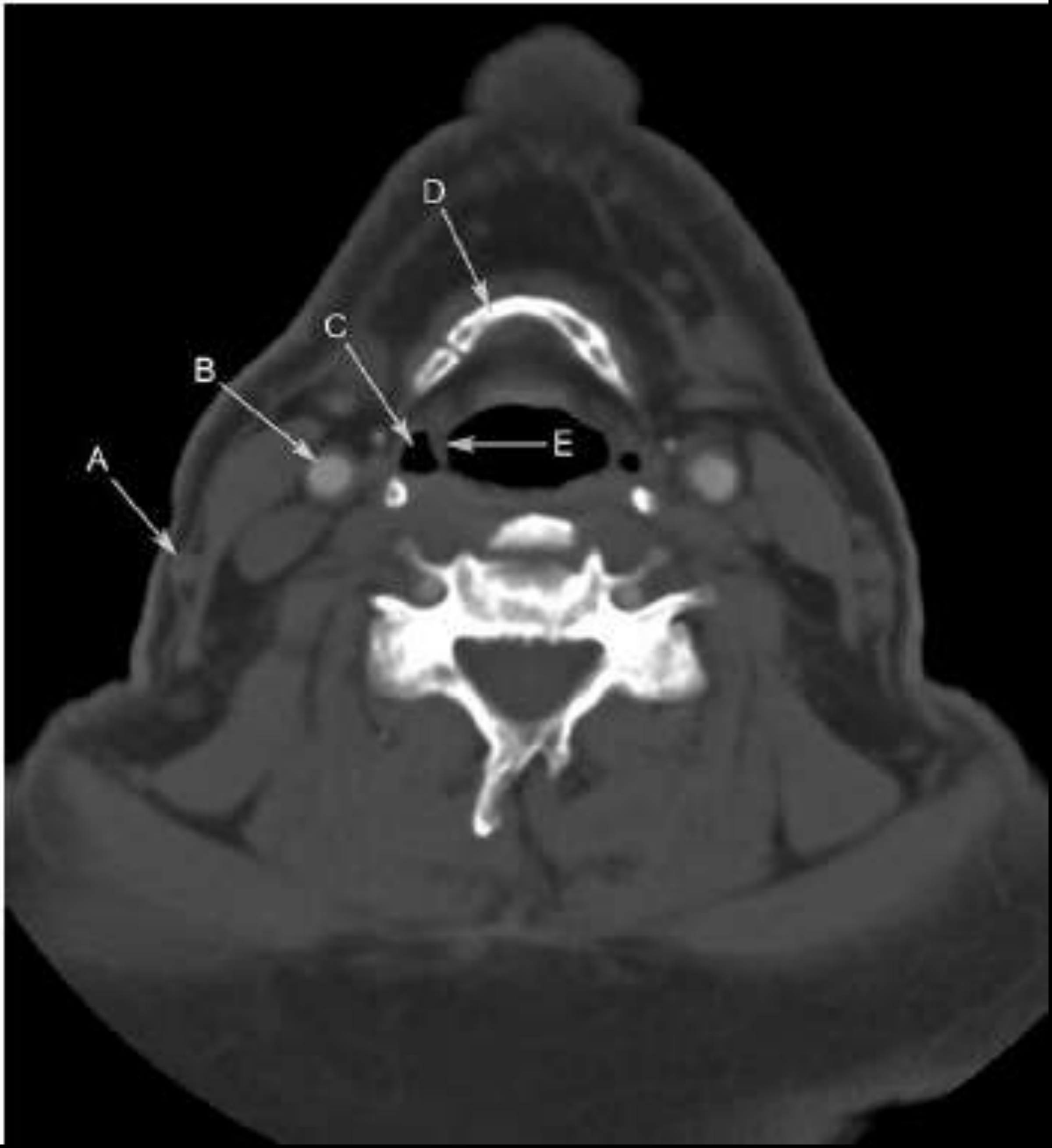
D Left thyroid cartilage

E Left arytenoid cartilage

The vocal cords are situated within the larynx, protected by a cartilaginous skeleton which consists of the thyroid cartilage anteriorly, the signet-shaped cricoid cartilage posteriorly and the epiglottis superiorly. The anterior margins of the true vocal cords are connected by the anterior commissure and the posterior margins are attached to the arytenoid cartilages.

The false (vestibular) vocal cords are a pair of thick folds of mucosa which lie superior to the true vocal cords. To distinguish them from the true vocal cords, one should look for the arytenoids cartilages – if not seen posteriorly, one is looking at the false cords.

Question 4.4



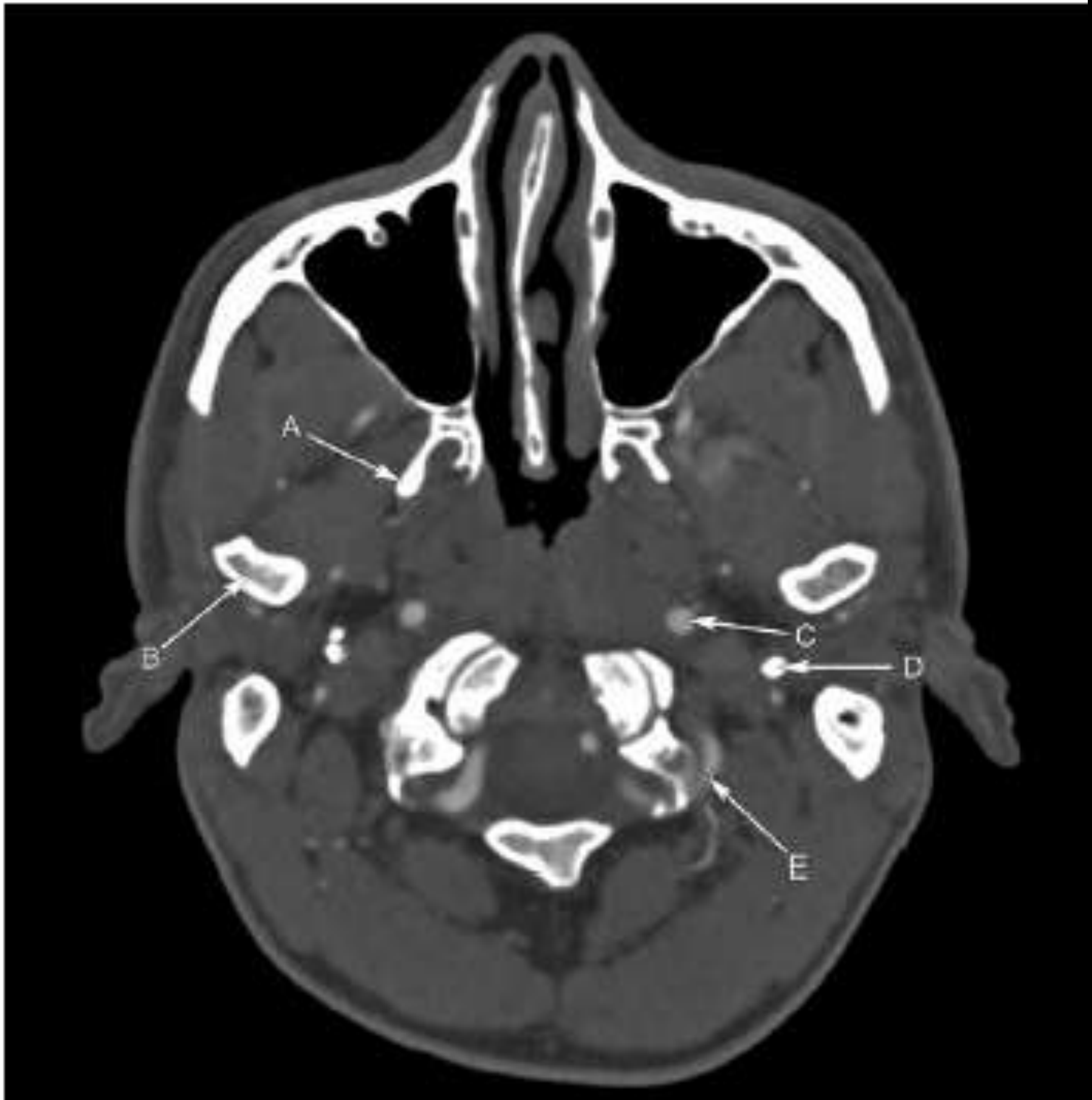
4.4 Axial CT of the neck with IV contrast

A Right external jugular vein.
B Right common carotid artery.
C Right piriform fossa.
D Hyoid bone.
E Right aryepiglottic fold.

The external jugular vein is formed within the parotid gland by the junction of the retromandibular vein and the posterior auricular vein. The vessel courses down within the superficial tissues along the posterior border of the sternocleidomastoid to drain into the subclavian vein. The right common carotid artery is a branch of the brachiocephalic artery, whereas the left common carotid artery is a direct branch of the aortic arch.

The aryepiglottic folds arise from the inferolateral aspect of the epiglottis and insert into the arytenoid cartilages. They define the piriform fossae laterally with the vestibule of the larynx medially.

Question 2.1

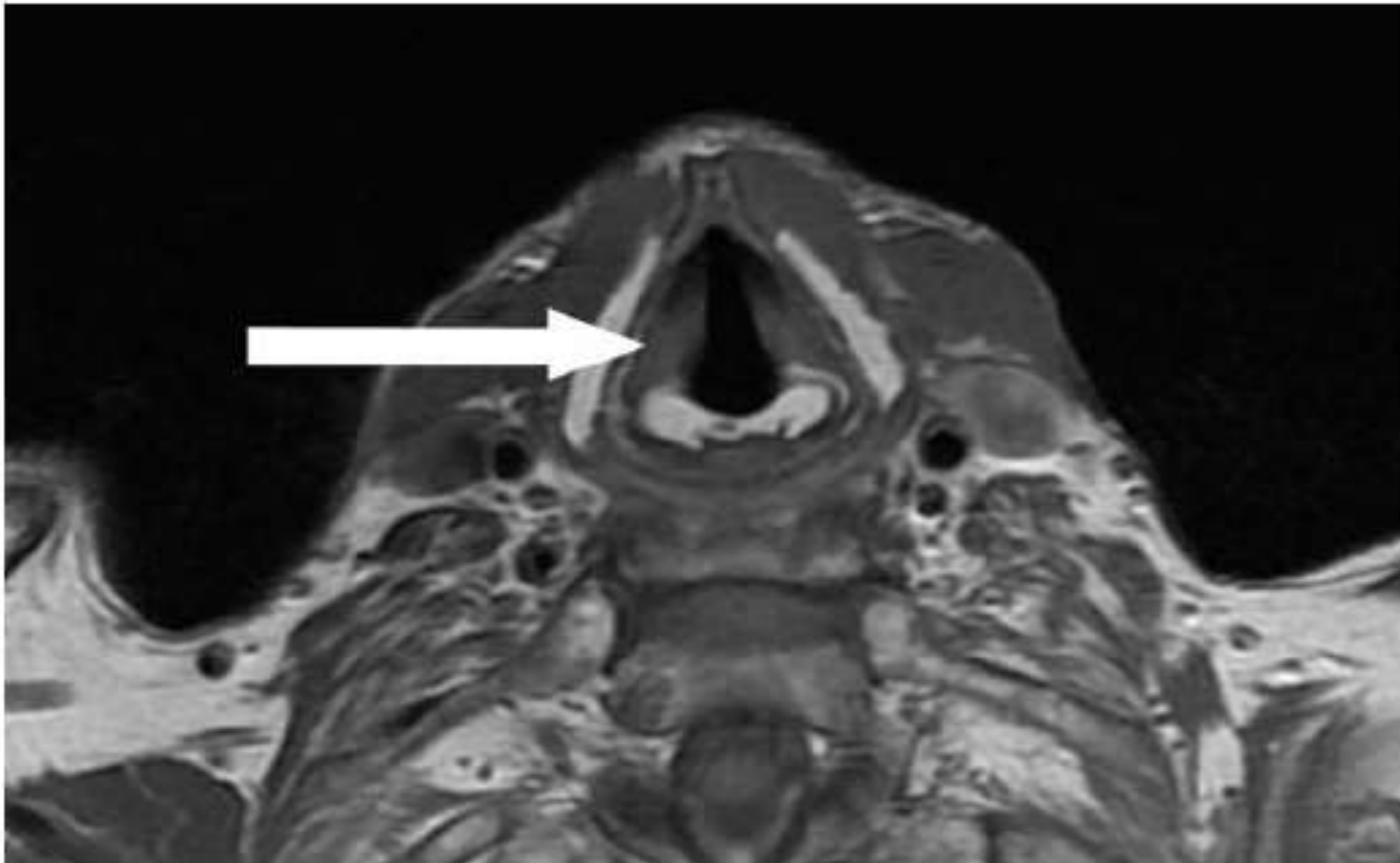


2.1 Axial CT of the upper neck with IV contrast

A Right lateral pterygoid plate.
B Right mandibular condyle.
C Left internal carotid artery.
D Left styloid process.
E Left vertebral artery.

The lateral and medial pterygoid plates are part of the sphenoid bone and descend perpendicularly from the region where the body and the greater wings unite. All categories of Le Fort fracture involve the pterygoid plates. The internal carotid artery arises at the level of C3 (where the common carotid artery bifurcates) and enters the base of the skull through the carotid canal. The styloid process is a pointed thin piece of bone that extends from the inferior surface of the temporal bone and serves as an important attachment to several ligaments and muscles of the larynx and tongue. The vertebral arteries are paired arteries that usually arise from the subclavian arteries and course through the foramen transversarium from C6 to C1. This image demonstrates the path of the vertebral arteries as they enter the foramen magnum, where they unite to form the basilar artery.

- **Question 26:**



Question 26: Axial T1-weighted MRI of the neck

Answer: Right vocal cord

- The true vocal cords are part of the glottis—the portion of the larynx that is triangular in cross section.
- The mucosa of the larynx wraps around the vocal ligaments to form the true cords, which are responsible for phonation.
- Superior to this, the laryngeal mucosa folds around the vestibular ligaments to form the false cords.

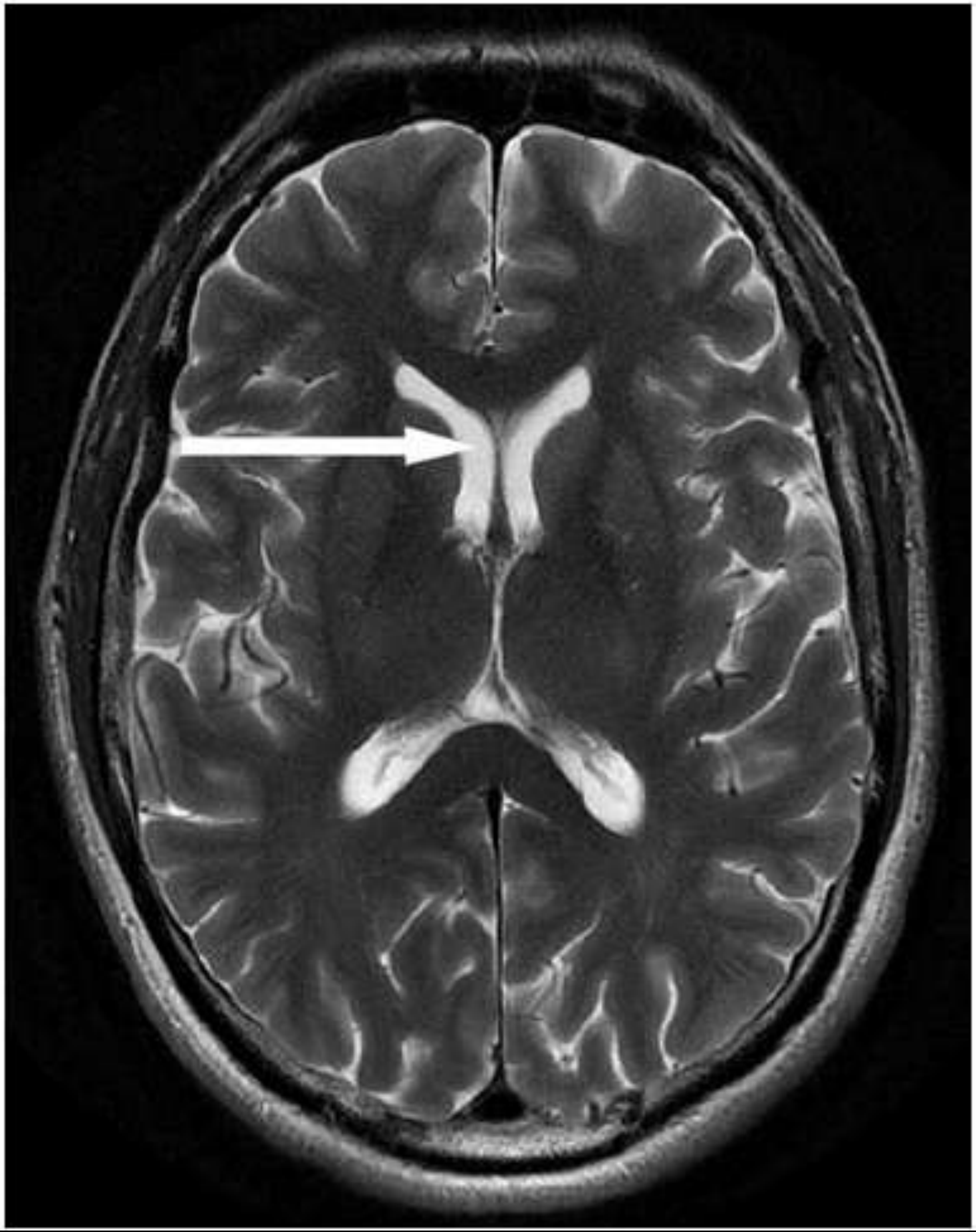
Question 27:

Question 27: Axial CT of the head

Answer: Right ramus of the mandible

- The ramus of the mandible is the posterior vertical extension of the body of the mandible.
- The superior mandibular ramus divides into the coronoid process (anteriorly) and the condyloid process extending to the mandibular condyle (posteriorly).

Question 28:

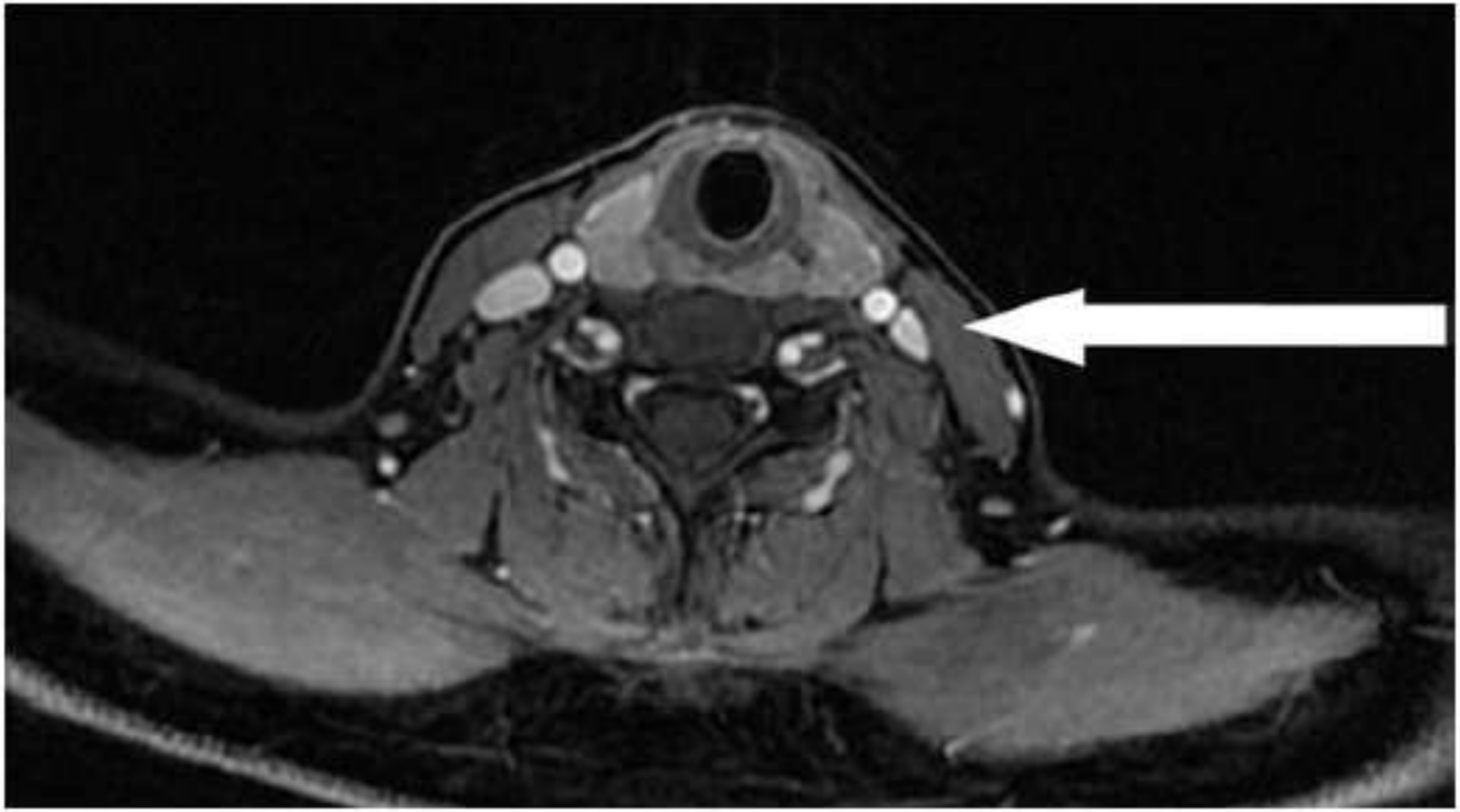


Question 28: Axial T2-weighted MRI of the brain

Answer: Frontal horn of the right lateral ventricle

- The lateral ventricles are paired C-shaped structures.
- They consist of the frontal horn, body (central part), temporal (inferior) horn, and the occipital (posterior) horn.
- They contain the choroid plexus, which produces the cerebrospinal fluid.

- **Question 29:**

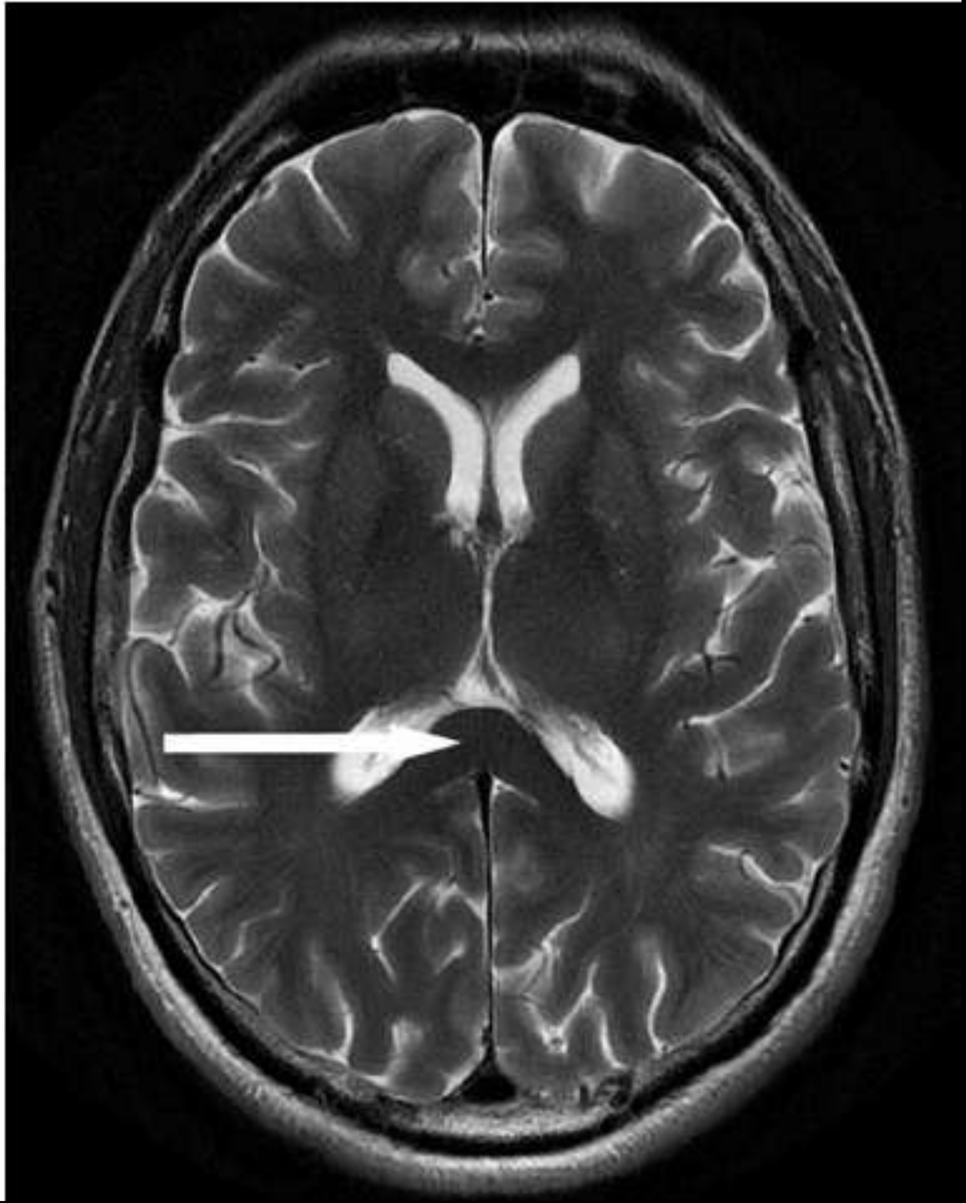


Question 29: Axial T2-weighted MRI of the neck

Answer: Left sternocleidomastoid muscle

- The sternocleidomastoid muscle lies anterolateral to the carotid sheath and is the largest muscle in the anterior part of the neck.
- The sternocleidomastoid muscle divides the neck into an anterior triangle and a posterior triangle. It is an important landmark when describing lymph node levels in the neck.

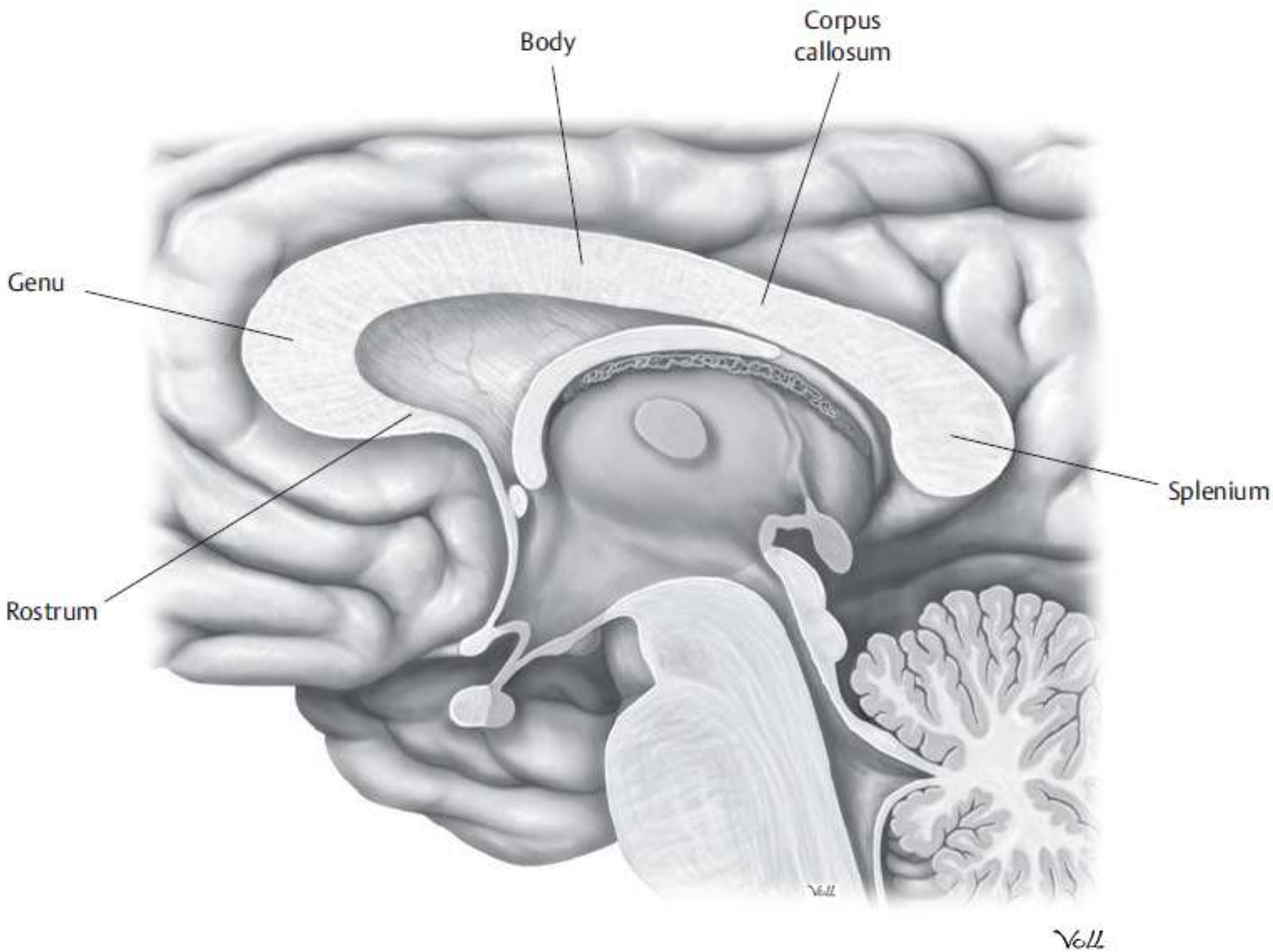
- **Question 30:**



Question 30: Axial T2-weighted MRI of the brain

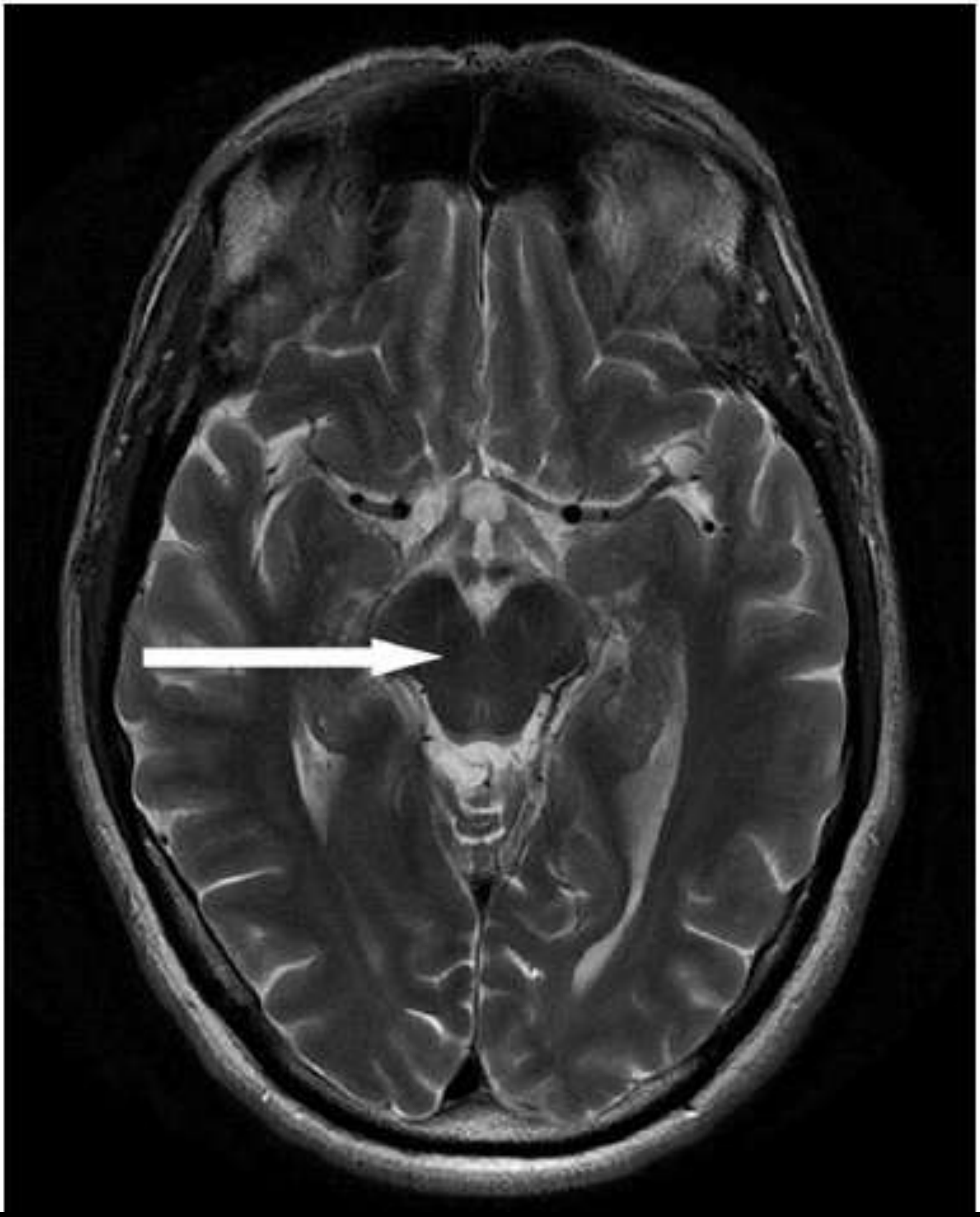
Answer: Splenium of corpus callosum

- This is a midline structure that crosses the interhemispheric fissure and facilitates communication between the left and right cerebral hemispheres.



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

Question 33:



Question 33: Axial T2-weighted MRI brain

Answer: Midbrain

- The midbrain is the most superior portion of the brainstem.
- On axial images, it is 'Mickey Mouse'–shaped; the cerebral peduncles resemble the ears.
- It connects to the thalamus (superiorly) and to the pons (inferiorly).
- The midbrain is divided into three portions:
  - Tectum (posterior)
    - Made up of the tectal/quadrigeminal plate and the superior and inferior colliculi
  - Tegmentum
  - Cerebral peduncles (anterior)
    - Separated by the interpeduncular fossa in the midline, which contains the mamillary bodies

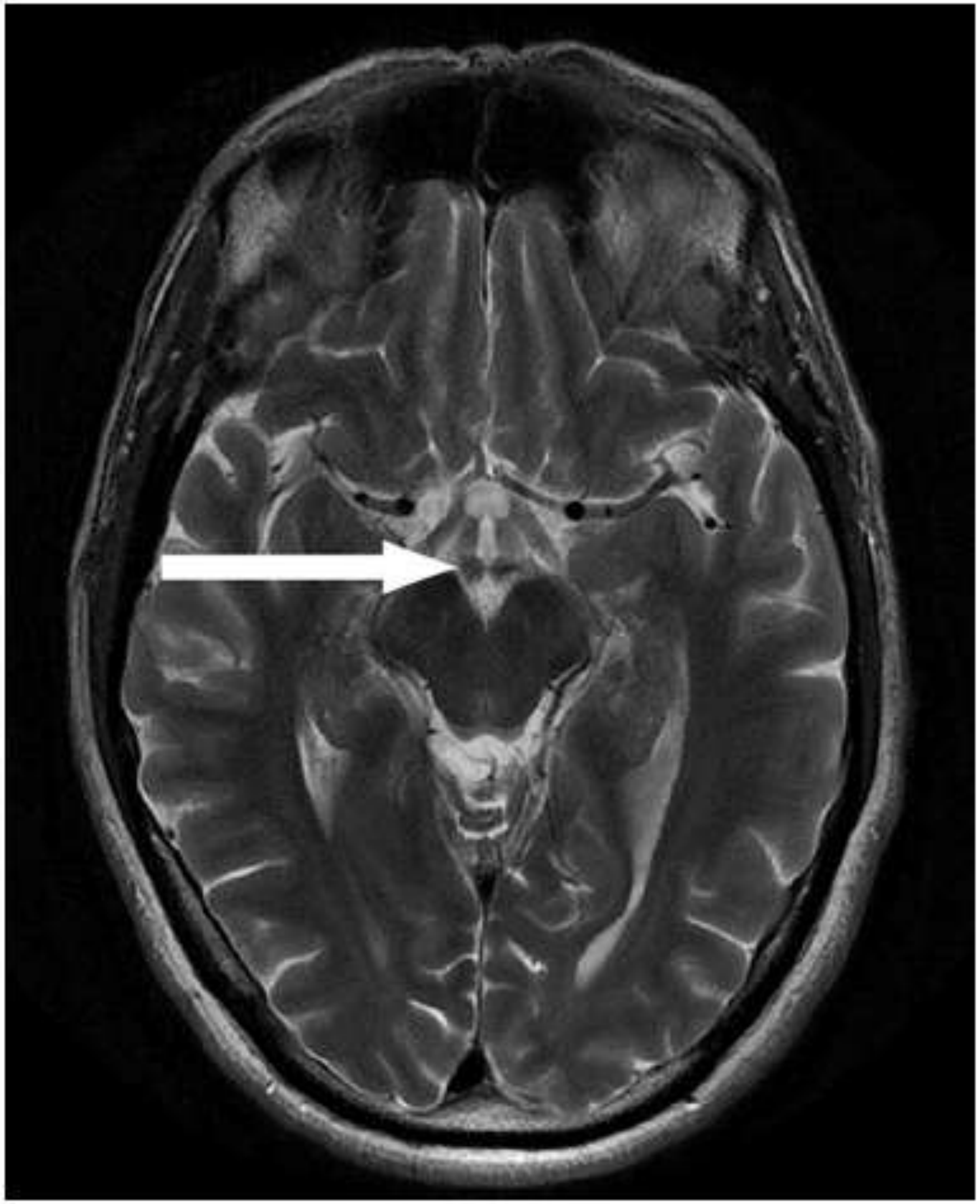
■ Question 34:

Question 34: Axial CT at the level of the lung apices

Answer: Left lobe of the thyroid gland

- On CT, the thyroid gland can be recognised as a midline structure on either side of the trachea; the thyroid has a higher attenuation than the rest of the soft tissues due to its high iodine content.

Question 35:



Question 35: Axial T2-weighted MRI of the brain

Answer: Right mamillary body

- The mamillary body is a paired, small, round structure located in the interpeduncular cistern/fossa.
- It extends from the hypothalamus.
- It returns low signal on a T2-weighted MRI.

- **Question 36:**

Question 36: T1-weighted MRI of the skull base

Answer: Left lateral pterygoid muscle

- The lateral pterygoid is a muscle of mastication with two heads.
- The upper head arises from the greater wing of the sphenoid bone and inserts onto the articular disc of the temporomandibular joint.
- The lower head arises from the lateral pterygoid plate and inserts onto the neck of the mandibular condyle as demonstrated on the image.

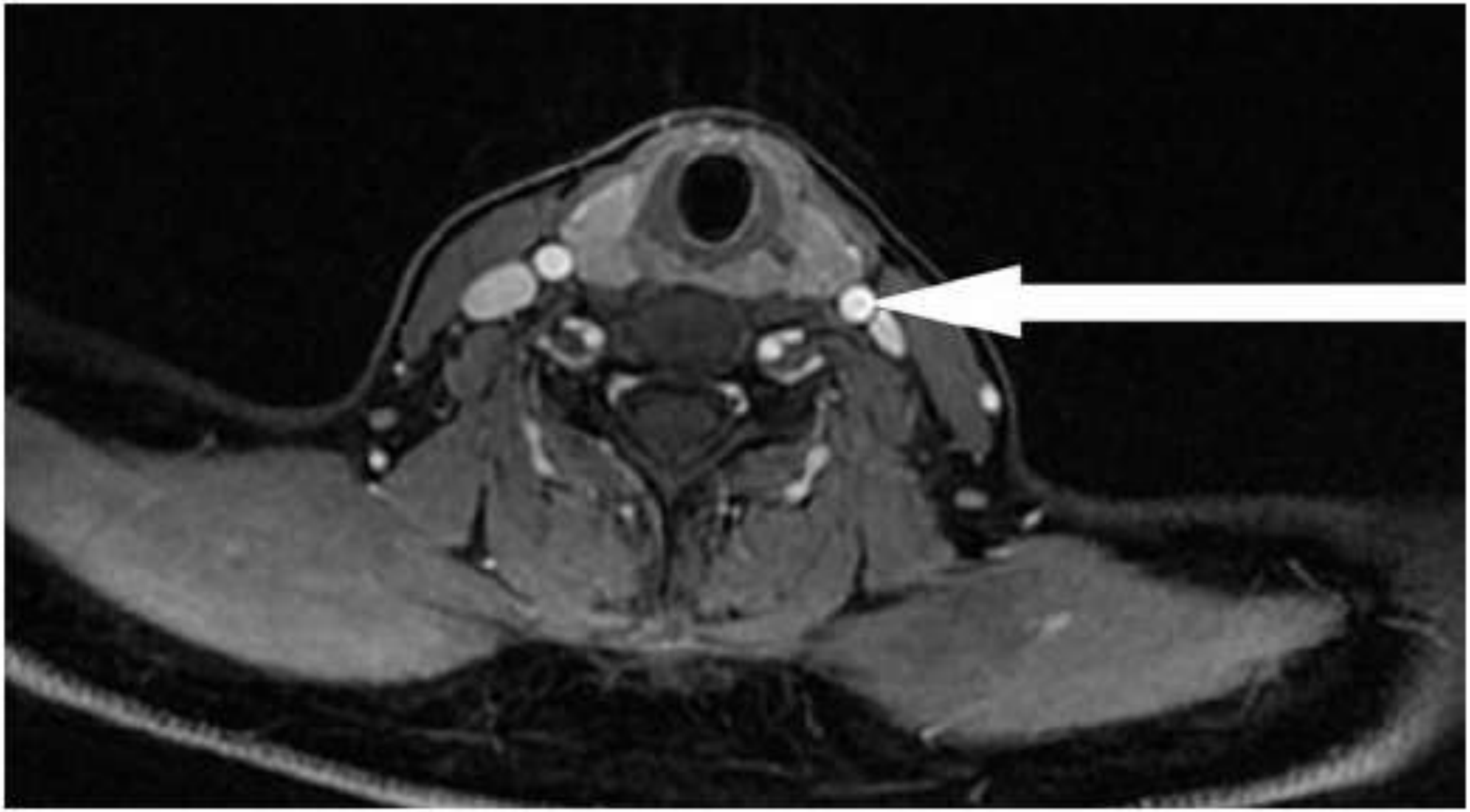
Question 37:

Question 37: MR angiogram of the circle of Willis (MIP image)

Answer: Left internal carotid artery

- The internal carotid arteries arise from the bifurcation of the common carotid arteries at the level of C4 and ascend to the base of the skull.
- They then enter the cranial cavity via the carotid canal in the petrous bone and follow a tortuous course before terminating at the anterior perforated substance by dividing into the anterior and middle cerebral arteries.
- At the circle of Willis, the internal carotid arteries can be recognised as the vessels with the greatest diameters.

- **Question 38:**

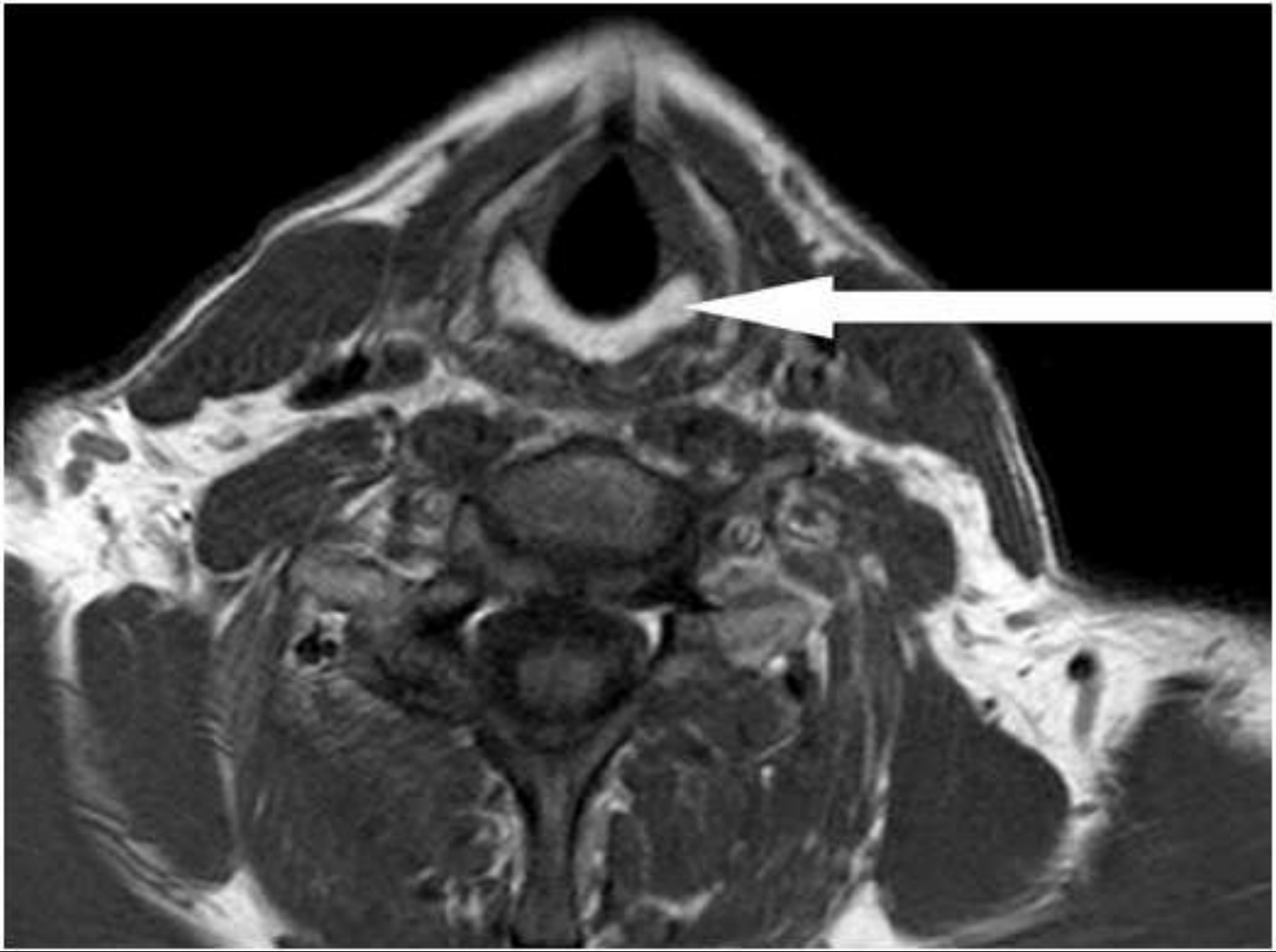


Question 38: T1-weighted, fat-suppressed, contrast-enhanced MRI of the neck

Answer: Left common carotid artery

- The left common carotid artery arises from the arch of the aorta and ascends into the neck.
- It travels in the carotid sheath with the internal jugular vein laterally and the vagus nerve posteriorly.
- The common carotid artery divides into the internal and external carotid arteries at the level of C4.

- **Question 39:**

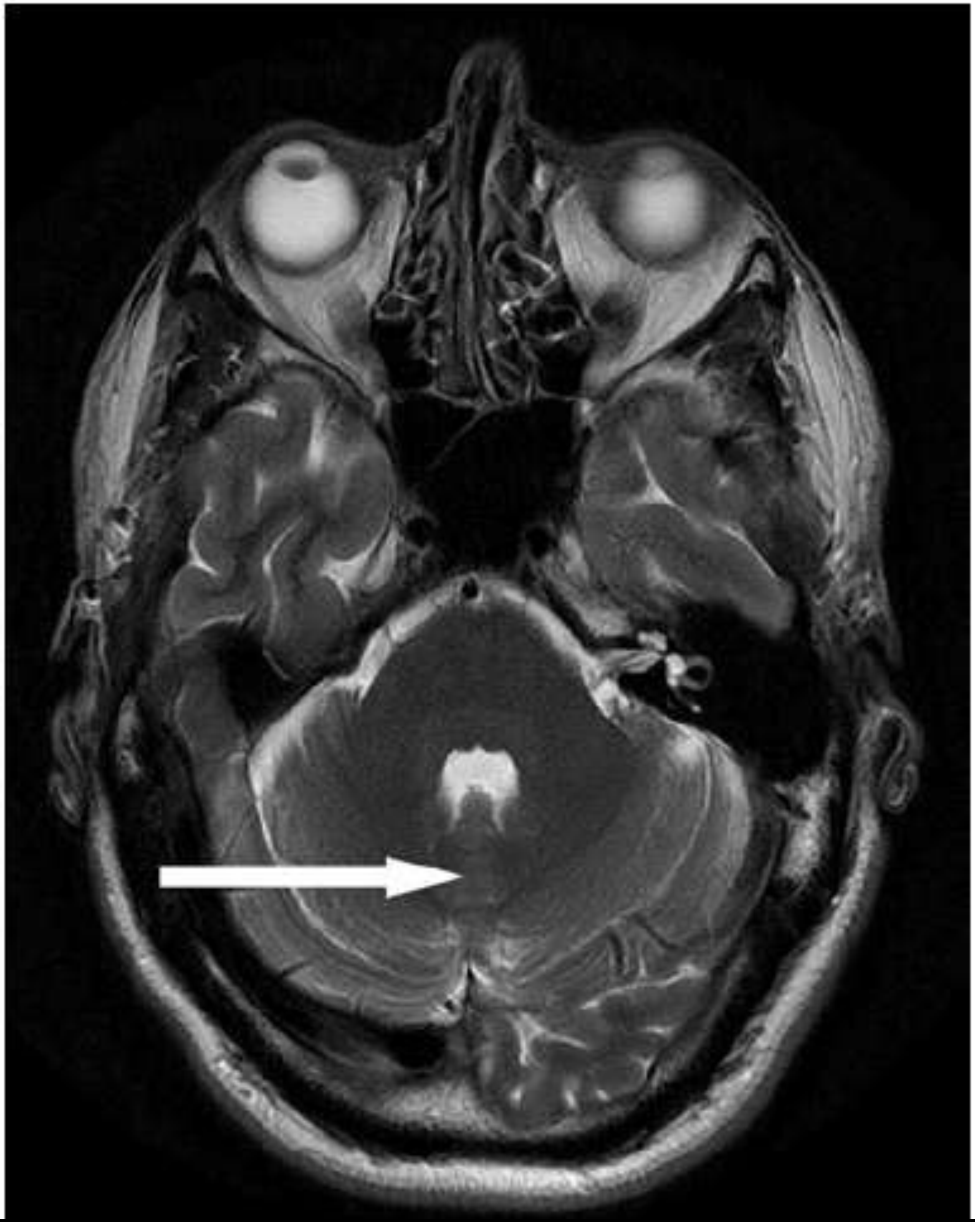


Question 39: MRI of the neck

Answer: Cricoid cartilage

- The cricoid cartilage is part of the cartilaginous framework that surrounds the larynx.
- The cricoid cartilage lies inferior to the thyroid cartilage and articulates with its inferior horns as demonstrated on the image.
- Although not apparent on this CT image, the cricoid cartilage is actually a ringed structure. The posterior part of the ring is greater in length in the craniocaudal dimension than the anterior part; hence, the anterior part of the cartilage cannot be seen on the image.

Question 41:

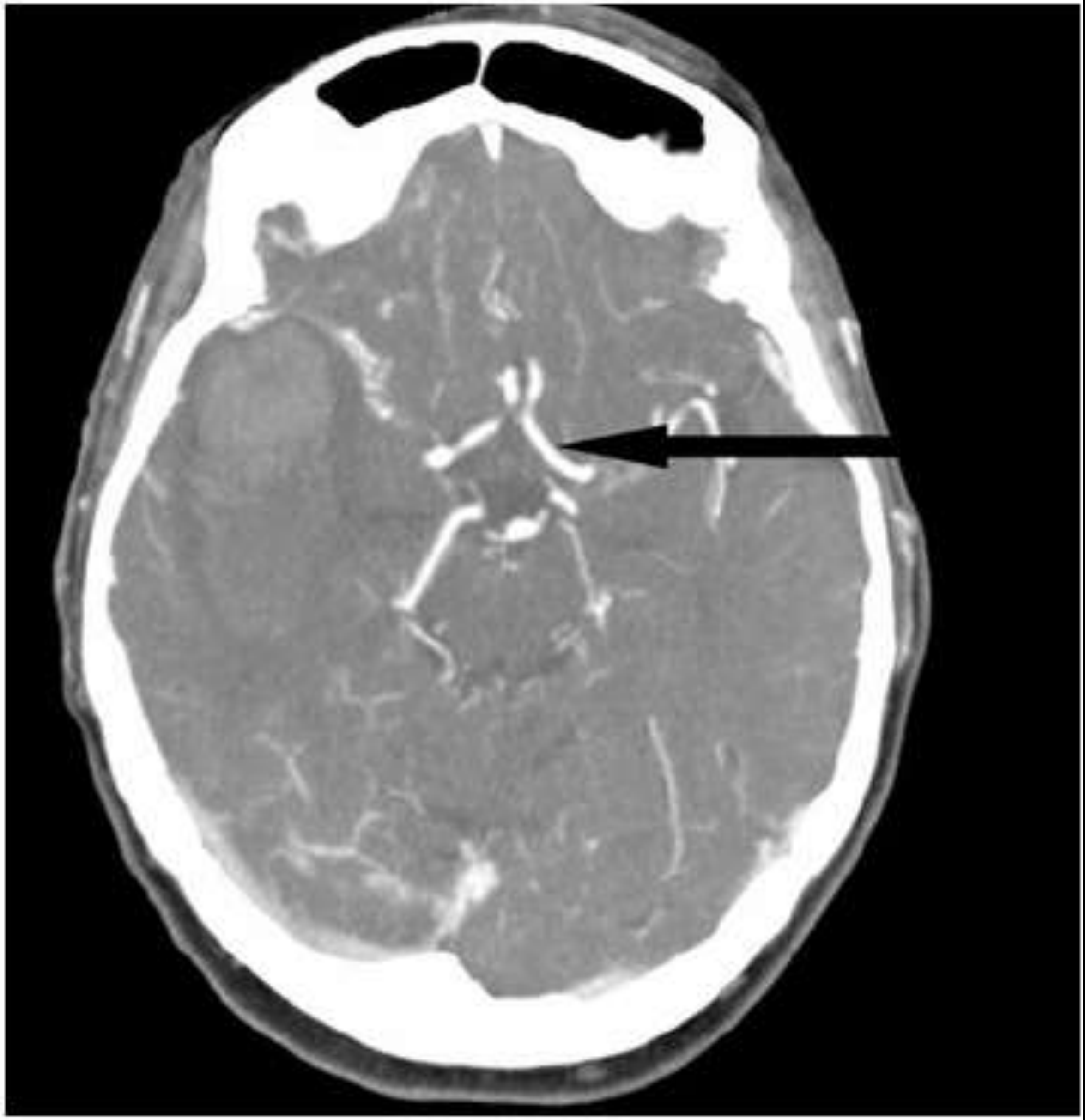


Question 41: Axial T2-weighted MRI of the brain

Answer: Cerebellar vermis

- The cerebellar vermis is a single midline structure in the posterior fossa that connects the two cerebellar hemispheres.
- It lies posterior to the fourth ventricle.
- The vermis is separated into nine lobules by fissures (folia).

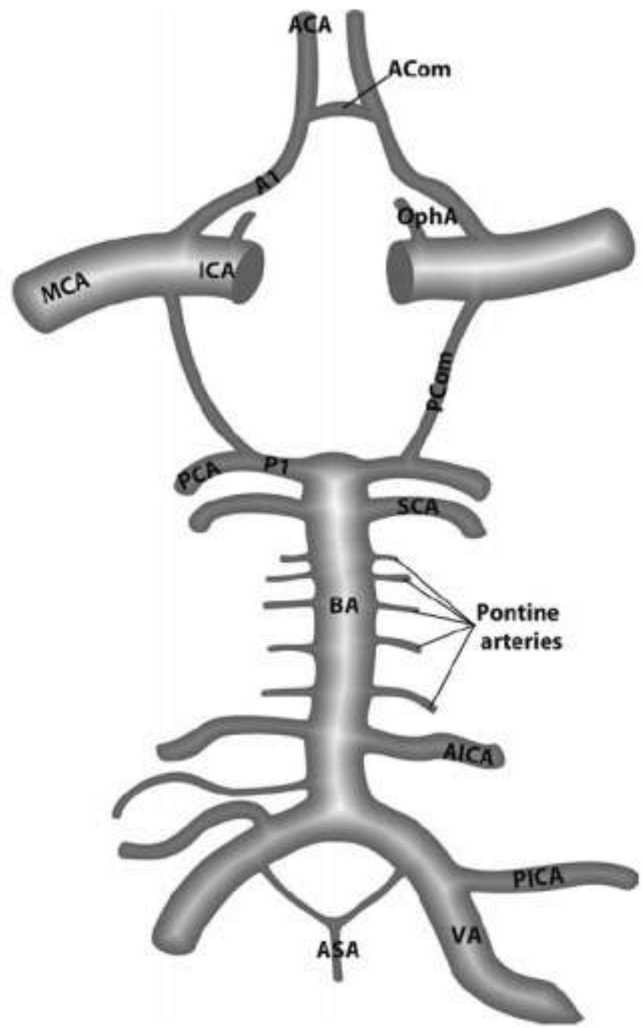
- **Question 42:**



Question 42: CT angiogram of the circle of Willis

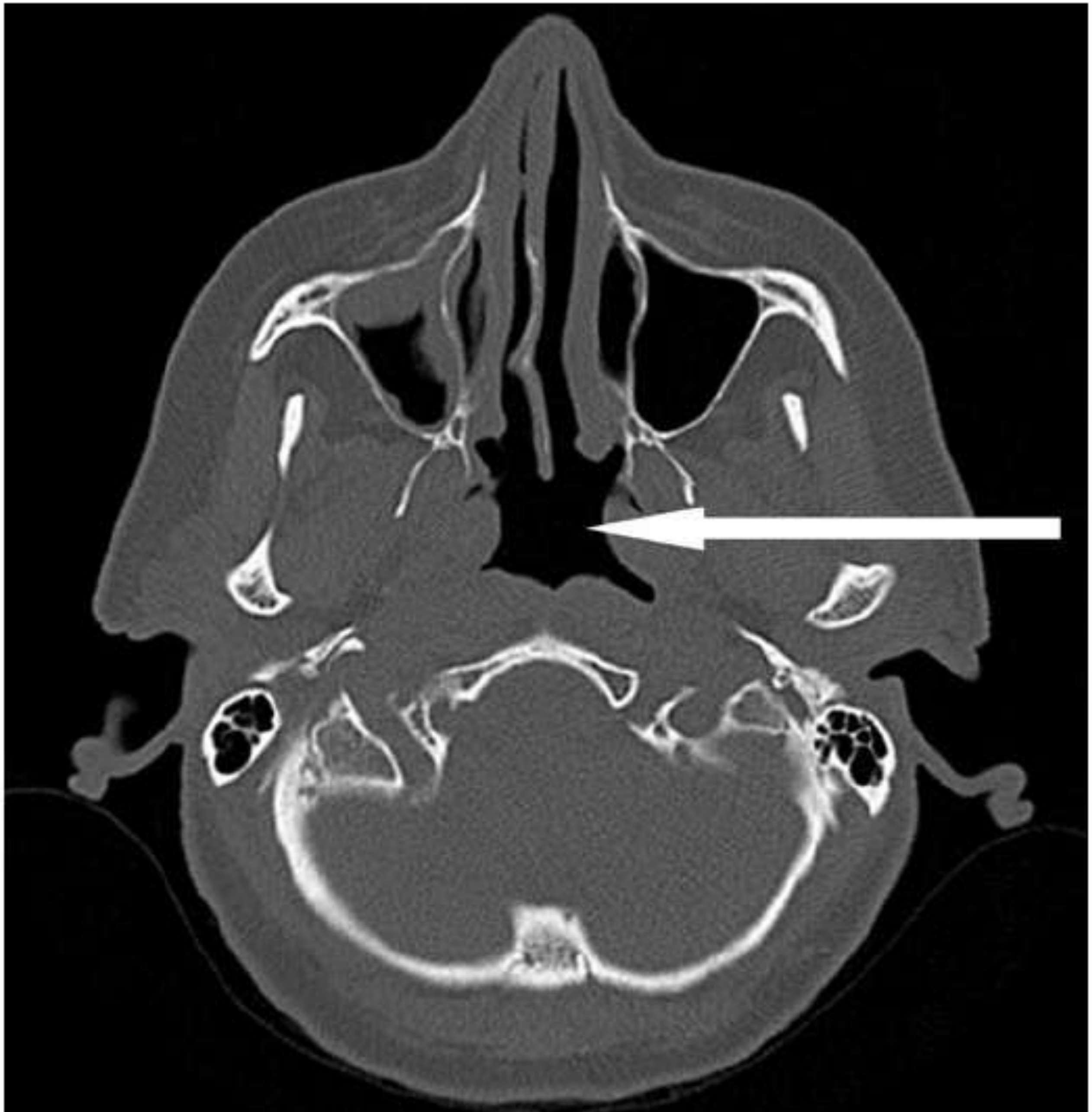
Answer: Left anterior cerebral artery (ACA)

- The circle of Willis is more pentagonal in shape than circular.
- It encloses the optic chiasm and pituitary stalk.
- The left and right ACA form the roof of the pentagon and are joined together by the anterior communicating artery (which cannot be clearly visualised on the image).
- This is not the best example of the circle of Willis, but it has been included because the examples in the examination are sometimes purposefully not of the best quality to test your knowledge.
- The figure below shows all the branches that form the circle of Willis.



From Sanna M, Piazza P Shin S, et al. Microsurgery of Skull Base Paragangliomas. Stuttgart, Germany: Thieme Medical Publishers; 2013.

- **Question 43:**

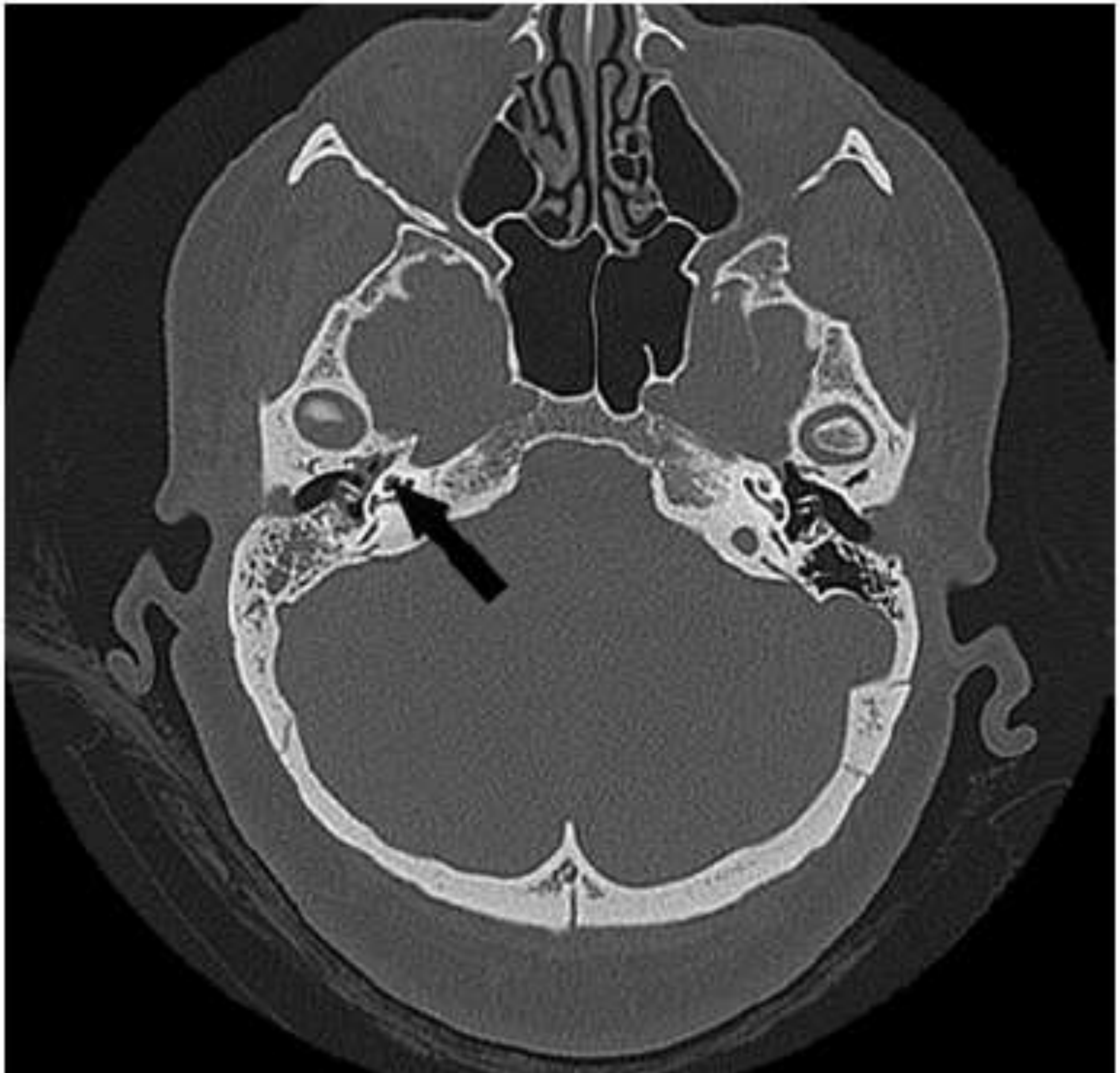


Question 43: Axial CT of the skull

Answer: Nasopharynx

- The pharynx is a muscular tube that is part of both the respiratory and gastrointestinal tracts.
- It is divided into three parts: the nasopharynx, oropharynx, and hypopharynx.
- On an axial image, the nasopharynx can be identified by its anterior communication with the nasal cavity.

Question 45:

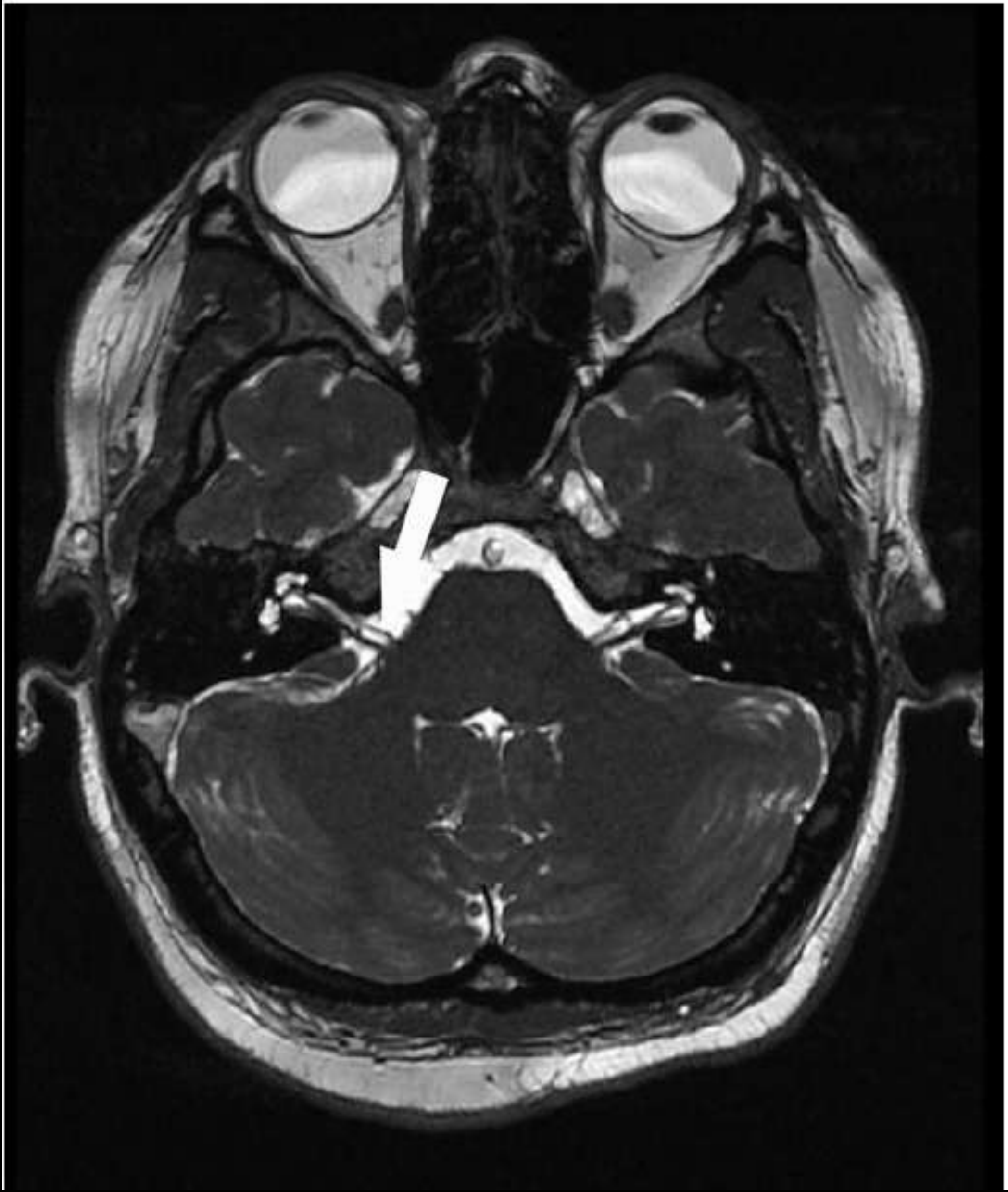


Question 45: Axial CT of the brain

Answer: Right cochlea

- The cochlea is a paired, spiral-shaped conical chamber that forms part of the vestibular system.
- *Cochlea* is Latin for 'snail shell'.
- It is part of the temporal bone and sits medial to the mastoid air cells and anterior to the vestibular aqueduct.

Question 47:

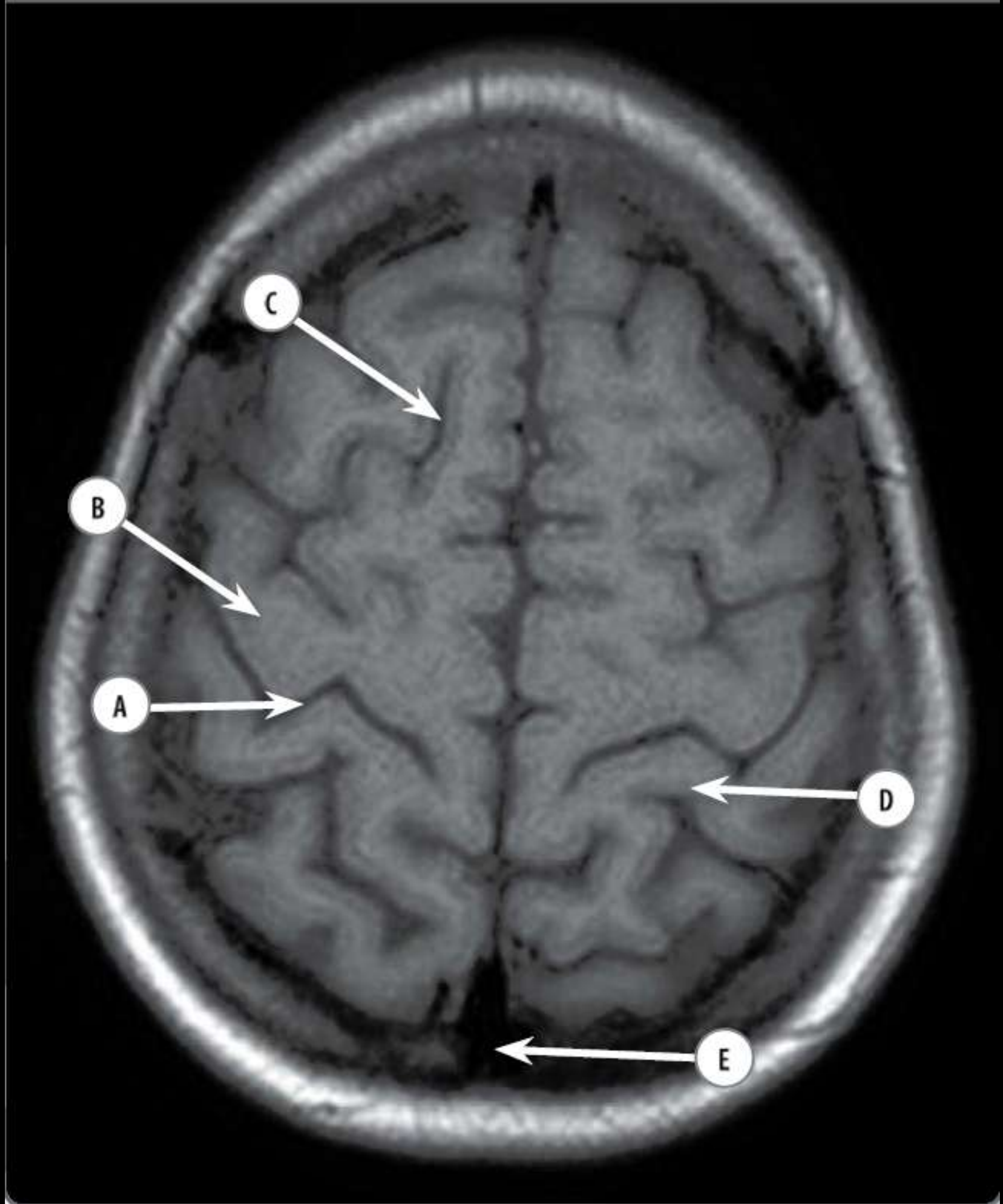


Question 47: Axial thin section T2-weighted MRI of the brain

Answer: Right facial nerve (CN VII)

- The facial nerve lies anterior to the vestibulocochlear nerve, which is also shown here.
- Moving more caudally, there are another two pairs of cranial nerves (CNs) that look very similar. They are the glossopharyngeal and vagus nerves.
- The best way to identify which pair is being shown is to look at the level of the brainstem and surrounding anatomy.
- CNs VII and VIII arise from the pons, as shown in the image. Note the other structures such as the orbits and temporal lobes. CNs IX and X are seen at the level of the medulla.

Case 1.6



Case 1.6

A Right central sulcus

B Right precentral gyrus

C Right superior frontal sulcus

D Left postcentral gyrus

E Superior sagittal sinus

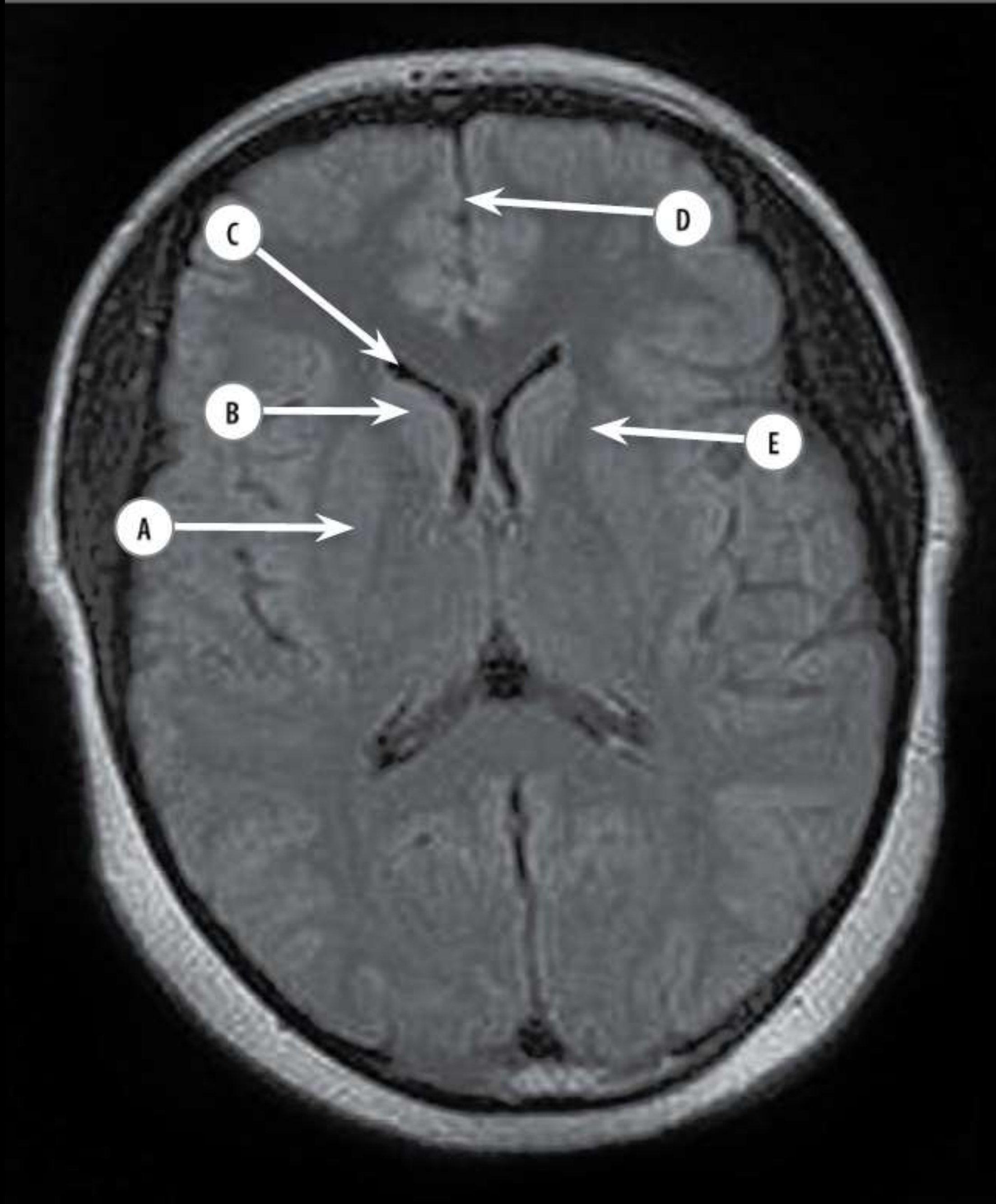
Axial MRI through the central sulcus.

The central sulcus (or Rolandic fissure) separates the frontal from the parietal lobe in each hemisphere. It runs in the near coronal plane. Anterior to the central sulcus lies the precentral gyrus which contains the primary motor cortex. Posterior to the central sulcus lies the postcentral gyrus or primary somatosensory cortex.

The superior frontal sulcus runs in the sagittal plane and separates the superior and middle frontal gyri. The posterior end of the superior frontal sulcus forms at right angles with the precentral sulcus. Identifying the precentral sulcus allows us to identify the central sulcus as it is the sulcus immediately posterior to it.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 46.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge University Press, 1999: 43.

Case 1.7



Case 1.7

A Right lentiform nucleus

B Head of the right caudate nucleus

C Anterior horn of the right lateral ventricle

D Interhemispheric fissure

E Anterior limb of the left internal capsule

Axial MRI of the brain at the level of the lateral ventricles.

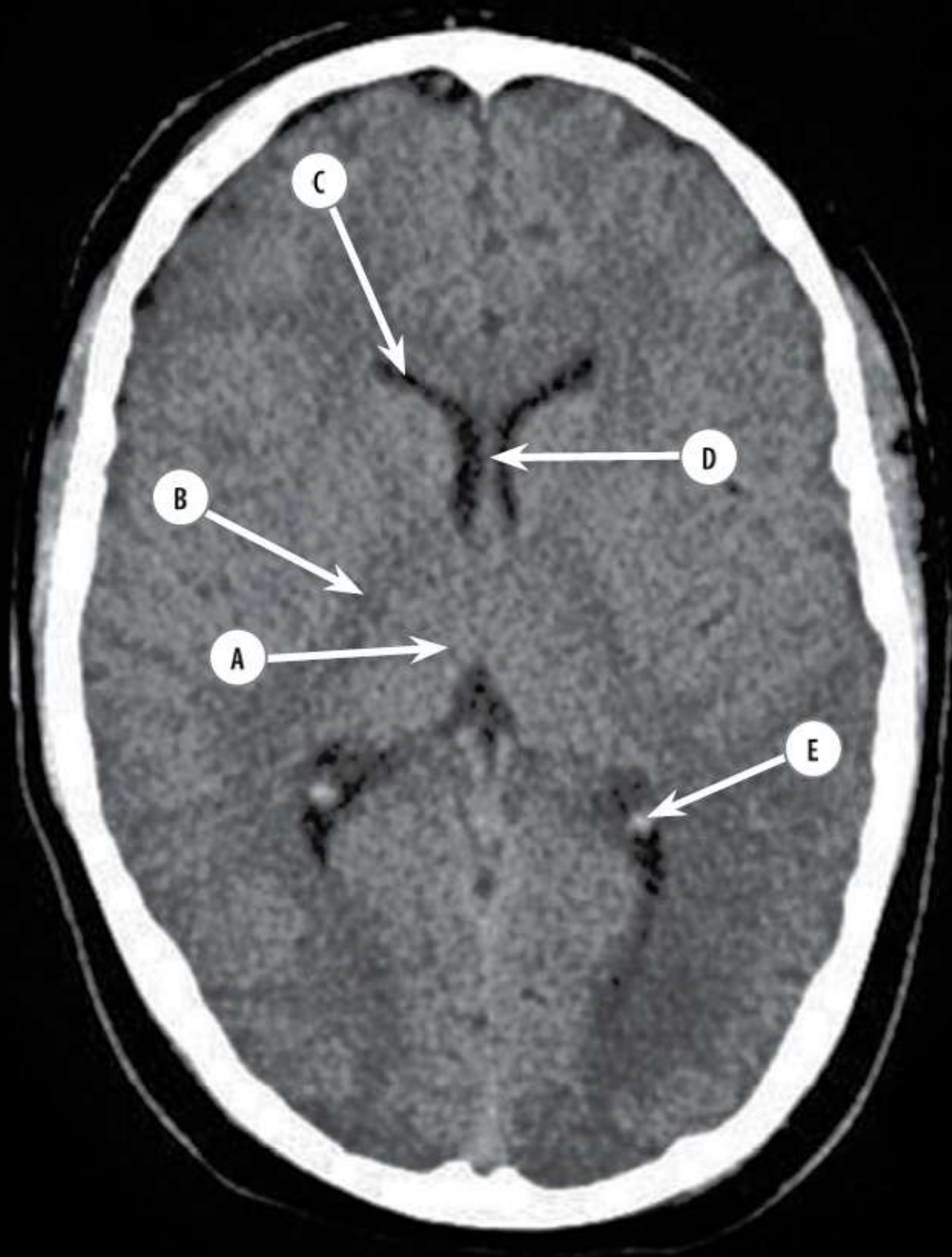
This axial section and the midline sagittal MRI must be studied in detail. They contain key anatomical structures and are always likely to feature in the exam. These structures should be studied in sagittal and coronal images to begin to form a three dimensional understanding of brain anatomy.

Within the cerebral hemispheres lie a number of nuclear masses collectively known as basal ganglia. The major components are the caudate nucleus, the putamen and the globus pallidus. For anatomical purposes, the putamen and globus pallidus are together called lentiform or lenticular nucleus. The putamen lies lateral to the globus pallidus.

The anterior limb of the internal capsule separates the lentiform nucleus from the head of the caudate nucleus.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 44.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 56.

Case 1.9



Case 1.9

A Right thalamus

B Posterior limb of the internal capsule (right)

C Anterior horn of the right lateral ventricle

D Septum pellucidum

E Choroid plexus (left)

Axial CT of the brain at the level of the basal ganglia.

This axial image is at the same level as the image in the previous case. It is, however, a different modality. T1-weighted MRIs can show the anatomy very clearly but CTs of the brain may be used in the exam. Make sure that you are comfortable with both modalities.

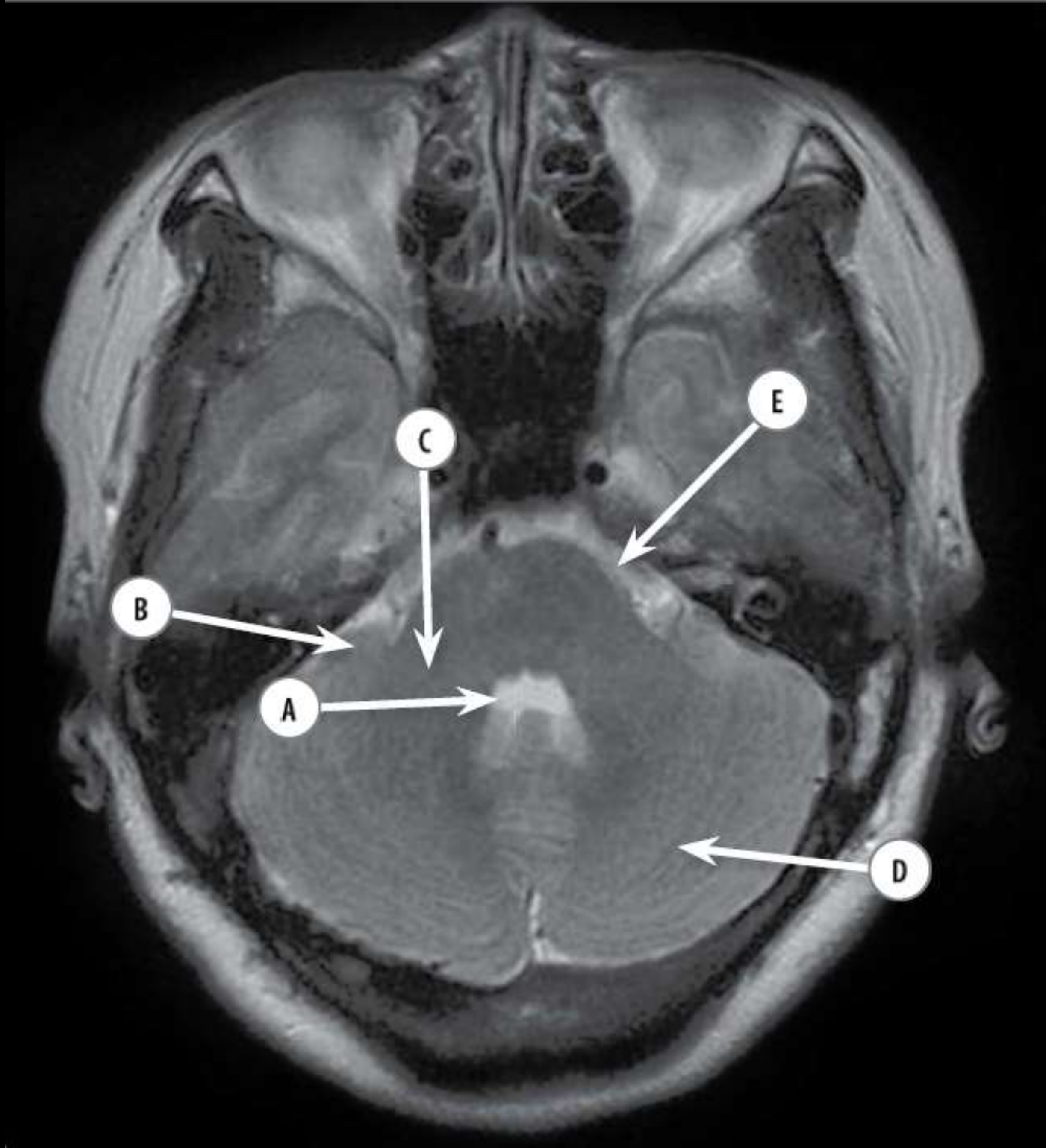
The windowing in this image has been set to optimise the appearance of brain parenchyma. The cortical and deep grey matter appears brighter than the white matter.

The thalamus is separated from the lentiform nucleus by the posterior limb of the internal capsule.

The septum pellucidum is a thin triangular membrane that separates the anterior horn of the lateral ventricles. Anatomical variants are common in this structure and you should be familiar with them.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 44.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 56.

Case 1.10



Case 1.10

A Fourth ventricle

B Right flocculus

Answers

C Right middle cerebellar peduncle

D Right cerebellar hemisphere

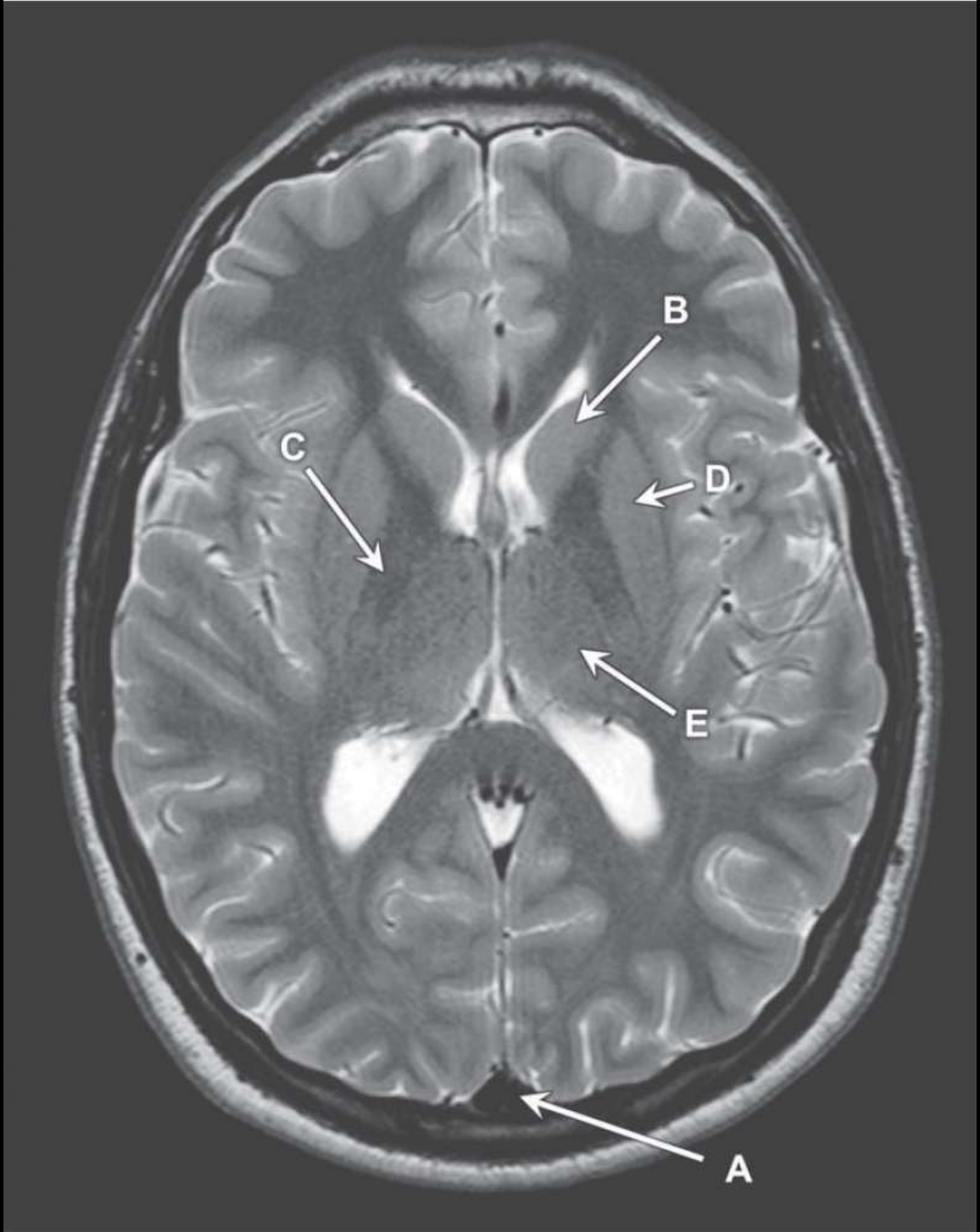
E Left cerebellopontine angle cistern

Axial MRI at the level of the fourth ventricle.

On axial imaging, the lower pons is dominated by the posterolaterally directed middle cerebellar peduncles. Lateral to these structures lie the cerebellopontine angle cisterns which are limited posteriorly by the flocculi, a pair of small cerebellar lobes.

The fourth ventricle has a 'roof' dorsally and a 'floor' ventrally. The roof is formed by the cerebellum and the floor by the pons and medulla. The lateral walls are formed by the cerebellar peduncles. Study these structures in the midline sagittal images to form a three dimensional understanding.

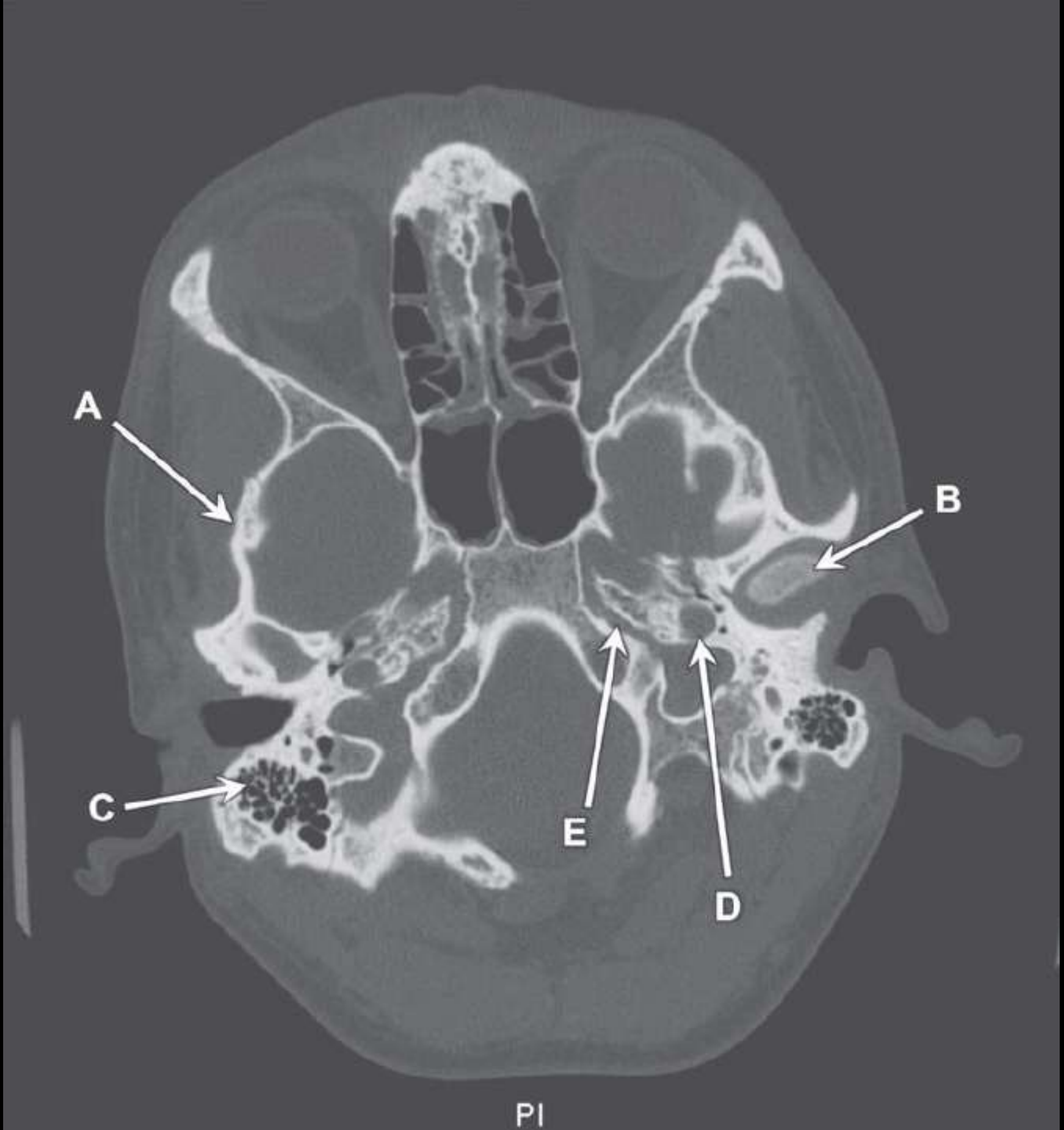
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 42.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging. Edinburgh: Saunders, 2004: 55.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 32.


B
C
D
E
A

Case 16

MRI brain. T2W axial section.

1. Superior sagittal sinus
2. Head of left caudate nucleus
3. Posterior limb of right internal capsule
4. Left lentiform nucleus
5. Left thalamus


A
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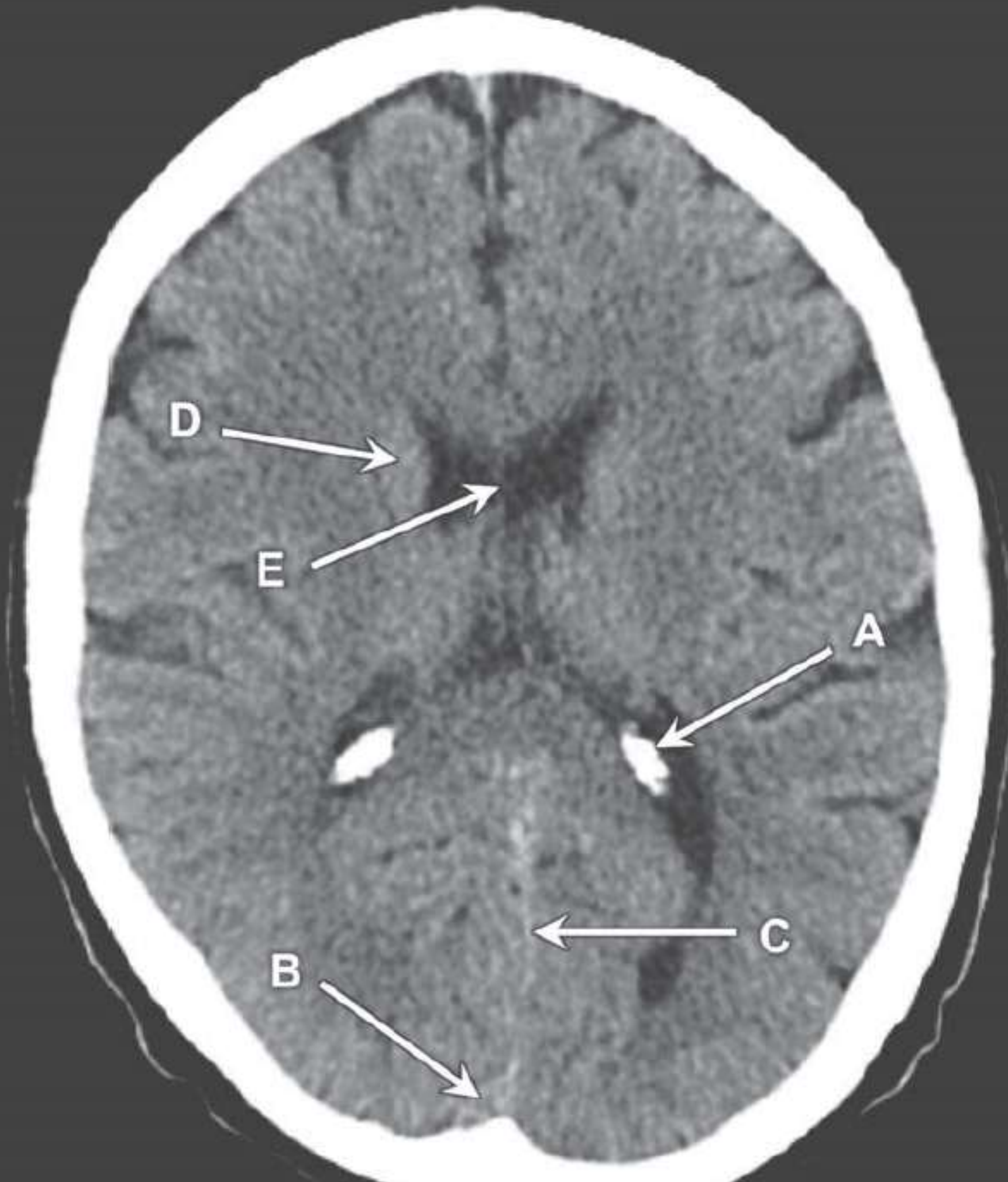
PI

Case 7

CT base of skull. Axial section.

1. Right squamous temporal bone
2. Left mandibular condyle
3. Right mastoid air cells
4. Left carotid canal
5. Left foramen lacerum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A
C
B

Case 14

CT brain. Axial section

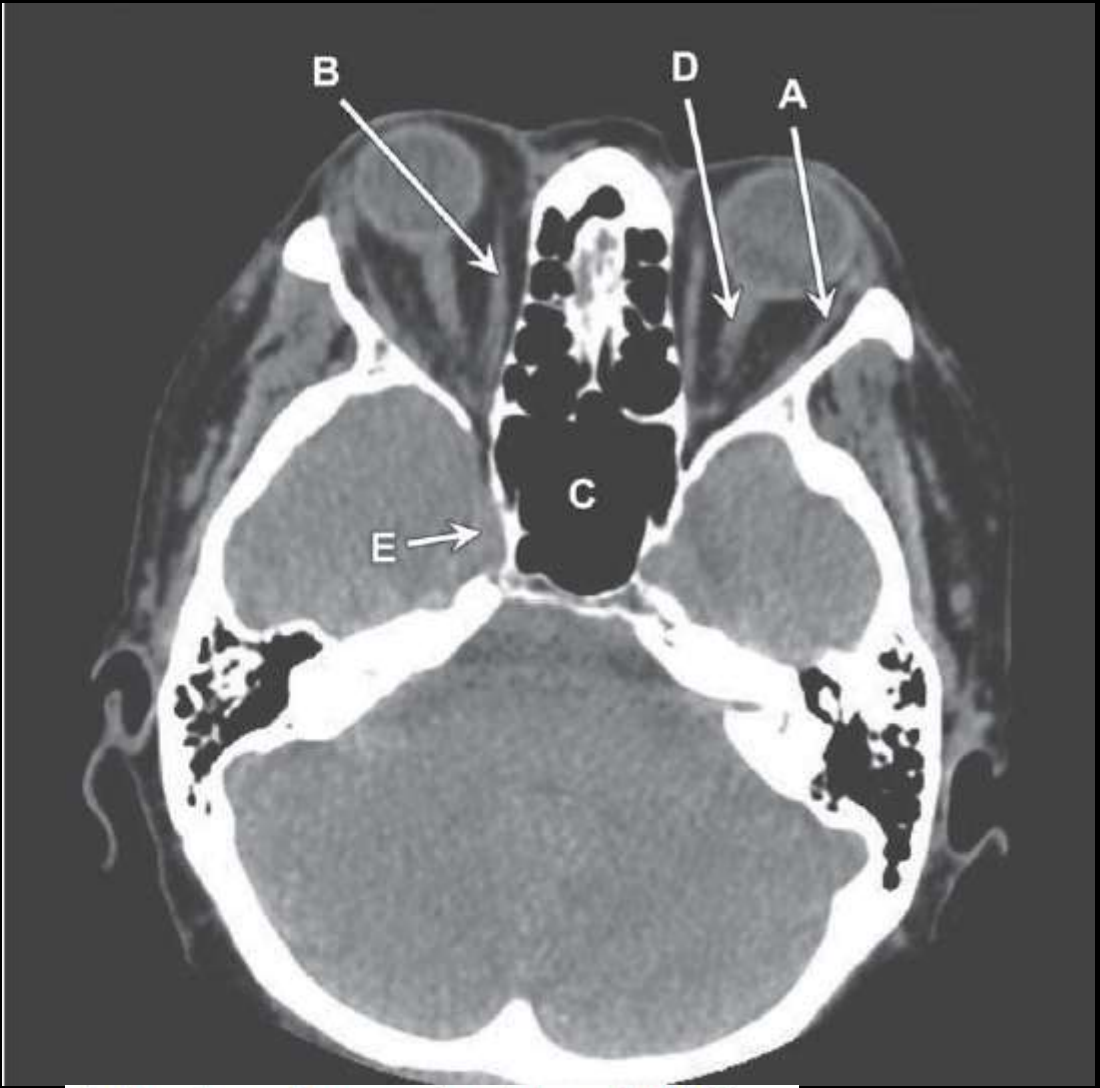
1. Left choroid plexus (calcified)
2. Superior sagittal sinus
3. Falx cerebri
4. Head of the right caudate nucleus
5. Septum pellucidum


D
B
C
A
E

Case 9

MRI internal auditory meati. T2 axial section

1. Left cerebellar peduncle
2. Right facial (VII) nerve
3. Right cochlea
4. Basilar artery
5. Right vestibulocochlear (VIII) nerve



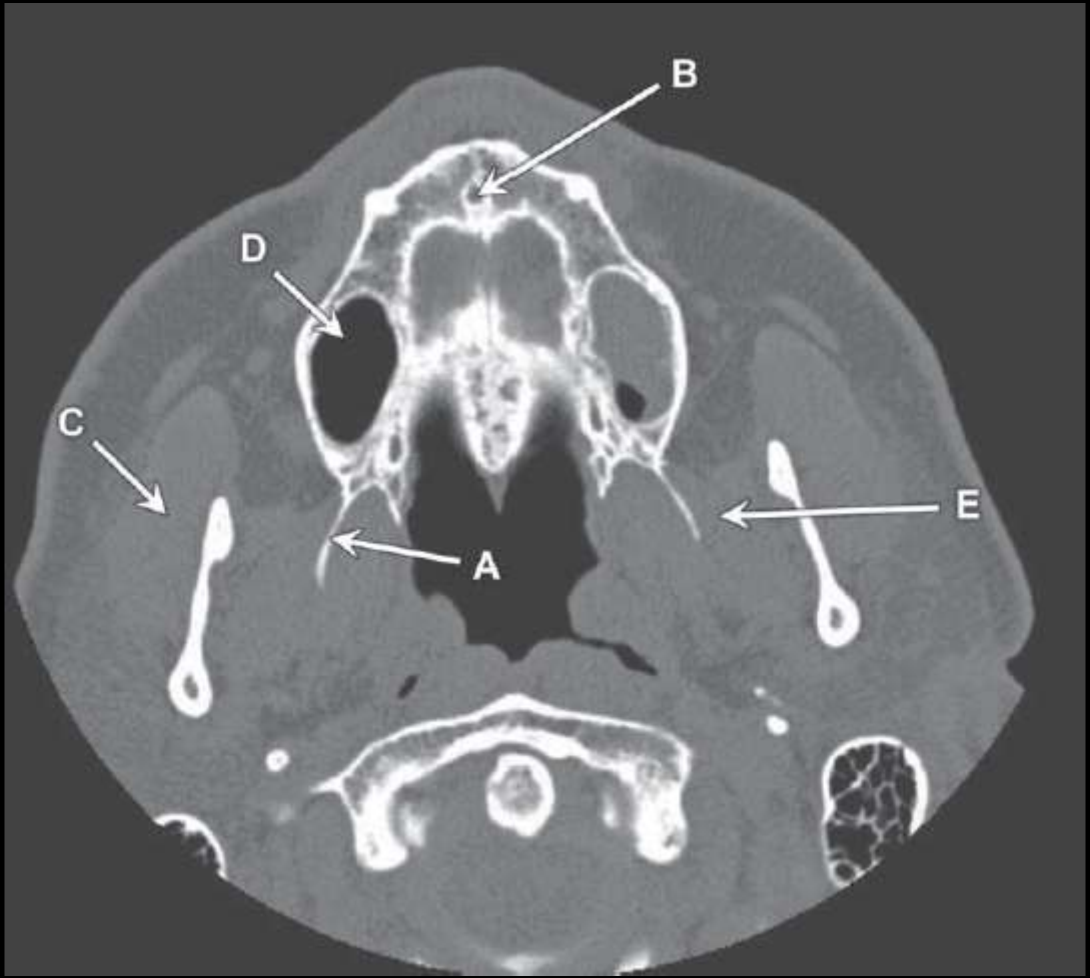
5. Name the vessel that passes through the area labelled E.

5. Hepatic portal vein

Case 17

CT orbits, non-contrast. Axial section.

1. Left lateral rectus
2. Right medial rectus
3. Sphenoid sinus
4. Left optic nerve
5. Right internal carotid artery



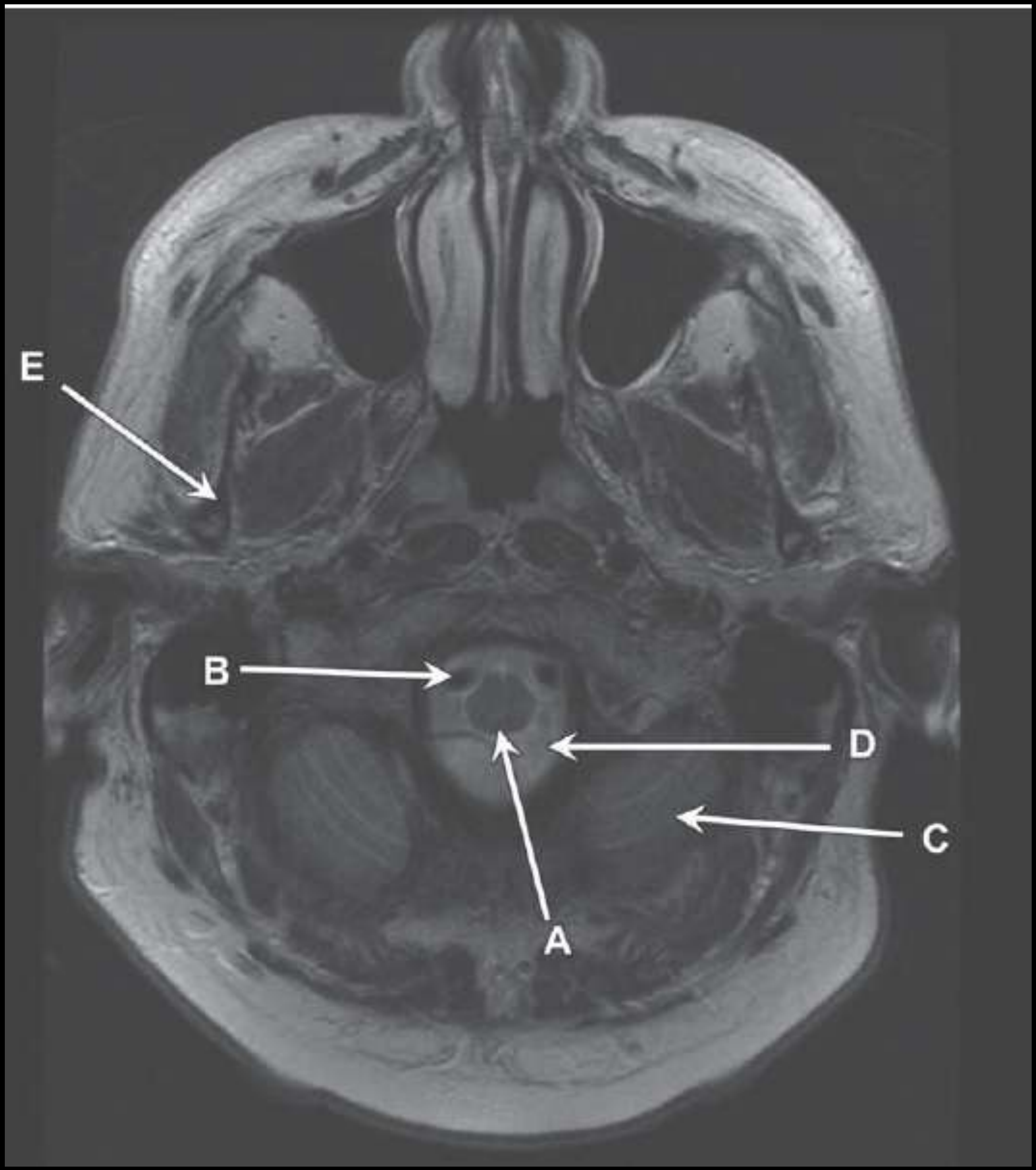
B
D
C
E
A

Case 3

CT base of skull. Axial imaging, 'bone windows'.

1. Right lateral pterygoid plate
2. Incisive foramen
3. Right masseter muscle
4. Right maxillary sinus
5. Left lateral pterygoid muscle

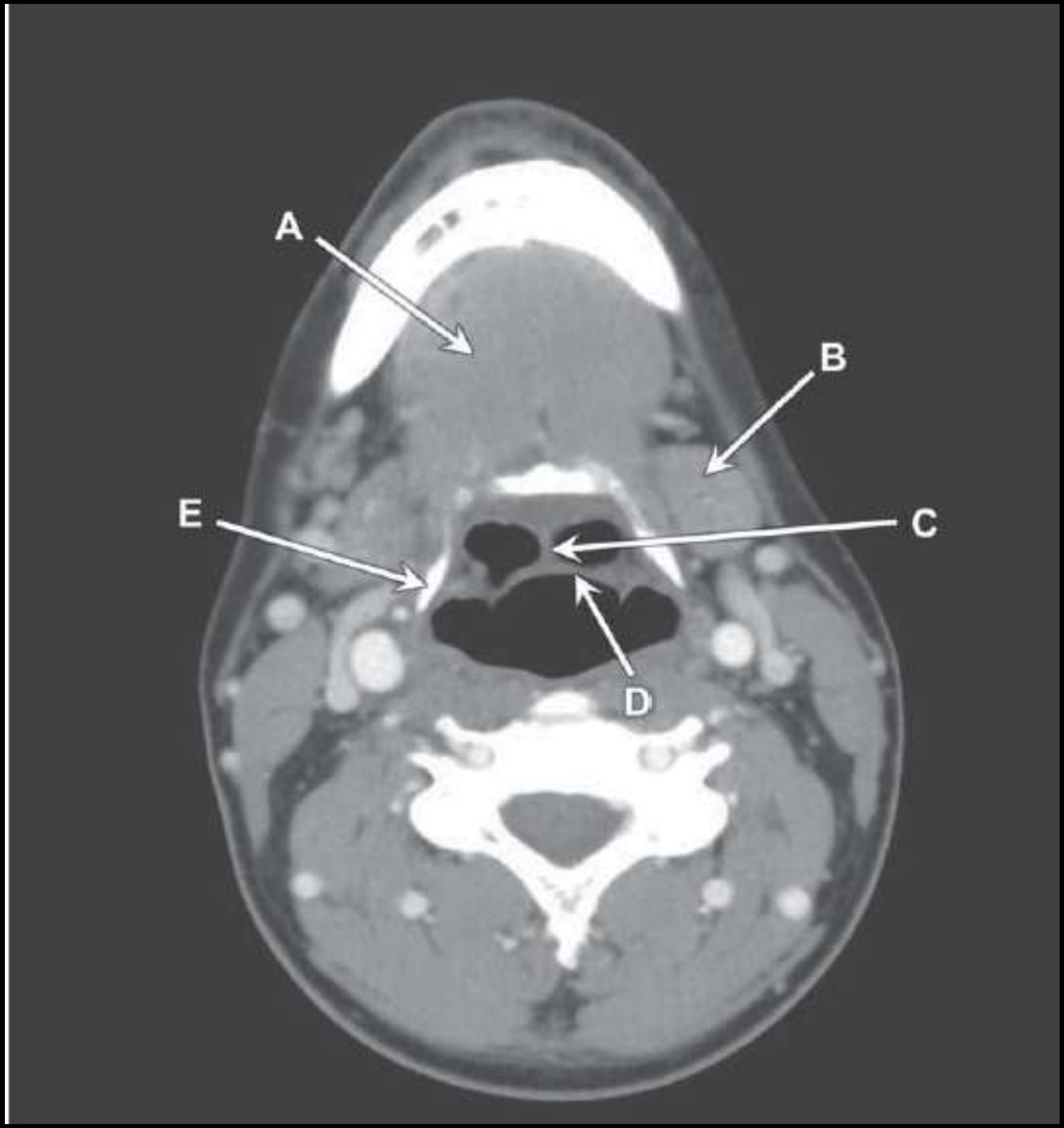
Note that, in this case, the right maxillary sinus is partly opacified by mucous. This is not an uncommon finding.


E
B
D
C
A

Case 14

MRI base of skull. T2W axial section.

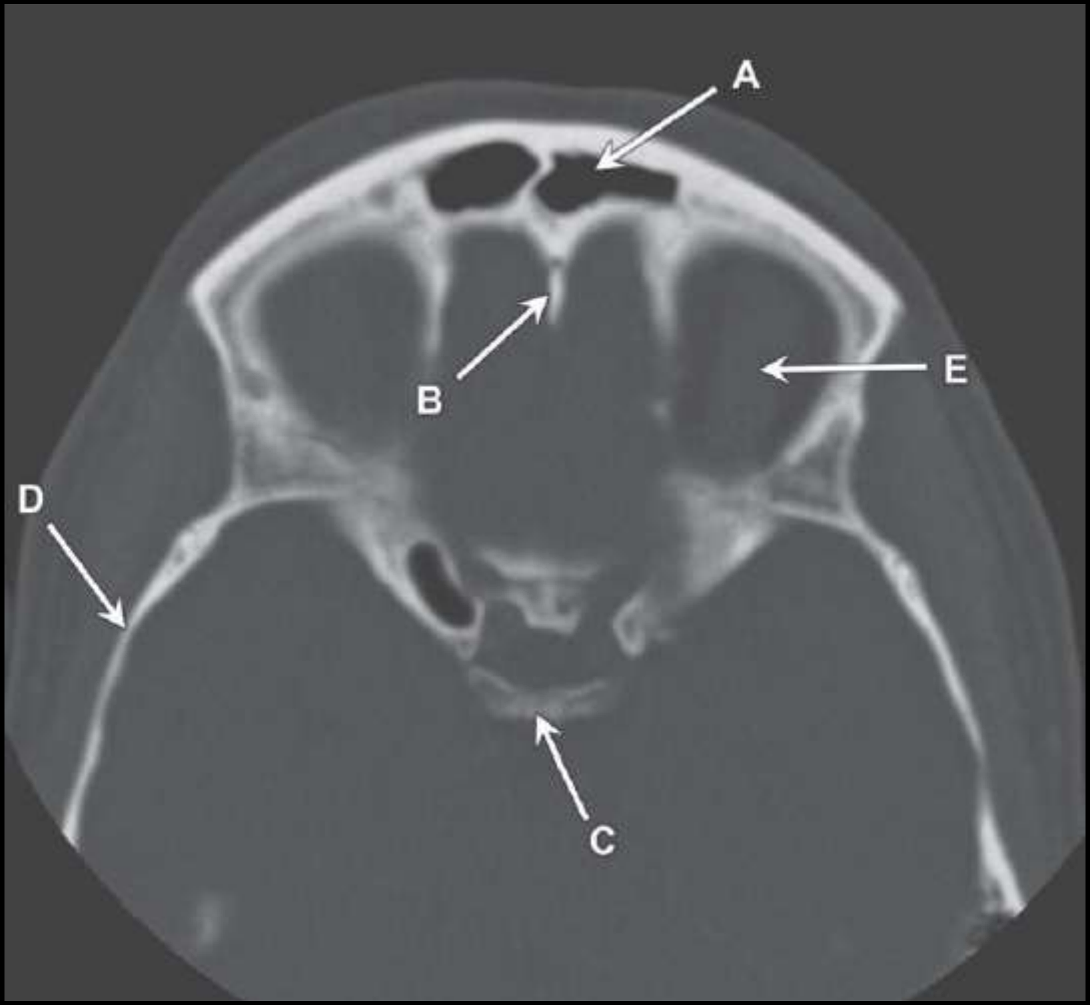
1. Medulla
2. Right vertebral artery
3. Left cerebellar hemisphere
4. Cisterna magna
5. Right mandibular ramus


A
B
C
D
E

Case 3

CT neck. Axial image.

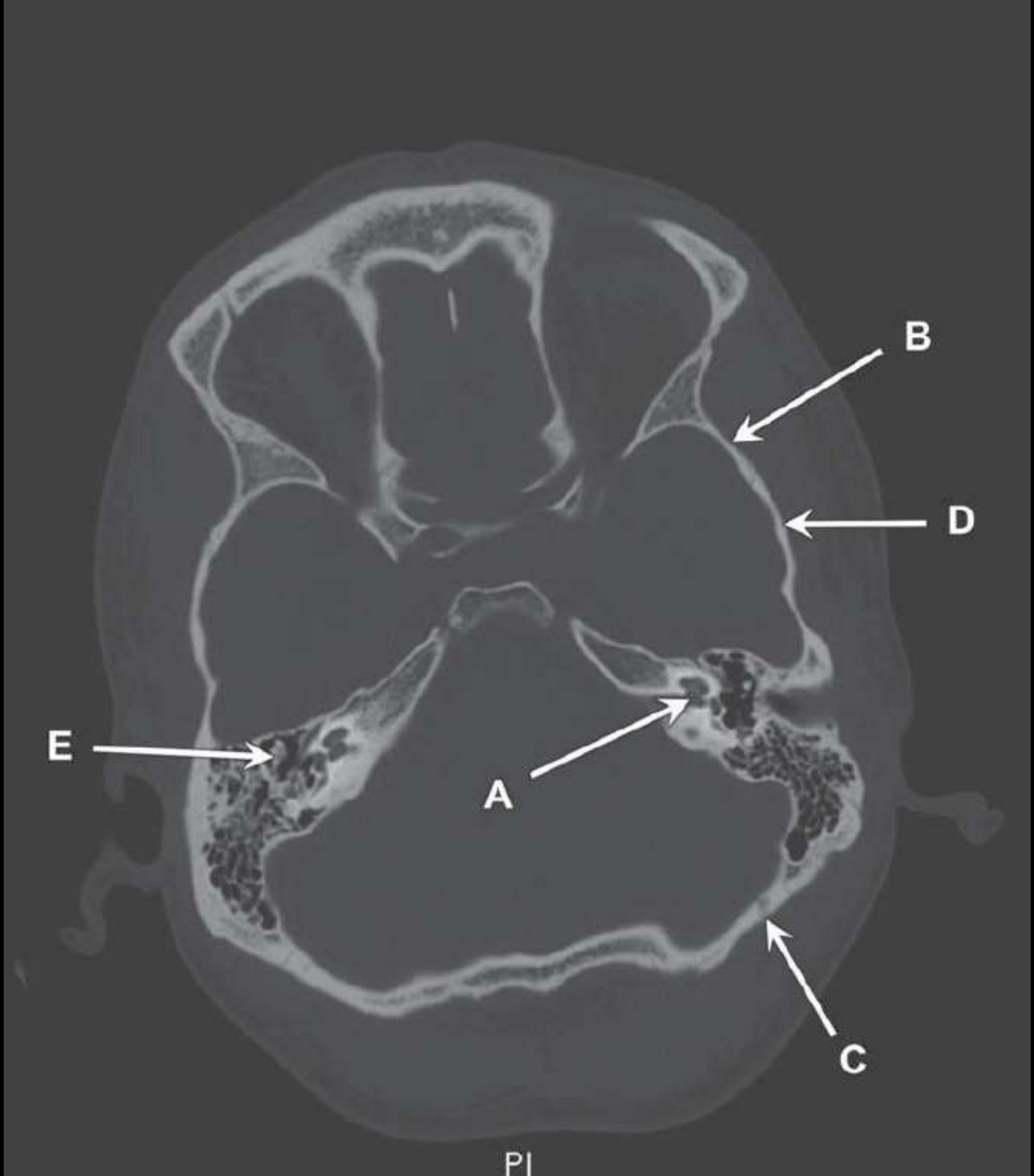
1. Tongue
2. Left submandibular gland
3. Median glossoepiglottic fold
4. Epiglottis
5. Hyoid bone


A
B
E
D
C

Case 9

CT orbits. Axial section.

1. Left frontal sinus
2. Crista galli
3. Dorsum sellae
4. Squamous part of the right temporal bone
5. Left superior rectus muscle

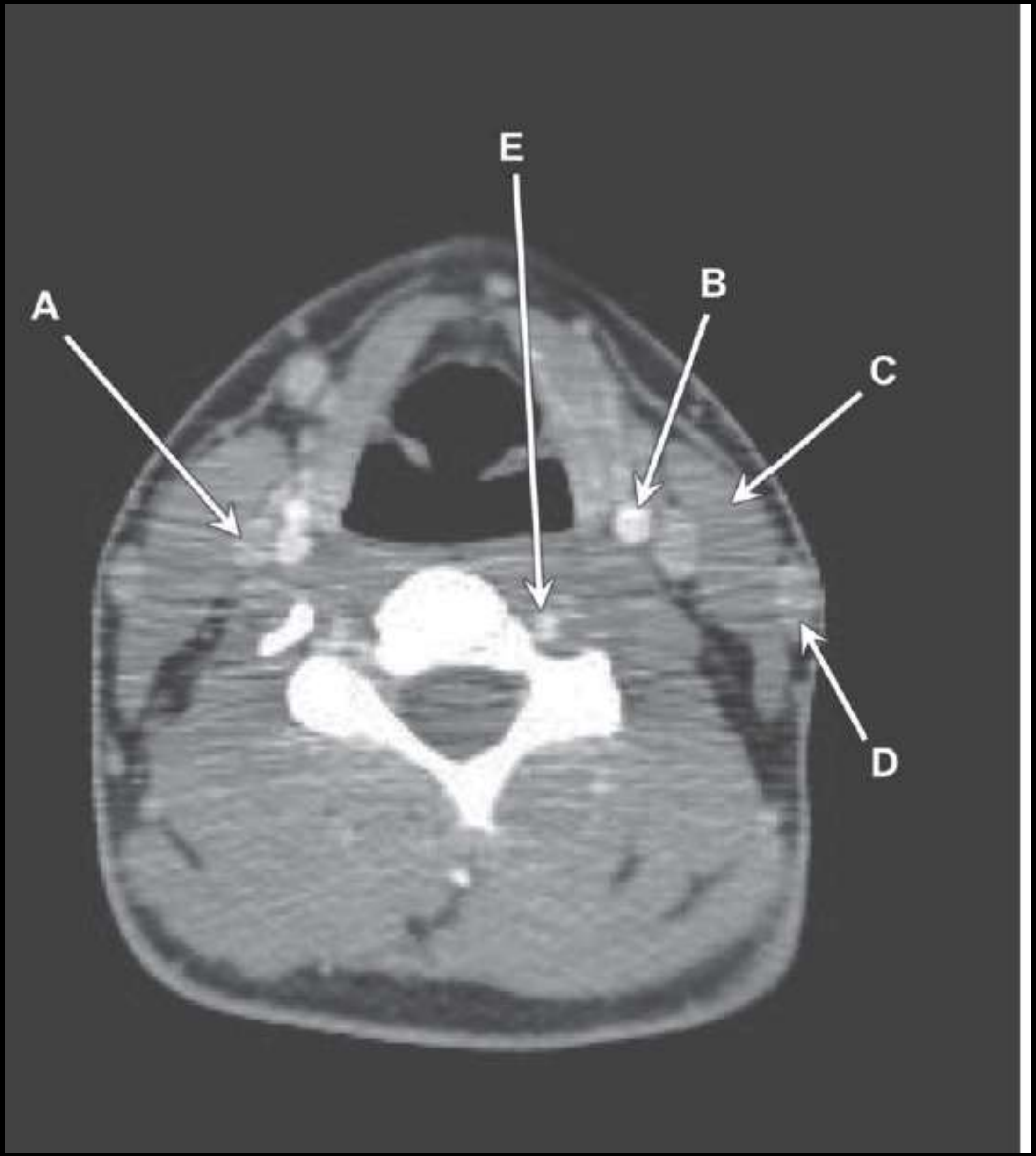

B
D
E
A
C
PI

Case 5

CT base of skull, axial image.

1. Left cochlea
2. Left zygomatic bone
3. Left lambdoid suture
4. Squamous part of the left temporal bone
5. Right incus

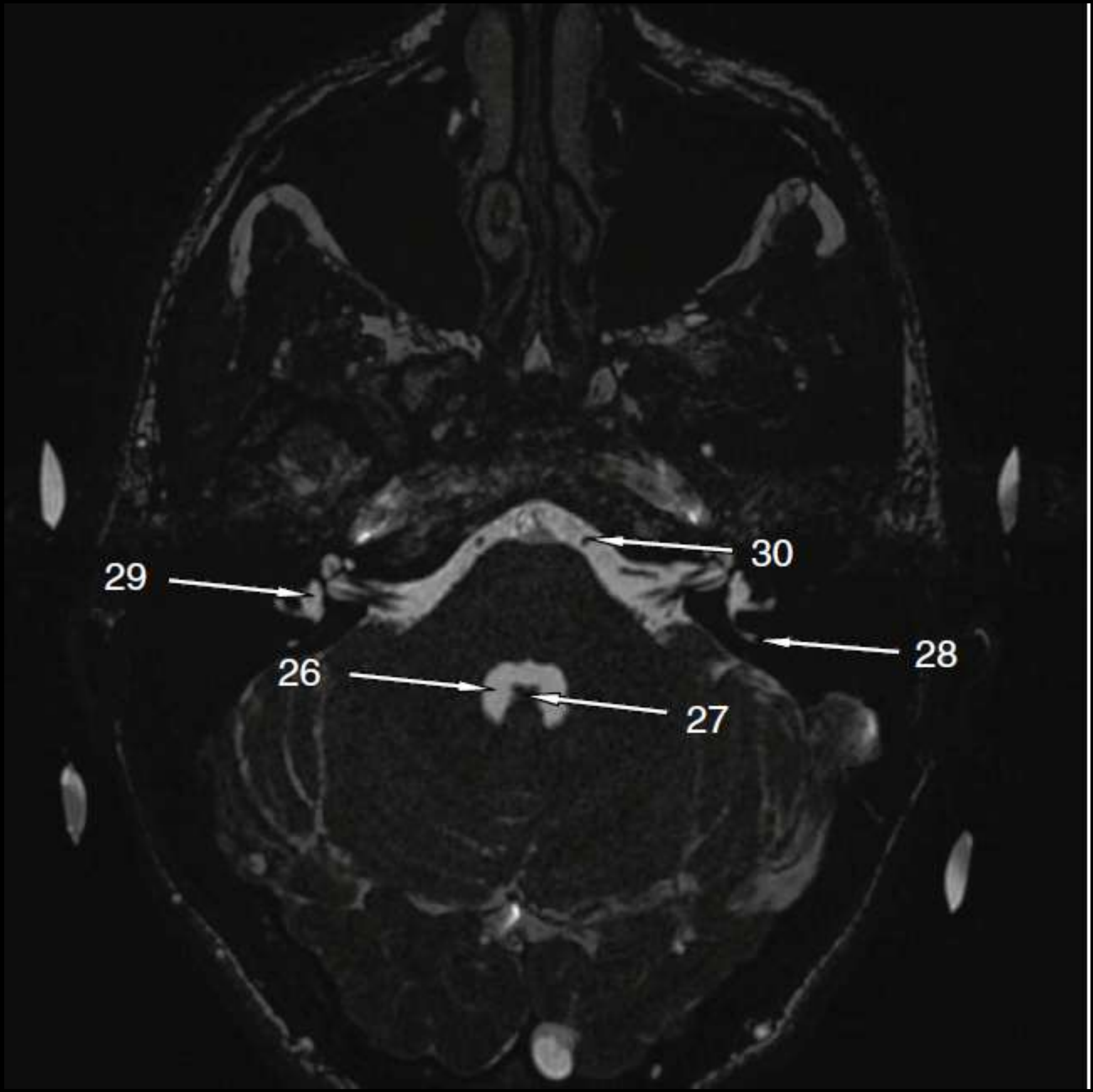
As well as the bones of the skull, it is important to know the bones of the middle ear and to have an appreciation of those parts of the inner ear that can be seen on CT.


A
B
C
D
E

Case 13

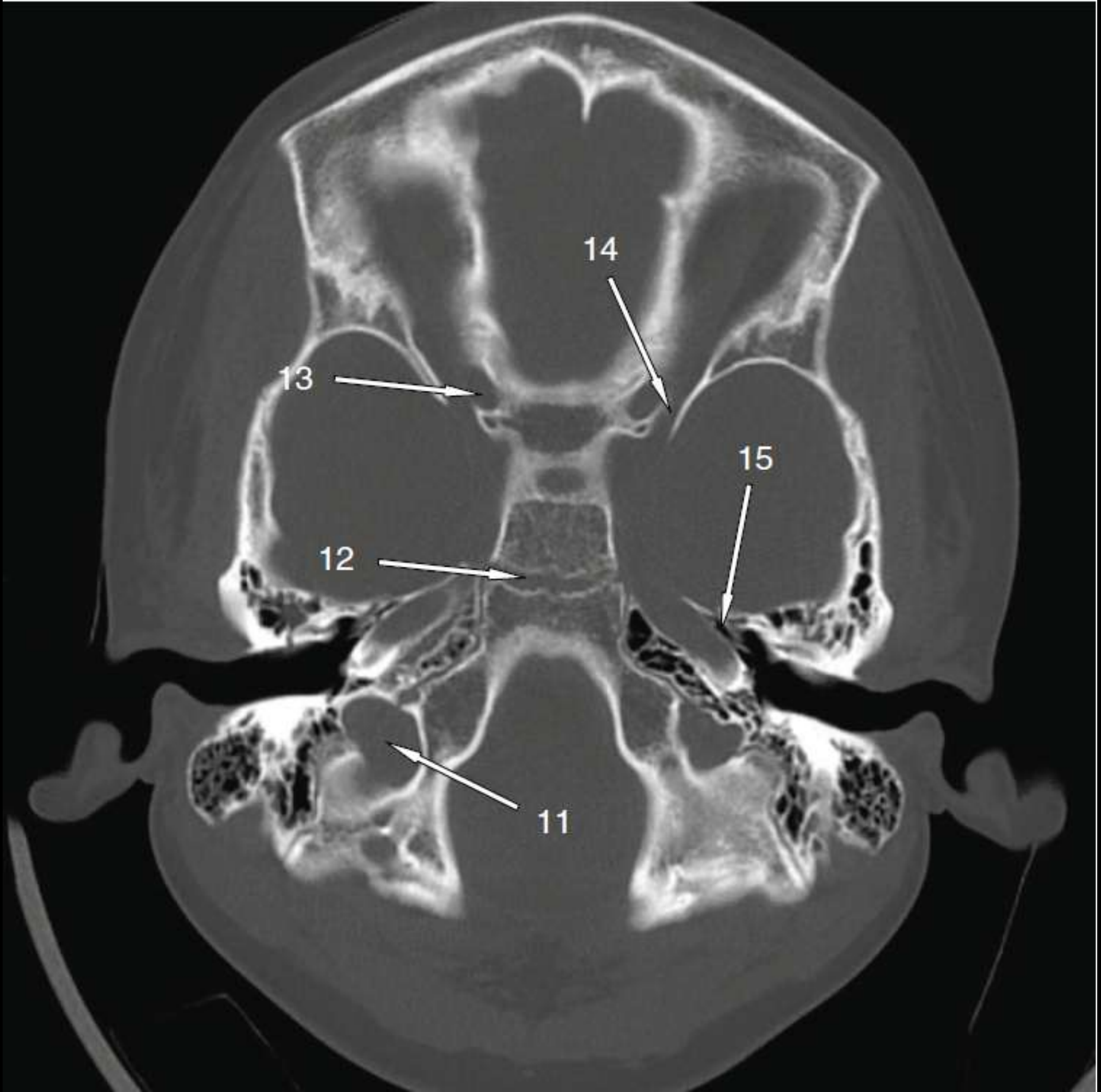
CT neck. Axial section.

1. Right internal jugular vein
2. Left common carotid artery
3. Sternocleidomastoid
4. Left external jugular vein
5. Left vertebral artery


29
30
28
26
27

MRI Head

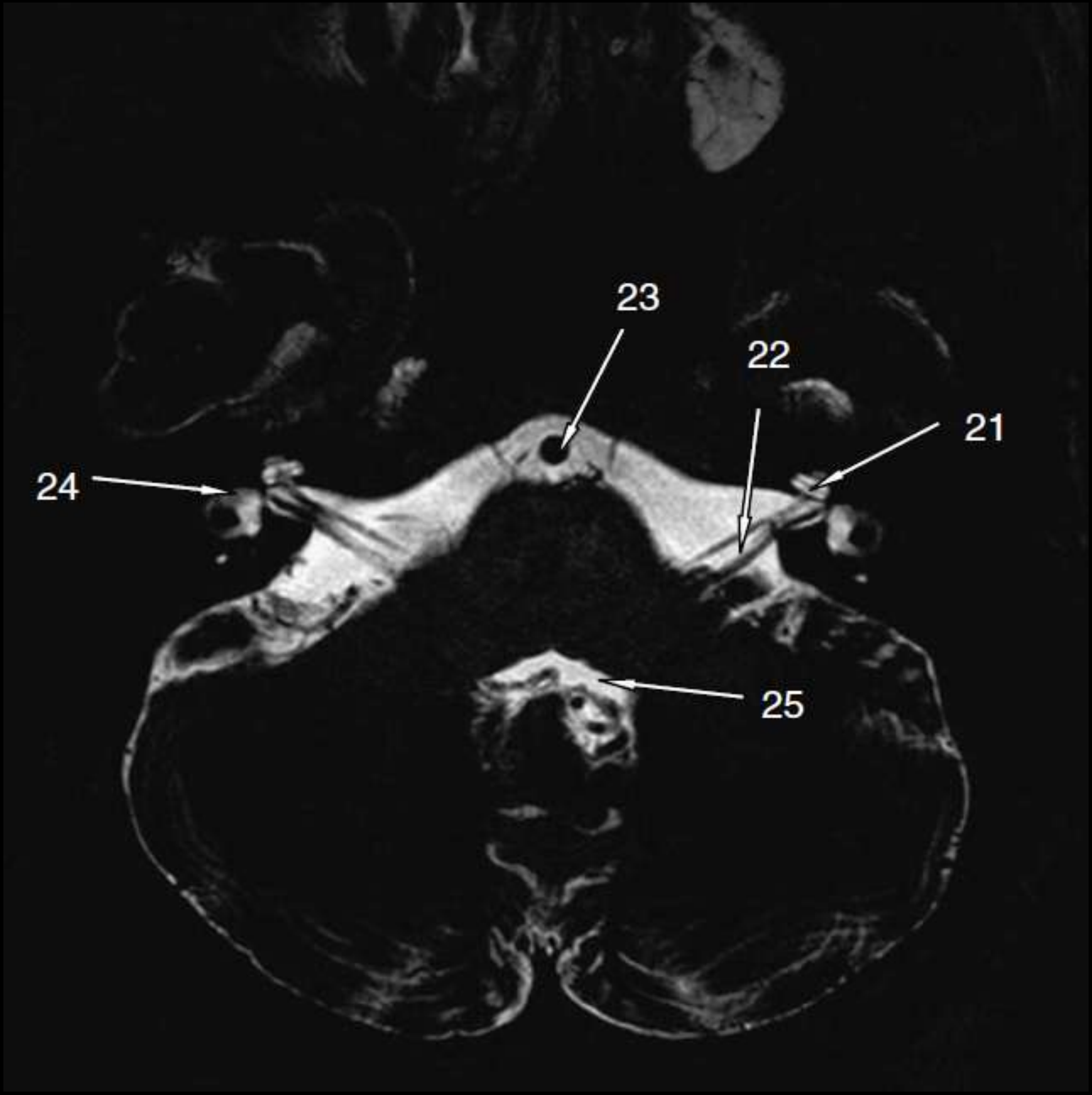
26. Fourth ventricle
27. Nodule of cerebellum
28. Left posterior semicircular canal
29. Right vestibule
30. Left sixth cranial nerve


14
13
15
12
11

CT Head

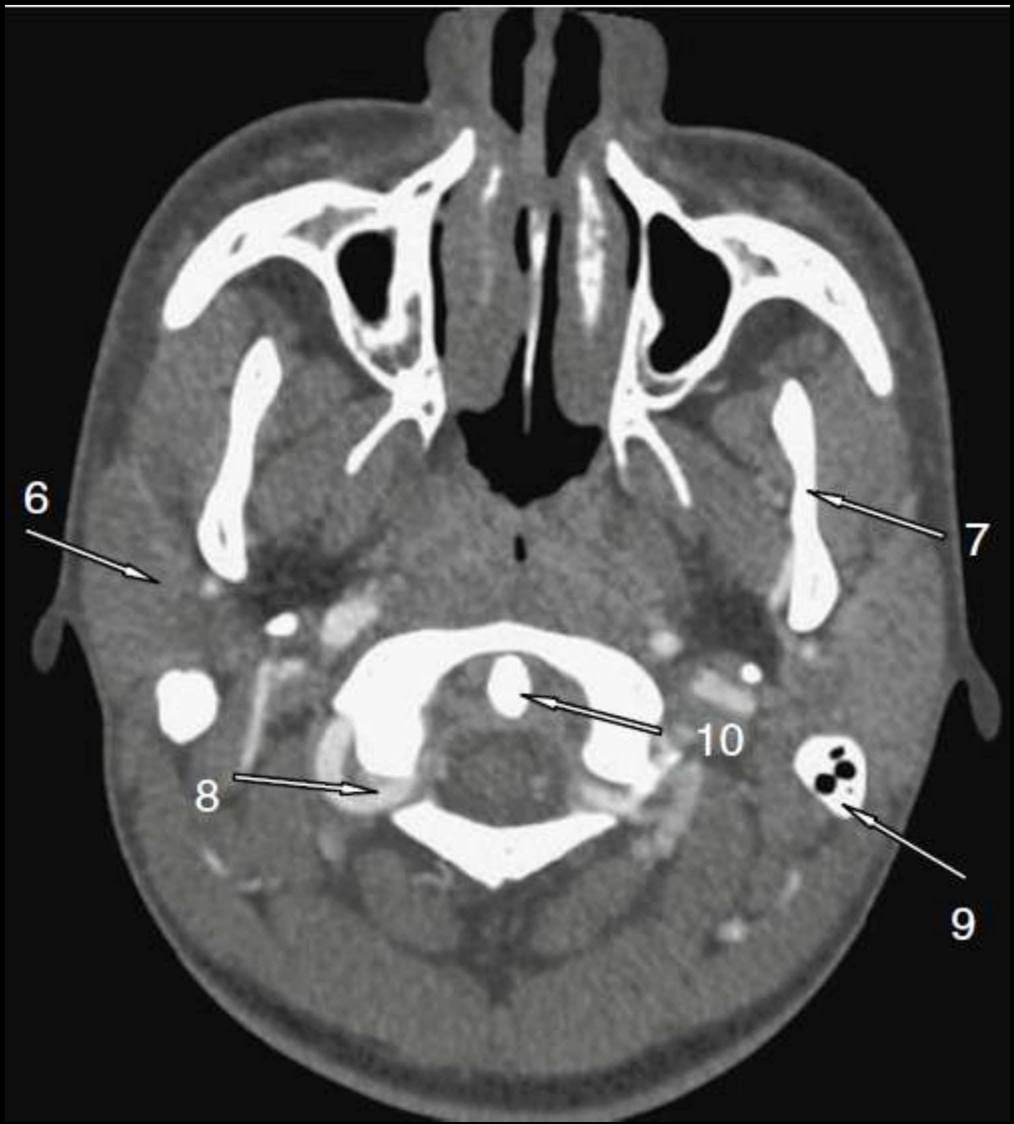
11. Right jugular foramen
12. Spheno-occipital or basi-occipital synchondrosis
13. Right optic canal
14. Left superior orbital fissure
15. Left Eustachian tube

The dural venous sinuses are often asymmetrical, with accompanying asymmetry of the jugular foramina. This can be useful when trying to decide if a small transverse sinus is due to thrombosis – a small sinus with a small jugular foramen is likely congenital.


23
22
21
24
25

MRI Head

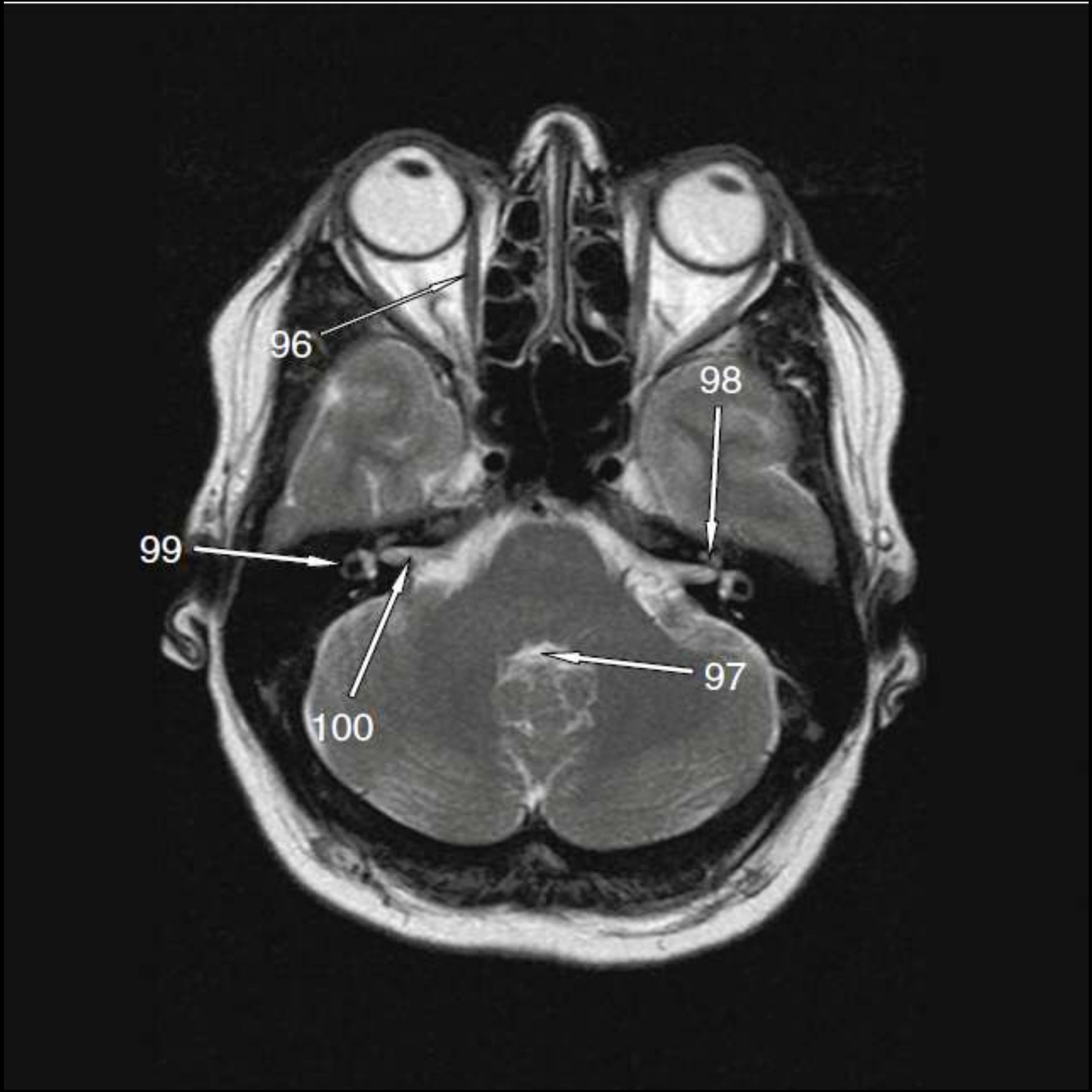
21. Left cochlea
22. Left vestibulocochlear (8th) nerve
23. Basilar artery
24. Right vestibular apparatus
25. Fourth ventricle


6
7
10
8
9

CT Head

6. Right parotid gland
7. Left ramus of mandible
8. Right vertebral artery
9. Left mastoid process/air cells
10. Odontoid peg

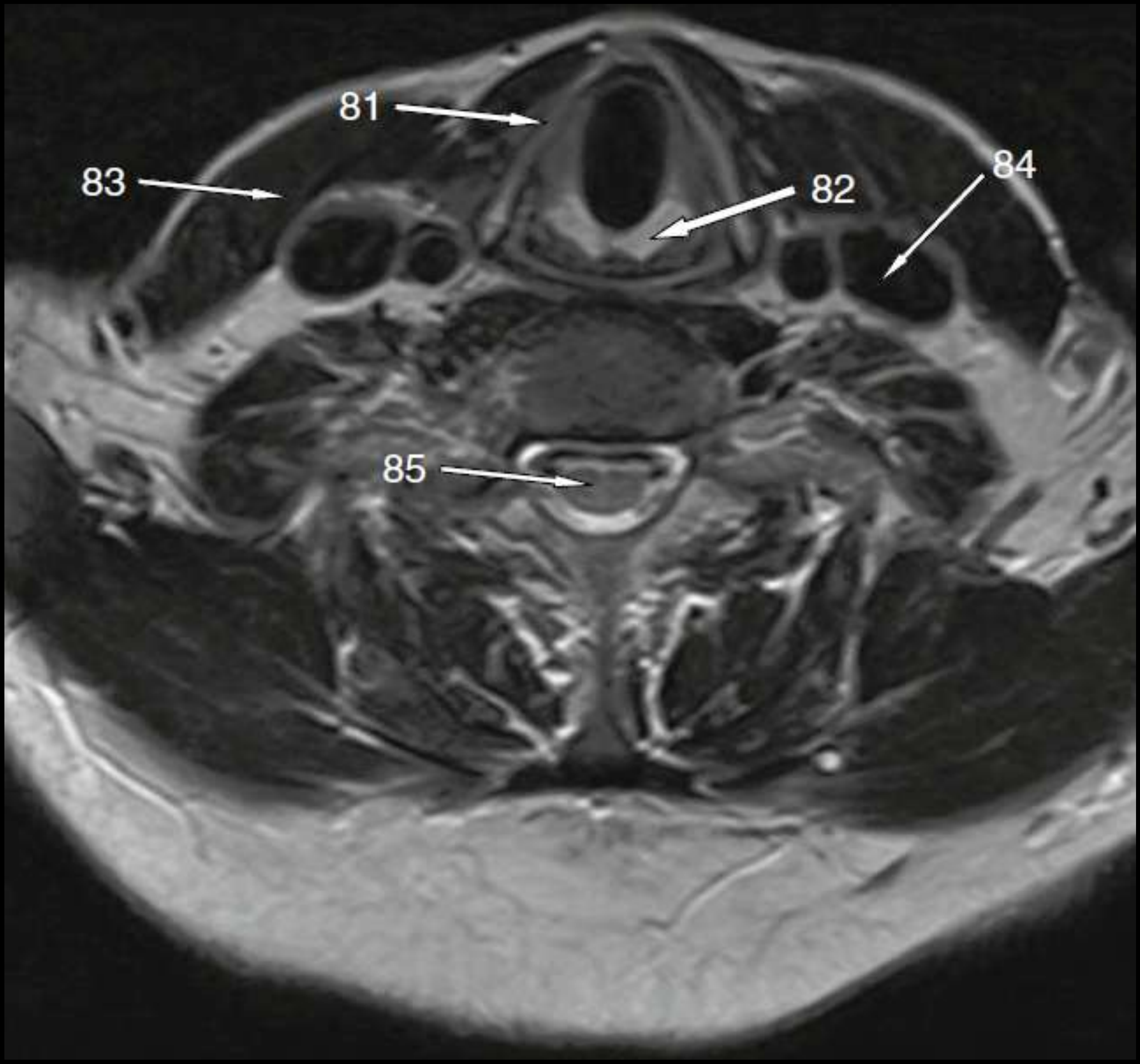
The mastoids can be recognised by air cells (low attenuation areas in the bone). The parotid gland has superficial and deep parts and wraps around the ramus of mandible posteriorly.


96
98
99
97
100

MRI Head

96. Right medial rectus muscle
97. Fourth ventricle
98. Left cochlea
99. Right semicircular canal
100. Right vestibulocochlear nerve in internal acoustic canal

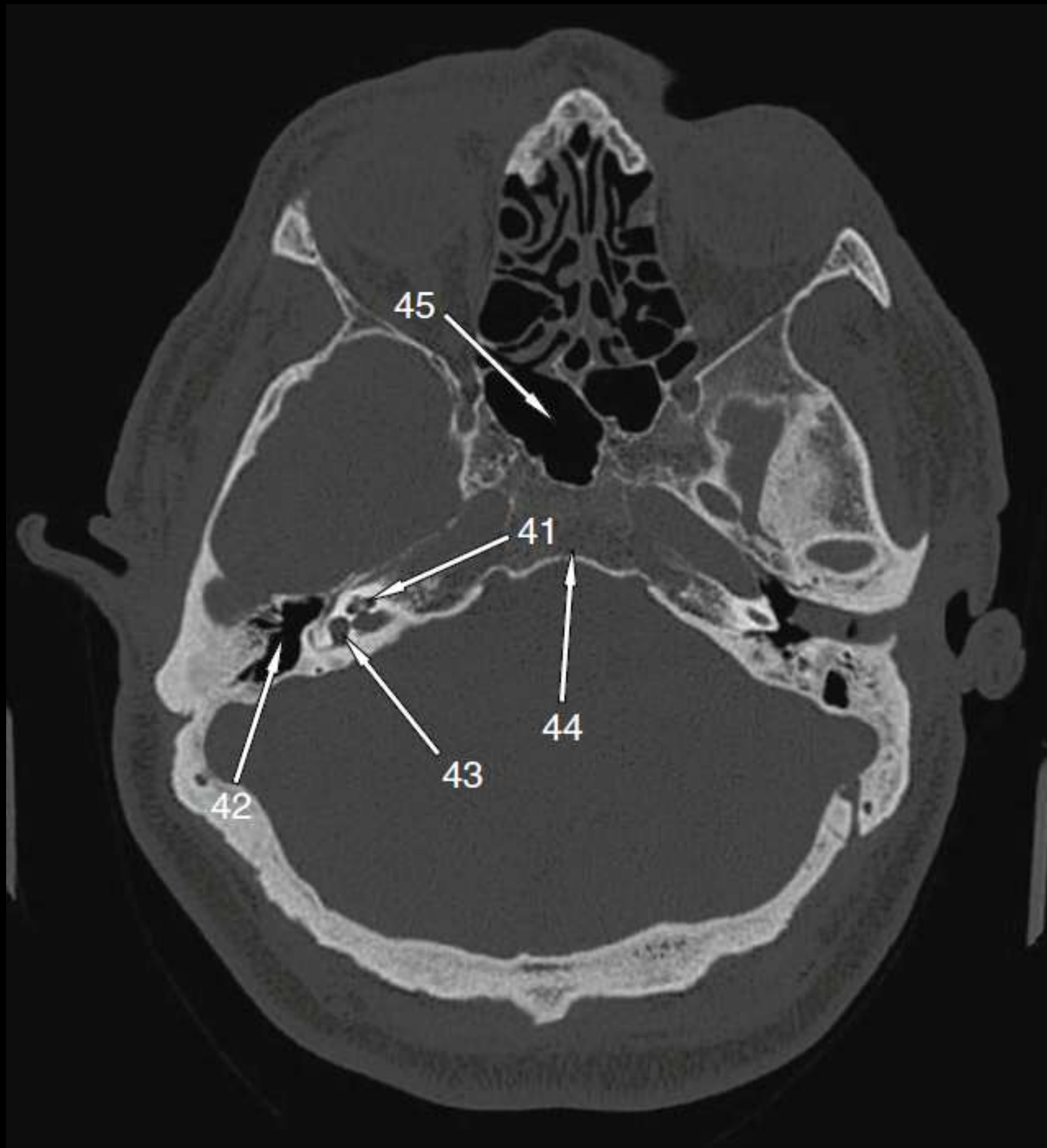
This is an axial T2 MRI showing the internal auditory meatus at the level of the VIII (vestibulocochlear) nerve. The extraocular muscles are also demonstrated. Fat saturation sequences are used to help distinguish the optic nerve and its sleeve of dura and CSF from the surrounding fat.


81
83
82
84
85

MRI Neck

81. Thyroid cartilage
82. Arytenoid cartilage
83. Right sternocleidomastoid muscle
84. Left internal jugular vein
85. Spinal cord

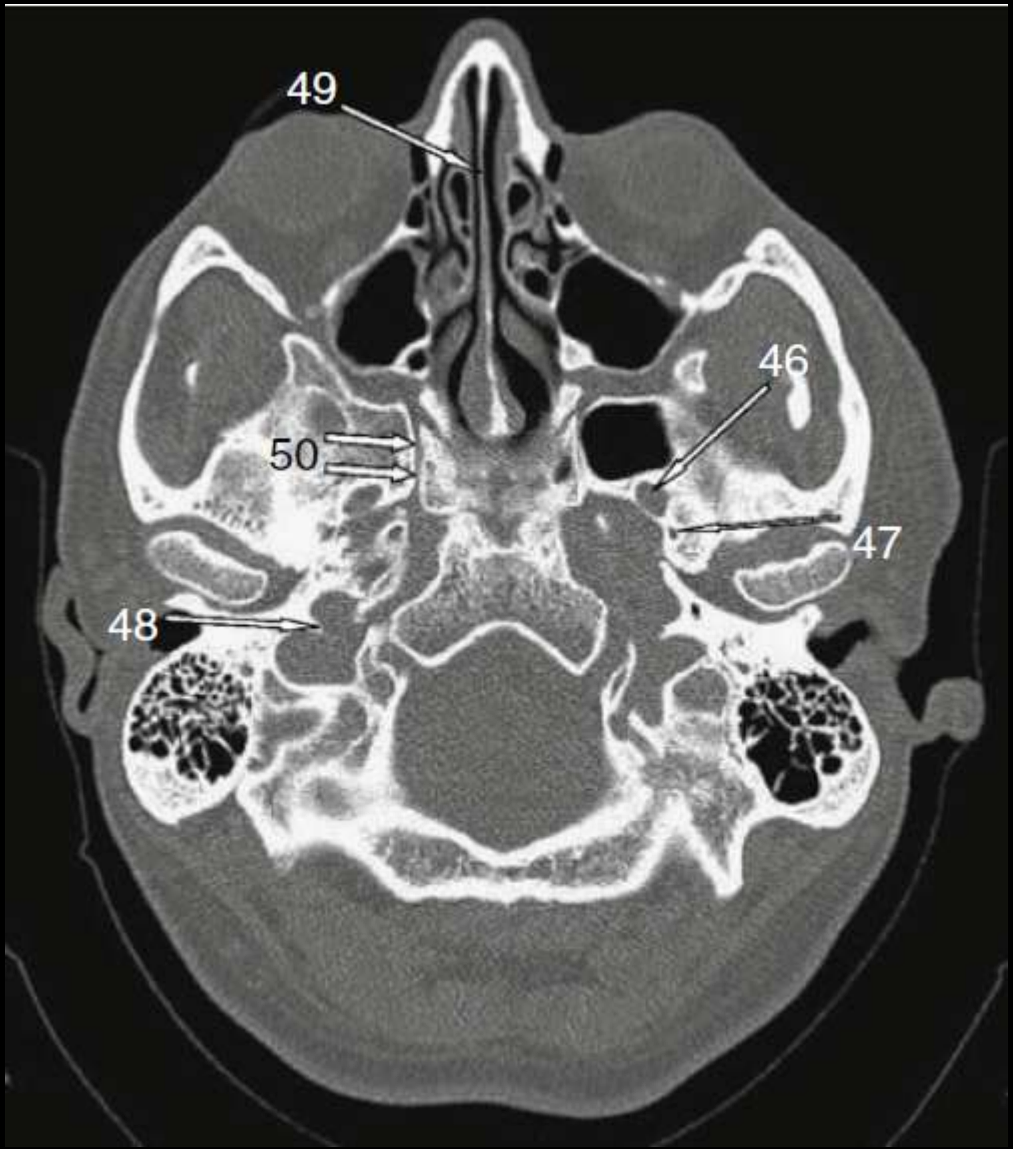
This is an axial T2-weighted MRI at the level of the glottis ldemonstrating a complete ring of cartilage. The thyroid cartilage is triangular on axial section with the apex pointing anteriorly with the cricoid cartilage seen posterior to the arytenoid cartilage. The paralaryngeal space is between the larynx and thyroid cartilage and is an important landmark in the staging of laryngeal tumours.


45
41
44
43
42

CT Head

41. Right cochlea
42. Right mastoid antrum
43. Right vestibule
44. Clivus
45. Sphenoidal sinus

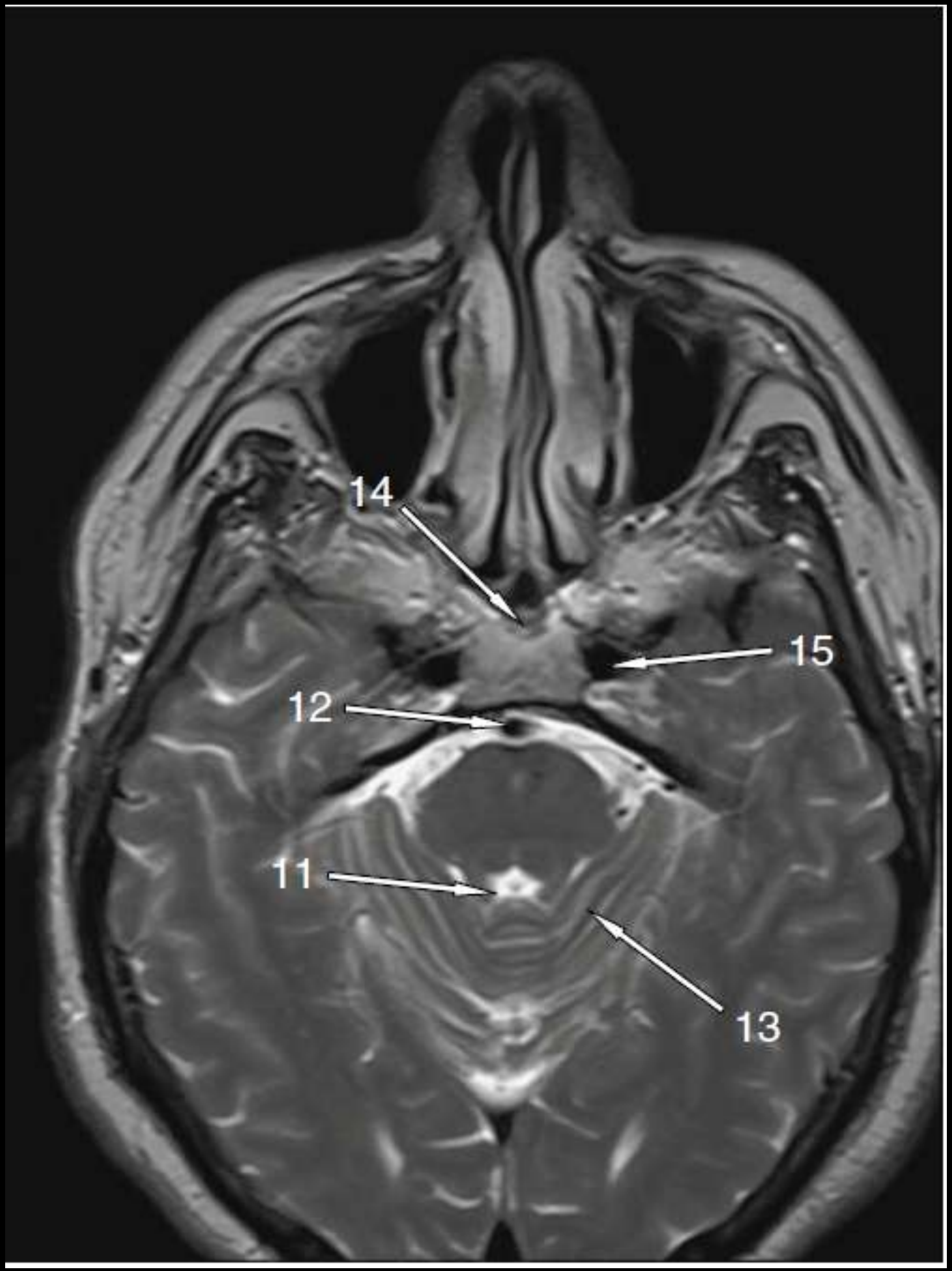
The spiral cochlea is demonstrated in this axial CT on bone window settings. Therefore the cerebellar hemispheres, temporal lobe and the soft tissues of the galea are barely identifiable. The bony labyrinth consists of a vestibule, which communicates posteriorly with the semicircular canals (of which there are three: superior, lateral and posterior) and anteriorly with the spiral cochlea.


49
46
50
47
48

CT Head

46. Left foramen ovale
47. Left foramen spinosum
48. Right caroticojugular spine
49. Nasal septum
50. Right pterygoid (vidian) canal

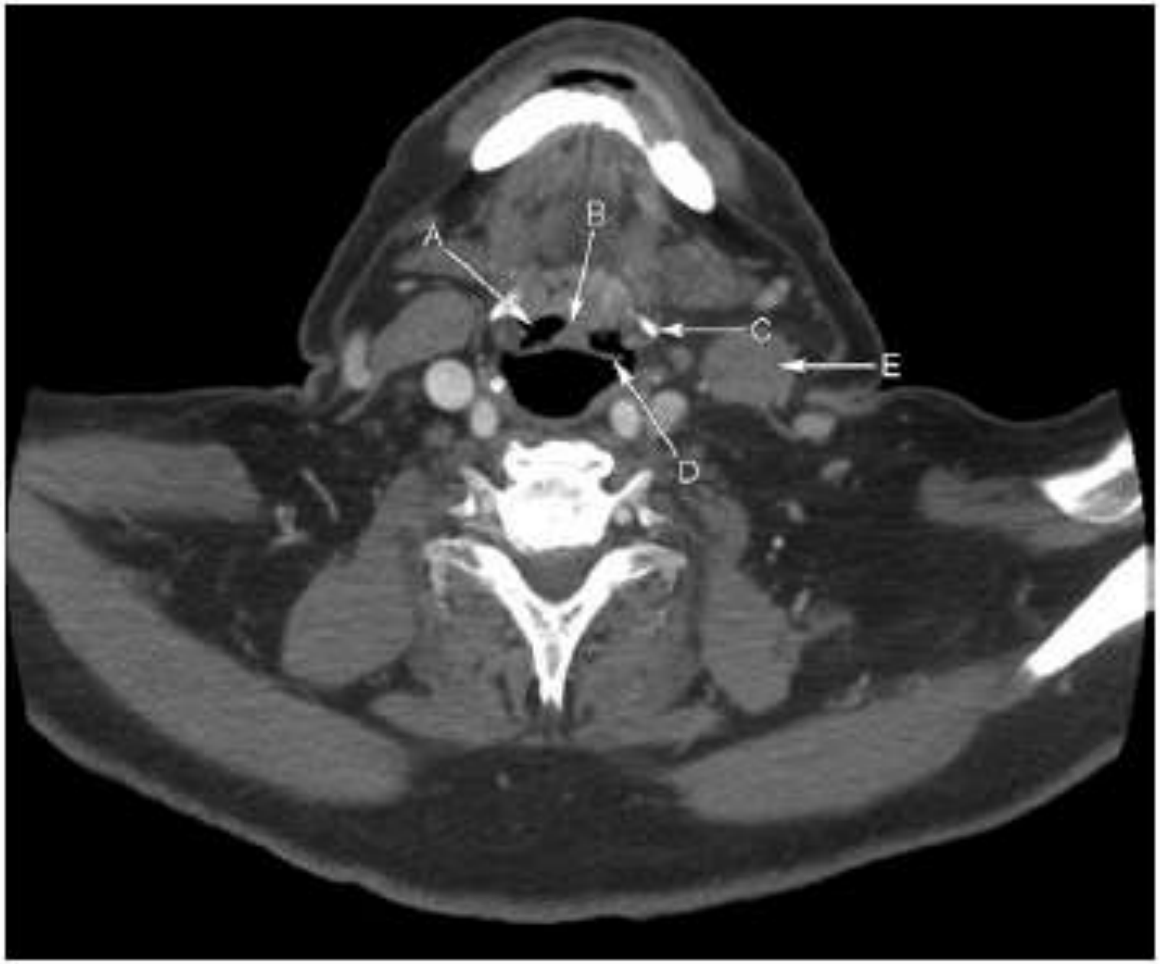
The pterygoid canal (also vidian canal) is a passage in the skull leading from just anterior to the foramen lacerum in the middle cranial fossa to the pterygopalatine fossa. It transmits the nerve of the pterygoid canal and its corresponding artery. It is an important landmark in transnasal endoscopic surgery for identifying the petrous part of the internal carotid artery.


14
15
12
11
13

MRI Head

11. Quadrigeminal cistern
12. Basilar artery
13. Cerebellar folia
14. Optic chiasm
15. Left internal carotid artery

Question 2.8



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

2.8 Axial CT of the neck with IV contrast

A Right vallecula.
B Median glossoepiglottic fold.
C Hyoid bone.
D Epiglottis.
E Left sternocleidomastoid muscle.

The epiglottic valleculae are depressions found just posterior to the base of the tongue and anterior to the epiglottis. Mucous membranes cover the anterior surface of the epiglottis. These are reflected from the epiglottis to the lateral walls of the pharynx and the root of the tongue, where they are called the glossoepiglottic folds. These comprise one median fold (as demonstrated) and two lateral folds.

The sternocleidomastoid muscle is a paired muscle located in the anterior superficial layers of the neck and is named after its bony attachments – the manubrium (sterno), clavicle (cleido) and mastoid processes of the temporal bone. The sternocleidomastoid can be recognized on CT as it is superficially related to the carotid sheath (as demonstrated in this image with the vessels filled with contrast). The carotid artery can be identified as it lies medial to the internal jugular vein.

The characteristic horseshoe shape of the hyoid bone is well demonstrated on axial CT and lies at the level of C3 between the mandible and the thyroid cartilage. It is the only bone in the body that does not articulate with any other bone and provides an important attachment for the muscles of pharynx posteriorly, the muscles of the floor of the mouth and tongue superiorly and the larynx inferiorly.

Question 3.4

Name the structures labelled A to E.

3.4 Axial T2 MRI of the internal auditory meatus

A Right middle cerebellar peduncle.
B Right cochlea.
C Basilar artery.
D Left lateral semicircular canal.
E Fourth ventricle.

T2 imaging of the brain can be easily recognized by the high signal intensity of the cerebrospinal fluid. MRI has become a primary imaging modality for demonstrating the internal auditory meatus for pathology, such as acoustic neuromas. The seventh and eighth cranial nerves enter the internal acoustic meatus. The cochlea can be recognized as it is fluid filled and therefore has a high signal. For further imaging and description of the internal auditory meatus, see Question 10.3

The basilar artery lies anterior to the pons in the prepontine cistern and appears black on T2-weighted imaging owing to signal flow void. The cerebellum communicates with the brainstem via the cerebellar peduncles. The fourth ventricle is bounded anteriorly by the pons and upper half of the medulla, posteriorly by the cerebellum and laterally by the cerebellar peduncles. It is continuous with the aqueduct of Sylvius superiorly and the central canal of the spinal cord inferiorly.

Question 4.2

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

4.2 Axial CT of the brain

A Left sylvian fissure.
B Cerebellar vermis.
C Posterior limb of the right internal capsule.
D Third ventricle.
E Left lentiform nucleus.

On brain CT the white matter appears darker than the cortical grey matter. The internal and external capsules are white matter tracts and can therefore be visualized as low attenuation lines adjacent to the basal ganglia. The external capsule is lateral to the lentiform nucleus and medial to the insular cortex. Cerebrospinal fluid spaces within the brain can be readily identified by their fluid attenuation and appear almost black.

The ventricular system of the brain is continuous with the central canal of the spinal cord. There are four ventricles – the right and left lateral ventricles, the third ventricle and the fourth ventricle. The lateral ventricles are large C-shaped structures, which have frontal, temporal and occipital horns. The third ventricle lies within the midline between the thalami and the fourth ventricle which lies within the hindbrain. They all communicate via different foramina. The following flow diagram depicts the ventricular system and the foramina:

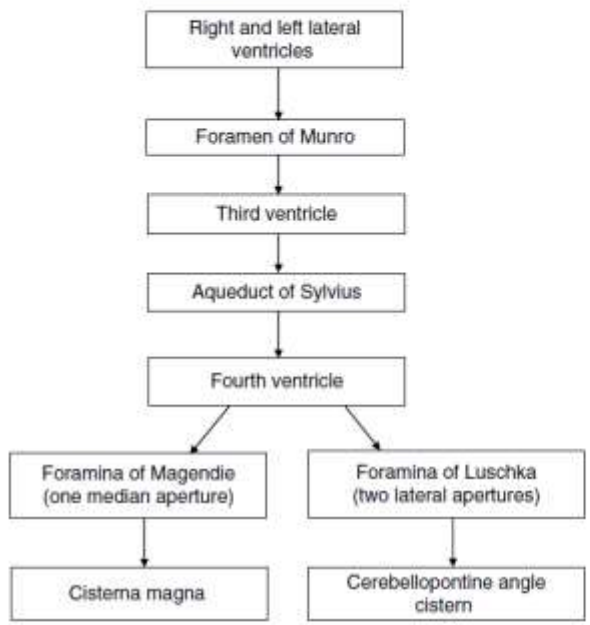
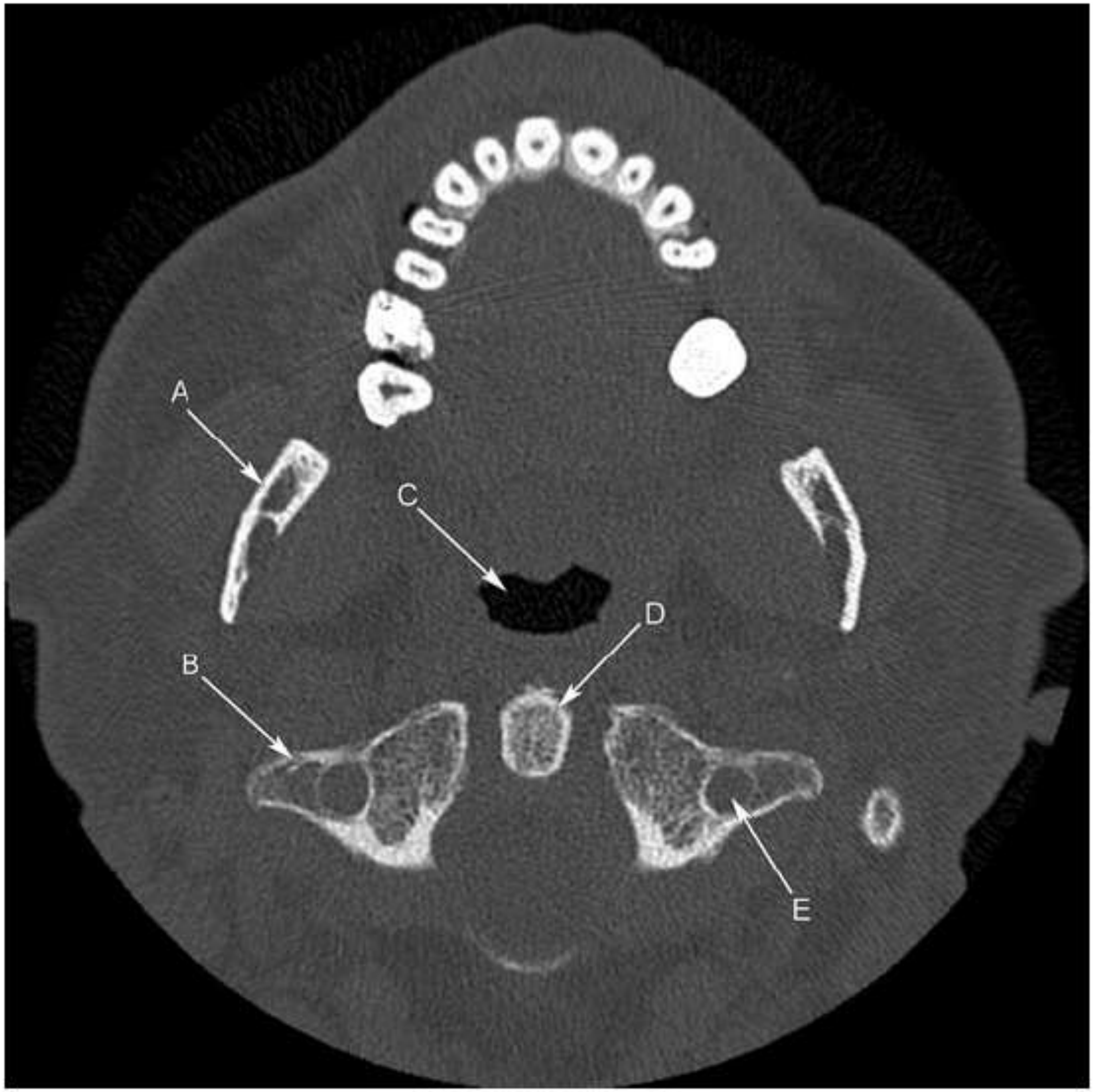


Figure 4.2 The ventricular system and the foramina

Question 4.18



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

4.18 Axial CT of the cervical spine

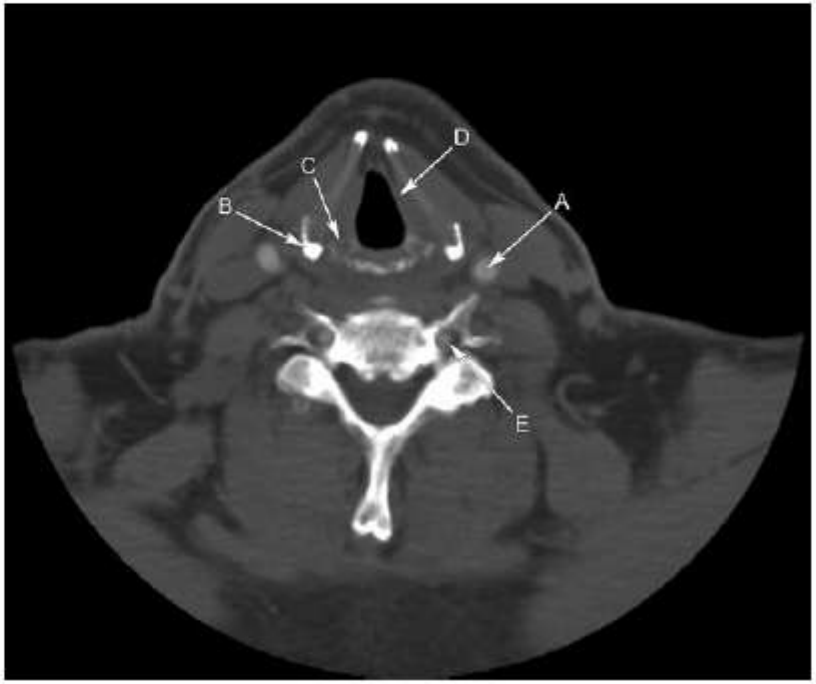
A Right mandible.
B Right transverse process of atlas (C1).
C Nasopharynx
D Dens; odontoid peg
E Left foramen transversarium

C1 is known as the atlas bone and forms the joint between the skull and the spine. It is unique as it has no body. It is ring-shaped and consists of an anterior and posterior arch with two lateral masses. Each lateral mass has a superior and inferior articular facet. C2 is known as the axis. There is no intervertebral disc between C1 and C2.

The pharynx conducts food to the digestive tract and air to the lungs and extends from the base of the skull to the level of the cricoid cartilage or C6 (where the larynx and oesophagus commence). It is split into the nasopharynx, oropharynx and hypopharynx (or laryngopharynx).

Nasopharynx	Lies posterior to the nose and extends from the skull base to the level of the soft palate (~C2)
Oropharynx	Extends from the soft palate to the level of the hyoid bone (C3)
Hypopharynx or laryngopharynx	Extends from the level of the hyoid bone to the level of the cricoid cartilage (C6)

Question 5.1



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

5.1 Axial CT of the neck with IV contrast

A Left common carotid.
B Right thyroid cartilage.
C Right arytenoid cartilage.
D Left vocal cord.
E Left vertebral artery.

The larynx connects the hypopharynx to the trachea and contains the vocal cords, which are responsible for phonation. It is supported by a number of cartilaginous structures, including the cricoid, arytenoid and thyroid cartilages. The larynx is split into three subsites – the supraglottis, glottis and subglottis.

Supraglottis	Superior boundary is the tip of the epiglottis Inferior border is the laryngeal ventricle, which separates the false from the true vocal cords Contents include the epiglottis, false vocal cords, aryepiglottic folds and arytenoid cartilage
Glottis (pictured here)	At the level of the true vocal cords Contains the true vocal cords and the anterior and posterior commissure
Subglottis	Upper boundary is the inferior border of the true vocal cords Lower boundary is the inferior border of the cricoid cartilage or the first tracheal ring

Question 5.2

Name the structures labelled A to E.

5.2 Axial CT of the brain with IV contrast

A Left anterior cerebral artery.
B Left internal carotid artery.
C Left middle cerebral artery.
D Basilar artery tip.
E Aqueduct of Sylvius.

The circle of Willis is a circle of arteries that supplies the brain and includes:

- The anterior cerebral arteries.
- The anterior communicating artery.
- The internal carotid arteries.
- The posterior communicating arteries.
- The posterior cerebral arteries.

Question 5.5

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

5.5 Axial CT of the brain

- **A** Temporal horn of right lateral ventricle.
- **B** Aqueduct of Sylvius.
- **C** Cerebellar vermis.
- **D** Quadrigeminal cistern.
- **E** Midbrain.

The midbrain can be recognized by its characteristic shape and central concavity, whereas the pons has a convex anterior surface (see Question 6.1). Vermis is Latin for 'worm', and is used to describe the median narrow wormlike structure that connects the two cerebellar hemispheres. The quadrigeminal cistern is a cerebrospinal fluid filled space and extends laterally from the quadrageminal cistern around the midbrain of the brainstem to connect the interpeduncular cistern. The aqueduct of Sylvius connects the third ventricle to the fourth ventricle.

For further information on the cisterns of the brain see Question 2.5.

Question 6.1

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

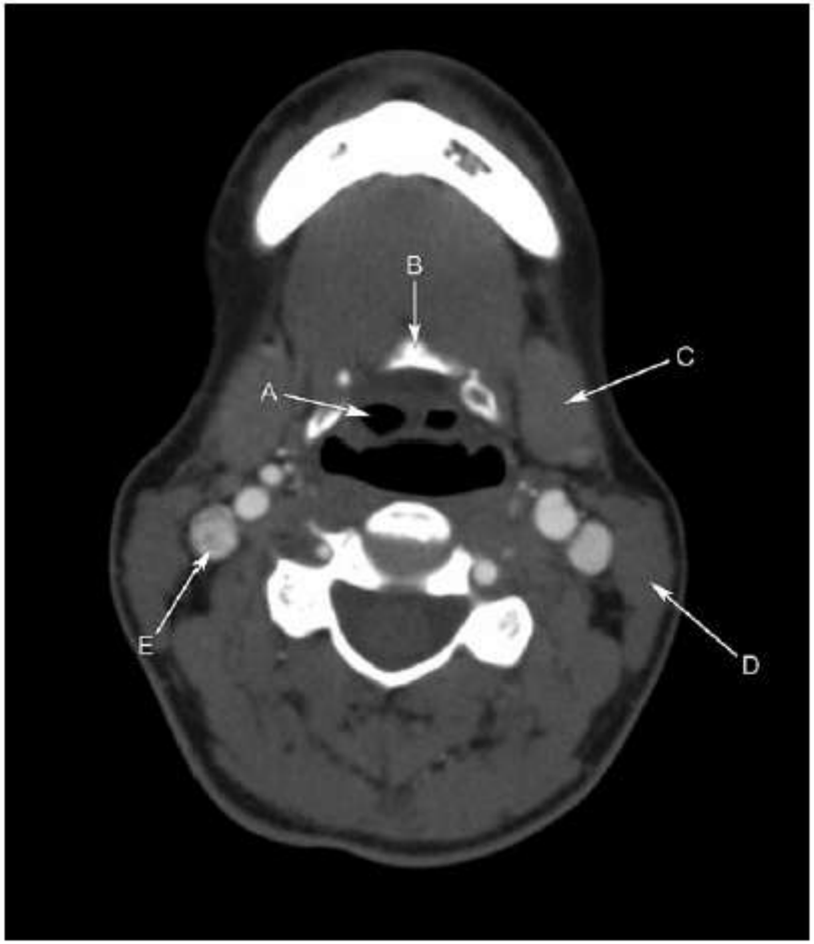
6.1 Axial CT of the brain

A Falx cerebri.
B Right middle cerebellar peduncle.
C Right cerebellar hemisphere.
D Left tentorium cerebelli.
E Pons.

The falx cerebri is a scythe-shaped fold of dura mater in the longitudinal fissure between the two cerebral hemispheres. It attaches anteriorly to the crista galli of the ethmoid and posteriorly to the upper surface of the tentorium cerebelli. The tentorium cerebelli is a tent of dura that separates the cerebellum from the inferior portion of the occipital lobe, thus defining the supratentorial and infratentorial spaces.

The cerebellum is connected to the rest of the central nervous system by three pairs of nerve tracts known as cerebellar peduncles. The inferior cerebellar peduncles connect the medulla spinalis and medulla oblongata with the cerebellum. They form a thick strand between the lower part of the fourth ventricle and the roots of the ninth and tenth cranial nerves. The middle cerebellar peduncles connect the pontine nuclei to the contralateral cerebellum. Their fibres are arranged in three fasciculi – superior, inferior and deep. The superior cerebellar peduncles connect the cerebellum to the midbrain. They form the upper lateral boundaries of the fourth ventricle. The anterior medullary velum connects the superior cerebellar peduncles, and between them they also form the roof the fourth ventricle.

Question 7.3



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

7.3 Axial CT of the neck with IV contrast

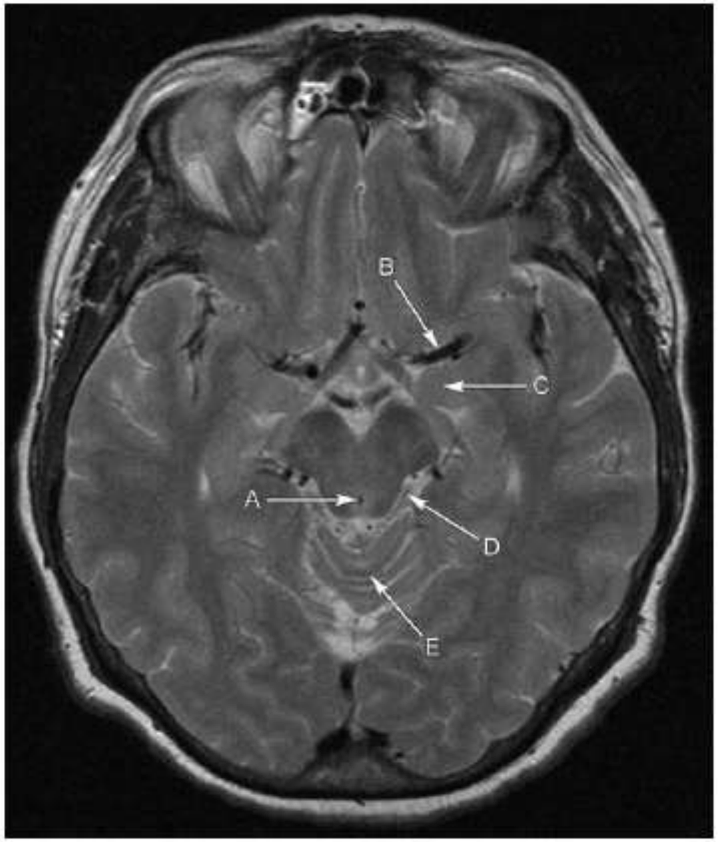
A Right vallecula.
B Hyoid bone.
C Left submandibular gland.
D Left sternocleidomastoid muscle.
E Right internal jugular vein.

The valleculae (or valleculae epiglottica) are a pair of depressions on either side of the median glossoepiglottic fold. They are important landmarks during intubation and are the site where the laryngoscope blade is placed to help visualize the epiglottis.

The right internal jugular vein is one of a pair of vessels that form the major venous drainage of the brain and the superficial face and neck. It is formed in the jugular foramen from the confluence of the inferior petrosal sinus and the sigmoid sinus. It has a common trunk within the neck that drains the anterior branch of the retromandibular vein, facial vein, superior and middle thyroid veins, pharyngeal vein and lingual veins. The internal jugular veins descend in the carotid sheath and join the subclavian veins to form the brachiocephalic veins. The thoracic duct inlet typically lies at the junction of the left internal jugular vein and the left subclavian vein. For this reason, when siting subclavian central lines it is often recommended that the right subclavian vein is used instead of the left to minimize the risk of thoracic duct injury.

Further relevant images and descriptions of neck anatomy can be seen in Questions 4.4, 5.1 and 6.3.

Question 7.5



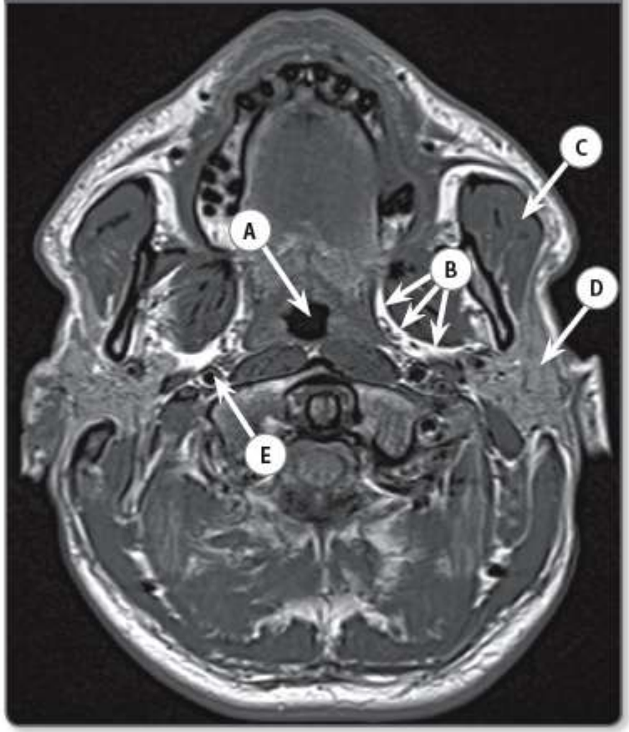
Name the structures labelled **A** to **E**.

7.5 Axial T2 MRI of the brain

A Cerebral aqueduct (aqueduct of Sylvius).
B Left middle cerebral artery.
C Head of the left hippocampus.
D Ambient cistern.
E Cerebellar vermis.

The cerebral aqueduct (aqueduct of Sylvius) is a channel connecting the third and fourth ventricles. Blockage to this channel impedes the flow of cerebrospinal fluid and can cause hydrocephalus. The ambient cistern is an extension of the quadrigeminal cistern, extending laterally around the midbrain. It acts as a connection between the quadrigeminal cistern and the interpeduncular cistern. The cerebellar vermis lies in between the cerebellar hemispheres and is the site of termination of the spino-cerebellar pathways.

Case 3.15



Case 3.15

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

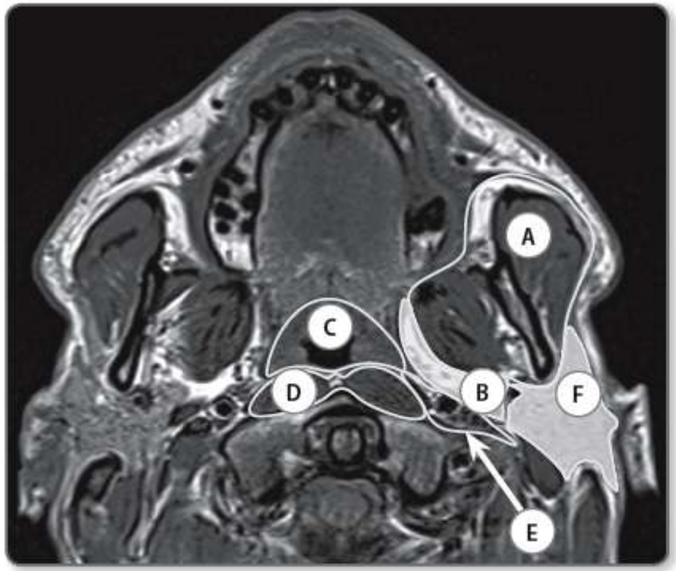


Figure 3.2 T1-weighted axial MRI illustrating anatomical spaces of the neck.

Table 3.2 Content of the anatomical spaces of the neck

Fig. 3.2 label	Anatomical space	Content
A	Masticator	Mandible, muscles, trigeminal nerve
B	Parapharyngeal	Fat, maxillary artery, nerves
C	Pharyngeal mucosal	Mucosa, lymphoid tissue, constrictor muscles
D	Retropharyngeal	Fat, pre-cervical muscles
E	Carotid	Carotid artery, jugular vein, lymph nodes, cranial nodes
F	Parotid	Parotid gland, facial nerve, lymph nodes, vessels

Case 3.15

A Oropharynx

B Left parapharyngeal space

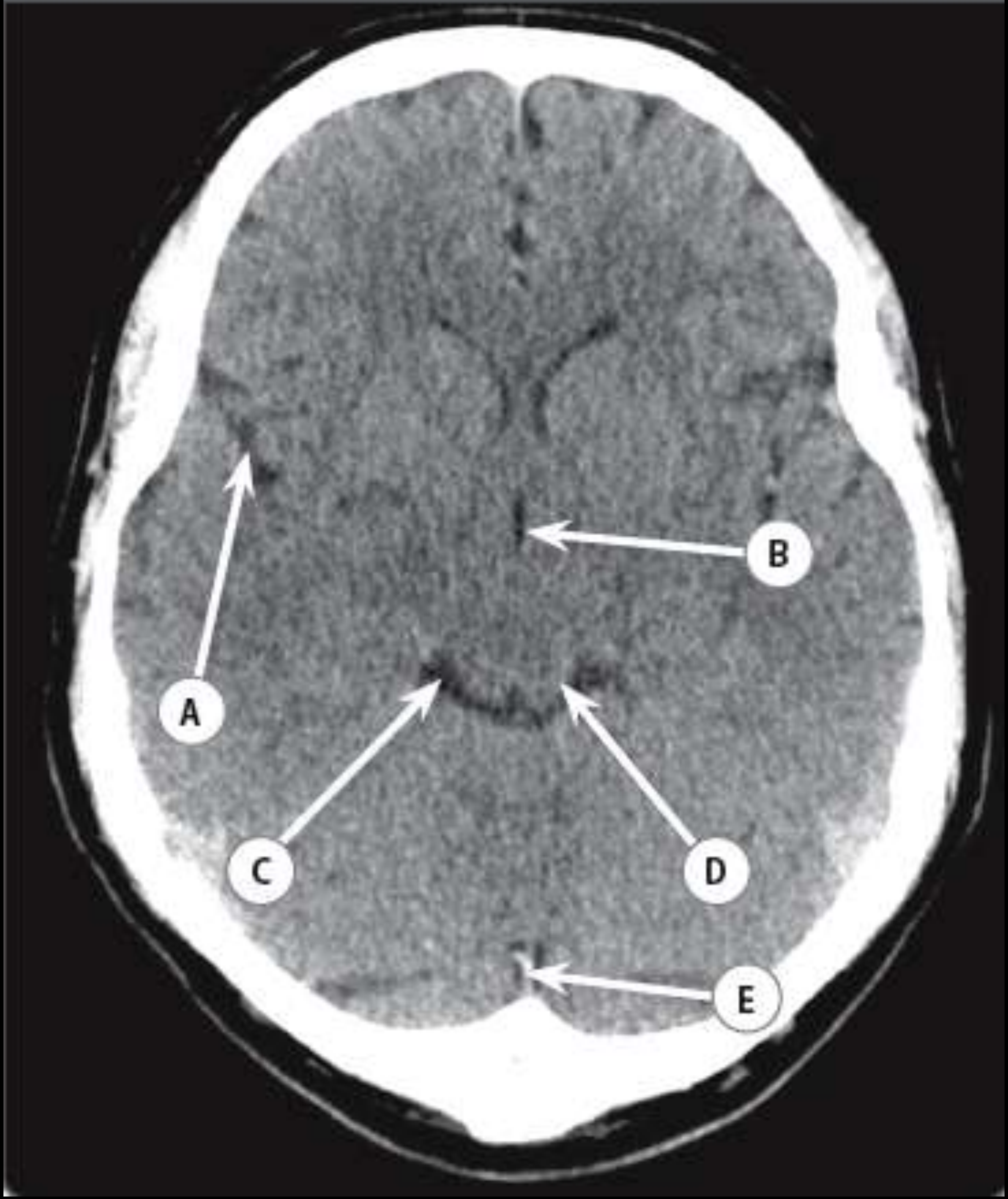
C Left masseter muscle

D Left parotid gland

E Right carotid artery

The neck is anatomically divided into spaces, orientated craniocaudally, separated by fascial planes. The spaces are named after anatomical structures they contain or neighbouring landmarks. Once the anatomical spaces become familiar (**Figure 3.2** and **Table 3.2**), the complex anatomy becomes easier to evaluate.

Case 4.13



Case 4.13

A Right sylvian fissure (lateral sulcus)

B Third ventricle

C Quadrigeminal cistern

D Left superior colliculus of midbrain

E Falx cerebri

The superior midbrain colliculi lie anterior to the quadrigeminal cistern, and on the axial image are shaped like a 'baby's bottom'. The shape of CSF spaces at this level resembles a 'smiling face', as illustrated in **Figure 4.2**.

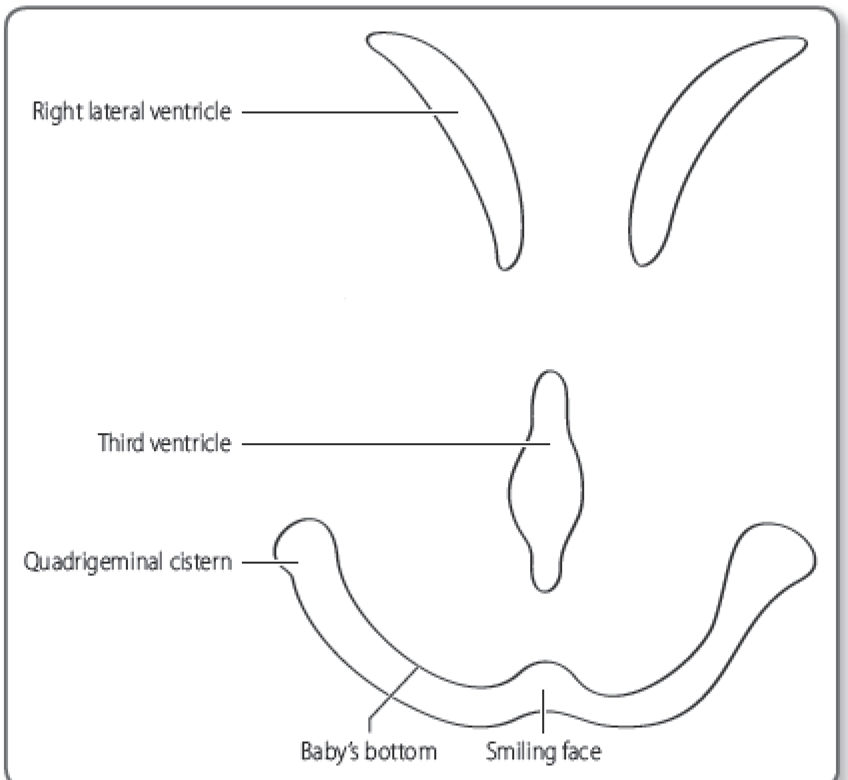
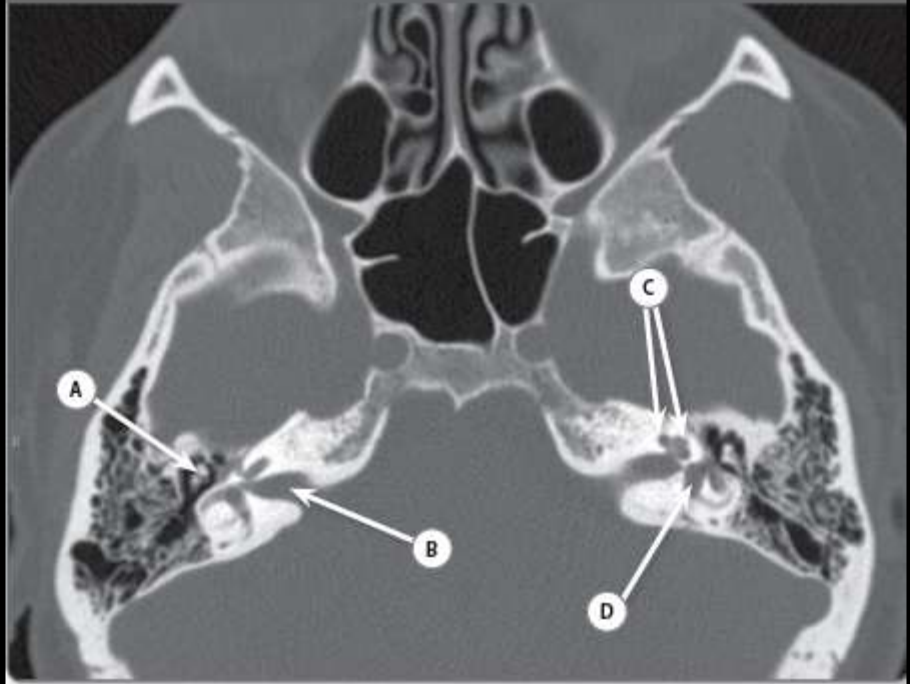


Figure 4.2 'Smiling face' – schematic illustration of the CSF relationships at the level of the quadrigeminal plate.

Case 5.3



Case 5.3

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the joint labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Which cranial nerve passes through the middle ear cavity?	

Case 5.3

A Right incudomalleolar joint

B Right internal auditory canal

C Left cochlea

D Left vestibulum

E Facial nerve (VII)

This high resolution CT depicts the petrous portion of the temporal bone with great precision. The structures of the middle ear have very characteristic names, of which a little imagination and Latin will help:

- **Cochlea** – Latin for 'snail shell' as it is coiled.
- **Vestibulum** – Latin for 'entrance hall' which is indeed the reception for the inner ear
- **Labyrinth** – derived from Greek mythology and representing a complicated maze-like structure. You find its analogy in the inner ear labyrinth, with a system of passages comprising cochlea, vestibulum and three semicircular canals
- **Auditory ossicles** – malleus (Latin for hammer), incus (anvil-shaped) and stapes (stirrup-shaped) articulate with each other in that order. The facial nerve crosses the middle ear cavity, helping create an easy to remember mnemonic:

  MISS – Malleus-Incus-Stapes-Seventh nerve
  Incus and malleus articulate with each other at the incudomalleolar joint, forming the characteristic 'ice cream cone' shape which is best appreciated on axial CT.

Case 6.10

Case 6.10

A Right retromolar trigone

B Oropharynx

C Left masseter muscle

D Superficial lobe of the left parotid gland

E Cervical spinal cord

Axial anatomy of the neck is complex. It is useful to be familiar with anatomical landmarks to help with level orientation. Three main levels can be recognised: nasopharynx, oropharynx and hypopharynx.

The level of the oropharynx can be recognised by identifying the mandible and tongue.

The retromolar trigone is a triangular band of mucosa which lies posterior to the molar teeth at the level of the ramus of the mandible.

Case 7.16

Case 7.16

A Third ventricle

B Head of the right caudate nucleus

C Cortex of the left insula

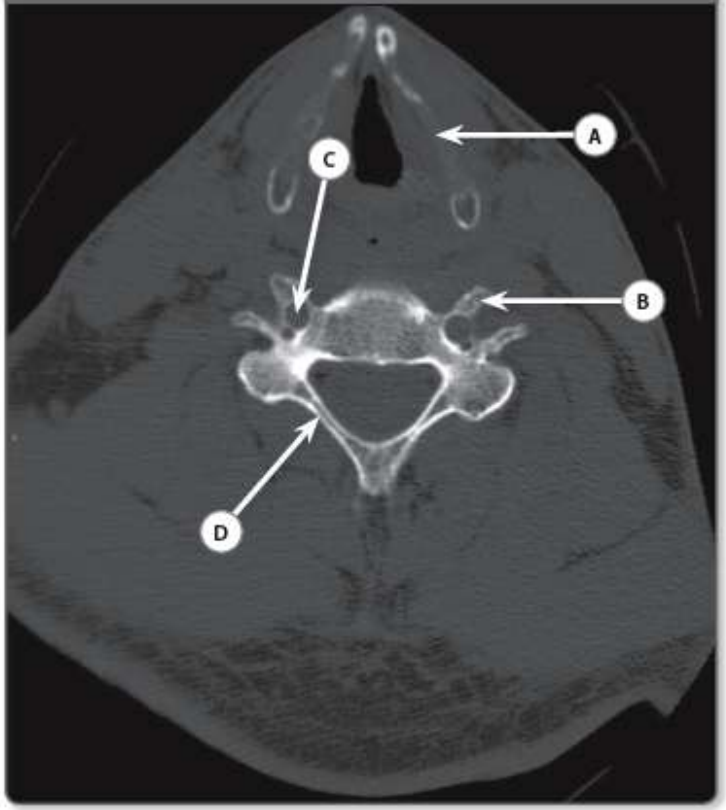
D Left lentiform nucleus

E Left hypothalamus

The MRI appearances of the neonatal brain differ significantly from that of an adult. As the myelination process has not fully completed at birth, the neonatal brain is 'wetter' than the adult brain, resulting in reversed T1 and T2 signal characteristics (i.e. white matter returns low signal on T1- and high on T2-weighted MRI).

At birth, only the myelinated posterior fossa structures (such as the brainstem, cerebellum and the posterior limb of the internal capsule) have adult appearances. It is important to recognise that these differences relate to normal anatomy and are not pathological.

Case 8.19



Case 8.19 Axial CT at the level of C5

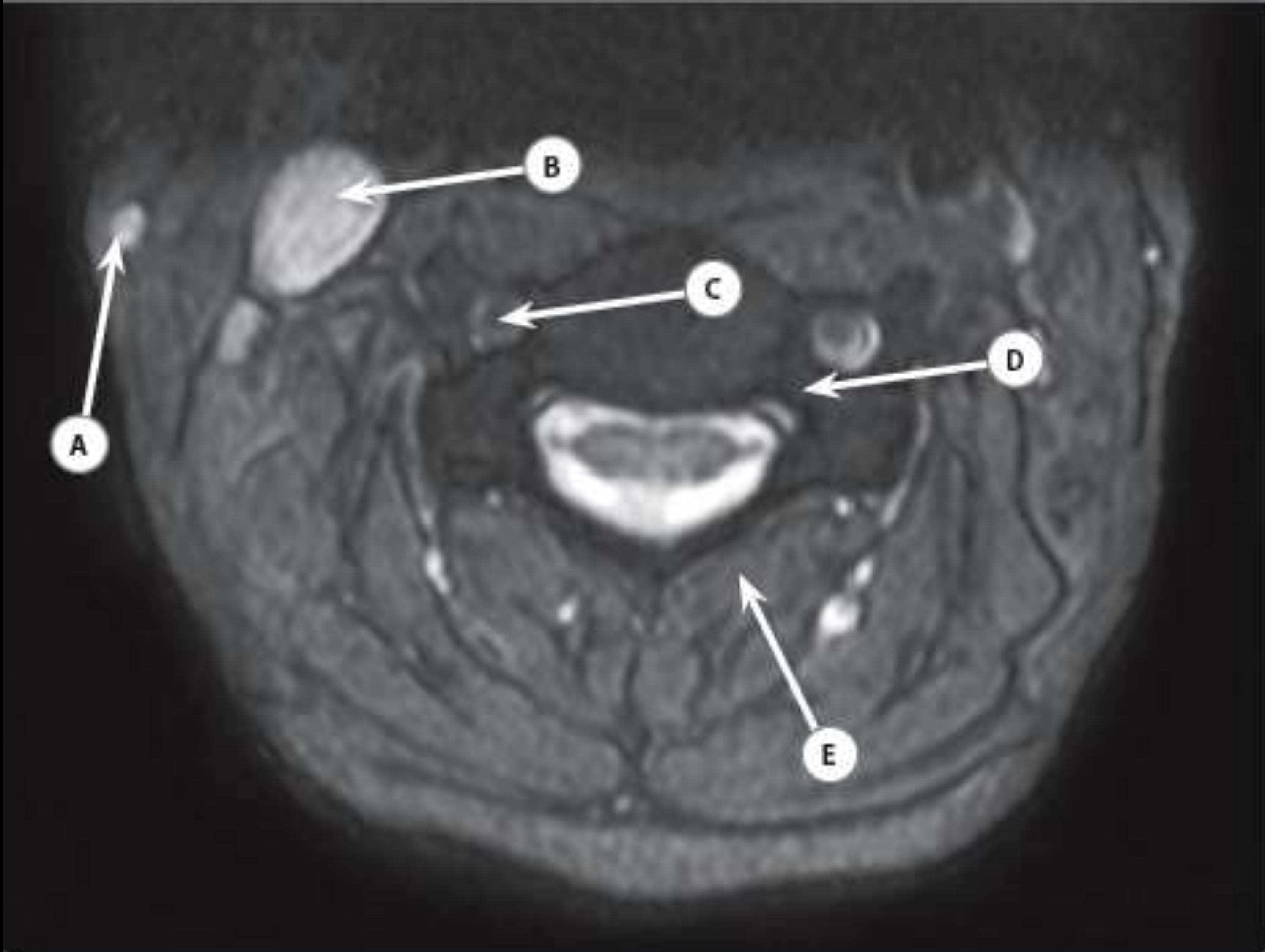
	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	What structure passes through the structure labelled C?	
D	Name the structure labelled D.	
E	Which anatomical variant is present on this image?	

Case 8.19

- **A** Left lamina of the thyroid cartilage
- **B** Anterior tubercle of C5
- **C** Right vertebral artery
- **D** Right lamina of C5
- **E** Bilateral double foramina transversaria

The foramen transversarium is present on each side in each of the upper six cervical vertebrae (not C7), with the vertebral artery passing through it as it courses superiorly to form the basilar artery with its contralateral counterpart. Double foramina transversaria are a recognised anatomical variant and may be present unilaterally or bilaterally, as in this case.

Case 9.10



Case 9.10

A Right external jugular vein

B Right internal jugular vein

C Right vertebral artery

D Left pedicle of C5

E Left erector spinae muscle

This is an axial STIR (short tau inversion recovery) MRI at the level of C5. STIR MRI sequences have a dual role to play in imaging of the spine, by improving detection of both vertebral metastatic disease and intramedullary disease of the spinal cord. As seen in this image, there is good anatomical detail of the spinal cord, with clear differentiation between grey matter (central) and white matter (peripheral). Blood vessels are also clearly demonstrated.

Case 9.18

E	Which cranial nerve exits the cranial cavity via the foramen labelled E?	

Case 9.18

A Vomer

B Left mandibular condyle

C Left occipitomastoid suture

D Medulla oblongata

E Left hypoglossal nerve (CN XII)

The occipital bone contains two important foramina – foramen magnum and the hypoglossal canal.

Foramen magnum is the largest opening of the skull base, connecting the posterior fossa and the spinal canal.

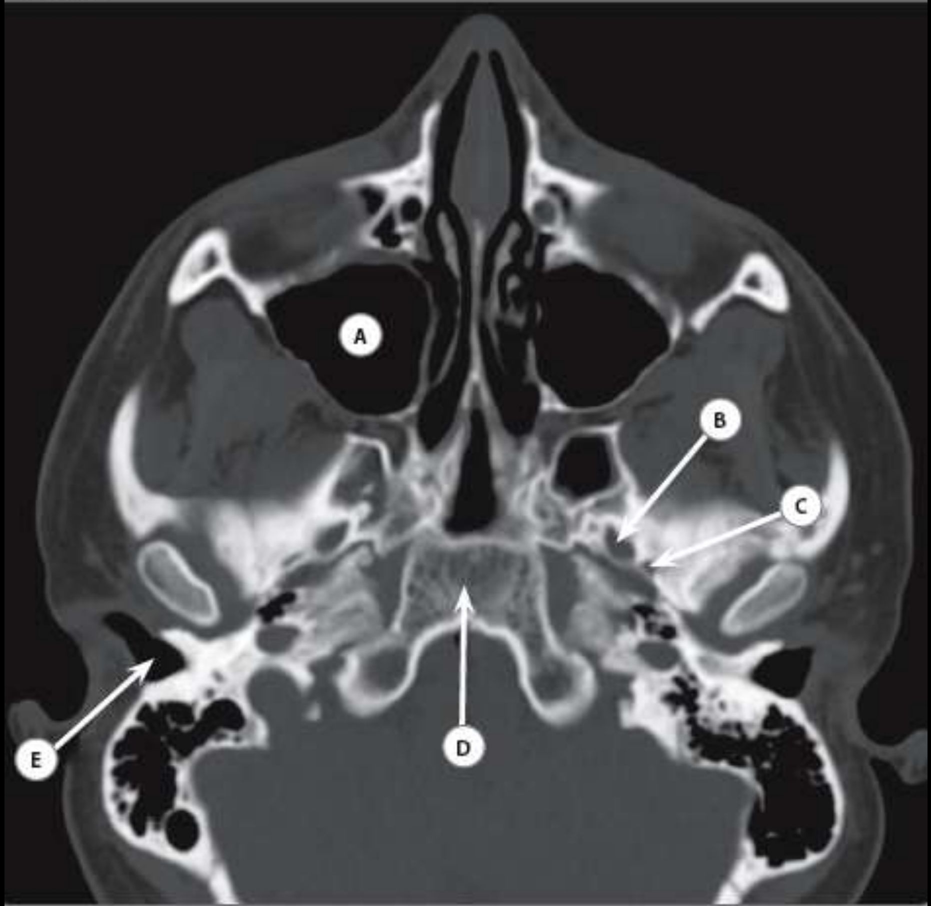
The contents of foramen magnum include the following:

- Medulla oblongata
- Vertebral artery and vein
- Spinal accessory nerve (CN XI)

Figure 9.2 Schematic illustration of the relationship between foramen magnum and the hypoglossal canal resembling the head of Shrek.

The hypoglossal canal transmits the hypoglossal nerve, which innervates the extrinsic muscles of the tongue. On the axial CT images, the hypoglossal canals are evident adjacent to the anterolateral borders of foramen magnum and posterior to the clivus. Together with foramen magnum, they resemble the head of Shrek (the famous computer-animated character), as depicted in **Figure 9.2**.

Case 10.6



Case 10.6

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Which cranial nerve exits the cranium via the foramen labelled B?	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the structure labelled E.	

Case 10.6

A Right maxillary antrum

B Mandibular division (V3) of the left trigeminal nerve (CN V)

C Left foramen spinosum

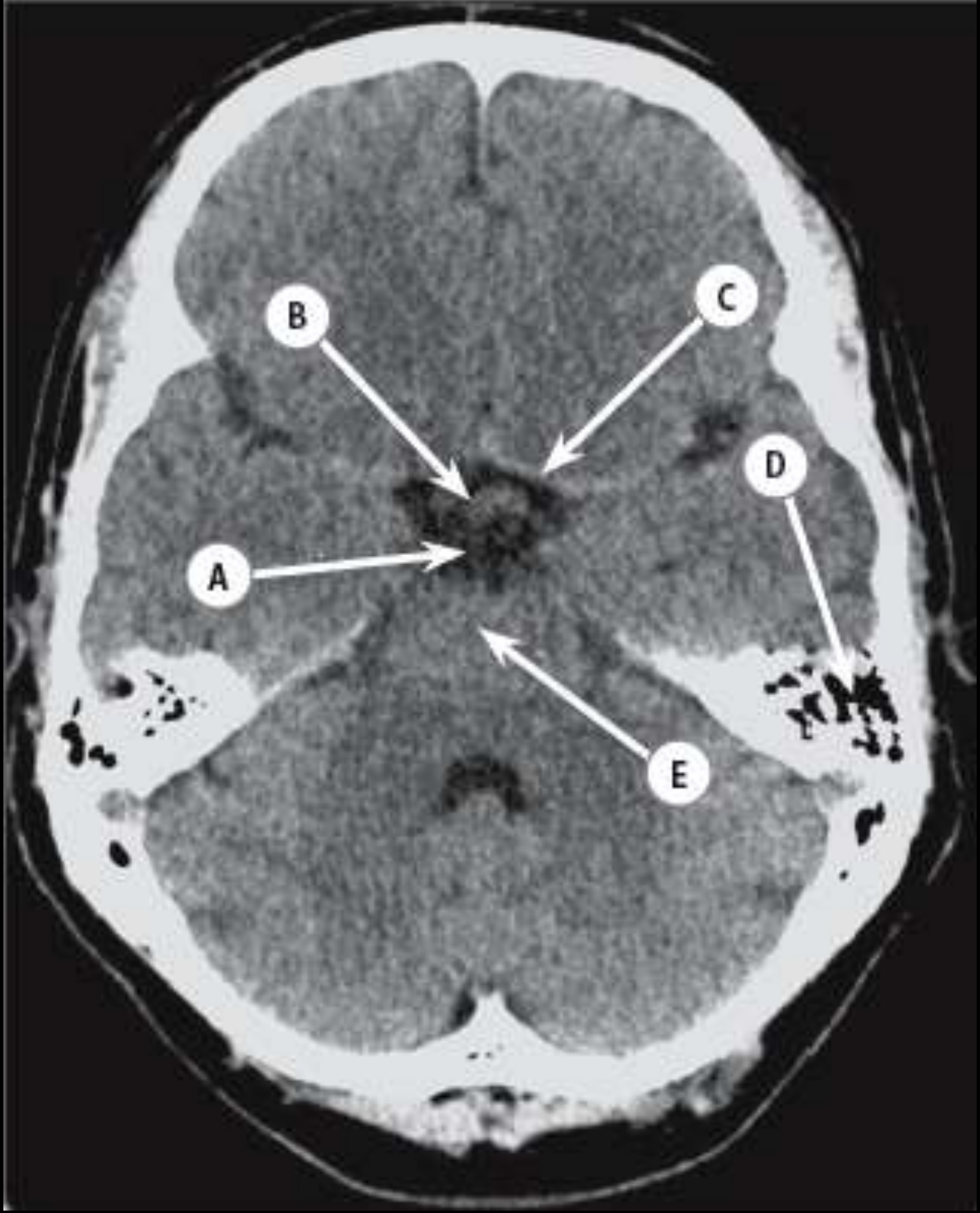
D Clivus

E Right external auditory canal

The sphenoid bone contains two major foramina: foramen ovale and foramen spinosum.

- **Foramen ovale** – larger than foramen spinosum. It lies medial to foramen spinosum and transmits the mandibular division of the trigeminal nerve along with the accessory meningeal artery
- **Foramen spinosum** – situated posterolateral to the foramen ovale and transmits the middle meningeal artery and vein

Case 11.3



Case 11.3

A Suprasellar cistern

B Optic chiasm

C Left middle cerebral artery

D Left mastoid air cells

E Pons

The shape of the CSF spaces at the level of the suprasellar cistern resembles a 'sad face'. The suprasellar cistern is also described as being star-shaped, as depicted in **Figure 11.1**.

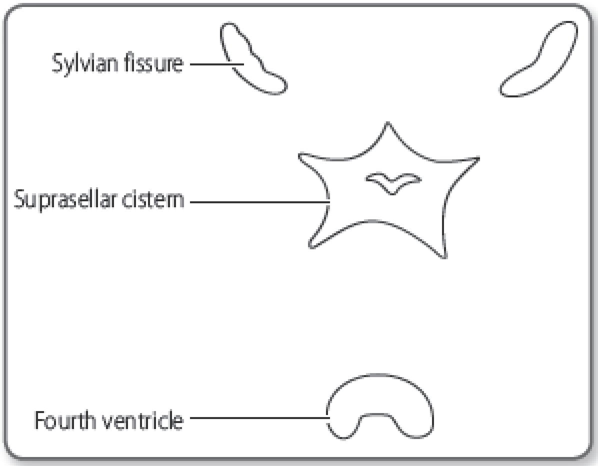
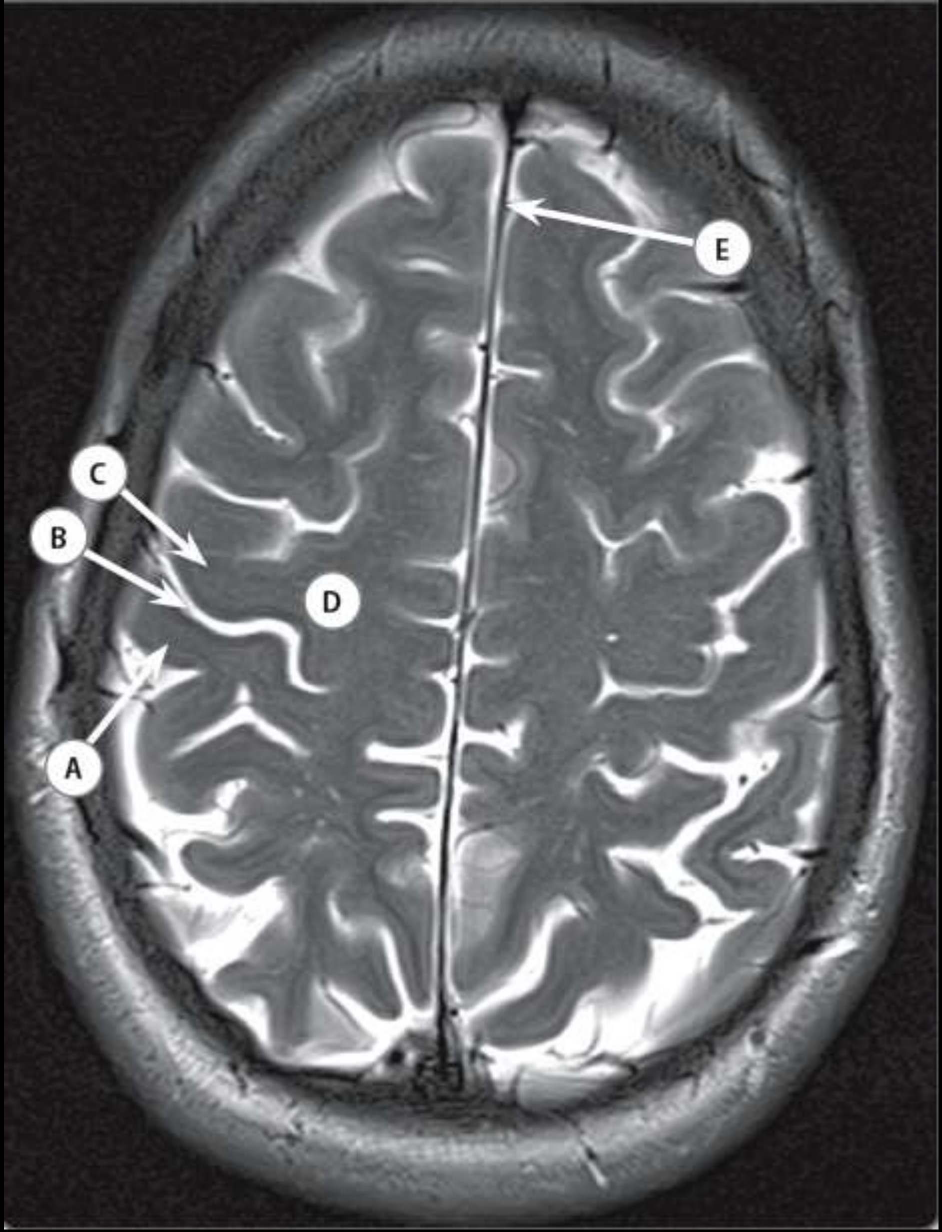


Figure 11.1 'Sad face.' Schematic illustration of the relationships between CSF spaces at the level of the suprasellar cistern.

Case 13.2



Case 13.2

A Right postcentral gyrus

B Right central sulcus (of Rolando)

C Right precentral gyrus

D Centrum semiovale

E Interhemispheric fissure/falx cerebri

The motor pathways travel from the precentral gyrus of the cerebral cortex, via the motor nuclei of the brainstem, to the spinal cord. There are three intracranial portions of the motor pathways:

- **Centrum semiovale** – from the cortex to the roof of the lateral ventricles
- **Corona radiata** – medial part, extending from the level of the roof of the lateral ventricles to the internal capsule
- **Internal capsule** – V-shaped area between the caudate and lentiform nuclei in the basal ganglia

Case 13.8

Case 13.8

A Right genioglossus muscle

B Left mylohyoid muscle

C Oropharynx

D Body of the mandible

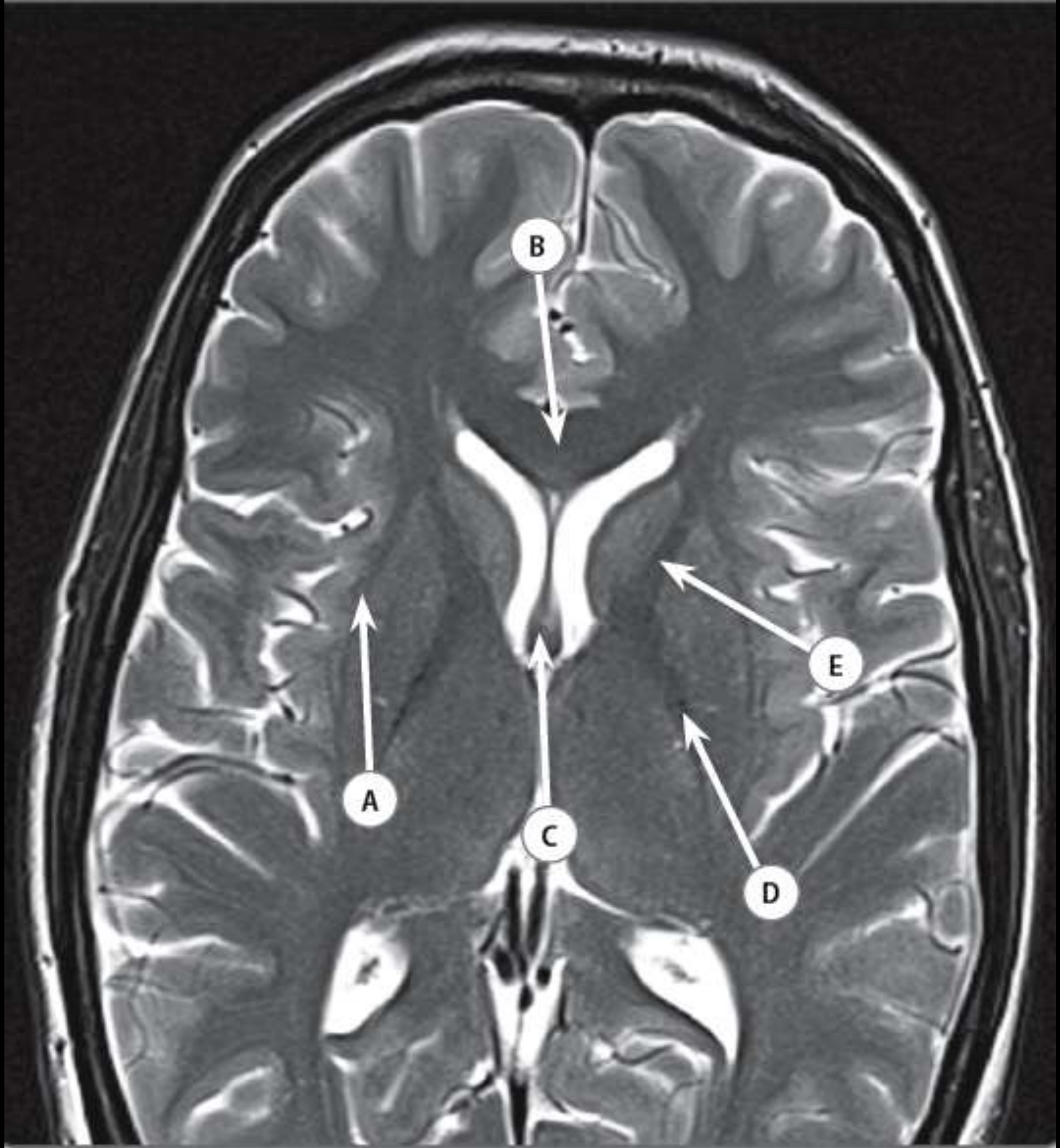
E Left sternocleidomastoid muscle

The floor of the mouth is the inferior boundary of the oral cavity, lying beneath the tongue. The floor of the mouth is divided by the mylohyoid muscle (which forms the oral diaphragm) into two spaces:

- Sublingual – superomedial
- Submandibular – inferolateral

Two other important muscles that help form the floor of the mouth are genioglossus and the anterior belly of digastric.

Case 14.2



Case 14.2

A Right external capsule

B Genu of corpus callosum

C Fornix

D Posterior limb of left internal capsule

E Anterior limb of left internal capsule

There are two main types of cerebral white matter tracts:

- **Transverse** (commissural) – linking paired structures across the midline. The corpus callosum is the largest commissural tract and is divided into four parts (from anterior to posterior): rostrum, genu, corpus and splenium. A good way of remembering this is that the genu (Latin for knee) points anteriorly.
- **Descending** – contain two pathways: the corticospinal, connecting the cerebral grey matter with the spinal cord; and the corticobulbar, between the cortex and motor nuclei in the brainstem. There are three main stations (from cranial to caudal): centrum semiovale, corona radiata and internal capsule.

Case 14.12

Case 14.12 Axial image at the level of C4

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	From what investigation is this image taken?	

Case 14.12

A Body of hyoid

B Left sternocleidomastoid muscle

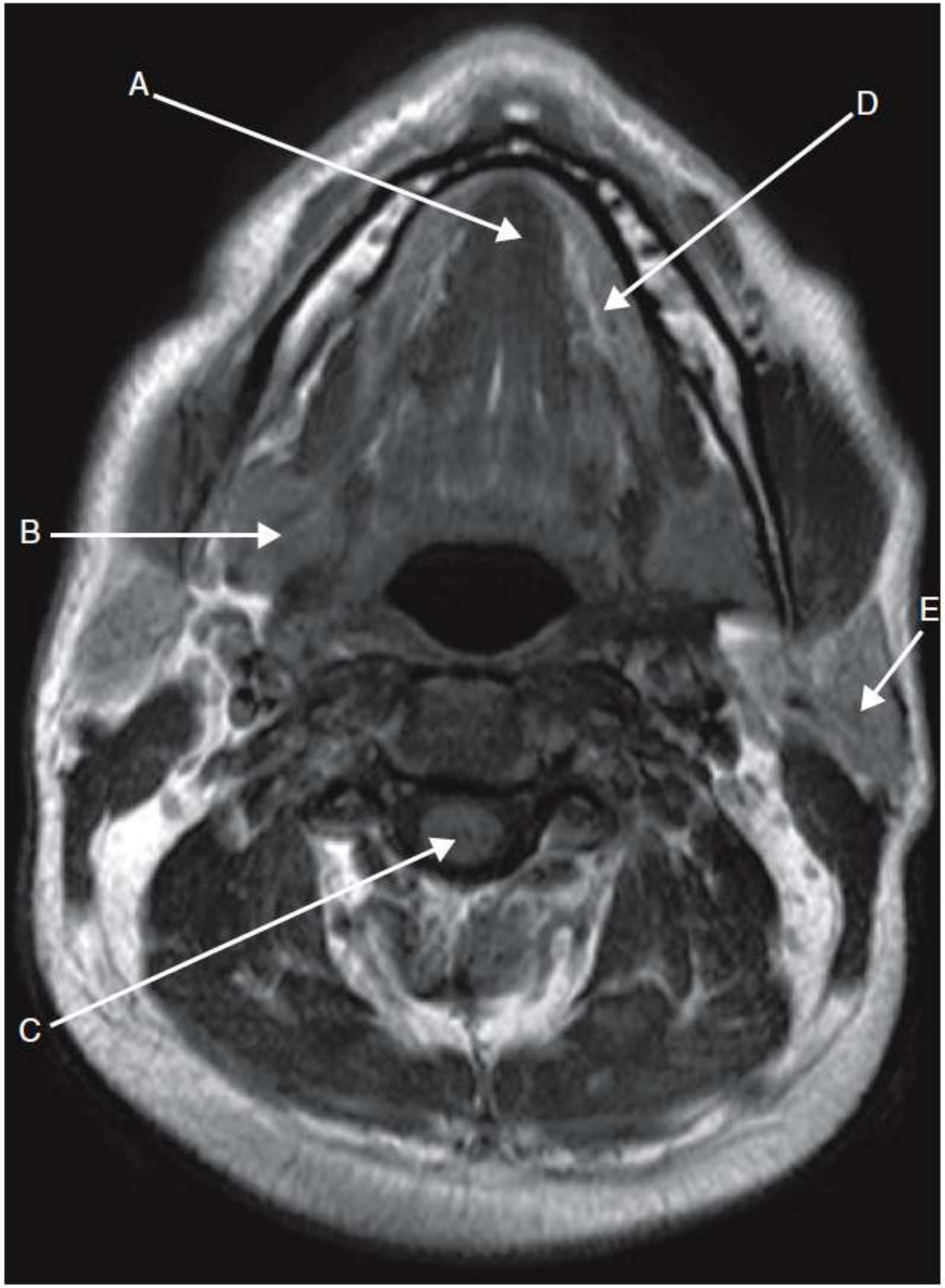
C Left foramen transversarium

D Right C4 ventral nerve root

E CT myelogram

CT myelography may be performed when MRI is contraindicated, to evaluate nerve roots and assess for the presence of intervertebral disc disease. Contrast is administered into the thecal sac and outlines the nerve roots. The ventral spinal roots carry only somatic motor fibres in the cervical spine, but will also carry sympathetic fibres from the T1–L2 levels and parasympathetic fibres from the S2–S4 levels. Afferent sensory fibres (somatic and visceral) are carried along the dorsal nerve roots. The dorsal and ventral nerve roots form the mixed spinal nerve within the intervertebral canal.

Case 1.5



1.5 Axial T1-weighted MR of the salivary glands

(a) Genioglossus muscle. This large fan-shaped muscle forms the bulk of the tongue. It arises from the superior mental spine on the inner surface of the mandible and inserts along the entire length of the undersurface of the tongue. Its relaxation during sleep is thought to contribute to sleep apnoea.
(b) Right submandibular gland. This image shows an axial view through the floor of the oropharynx. The submandibular duct ('Wharton's duct') opens in the floor of the mouth on either side of the frenulum.
(c) Spinal cord.

(d) Left sublingual gland. The sublingual glands lie anterior to the submandibular gland under the tongue, beneath the mucous membrane of the floor of the mouth. Its acini secrete mucous fluid and it receives secreto-motor nerve supply from the chorda tympani nerve.
(e) Left parotid gland. The parotid glands are relatively fatty in appearance and therefore are high signal on T2-weighted and T1-weighted images.

A number of key structures run through the parotid gland including the terminal part of the external carotid artery (often giving off its two terminal branches, maxillary artery and the superficial temporal artery inside the gland), the retromandibular vein and branches of the facial (VII) nerve.

The facial nerve runs superficial to the artery and vein and divides into its five terminal branches in the gland.

Inflammation of the gland causes parotitis, often the consequence of a calculus blocking the parotid duct. Mumps may also cause painful parotitis.

Case 2.13

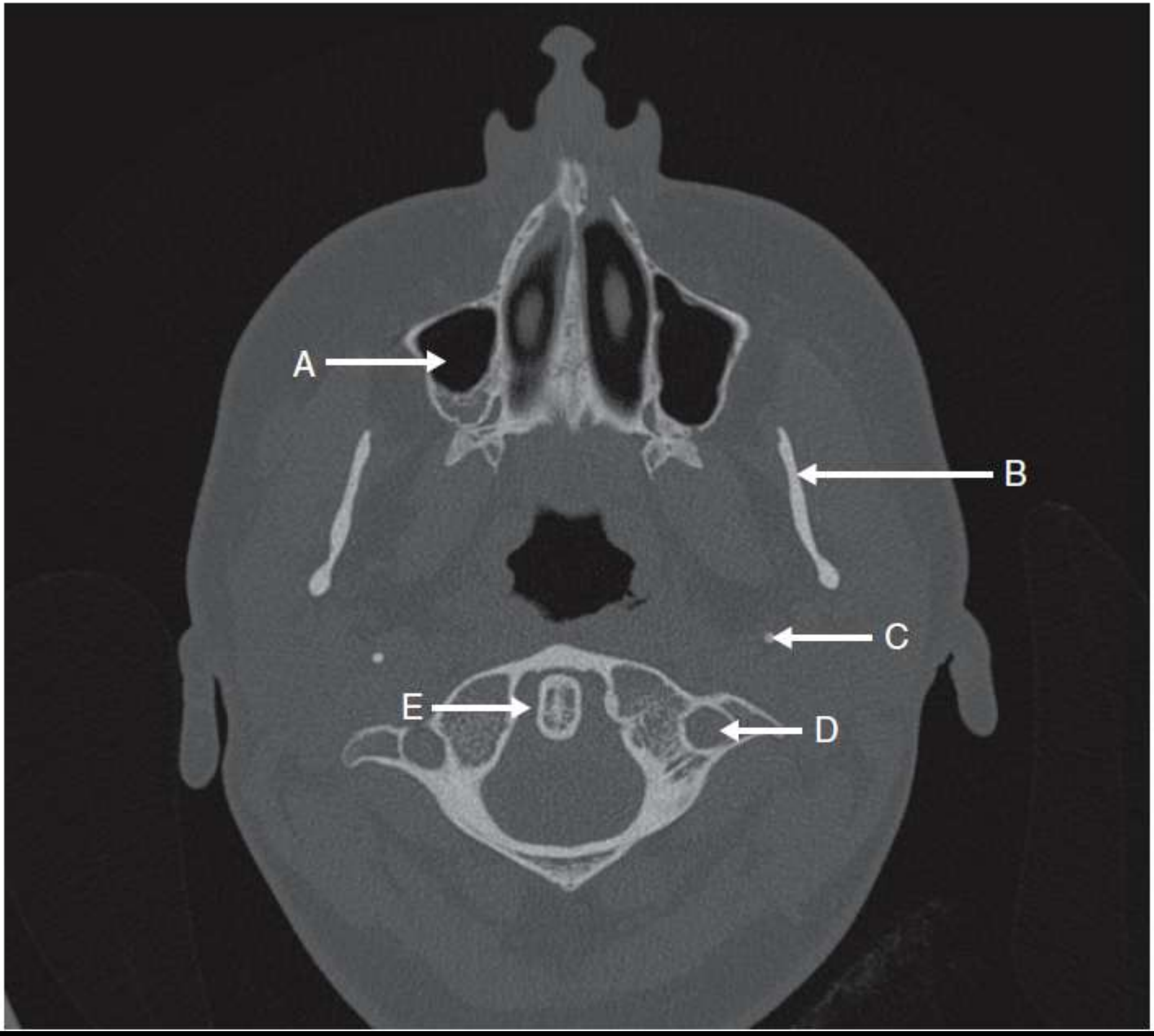
2.13 Unenhanced CT brain

(a) Right anterior cerebral artery.
(b) Right middle cerebral artery. The largest branches of the internal carotid artery (ICA) are the middle cerebral arteries, which supply the majority of the brain including the sensory and motor cortices of the head and upper limb, as well as Broca's expressive speech area.
(c) Right posterior cerebral artery.
(d) Left lentiform nucleus (part of the basal ganglia). This is a triangular area of grey matter between the internal and external capsules. Infarcts are most frequently seen in the basal ganglia which are supplied by the lenticulostriate branches from the middle cerebral artery and the resultant infarcts are called lacunar infarcts (lacuna = pond or lake. Latin).
(e) Left frontal lobe.

The vascular territories are significant if there are recent or acute infarcts in more than one territory, which imply embolic disease rather than occlusive stenosis within the carotid.

Between the vascular territories lie watershed zones where transient global hypoperfusion (cardiac arrest, general anaesthesia, systemic shock) can result in impaired flow to one or both parent vessels thereby compromising circulation to a critical level in these border zones.

Case 3.4



3.4 Axial skull base CT

(a) Right maxillary sinus. The maxillary sinus is one of the paranasal sinuses. Opacification of the maxillary sinus on a plain radiograph may indicate an occult facial bone fracture following trauma; however, it can also be opacified as a consequence of other sinus diseases that result in loss of the normal sinus aeration.

(b) Left coronoid process (mandible). The coronoid process of the mandible is a site of attachment of several muscles. Temporalis muscle attaches to its internal surface and the tip while the masseter muscle is attached to the external surface.

(c) Left temporal styloid process. The styloid process of the temporal bone is a needle-like bony structure that provides the attachment sites of several ligaments and muscles:

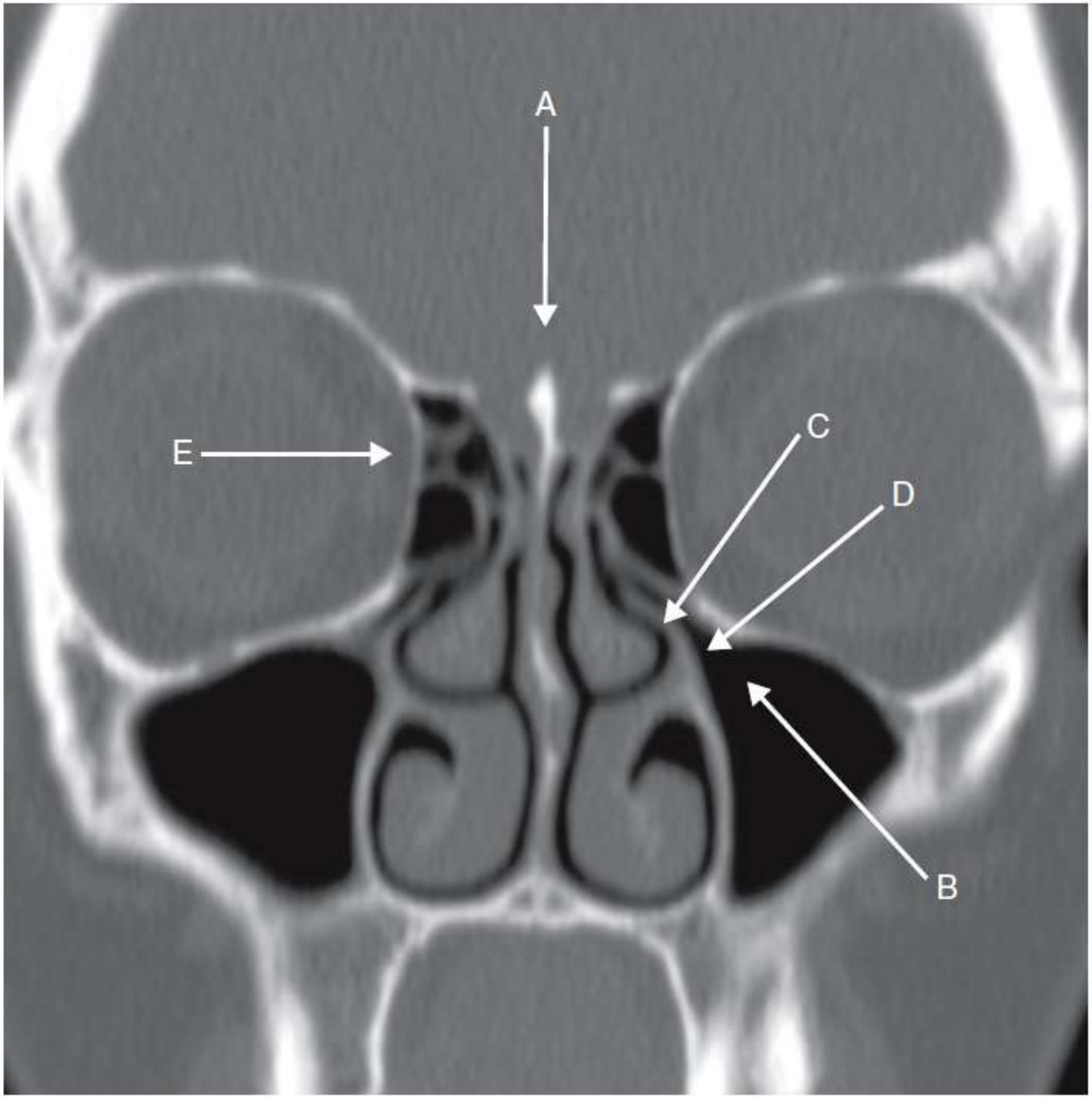
Stylohyoid ligament
Stylomandibular ligament
Styloglossus muscle
Stylohyoid muscle
Stylopharyngeus muscle.

(d) Left vertebral artery. The vertebral artery arises from the subclavian artery and passes upwards through the vertebral foramina in the transverse process of the upper six cervical vertebra. The artery enters the skull through the foramen magnum and, at the level of the pons, the vertebral arteries from either side fuse to form the basilar artery. Within the skull the vertebral artery gives off the posterior inferior cerebellar artery and the anterior spinal artery.

The single basilar artery gives off many branches, the paired anterior inferior cerebellar arteries, multiple bilateral pontine arteries, superior cerebellar arteries. The basilar artery then bifurcates to form the posterior cerebral arteries often with one being dominant and the main supply to the occipital lobe of the brain.

(e) Odontoid peg. The odontoid peg is embryologically the body of the C1 vertebra that has fused to the body of C2 to form a prominence that facilitates rotation of the head.

Case 3.11



3.11 Coronal CT paranasal sinuses

(a) Crista galli. This is a median ridge of bone that projects from the cribriform plate of the ethmoid bone.

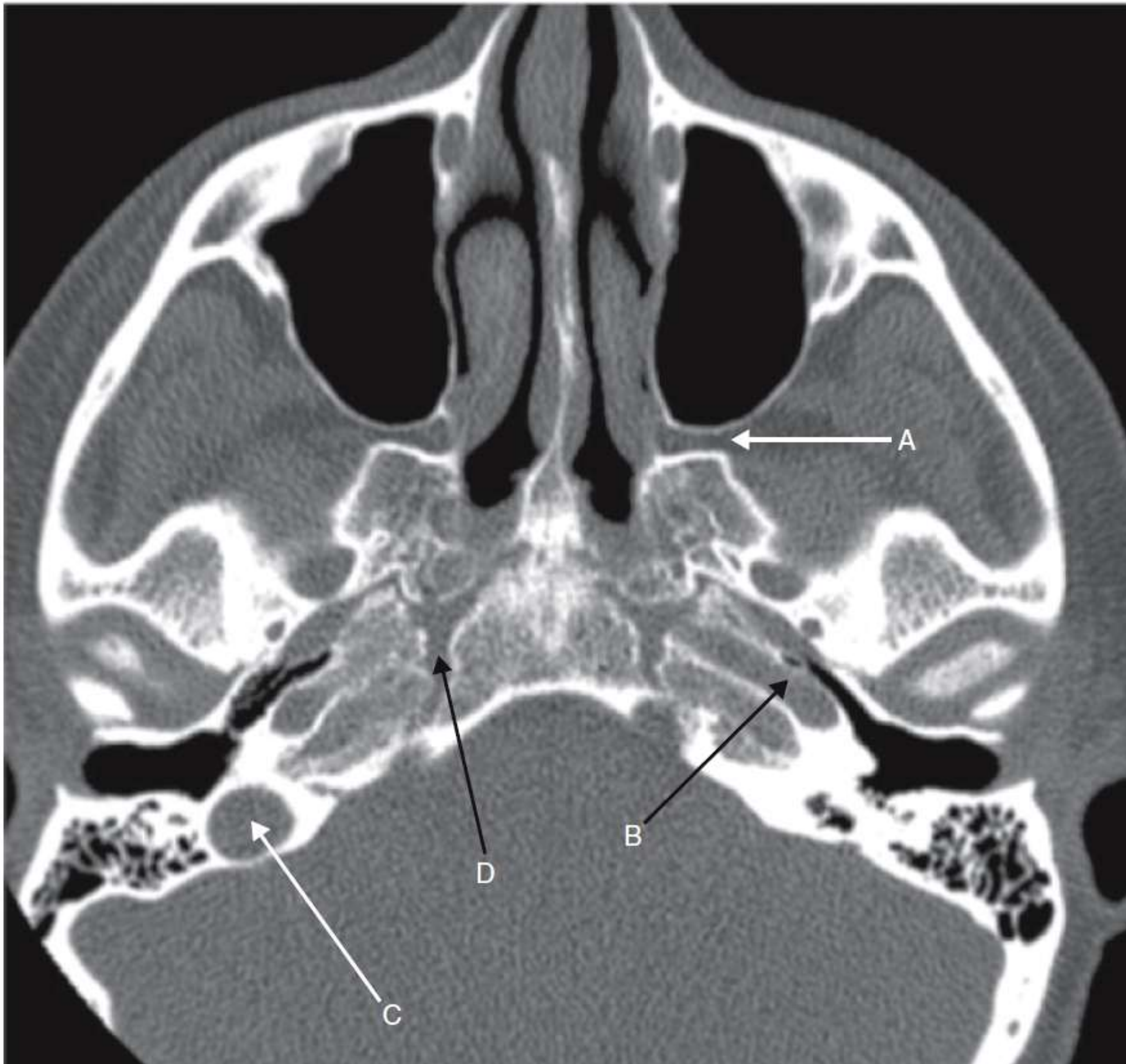
(b) Left maxillary ostium. This is the opening of the maxillary sinus, located in the middle meatus of the lateral nasal cavity.

(c) Left uncinate process. This is a bony projection, formed from the medial wall of the maxillary sinus.

(d) Left infundibulum. This is the channel which drains the maxillary sinus.

(e) Right lamina papyracea. This is the paper-thin bony wall between the orbits and the ethmoid sinuses.

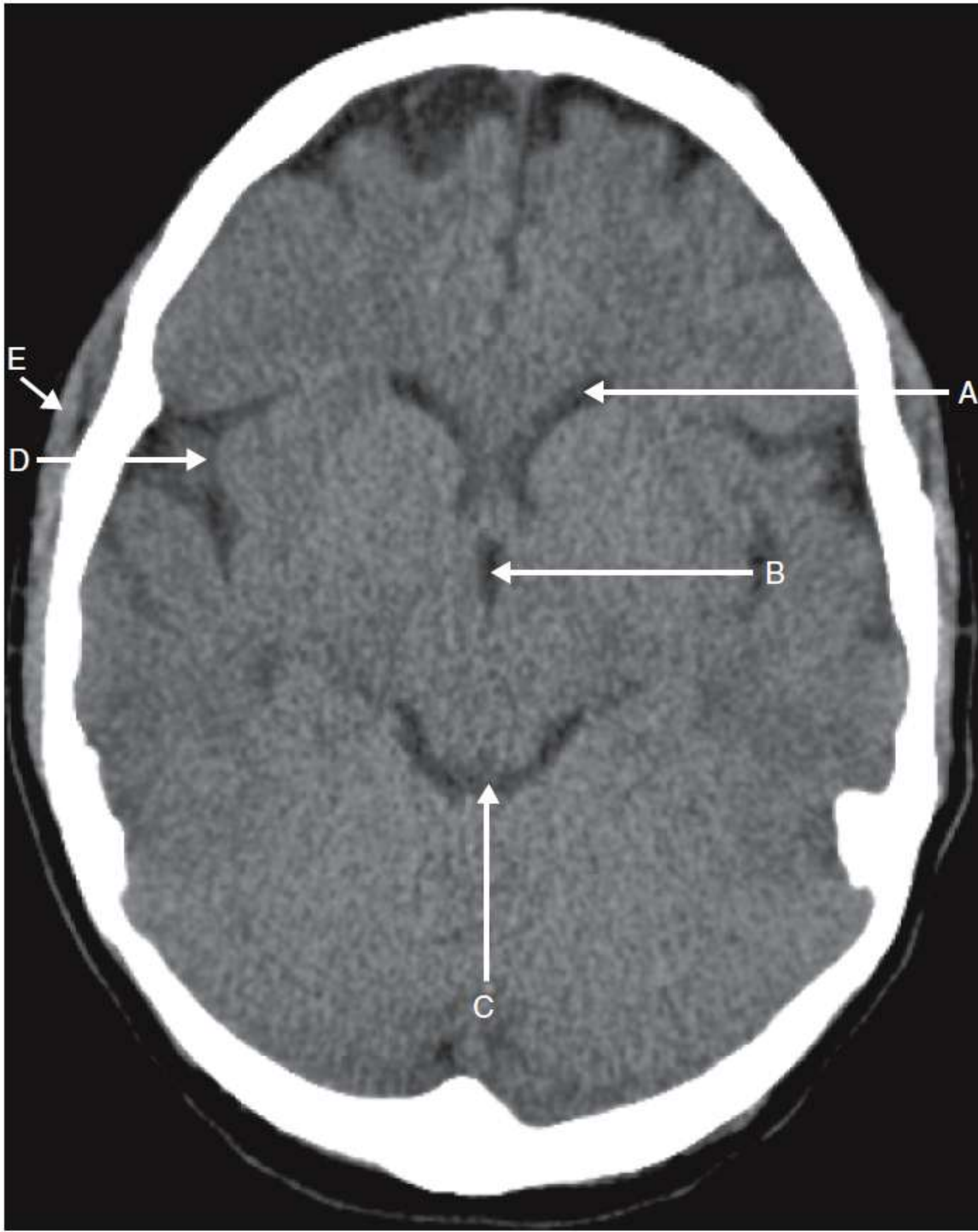
Case 3.18



3.18 Axial CT skull base (bone windows)

(a) Left pterygopalatine fossa. This communicates laterally with the infratemporal fossa, and superiorly with the orbit and middle cranial fossa. Therefore, it may facilitate spread of pathology between these spaces.
(b) The maxillary division of the V cranial (trigeminal) nerve. This runs through the foramen rotundum and into the orbit via the inferior orbital fissure.
(c) Left carotid canal. This contains the internal carotid artery.
(d) Right jugular foramen. This contains the internal jugular vein, IX, X, XI cranial nerves, inferior petrosal sinus and branches of the ascending occipital and pharyngeal arteries.
(e) Right foramen lacerum. The internal carotid artery runs through its posterior aspect after emerging from the carotid canal.

Case 5.15



5.15 Axial unenhanced CT brain

(a) Anterior horn of the left lateral ventricle. The lateral ventricles are C-shaped cavities which sit below the corpus callosum, consisting of a body, anterior and temporal horns. They drain into the third ventricle via the interventricular foramina of Monro (one on each side).

(b) Third ventricle. The cerebrospinal fluid (CSF) drains from the third to fourth ventricle via the cerebral aqueduct (of Sylvius). The fourth ventricle empties into the central canal of the spinal cord or the subarachnoid space via the foramen of Magendie (centrally) and the two foramina of Lushka (laterally). CSF is absorbed from the subarachnoid space via the arachnoid villi which project out of the superior sagittal sinus.

(c) Quadrigeminal cistern. This is one of a series of cisterns which lie within the subarachnoid space, around the base of the brain and brainstem. Given the circle of Willis lies within this space, a subtle subarachnoid haemorrhage may only be apparent here, either as high attenuation within one of the cisternal spaces, effacing the Sylvian fissure or layered posteriorly in the lateral or fourth ventricles.

(d) Right Sylvian fissure.

(e) Right temporalis muscle.

Case 5.20

5.20 Axial T1-weighted MR of the neck

(a) Left parotid gland. This is the largest salivary gland and is divided into deep and superficial lobes which are connected around the posterior surface of the mandible by the isthmus. Its duct (Stensen's duct) opens into the buccal cavity opposite the upper second molar tooth.

(b) Left masseter muscle. This muscle lies in the masseteric space with the pterygoid muscles. It has deep and superficial components and is innervated by a branch of the mandibular nerve (trigeminal nerve III). The space is an important tissue compartment in the face and can be the site of abscess formation. It is often difficult to diagnose pathology here.

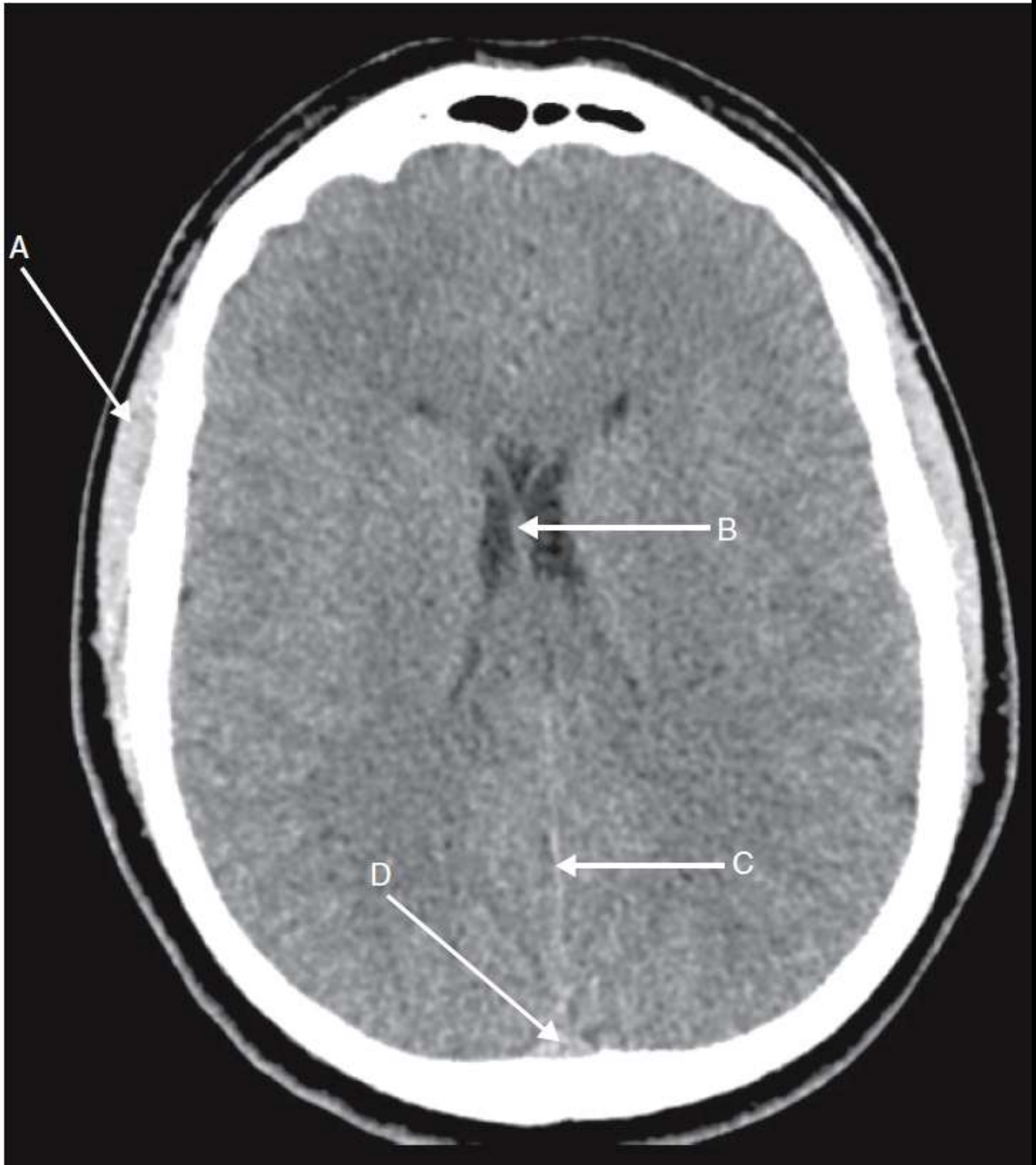
(c) Left pterygoid muscles. The medial pterygoid muscle extends from the pterygoid plates medially to the inner surface of the mandibular condyle laterally. The medial

pterygoid inserts with the masseter by a common tendinous sling onto the medial surface of the ramus and angle of the mandible. It thus contributes to elevation of the jaw. The lateral pterygoid muscle arises from the greater wing of the sphenoid bone, and the lateral surface of the lateral pterygoid plate. It inserts onto the mandibular condyle with its superior head attaching onto the articular disc and fibrous capsule of the temporomandibular joint. It acts by lowering the mandible and so opens the jaw. Unilateral action of a lateral pterygoid produces contralateral excursion and so contributes to chewing.

(d) Left lateral wall of the pharynx. Lateral to this lies fat in the left parapharyngeal space which is seen as high signal on this T1-weighted image.

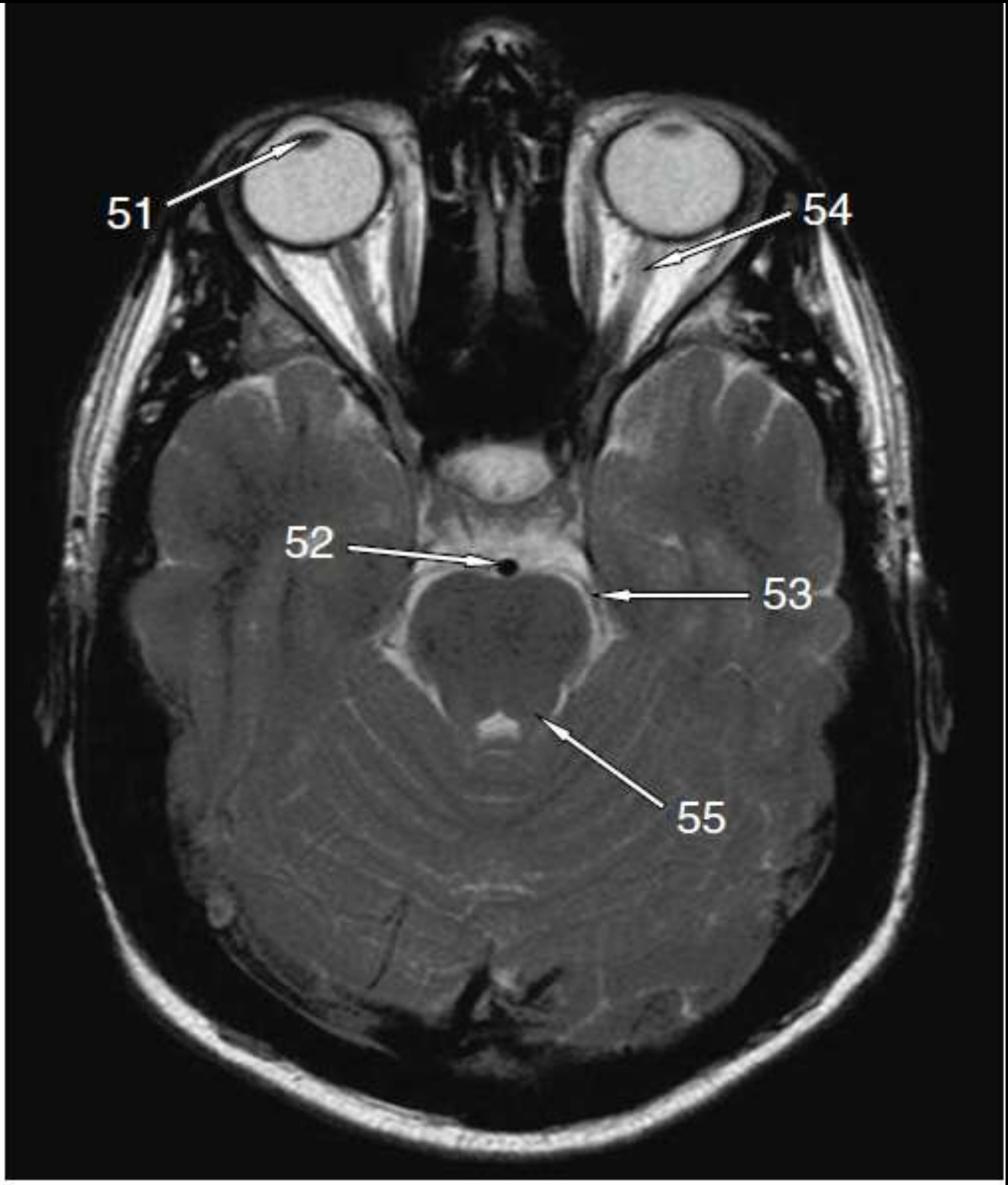
(e) Right ramus of the mandible. The fatty marrow appears bright and the cortex dark on this T1-weighted image.

Case 8.19



8.19 Axial unenhanced CT brain

(a) Right temporalis muscle.
(b) Septum pellucidum.
(c) Falx cerebri.
(d) Superior sagittal sinus.
(e) Cavum septum pellucidum. Cavum septum pellucidum (CSP) is a potential space filled with cerebrospinal fluid that occurs between the leaflets of the septum pellucidum. It is limited posteriorly by the fornix, unlike cavum vergae, which extends as far back as the splenium of the corpus callosum. It is present in 100% of fetuses with approximately 85% fusing by 6 months.

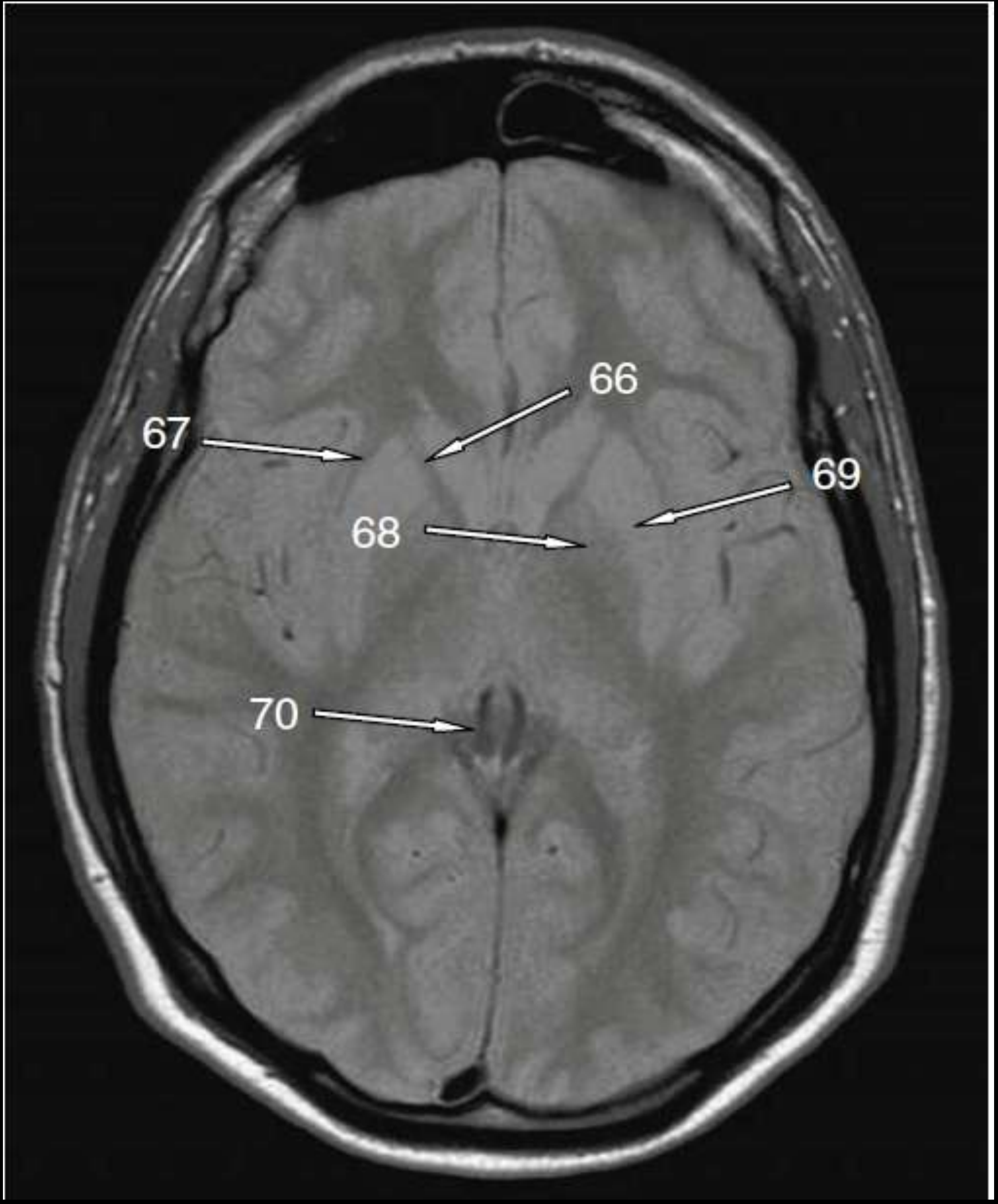


51
54
52
53
55

MRI Brain

51. Lens of right eye
52. Basilar artery
53. Left posterior cerebral artery
54. Left optic nerve
55. Left superior cerebellar peduncle

Vessels in MR are represented as signal void (low signal) because of flow artefact. This slice is through the superior pons; structure 55 is therefore the superior cerebellar peduncle bridging between the pons and cerebellum. The superior and inferior colliculi of the quadrigeminal plate are found higher than this, at the level of the midbrain and do not bridge across to the cerebellum.


66
67
69
68
70

MRI Brain

66. Anterior limb of right internal capsule
67. Right external capsule
68. Left globus pallidus
69. Left putamen
70. Right internal cerebral vein

The globus pallidus (medial) and the putamen (lateral) make up the lentiform nucleus. The external capsule is found lateral to the lentiform nucleus.

The internal cerebral veins are found in the quadrigeminal cistern.


66
67
68
70
69

MRI Brain

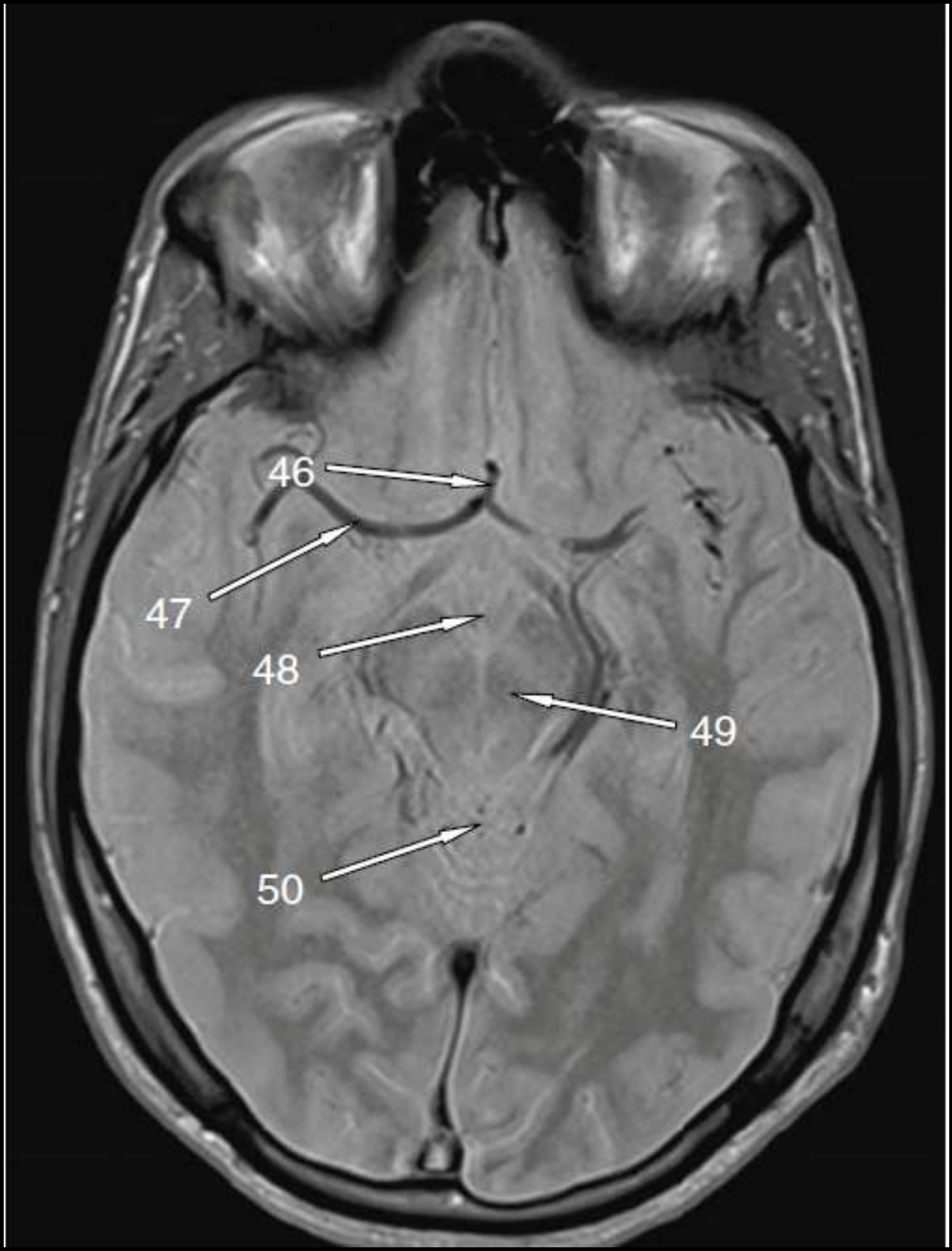
66. Sphenoidal sinus
67. Interpeduncular cistern
68. Aqueduct of Sylvius
69. Choroid plexus in trigone of left lateral ventricle
70. Quadrigeminal cistern

The corpora quadrigemina is made up of the superior and inferior colliculi. The quadrigeminal cistern is the subarachnoid space posterior to it. It contains the confluence of veins which form the great cerebral vein of Galen.


96
97
98
99
100

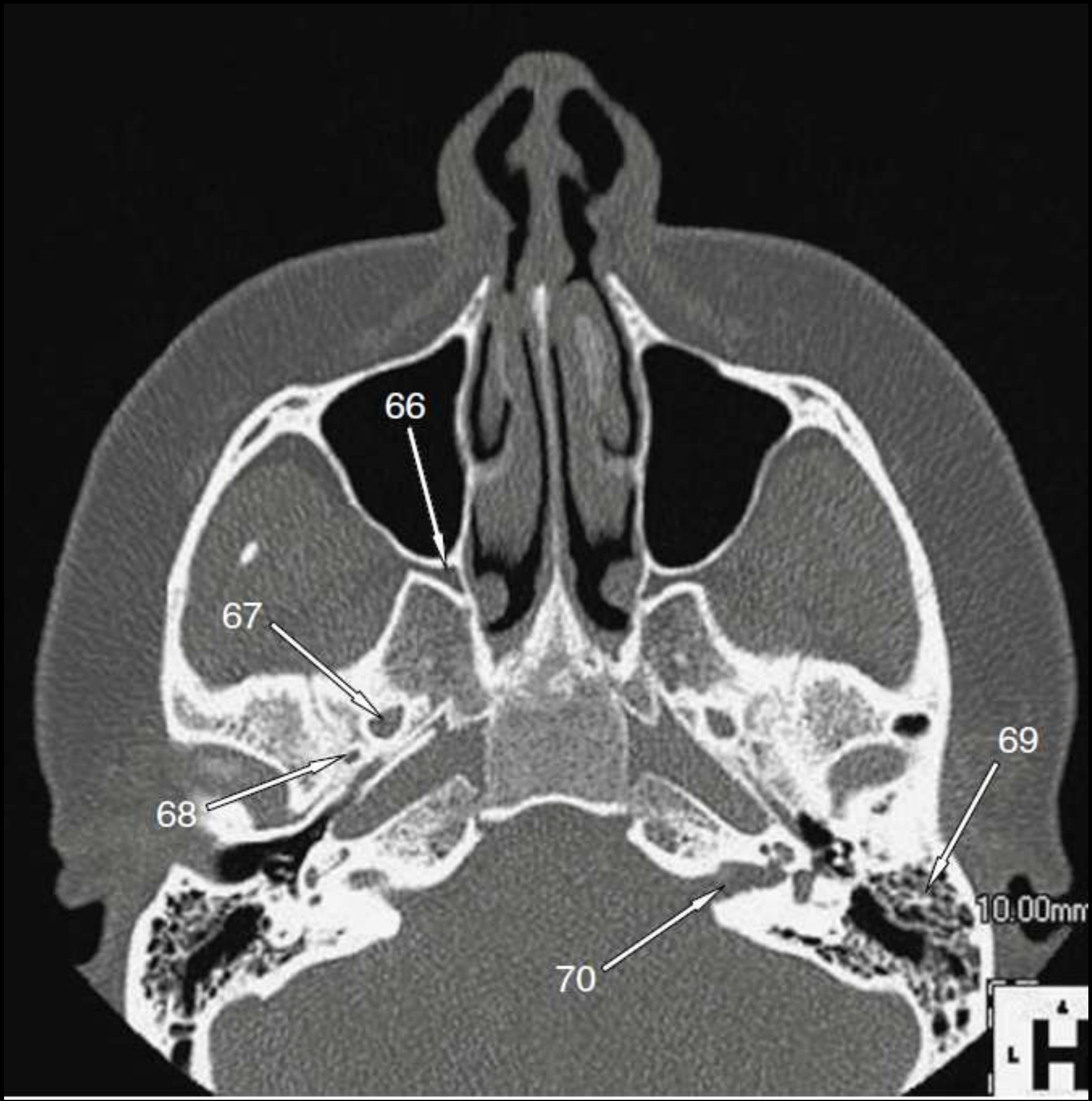
MRI Brain

96. Genu of corpus callosum
97. Head of right caudate nucleus
98. Left interventricular foramen of Monro
99. Left thalamus
100. Splenium of corpus callosum


46
47
48
49
50

MRI Brain

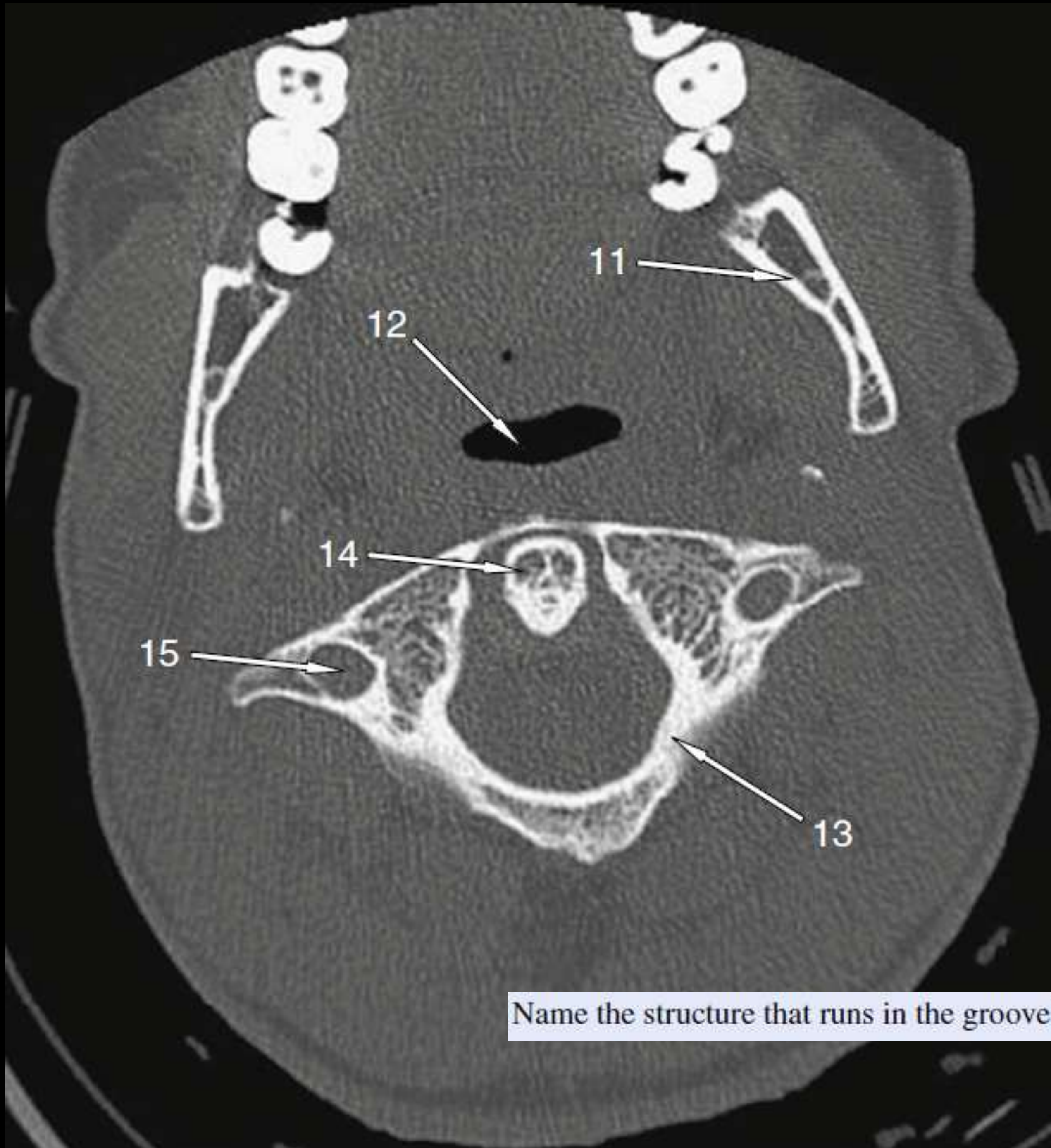
46. Left anterior cerebral artery
47. Right middle cerebral artery
48. Interpeduncular cistern
49. Left red nucleus
50. Quadrigeminal cistern


66
67
68
69
70
10.00mm

CT Sinuses

66. Right pterygopalatine fossa
67. Right foramen ovale
68. Right foramen spinosum
69. Left mastoid air cells
70. Left internal auditory meatus

The internal auditory meatus/internal acoustic meatus is a canal in the petrous part of the *temporal bone*. The VII and VIII cranial nerves enter here.



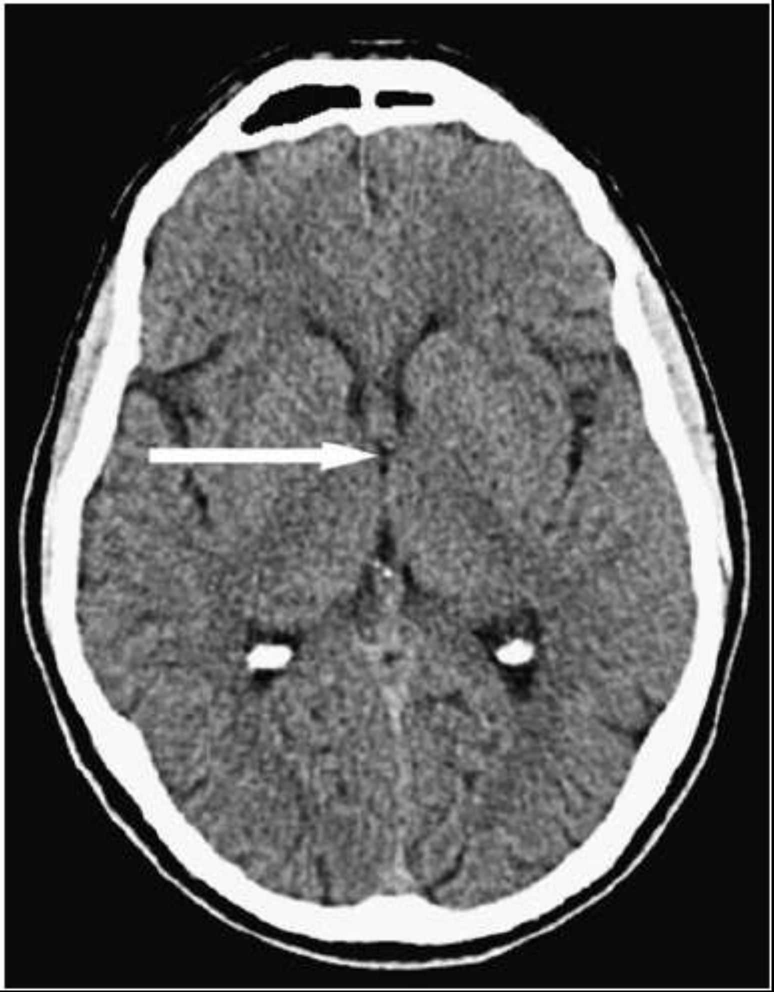
Name the structure that runs in the groove labelled 13.

CT Head

11. Left ramus of mandible
12. Oropharynx
13. Left vertebral artery
14. Odontoid process (dens) of C2 (axis) vertebra
15. Right transverse foramen (foramen transversarium) of C1 (atlas) vertebra

At C1, the vertebral artery lies in the groove on the upper surface of the posterior arch of the atlas before entering the foramen magnum.

Question 17:

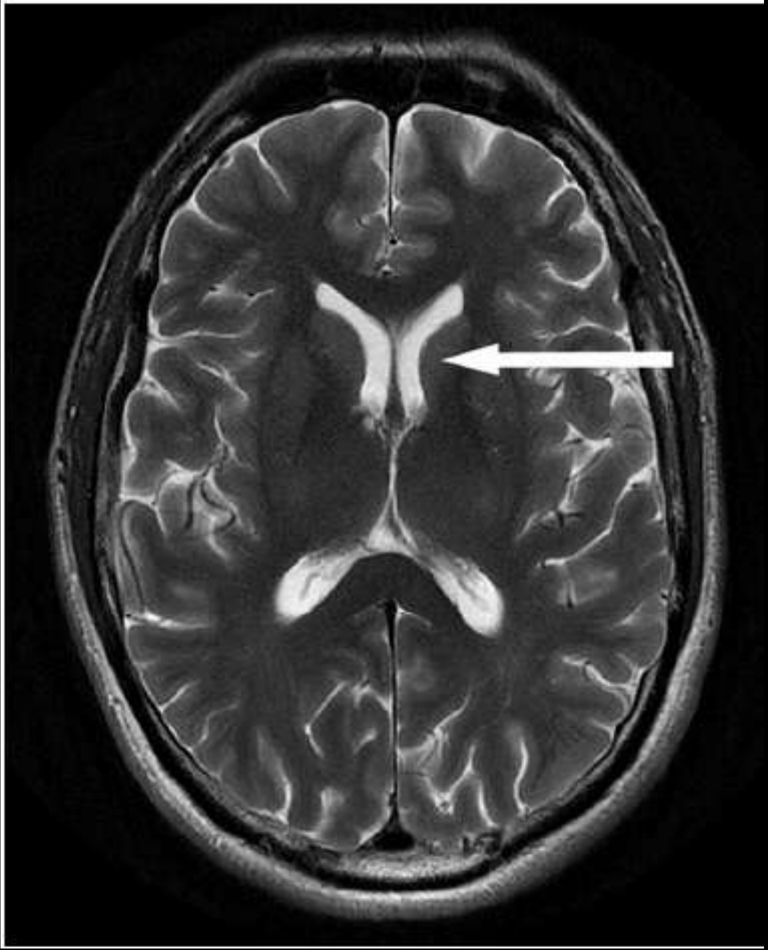


Question 17: Axial CT of the brain

Answer: Third ventricle

- The third ventricle is a slitlike structure in the midline that is filled with cerebrospinal fluid.
- It is connected to the lateral ventricles by the foramina of Monro and to the fourth ventricle by the aqueduct of Sylvius.
- The thalami sit on either side of the third ventricle.

- Question 18:

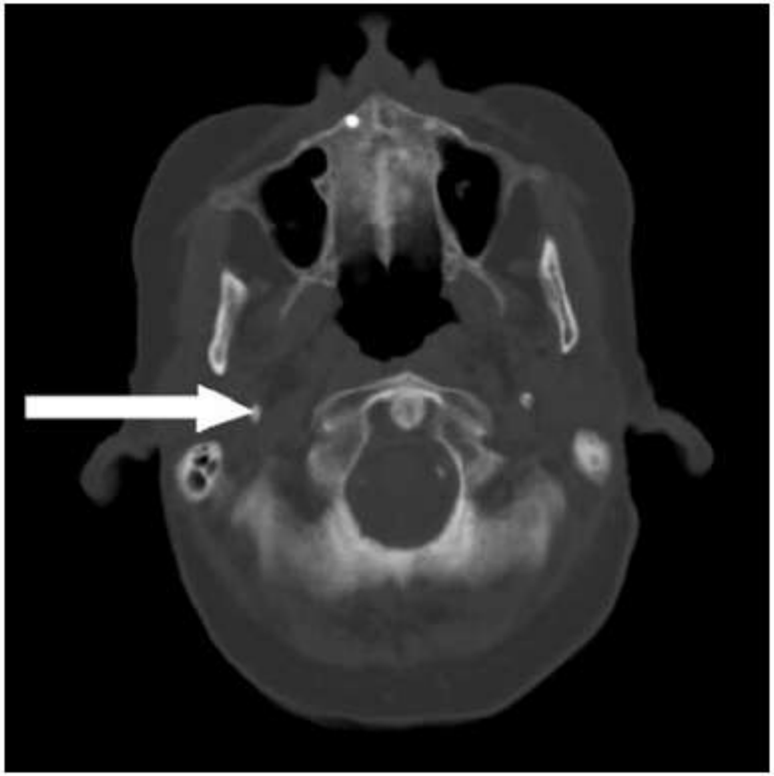


Question 18: Axial T2-weighted MRI of the brain

Answer: Head of the left caudate nucleus

- The caudate nucleus lies lateral to the frontal horn of the lateral ventricle and medial to the internal capsule.
- The caudate consists of the head, body, and tail (posterior).
- Putamen + caudate nucleus = striatum

- **Question 20:**

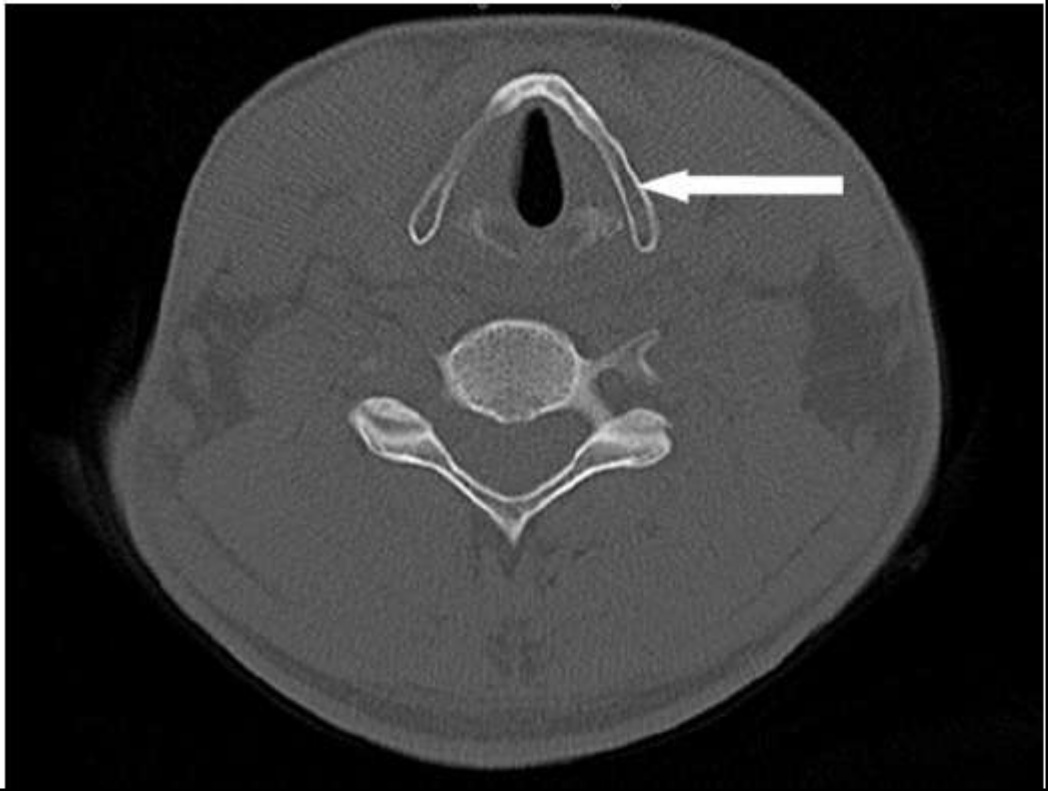


Question 20: Axial CT of the skull base

Answer: Right styloid process

- The styloid process is a long and slender projection of the petrous temporal bone.
- It is the site of attachment of three muscles: the styloglossus, stylohyoid, and stylopharyngeus.
- On axial imaging, the styloid process appears as a small, rounded segment of bone between the ramus of the mandible anteriorly and the mastoid air cells posteriorly.

Question 21:

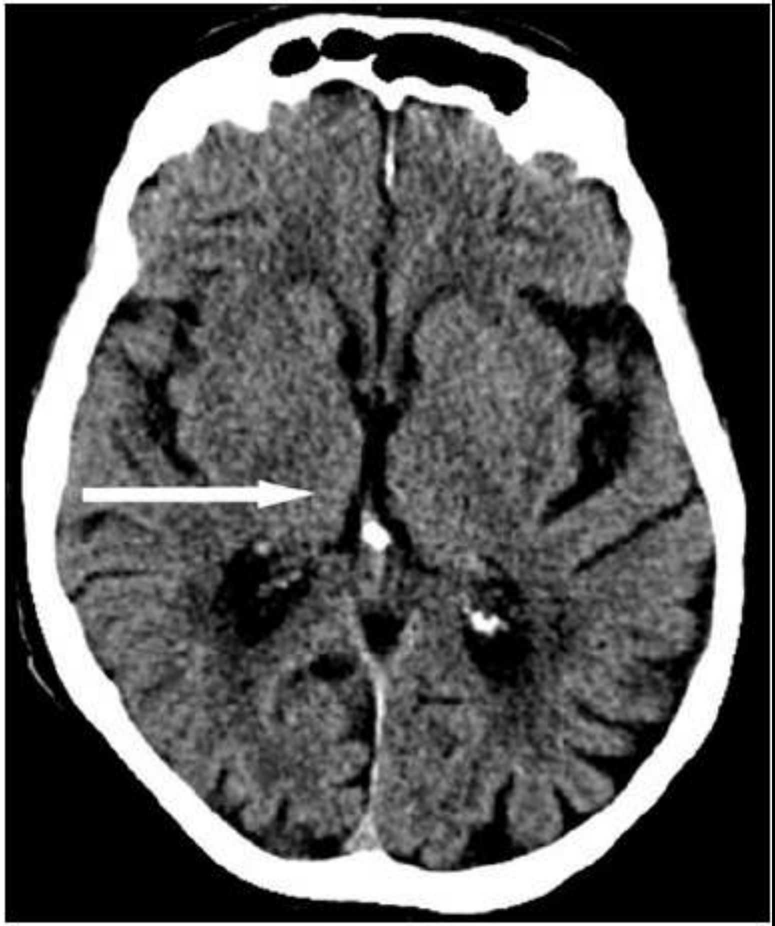


Question 21: Axial CT of the neck

Answer: Thyroid cartilage

- When viewed anteriorly, the thyroid cartilage is a shield-shaped structure that is composed of two flat plates (laminae) that converge in the midline to form the laryngeal prominence.
- The epiglottis is attached to the inner surface of the thyroid cartilage at the midline.
- Extending from the posterior border of each lamina are superior and inferior horns to which numerous muscles of the larynx attach.

- **Question 22:**



Question 22: Axial CT of the brain

Answer: Right thalamus

- The thalamus is a paired, walnut-shaped, deep grey matter multinuclear structure that lies on either side of the third ventricle and anterior to the occipital horn of the lateral ventricles.
- It acts as a sensory and motor synaptic relay centre.

- **Question 23:**

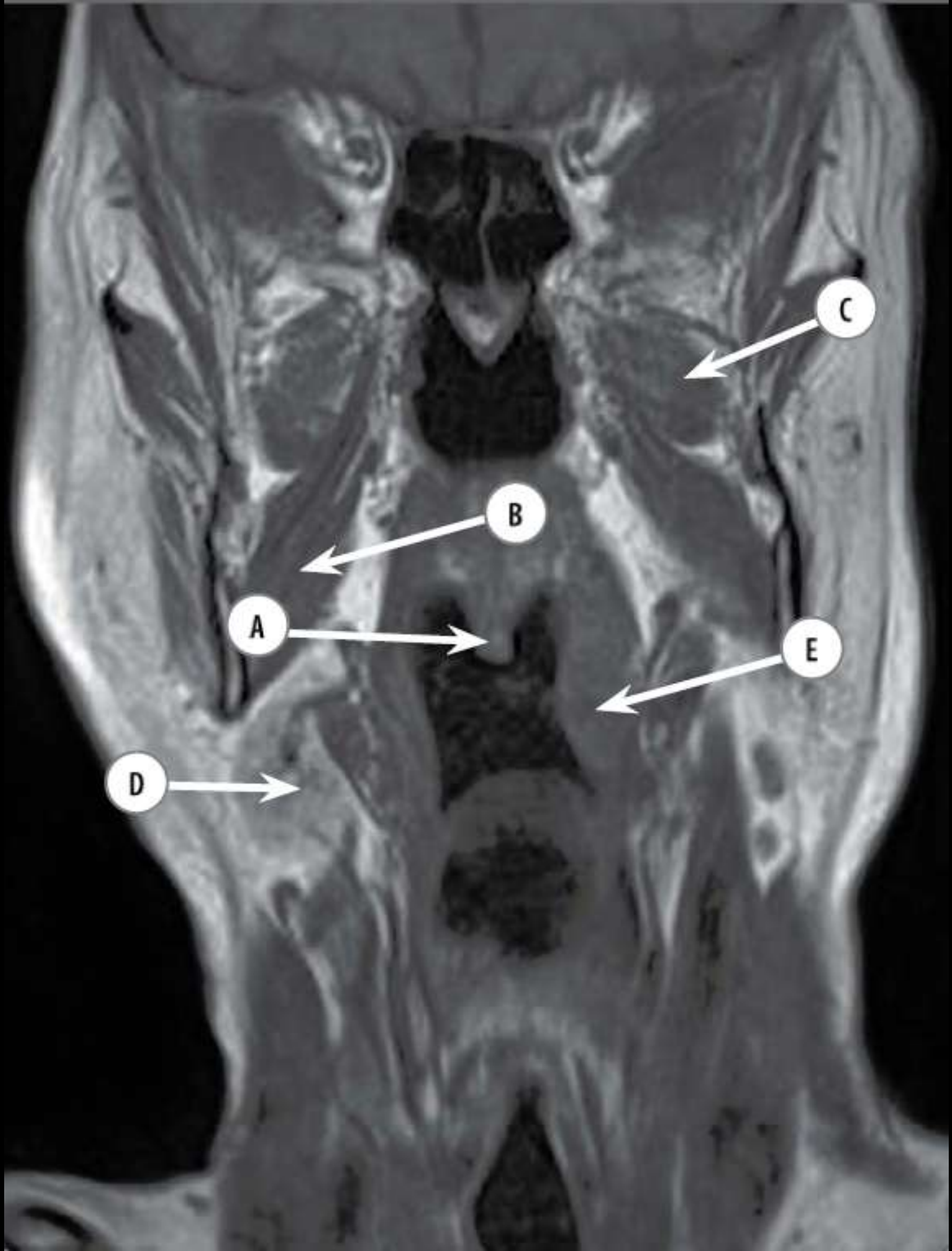
Question 23: Axial CT of the brain

Answer: Left central sulcus of Rolando

- The central sulcus of Rolando is identifiable on an axial CT as the most crooked horizontal fissure resembling an upside down omega (Ω).
- It separates the frontal lobe from the parietal lobe posteriorly.
- The precentral gyrus (anterior) is involved with motor control; the postcentral gyrus (posterior) is involved with sensation.

CORONAL

Case 1.48



Case 1.48

A Uvula

B Right medial pterygoid

C Left lateral pterygoid

D Right submandibular gland

E Palatal constrictor muscles

Coronal MRI of the neck.

The uvula is a soft tissue projection from the middle of the soft palate. It aids in articulation of speech, particularly in guttural, uvular consonant and clicking sounds not found in English. The palatal constrictor muscles (palatoglossus and palatopharyngeus) run from the base of the uvula to the tongue and pharynx. They form the anterior and posterior fauces, between which the palatine tonsils sit.

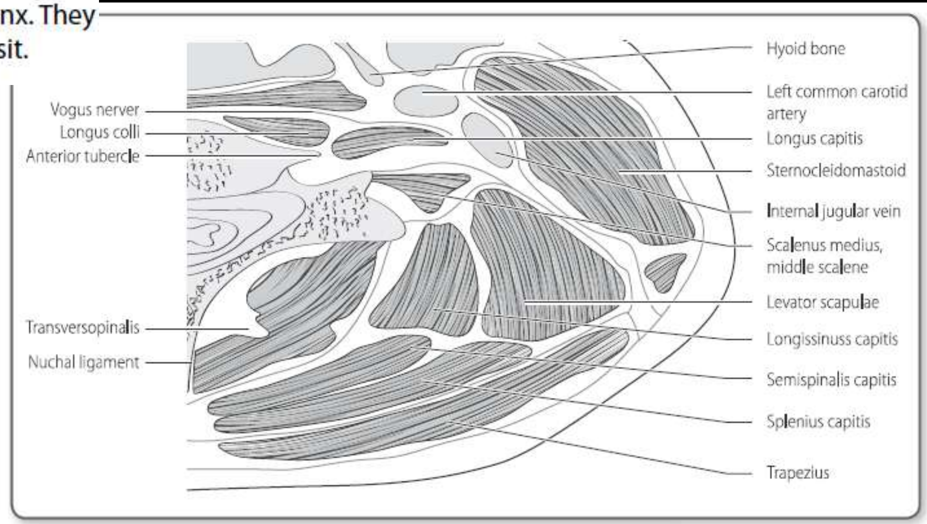
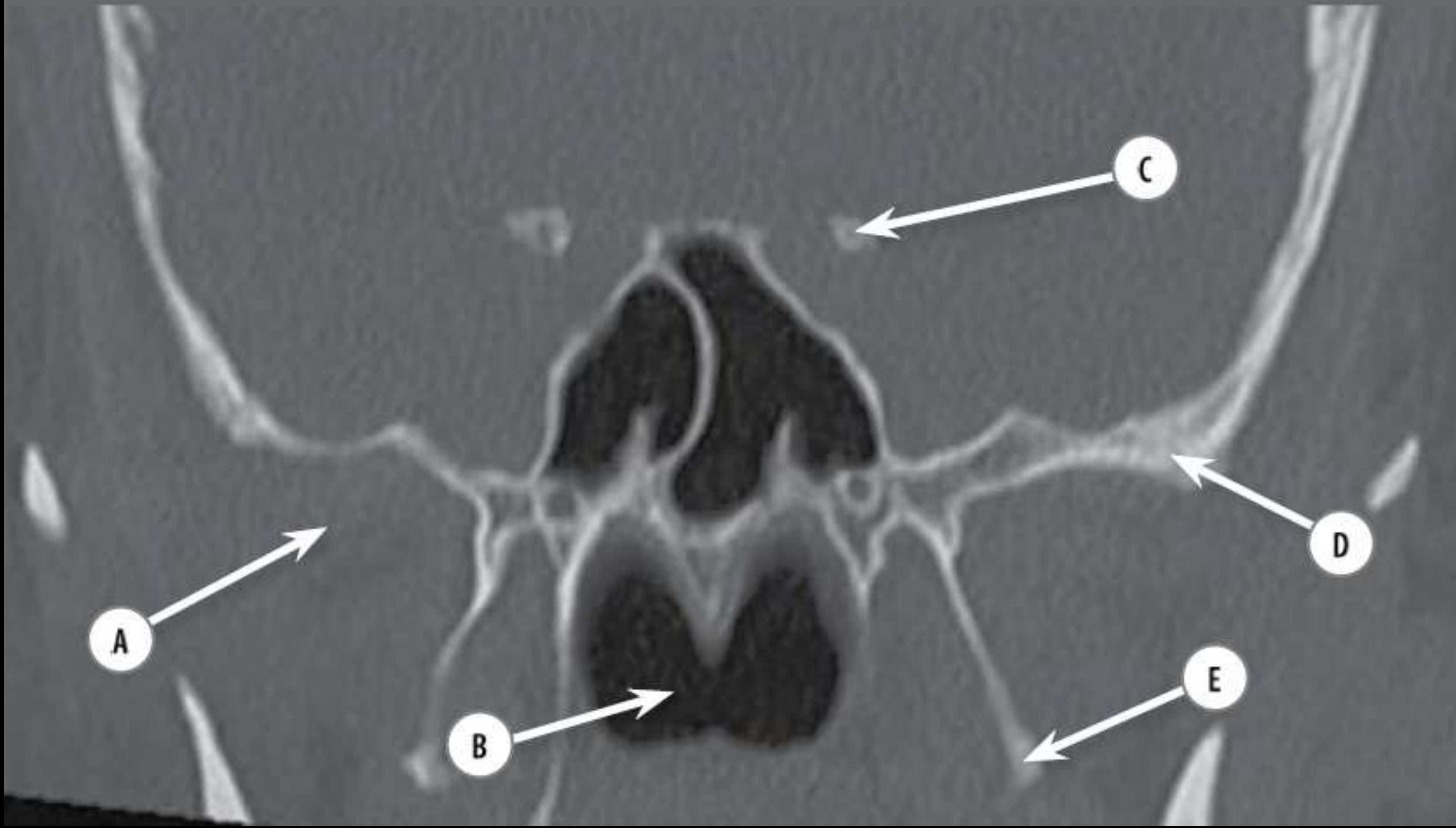


Figure 1.12 The deep muscles of the neck.

The submandibular gland sits in the submandibular or digastric triangle, which is a space between the inferior border of the mandible and the anterior and posterior bellies of the digastric muscle. The submandibular (Wharton's) duct opens in the floor of the mouth adjacent to the frenulum of the tongue.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 30–31.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 935, 1032.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 17, 41.

Case 1.57



Case 1.57

A Right infratemporal fossa

B Nasopharynx

C Left anterior clinoid process

D Left greater wing of sphenoid

E Left lateral pterygoid plate

Coronal CT of the head.

The sphenoid bone is made up of a body (the basisphenoid), greater and lesser wings, as well as the pterygoid plates, which extend inferiorly behind the maxilla. The lesser wing of the sphenoid bone makes up the posterior part of the floor of the anterior cranial fossa, while the greater wing forms the floor of the middle cranial fossa. The posterior border of the lesser wing is demarcated by the sphenoid ridge, while the posterior border of the greater wing is found where it meets the petrous

ridge. Below the greater wing of sphenoid is found the infratemporal fossa, into which open the foramen ovale and spinosum.

The sphenoid sinuses are contained within the body of sphenoid. These are paired, usually asymmetric structures.

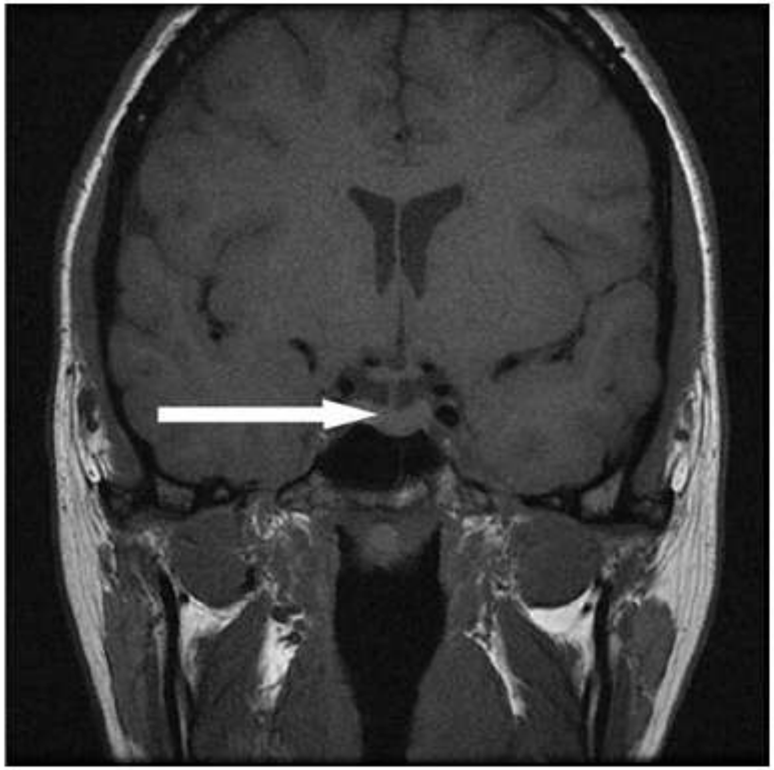
The infratemporal fossa is found below the floor of the middle cranial fossa, lateral to the nasopharynx and posterior to the maxilla. Behind it is found the styloid process, the carotid artery, jugular vein, and the deep part of the parotid gland. Laterally, this space extends to the zygomatic arch, mandibular ramus and the temporalis muscle. There is no separation between the temporal fossa superiorly and the infratemporal fossa below – they communicate via the space between the zygomatic arch and the skull.

The medial extent of the infratemporal fossa is bounded by the lateral pterygoid plate, and the pterygoid muscles are contained within it. The pterygomaxillary fissure separates the pterygoid plates from the maxilla superiorly.

There is a small medial depression of the pterygomaxillary fissure, called the pterygopalatine fossa, which is found between the pterygoid process and the posterior maxilla. This fossa has several spaces which open into it. Superiorly, it communicates with the orbit via the inferior orbital fissure, and the middle cranial fossa via the foramen rotundum. Through the sphenopalatine foramen, it communicates with the nasal cavity, and through the greater palatine canal, the mouth. Laterally, this space opens out into the infratemporal fossa. From the foramen rotundum, the maxillary division of the 5th cranial nerve crosses this space before passing through the inferior orbital fissure. It also contains the pterygopalatine segment of the maxillary artery.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2011: 35.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 22.

- **Question 7:**

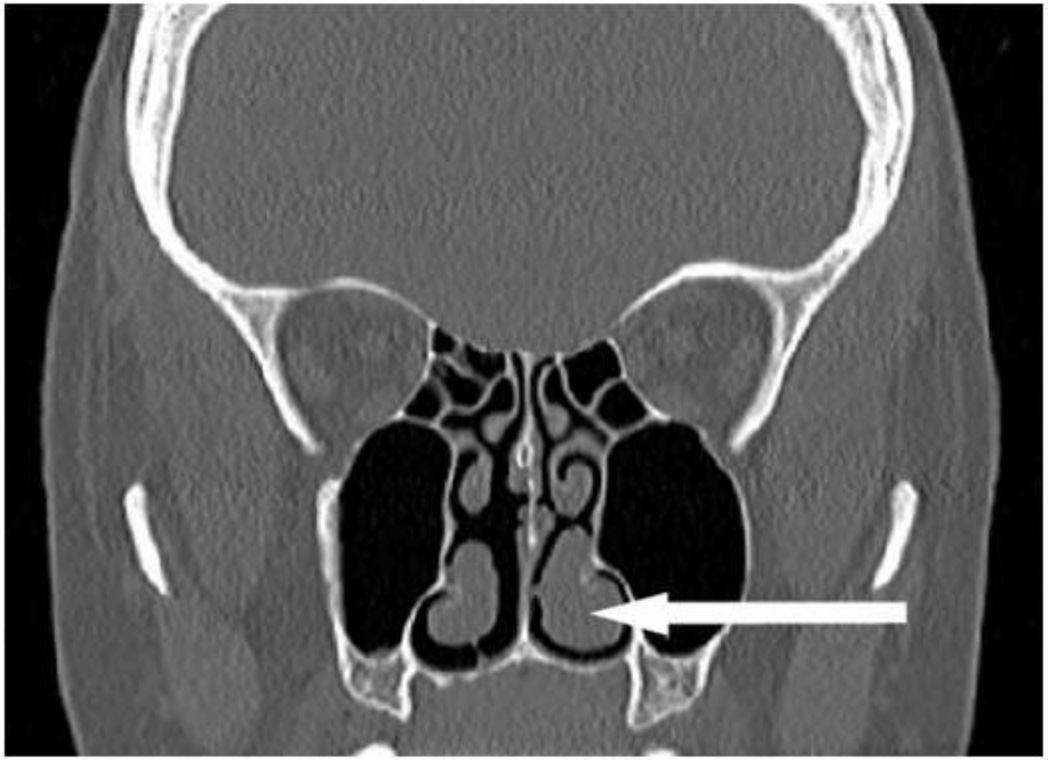


Question 7: Coronal T1-weighted MRI of the brain

Answer: Pituitary gland

- The pituitary gland is harder to recognise on coronal images given that you will be more used to looking at it on sagittal views.
- There are several clues that will help you identify this structure.
  - It sits within a depression in the sphenoid sinus—this is the sella turcica.
  - There is a stalk arising from its superior aspect—this is the infundibulum.
  - It is a midline structure.
  - The optic chiasm is superior.

■ Question 10:

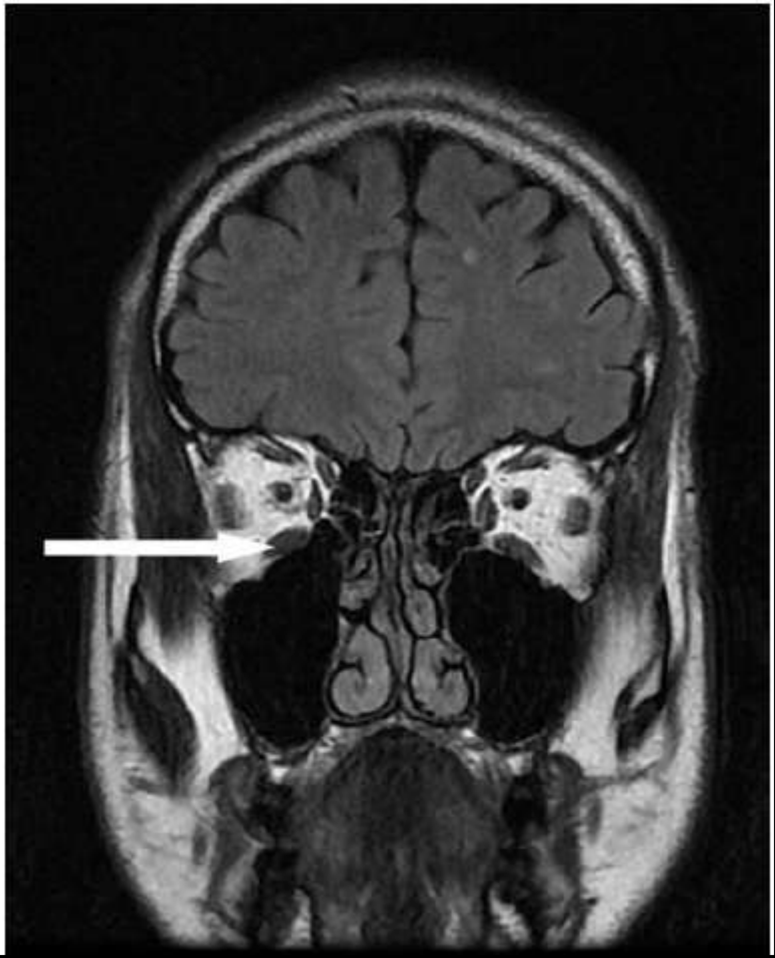


Question 10: Coronal CT of the brain

Answer: Left inferior nasal turbinate bone

- The turbinates are respiratory epithelium-lined, curled bones in the lateral portion of the nasal cavity.
- They are divided by the nasal septum in the midline.
- There are three pairs of nasal turbinates:
  - Inferior turbinates (the largest)
  - Middle turbinates
  - Superior turbinates

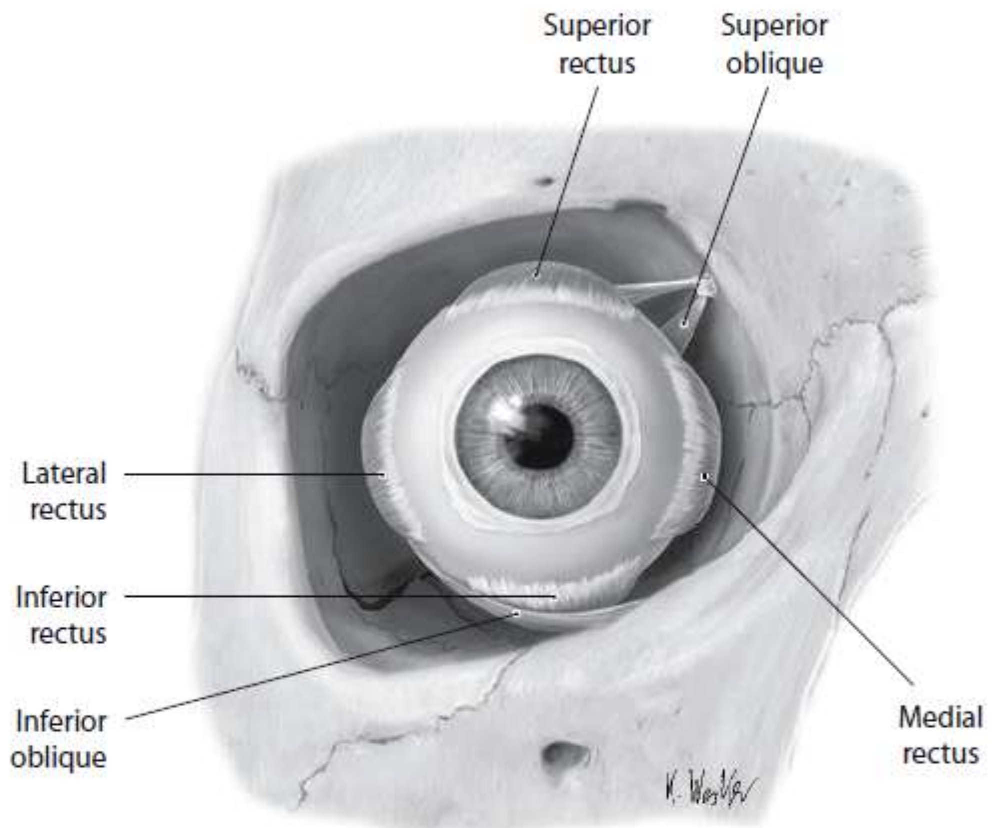
Question 11:



Question 11: Coronal MRI of the brain

Answer: Right inferior rectus muscle

- The inferior rectus muscle is a paired structure that depresses the eye.
- It is innervated by the oculomotor nerve.
- It is one of the six extraocular muscles of the orbit. See figure below.



From Atlas of Anatomy, © Thieme 2008, illustration by Karl Wesker.

Q5

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 which separates the two lateral ventricles

Q5 Answers

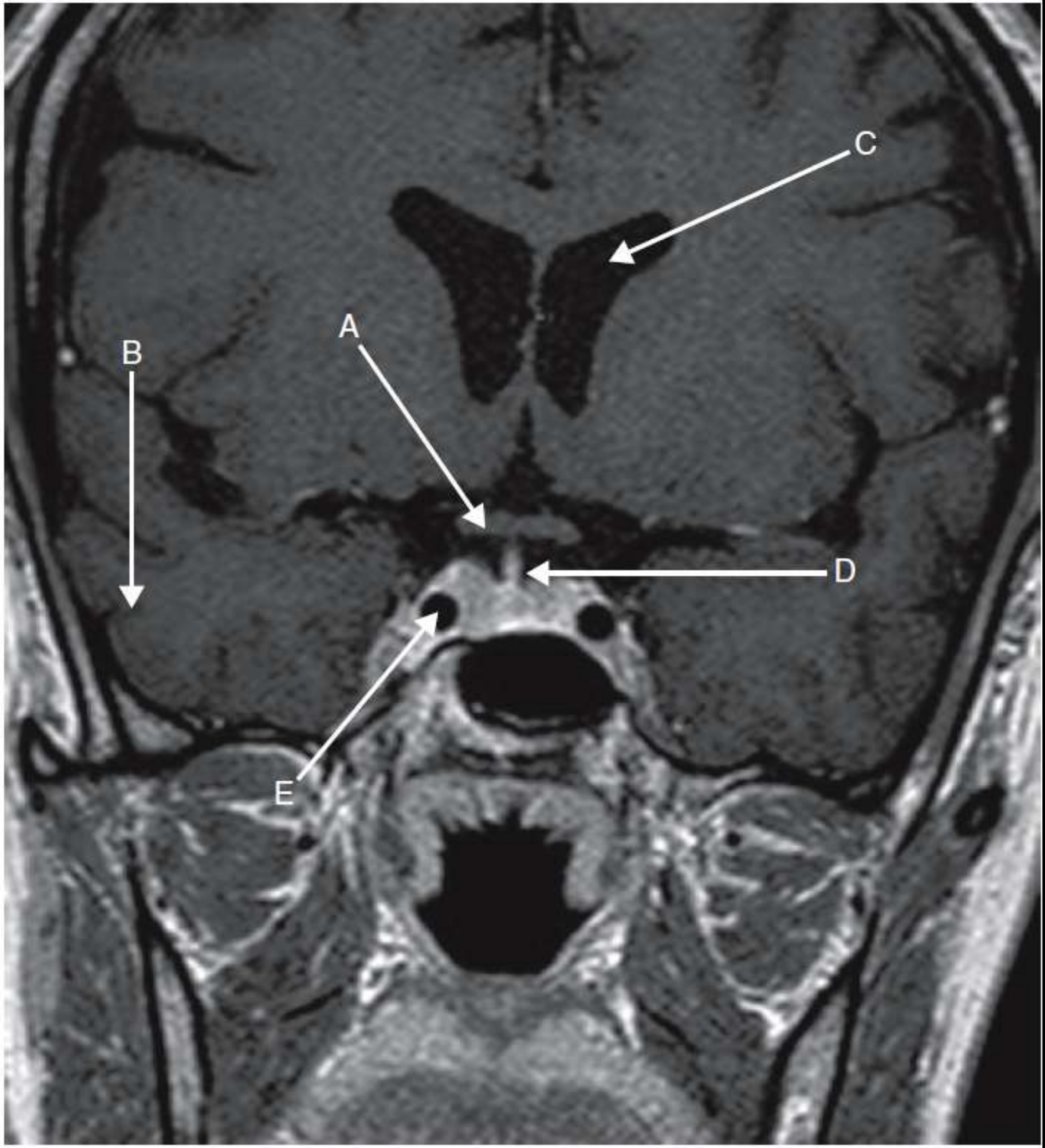
- **a** Corpus callosum
- **b** Right head of caudate
- **c** Anterior limb left internal capsule
- **d** Right internal carotid artery within cavernous sinus
- **e** Septum pellucidum

T2W MRI of brain, coronal section at level of cavernous sinus

In coronal section the corpus callosum is clearly seen connecting the white matter of the two cerebral hemispheres. Similarly, the limbs of the internal capsule are seen to radiate from central to peripheral; the anterior limb lies anterior to the midline of the brains long axis which roughly corresponds with the position of the midbrain (the image provided is anterior to the brainstem).

The carotid artery turns through 180 degrees within the cavernous sinus before exiting superiorly and dividing into its terminal branches.

Case 6.7



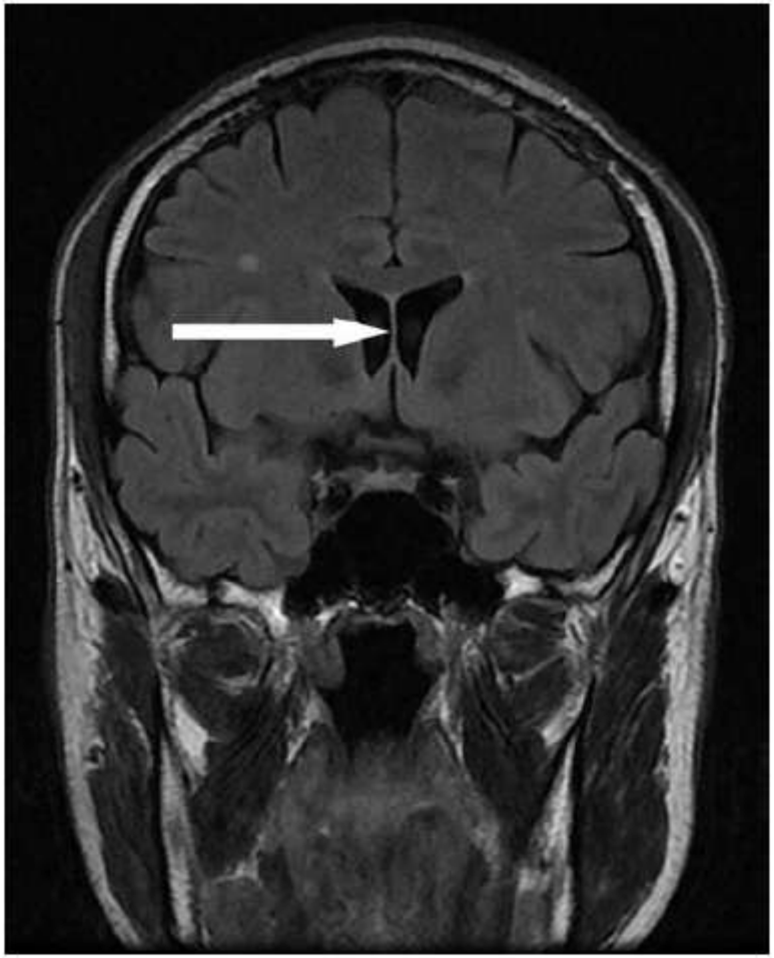
6.7 Coronal MRI pituitary

(a) Optic chiasm.
(b) Right middle temporal gyrus.
(c) Left lateral ventricle.
(d) Pituitary stalk.
(e) Right internal carotid artery in cavernous sinus. The cavernous sinus is a large thin-walled vein bordered by the temporal and sphenoid bones and lying lateral to the sella turcica. In addition to the internal carotid artery, the III, IV, V and VI cranial nerves also lie within the sinus.

Coronal MRI is useful for assessing the pituitary gland. When learning, a lot of radiologists think the sagittal sequence is more useful, but in practice the coronal sequence enables complete assessment of the pituitary when pre- and post-contrast T1-weighted sequences are obtained. The superior surface of the pituitary is concave or horizontal upwards. Any convexity upwards suggests a space-occupying lesion.

The pituitary stalk should lie in a central position and the pituitary gland should enhance uniformly. An area of pituitary that does not enhance may be caused by a pituitary microadenoma.

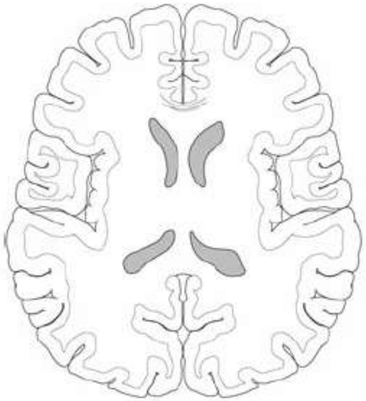
Question 49:



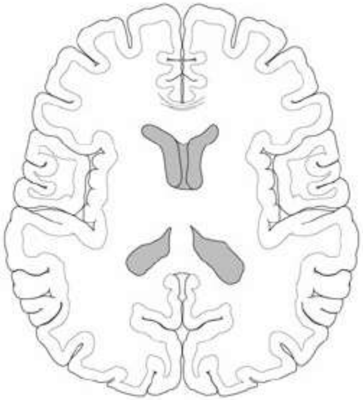
Question 49: Coronal MRI of the brain

Answer: Septum pellucidum

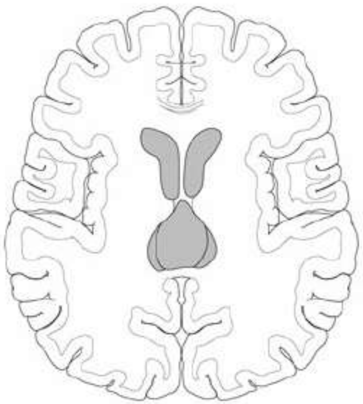
- The septum pellucidum is a thin, vertical membrane in the midline extending from the corpus callosum to the fornix posteriorly.
- It separates the frontal horns of the left and right lateral ventricles.
- The septum pellucidum is situated anterior to the foramina of Monro.
- Normal variants:
  - Cavum septum pellucidum (anterior) and/or cavum septum vergae (posterior): Nonobliteration of the potential space between the leaflets of the septum pellucidum
  - Cavum velum interpositum: Dilated CSF-filled space involving the velum interpositum, which extends from the foramina of Monro to the quadrigeminal cistern



Normal

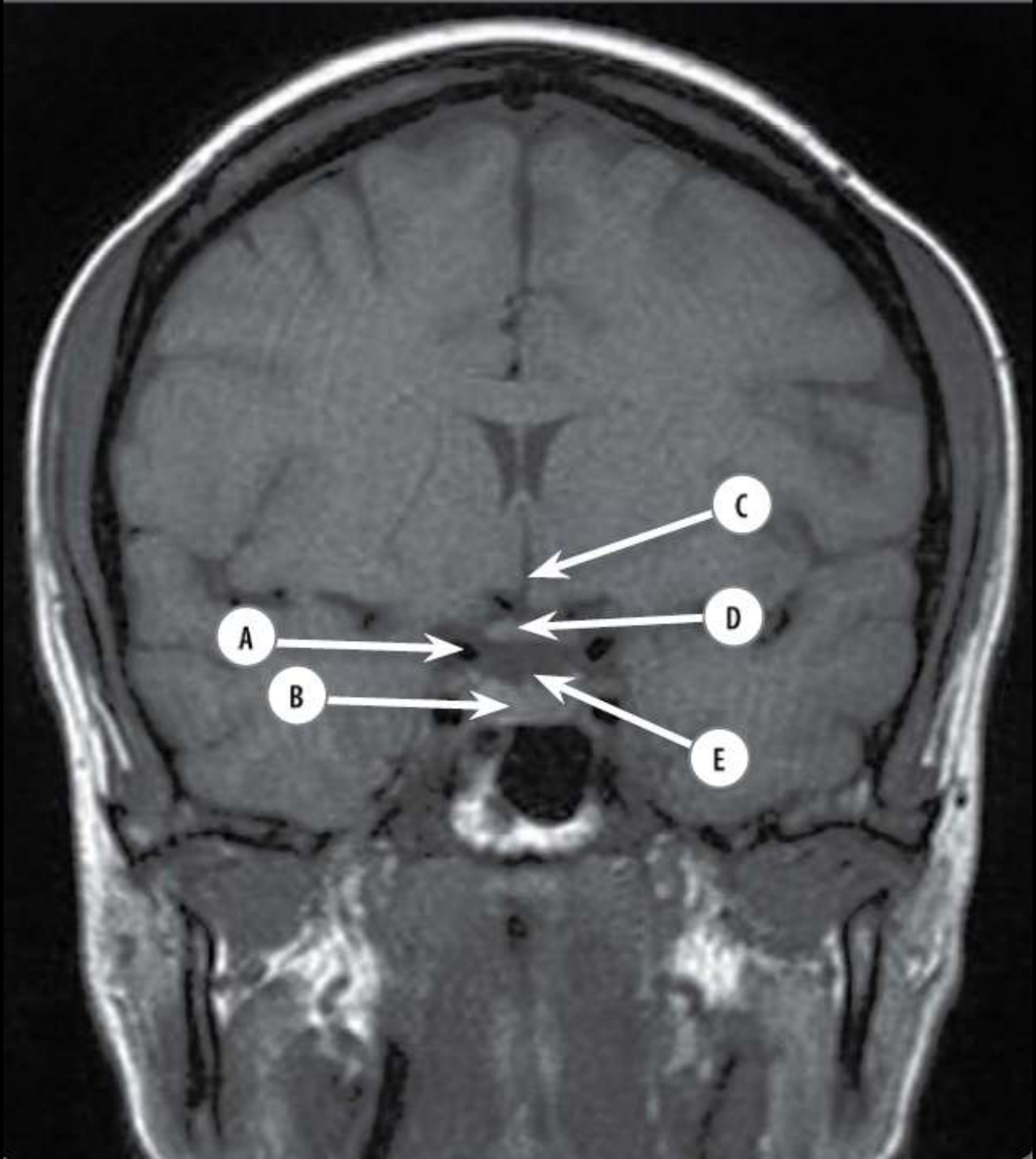


Cavum septum pellucidum



Cavum velum interpositum

Case 1.52



Case 1.52

A Right anterior cerebral artery

B Pituitary gland

C Third ventricle

D Optic chiasm

E Pituitary stalk

Sagittal MRI through the pituitary fossa.

The pituitary gland sits in the pituitary fossa of the sella turcica. It is connected to ce bodies of the hypothalamus by a stalk or infundibulum, which arises from the tuber cinereum in the floor of the third ventricle (**Figures 1.15** and **1.16**).

The posterior lobe produces the hormones oxytocin and vasopressin, and their presence gives a high signal on T1-weighted MRI. They are released in response to nervous stimulation from the hypothalamus.

The anterior lobe is of lower signal and secretes adrenocorticotropic hormone, thyroid-stimulating hormone, luteinising hormone, follicle-stimulating hormone, growth hormone and prolactin in response to factors carried down from the hypothalamus by the hypophyseal veins.

The third ventricle is the slit-thin midline ventricle which lies between the thalami.

Case 1.52

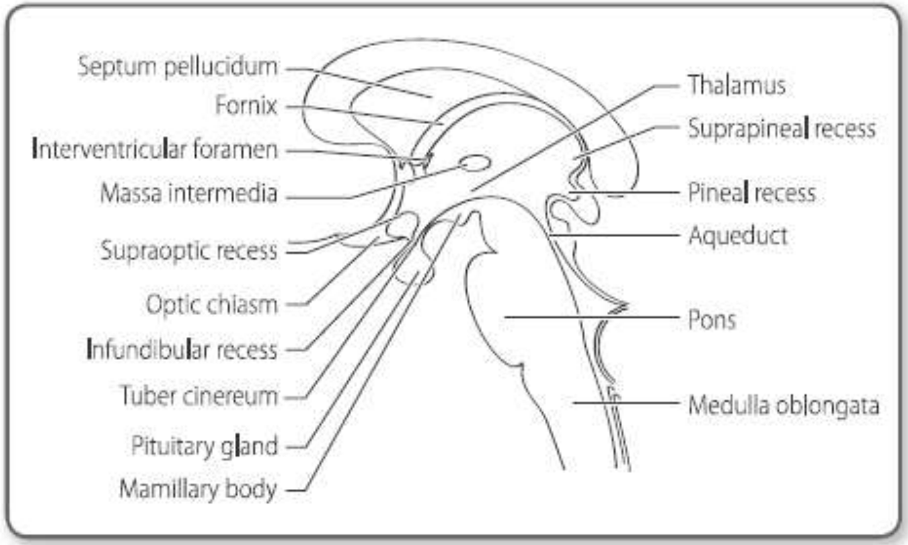


Figure 1.15 Sagittal anatomy of the third and fourth ventricles.

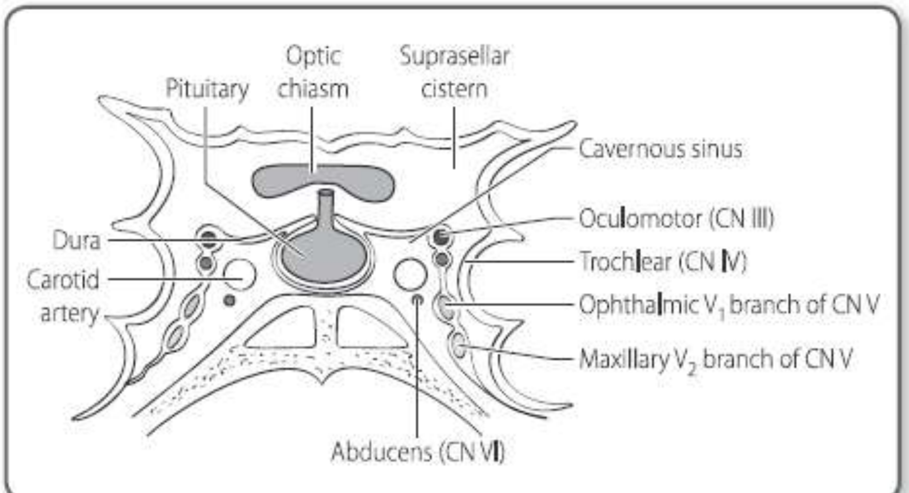


Figure 1.16 Coronal anatomy of the cavernous sinus C, carotid artery; SS, sphenoid sinus.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 54.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 887.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 66.

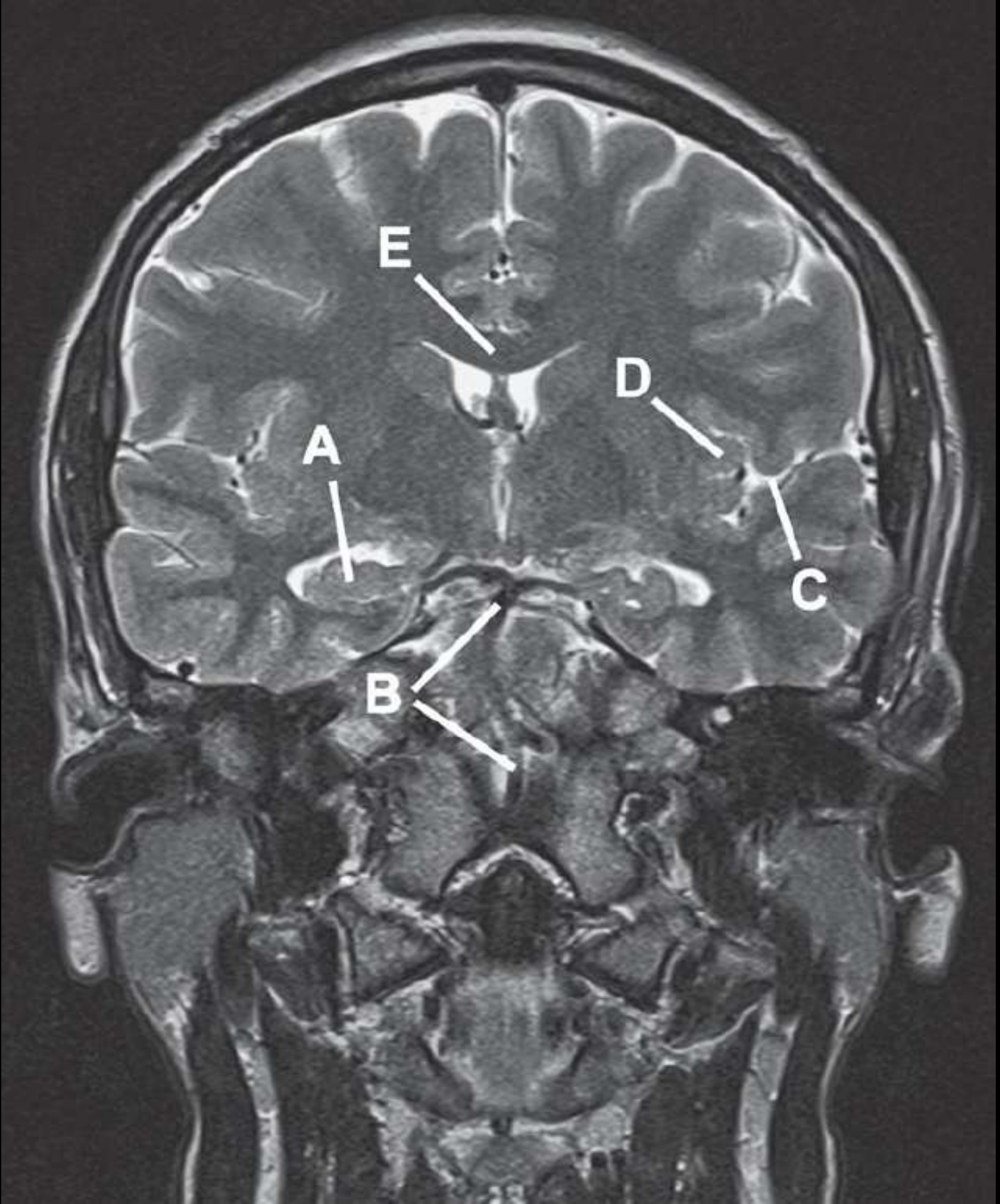
Case 6.15

6.15 Coronal T1-weighted MR oropharynx

(a) Subglottis. This is the area immediately below the cords and is an important area for assessing tumour spread in laryngeal carcinoma.
(b) Right vocal cord. The vocal cords are identified by their muscle signal intensity.
(c) Left submandibular gland. The normal gland appears of intermediate signal intensity compared with muscle on both T1-weighted and T2-weighted images.
(d) Midline septum of the tongue. This is high signal on T1-weighted and T2-weighted images due to fat content.

This is an important landmark when staging tongue tumours to assess spread across the midline.

(e) Soft palate. This marks the division between the naso- and oropharynx.


E
D
A
C
B

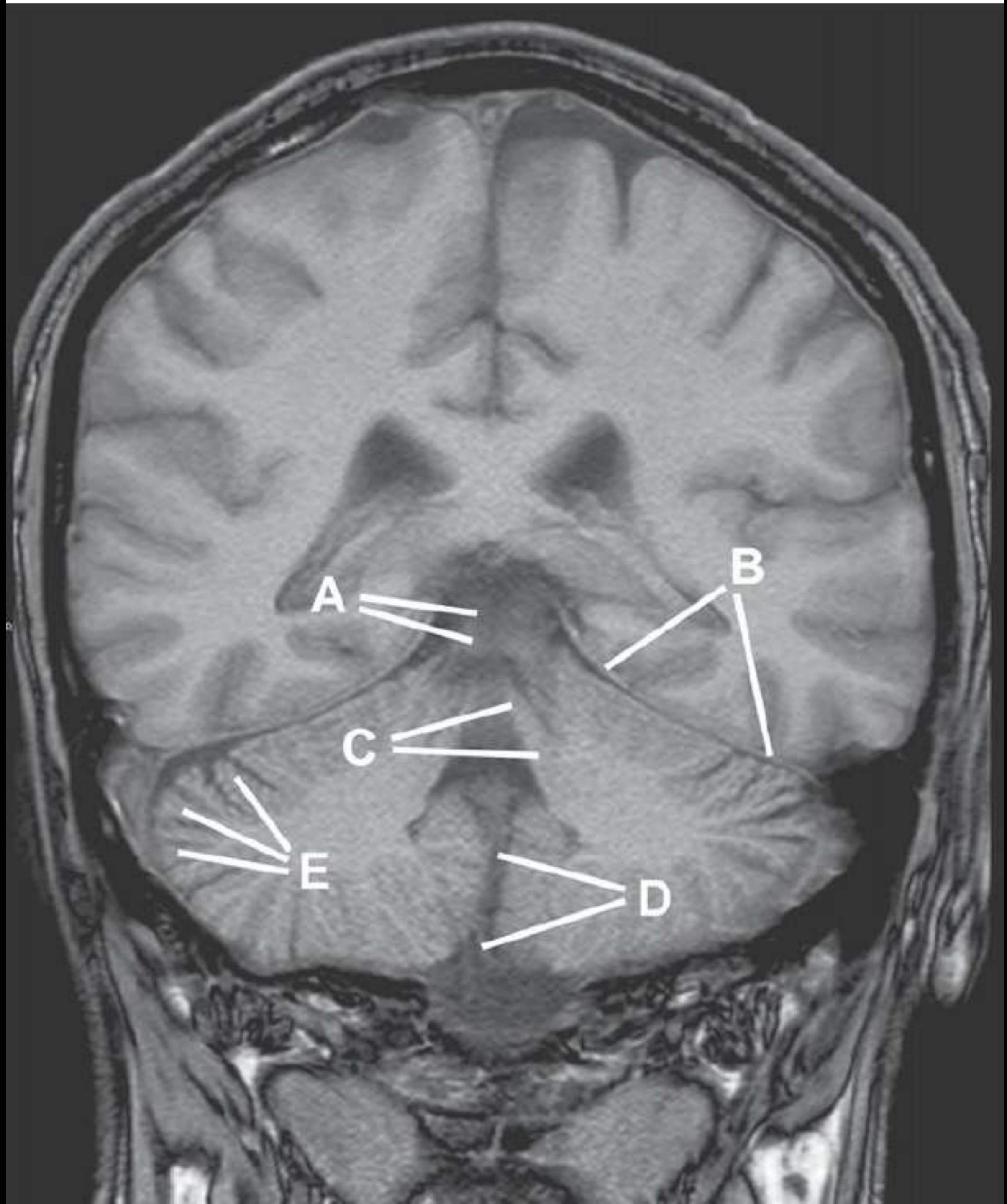
Q17 Answers

a Hippocampus
b Basilar artery
c Sylvian fissure
d Insula
e Corpus callosum

T2W MRI of brain, coronal section at level of the hippocampi

The limbic system describes a number of structures including the hippocampus, amygdala, cingulate gyrus, mammillary body and fornix (to name only a few) which are grouped as two C-shaped arches located medially in the cerebral hemispheres. They are functionally related, all being involved with emotion, memory and instinctive behaviour. Many of these structures are recognizable on MRI. The hippocampus is best seen in the coronal plane as a curved elevation in the floor of the inferior horn of the lateral ventricle. The parahippocampal gyrus lies inferior to the hippocampus and forms the infero-medial part of the temporal lobe. The insular cortex forms the floor of the lateral sulcus (sylvian fissure); its function is not clearly defined but is related to the limbic system.

The corpus callosum is the largest of the commissural white matter tracts (commisures link corresponding parts of the two hemispheres) and is best demonstrated on a midline sagittal view.


A
B
C
D
E

Q21 Answers

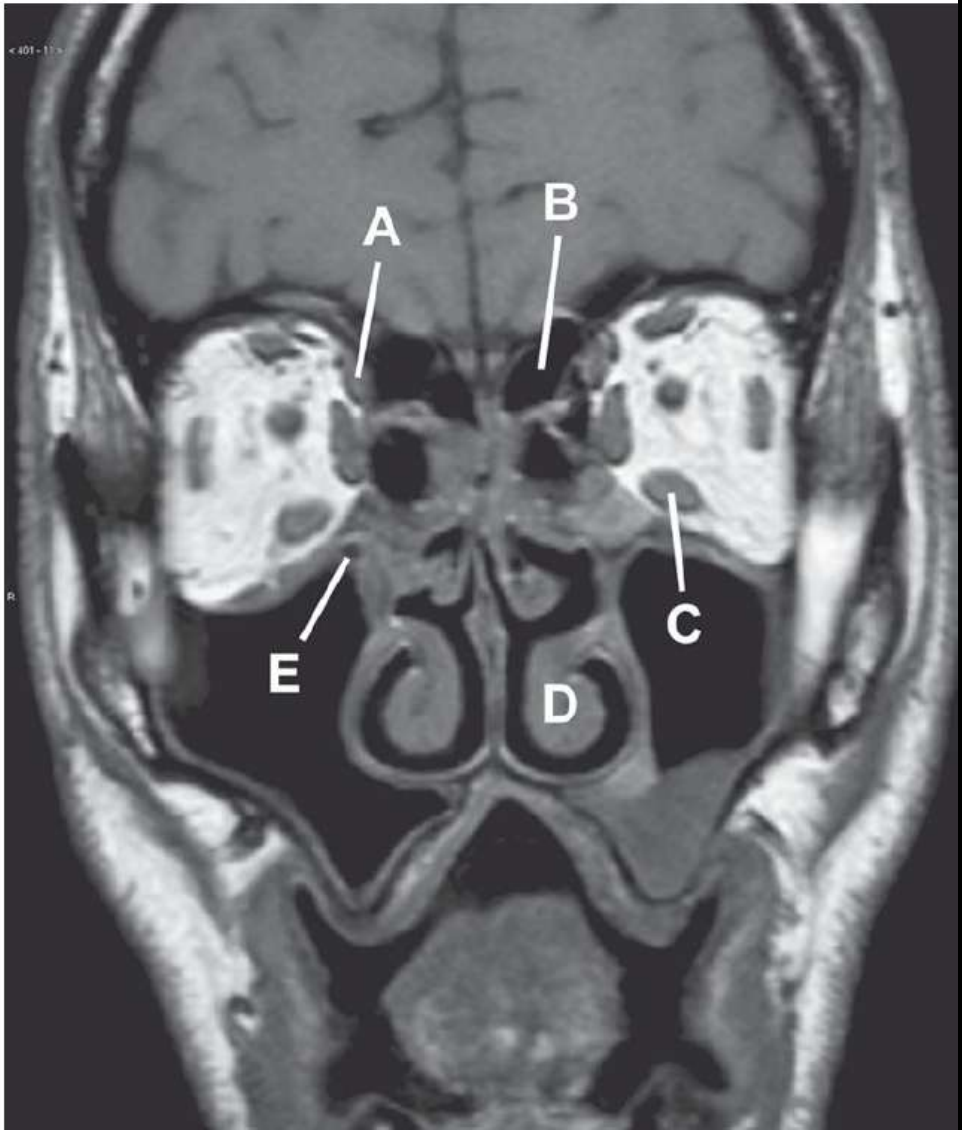
- **a** Superior and inferior colliculus
- **b** Tentorium cerebelli
- **c** Left superior cerebellar peduncle
- **d** Vermis
- **e** Folia

T1W MRI through cerebellum and 4th ventricle, coronal section

The cerebellum lies in the posterior fossa of the cranium and is separated from the cerebral hemispheres by the tentorium cerebelli, an invagination of dura between the cerebral and cerebellar hemispheres similar to the falx cerebri in the sagittal midline. The cerebellum lies posterior to the brain stem and the two are connected by three paired peduncles, named superior, middle and inferior. Between these peduncles and between the cerebellum and brainstem is the 4th ventricle. The two cerebellar hemispheres are joined in the midline by the vermis. Each hemisphere is divided into anterior, posterior and flocculonodular (inferior) lobes; the nodule lies at the end of the vermis near the floor of the 4th ventricle. The cerebellar surface is highly convoluted, the gyri are known as folia (as in foliage or leaves).

Q23

- **a** Name the structure labelled A
- **b** Name the structure labelled B
- **c** Describe the movement provided by the muscle labelled C
- **d** Name the structure labelled D
- **e** Name the opening labelled E



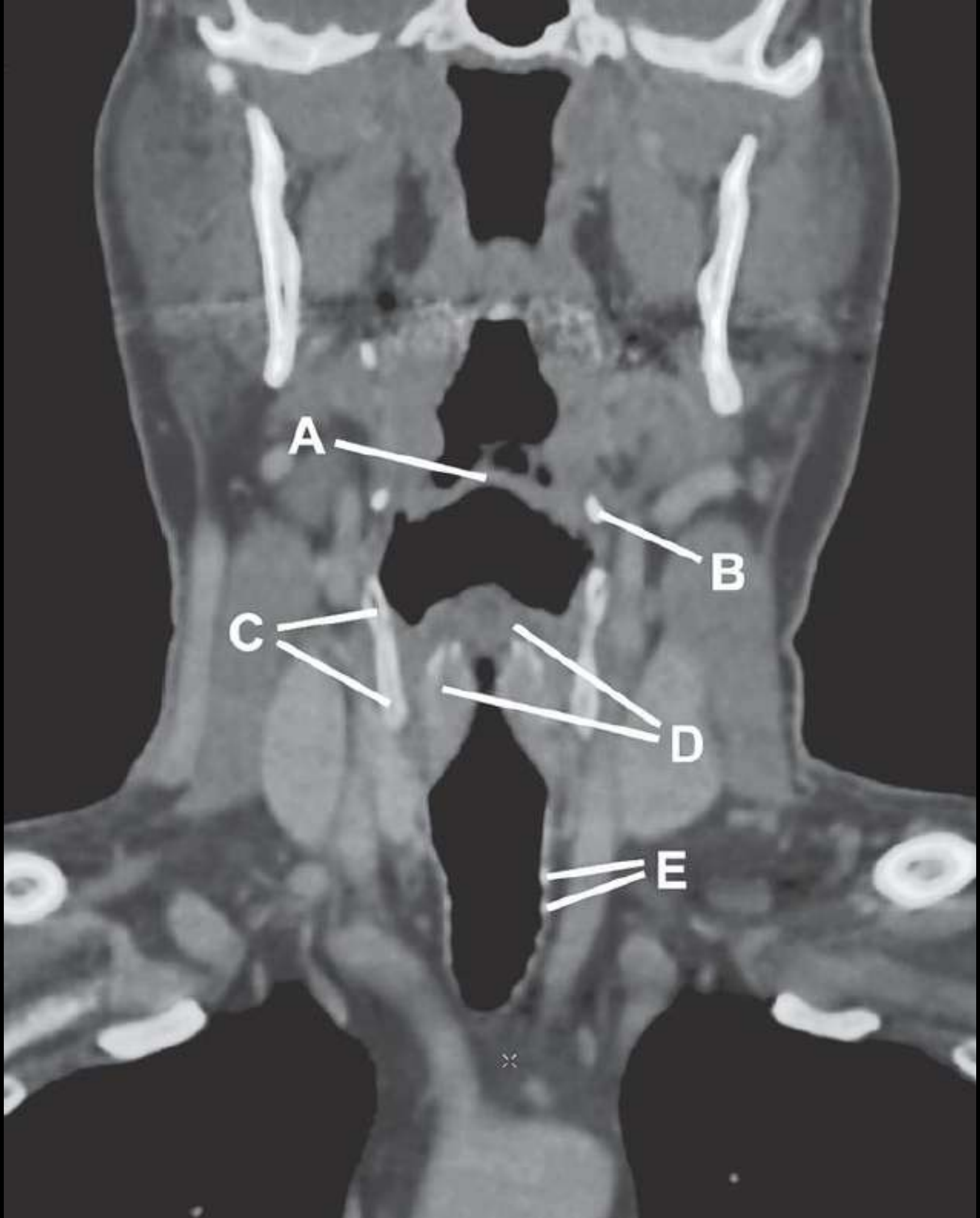
Q23 Answers

a Superior oblique muscle
b Posterior ethmoid sinus
c The inferior rectus muscle provides downward (and medial) rotation of the eyeball
d Inferior nasal concha (or turbinate)
e Maxillary ostium (part of the ostiomeatal complex)

T1W MRI through posterior orbits and paranasal sinuses

The eye moves through the function of six muscles. These are named superior, inferior, medial and lateral rectus and the superior and inferior oblique muscles. The recti muscles pull the eye in the direction they are situated. The oblique muscles are named counter intuitively as the superior depresses the eye while the inferior raises it. Most of these muscles are supplied by the occulomotor nerve (CN III), except the lateral rectus and superior oblique which are supplied by the abducent (CN VI) and trochlear nerves (CN IV), respectively.

The three paired nasal conchae (superior, middle and inferior) are separated by spaces known as meati. The paranasal sinuses are situated around the nasal cavity and also drain into it. They are paired and include the frontal, ethmoid (with anterior, middle and posterior parts), sphenoid and maxillary sinuses. The maxillary sinus drains from its superior medial aspect via the maxillary ostium into the ethmoid infundibulum which in turn drains into the middle meatus of the nasal cavity. These structures are collectively known as the ostiomeatal complex. The nasolacrimal duct running from the medial angle of the eye also drains into the nasal cavity (inferior meatus).

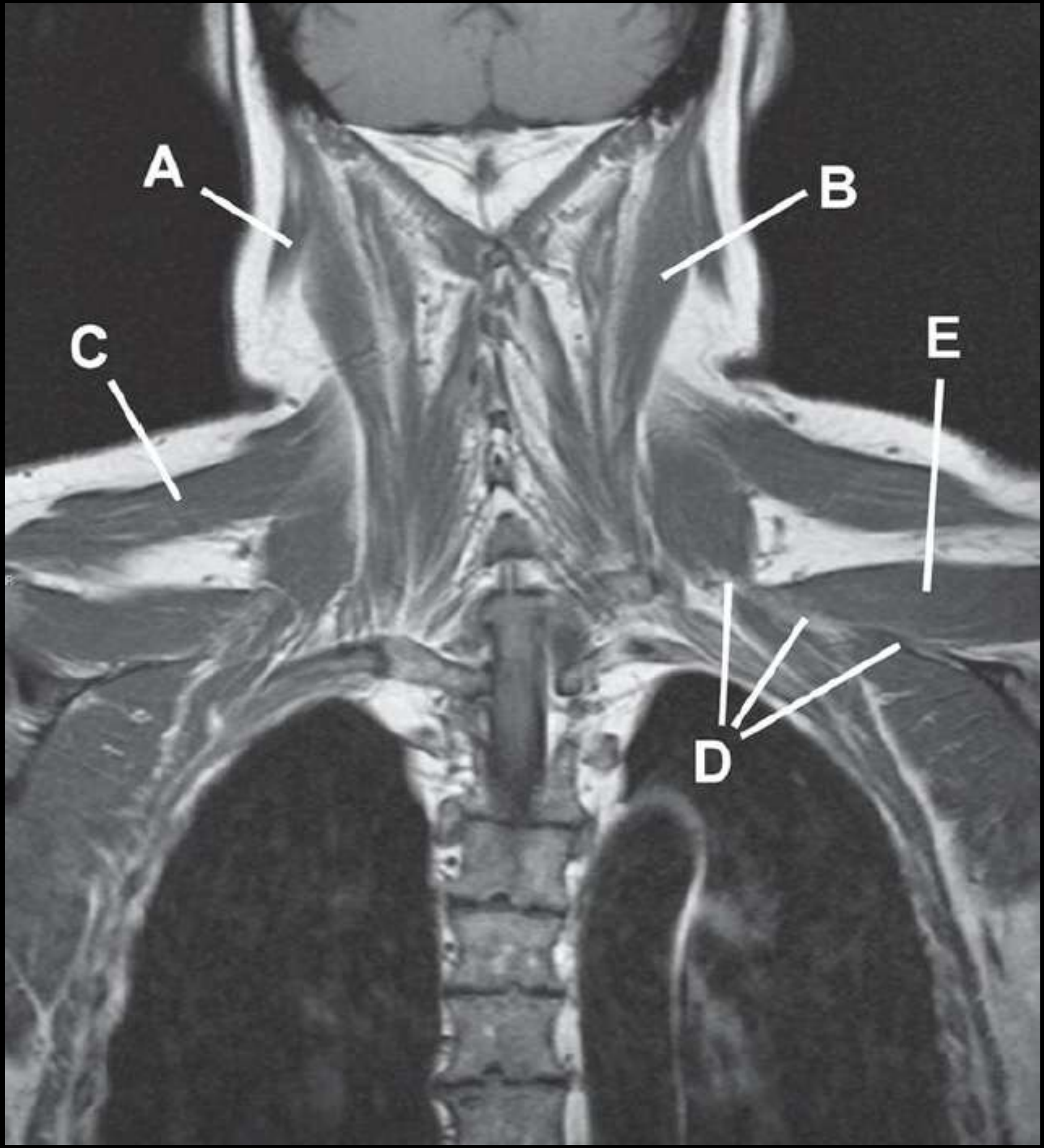

A
B
C
D
E

Q33 Answers

a Epiglottis
b Greater horn of hyoid bone
c Thyroid cartilage
d Cricothyroid membrane forming vocal cords
e Cartilaginous tracheal rings

CT scan through larynx shown with bone windows, coronal section

The larynx connects the pharynx with the trachea and contains the vocal cords. Several cartilaginous structures compose the larynx. The thyroid cartilage provides antero-lateral coverage of the vocal cords, while the epiglottic cartilage acts like a lid to cover the larynx when swallowing. The arytenoid cartilages sit on either side of the midline on the lamina of the cricoid cartilage. Attached to the anteriorly projecting vocal processes of the arytenoid are the vocal cords; movement here leads to changes in the length and tension of the vocal cords which is the means for vocalizing. The corniculate and cuneiform cartilages are very small structures attached to the arytenoid cartilage, these are not usually individually discernable with CT. The cricoid cartilage lies between the thyroid cartilage above and the trachea below and is the only complete ring of cartilage in the larynx or trachea.


A
B
C
E
D

Q38 Answers

a Sternocleidomastoid muscle
b Splenius muscle
c Trapezius muscle
d Spine of scapula
e Supraspinatus muscle

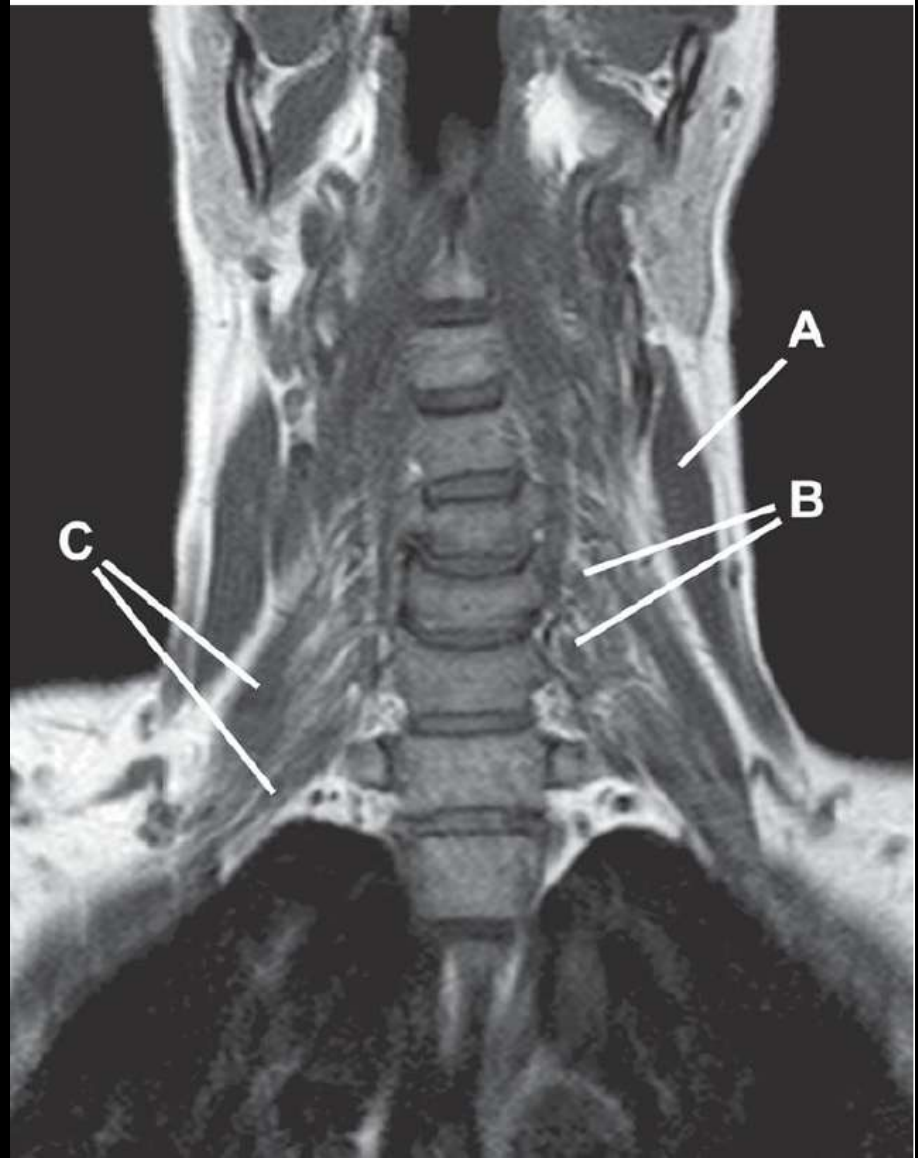
T1W MRI of posterior neck and shoulder muscles, coronal view

Each splenius muscle is composed of two parts (capitis and cervicis) which act as a single functional group. When both sides contract together they act to extend the head and neck. Independently, the splenius will perform lateral flexion and rotation of the neck to the same side. Lateral flexion also involves the ipsilateral sternocleidomastoid as well as other neck muscles.

The trapezius muscle covers the superior aspect of the shoulder and functionally is used to shrug the shoulders (upper fibres). The trapezius and sternocleidomastoid are innervated by the accessory nerve (motor, CN XI) and branches from the cervical plexus (sensory, C3/4).

Q39

a Name the structure labelled A
b Name the structures labelled B
c Name the muscle group labelled C
d Name the distal structure to which B contribute
e Describe the relationship between structures B and C within the root of the neck



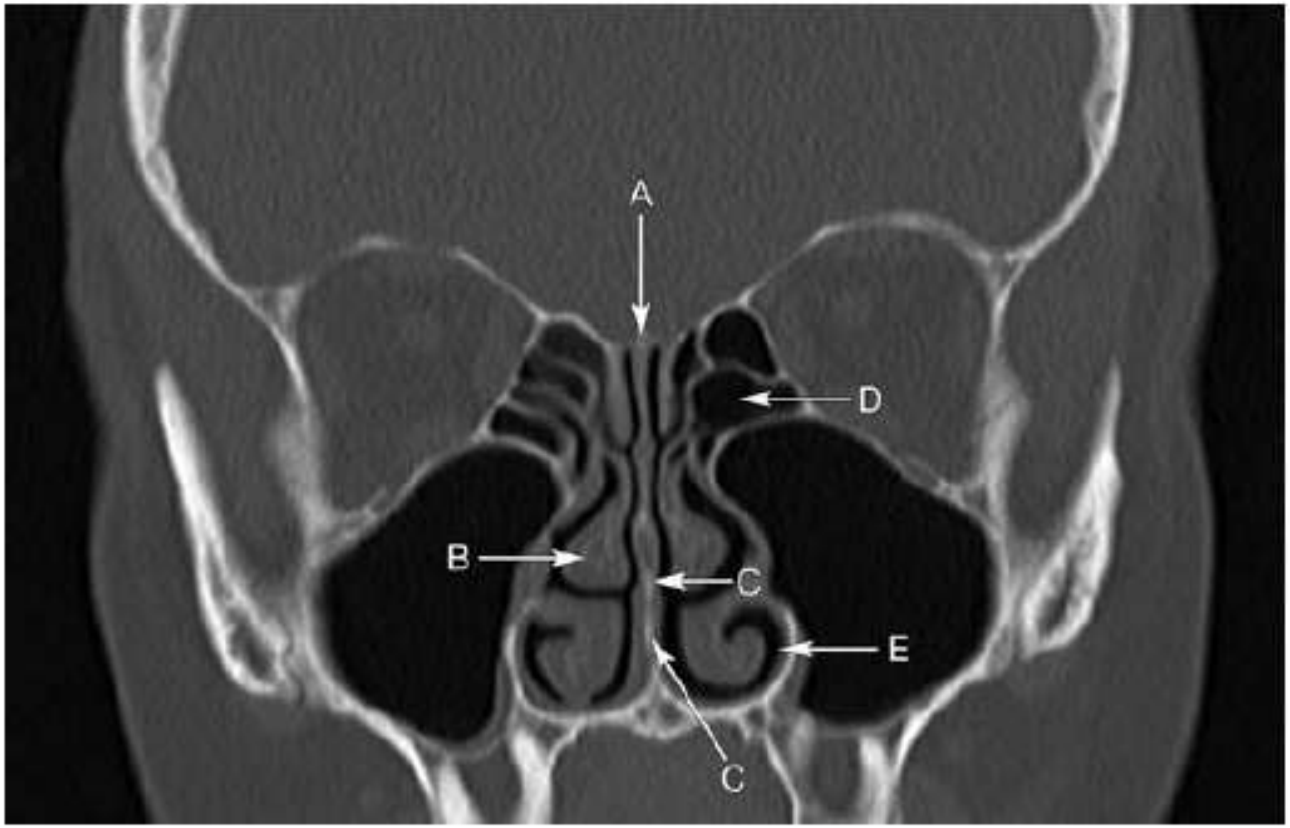
Q39 Answers

a Sternocleidomastoid muscle
b Left lower anterior cervical nerve roots
c Scalene muscles
d Brachial plexus
e The brachial plexus nerve roots leave the root of the neck by passing between the anterior and medial scalene muscles

T1W MRI of neck showing brachial plexus nerve roots, coronal view

The brachial plexus provides nerve supply to the upper limb. It is formed from the anterior nerve roots of C5 to T1. These nerve roots pass between the anterior and medial scalene muscles to exit the root of the neck. The subclavian artery follows the same path between anterior and medial scalene muscles; the subclavian vein passes anterior to the scalenus anterior muscle. The scalene muscles also include scalenus posterior.

Question 8.3



Name the structures labelled A to E.

8.3 Coronal CT of the sinuses

A Cribriform plate.
B Right middle turbinate.
C Nasal septum.
D Left ethmoid sinus.
E Left inferior meatus.

The nasal cavity is divided into two halves by the nasal septum. The nasal septum i formed by the perpendicular plate of the ethmoid bone, the septal cartilage and th vomer. The lateral walls of the nasal cavity are irregular due to the three turbinate (or conchae) – superior, middle and inferior. These divide the cavity into superio

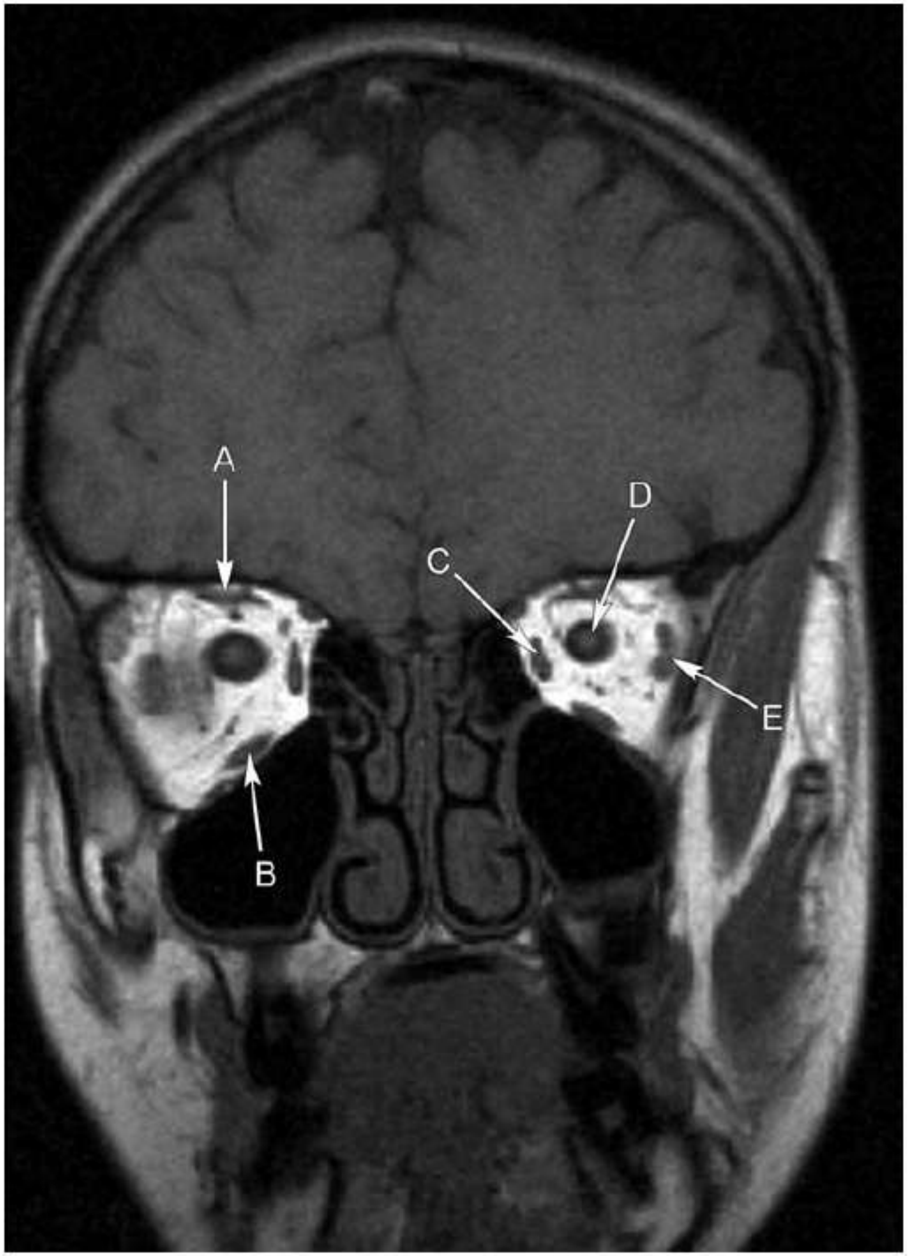
middle and inferior meati, each lying underneath the turbinate of the corresponding name. Above the superior turbinate is the sphenoethmoidal recess.

Drainage connections into the nasal cavity:

Sphenoethmoid recess	Sphenoid air cells
Superior meatus	Posterior group of ethmoid air cells
Middle meatus	Anterior group of ethmoid air cells, frontal sinus
Inferior meatus	Nasolacrimal duct

The cribriform plate is part of the ethmoid bone and forms the central portion of the roof of the nasal cavity.

Question 8.4



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

8.4 Coronal T1 MRI of the brain

A Right superior rectus muscle.
B Right inferior rectus muscle.
C Left medial rectus muscle.
D Left optic nerve.
E Left lateral rectus muscle.

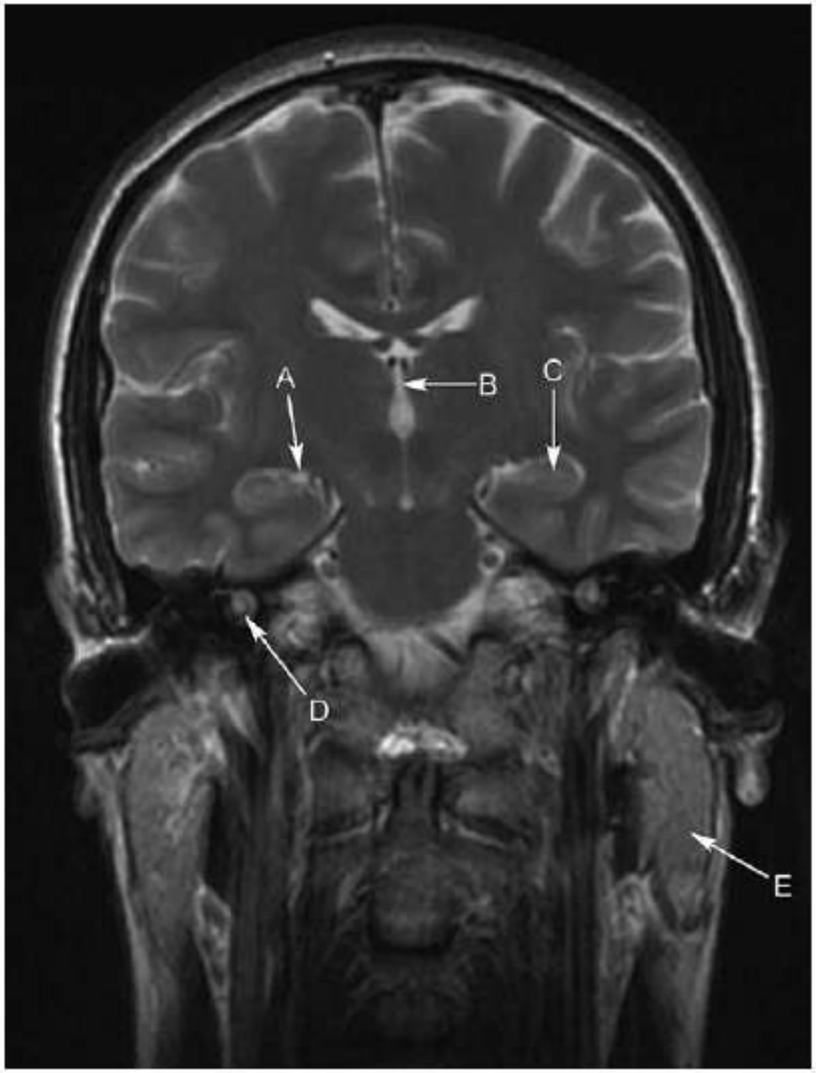
There are six extrinsic ocular muscles controlling eye movement – four rectus muscles (superior, inferior, medial and lateral) and the superior and inferior oblique muscles. The rectus muscles share a common tendinous ring called the annulus of Zinn, and insert into the sclera of the orbit. The superior oblique muscle arises from the sphenoid bone superomedial to the optic foramen. The inferior oblique muscle arises from the anterior part of the orbital floor.

The following formula can help as a mnemonic to remember the innervation of the orbital nerves:

LR6SO4R3.

Lateral rectus	Sixth cranial nerve (abducens)
Superior oblique	Fourth cranial nerve (trochlear)
Rest of the muscles	Third cranial nerve (oculomotor)

Question 9.1



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

9.1 Coronal T2 MRI of the brain

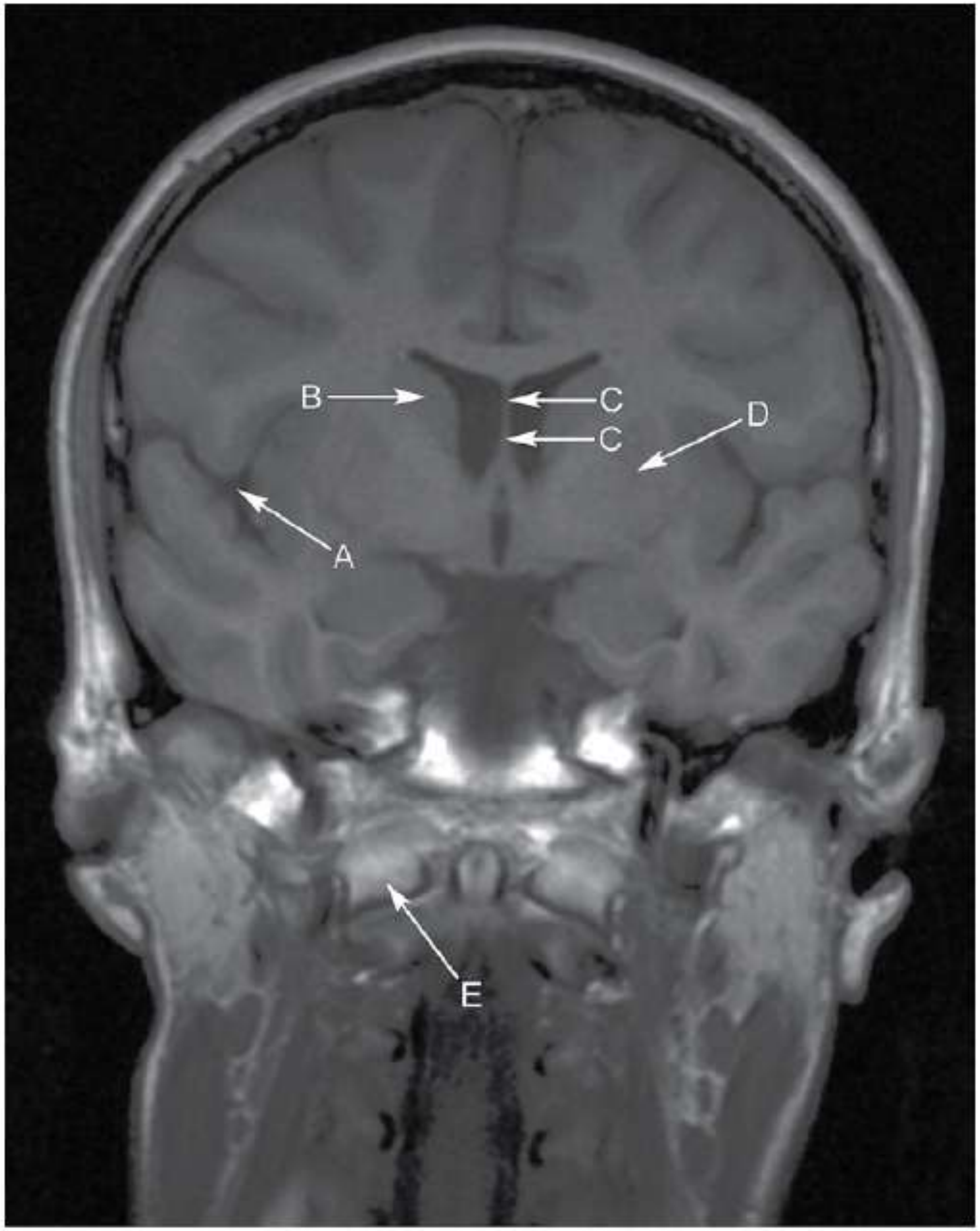
A Temporal horn of right lateral ventricle.
B Third ventricle.
C Left hippocampus.
D Right cochlea.
E Left parotid gland.

The lateral ventricles drain cerebrospinal fluid into the third ventricle via the right and left interventricular foramen (foramen of Munro). The third ventricle drains into the fourth ventricle via the cerebral aqueduct (aqueduct of Sylvius). The fourth ventricle drains via a central foramen of Magendie and two lateral foramina of Luschka.

The hippocampus is a key part of the limbic system and is seen as a curved prominence on the inferior horn of the lateral ventricle. It is a grey-matter structure with a thin covering of white matter, which is known as the alveus.

For more information and a flow diagram of the ventricular system see Question 4.2.

Question 9.2



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

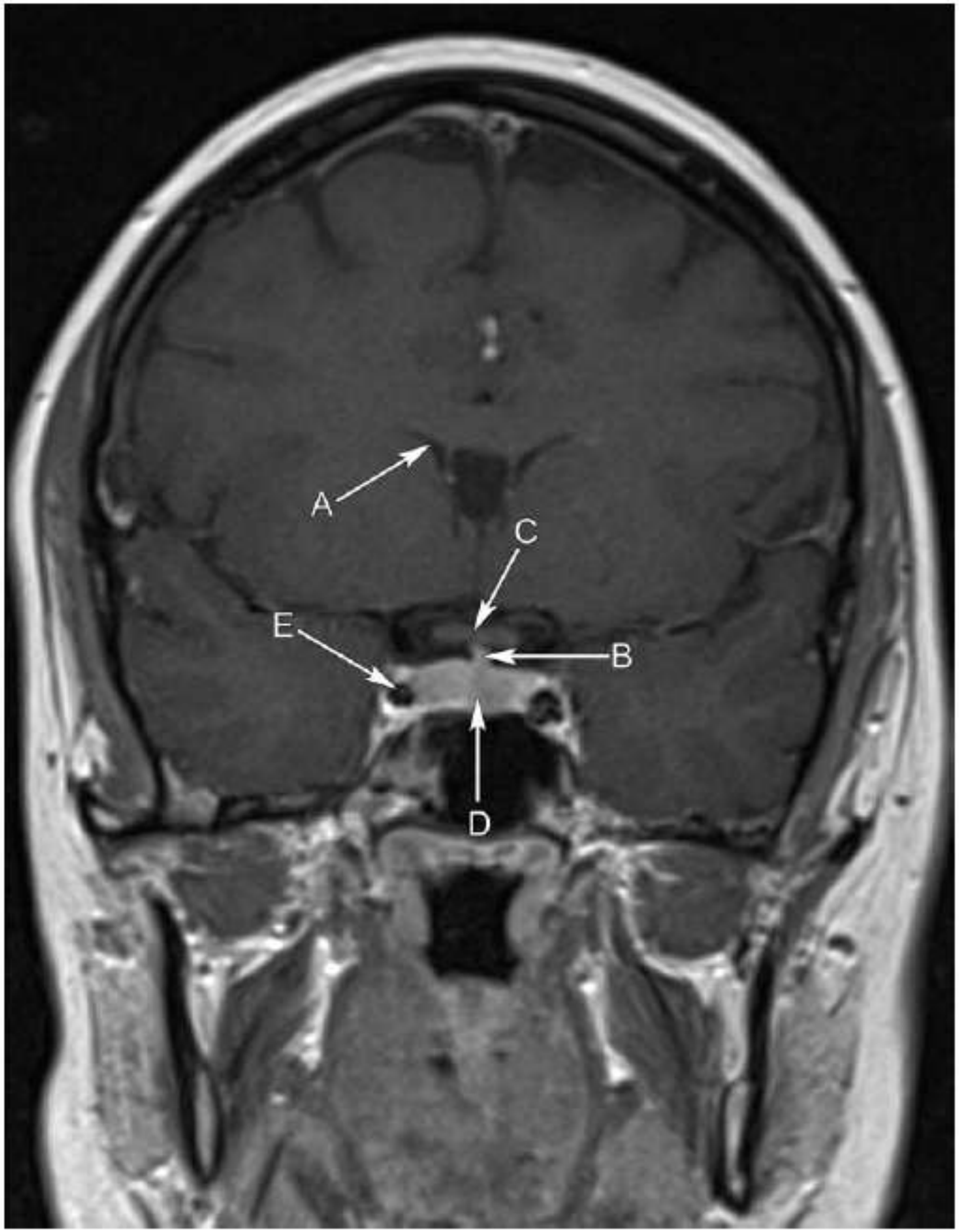
9.2 Coronal T1 MRI of the brain

A Right sylvian fissure.
B Right caudate nucleus.
C Septum pellucidum.
D Left putamen.
E Right lateral mass of C1.

The septum pellucidum is a thin membrane separating the anterior horns of the lateral ventricles. It consists of two layers of both white and grey matter, called the laminae septi pellucidi. During foetal development there is a space between these two laminae called the cavum septum pellucidum. This is fused in 85% of individuals by six months of age but can persist into adulthood as a normal variant.

For an example of a cavum septum pellucidum see Question 9.8.

Question 9.8



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

9.8 Coronal T1 MRI of the brain with IV contrast

A Right lateral ventricle.
B Infundibulum (pituitary stalk).
C Optic chiasm.
D Pituitary gland.
E Right internal carotid artery.

The pituitary gland lies within the sella turcica, which is covered by a dural fold called the diaphragma sellae. It is connected to the hypothalamus by a thin process called the infundibulum (or pituitary stalk). The pituitary gland is generally divided into two sections – anterior (adenohypophysis) and posterior (neurohypophysis). There is a further intermediate section, but this is only a few cells thick and is generally included with the anterior pituitary.

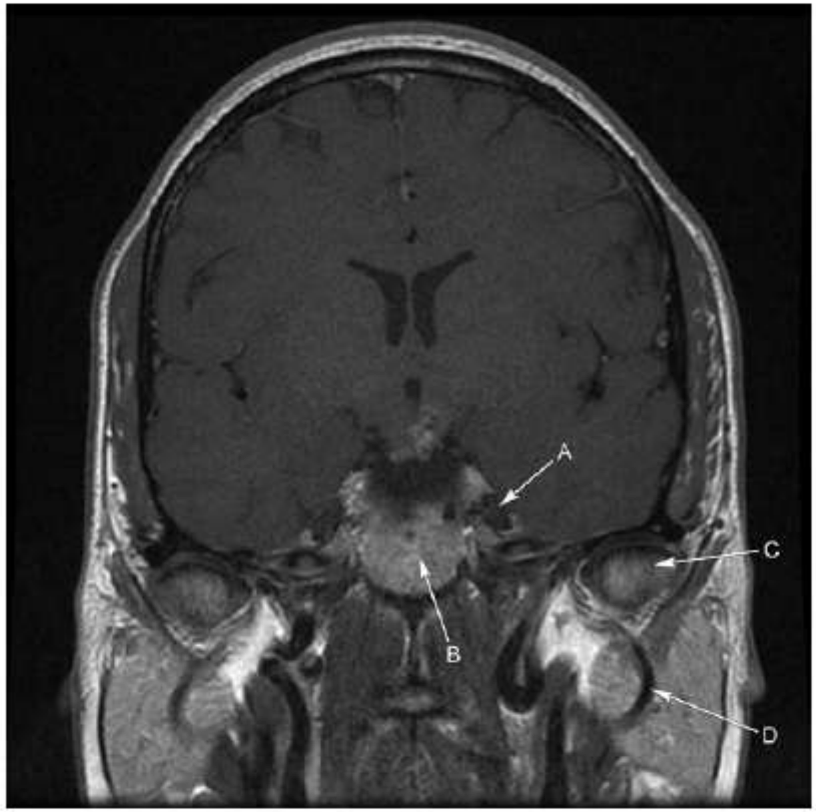
At birth, the pituitary gland is globular in shape and exhibits a generalized high signal on T1-weighted MRI. By six weeks of age this high signal has largely diminished in the anterior lobe, which returns an isointense signal similar to brain parenchyma. The posterior pituitary continues to display a high signal on T1-weighted MRI, giving rise to the characteristic posterior pituitary bright spot. This normal finding is said to be related to the high neurophysin content of the posterior pituitary. The adult pituitary gland is normally 3–8 mm in height, and is generally larger in females.

Anatomical relations to the pituitary gland:

Superior	Optic chiasm (within suprasellar cistern)
Lateral	Cavernous sinuses (walls of the pituitary fossa)
Anteroposterior	Sphenoid sinus

This image displays an incidental finding of a cavum septum pellucidum.

Question 9.20



Name the structures labelled **A** to **D**.
E What structure is located in A?

9.20 Coronal FLAIR MRI of the brain

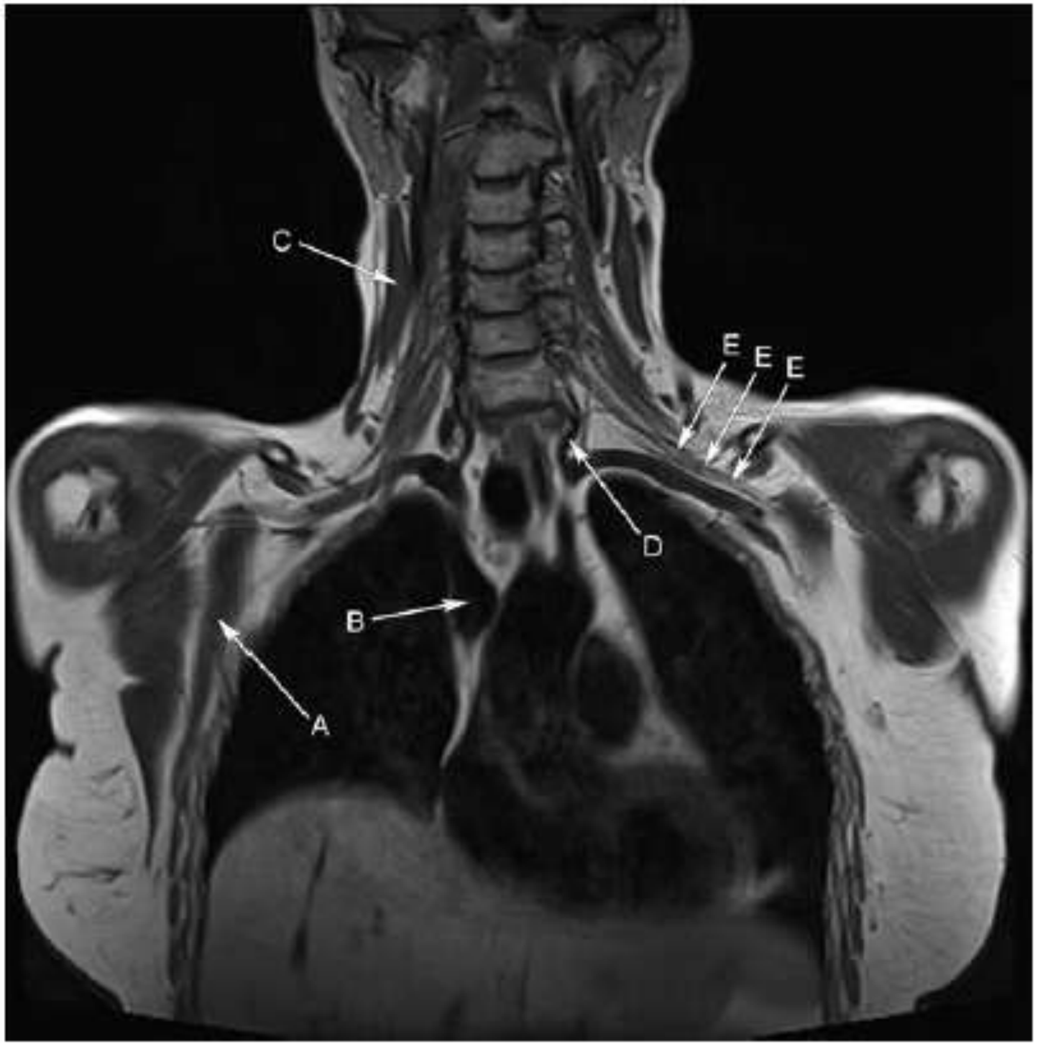
A Left Meckel's cave.
B Clivus.
C Left mandibular condyle.
D Terminal branch of the left external carotid artery.
E Left trigeminal ganglion.

Meckel's cave is a cerebrospinal fluid filled space lying immediately lateral to the cavernous sinus. It is bounded by dura overlying four structures:

Superolateral	Cerebellar tentorium
Superomedial	Lateral wall of the cavernous sinus
Medial	Clivus
Inferolateral	Posterior petrous

The trigeminal nerve (CN V) enters it through a defect in the dura and then expands to form the trigeminal (Gasserian) ganglion, which gives rise to the three branches of the trigeminal nerve.

Question 10.6



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

10.6 Coronal T1 MRI of the brachial plexus

A Right pectoralis minor muscle.
B Superior vena cava.
C Right sternocleidomastoid muscle.

D Left vertebral artery.
E Trunks of the left brachial plexus.

MRI is commonly used to assess the brachial plexus. The nerves are best demonstrated on T1-weighted imaging as they are surrounded in fat and appear hypo- or isointense to muscle. The brachial plexus is formed by the ventral rami of the nerve roots of C5–T1 and emerges between the scalenus medius and scalenus anterior muscles. The roots then merge to form three trunks:

Upper trunk	Formed by the roots C5/6
Middle trunk	Formed by the root C7
Lower trunk	Formed by the roots C8/T1

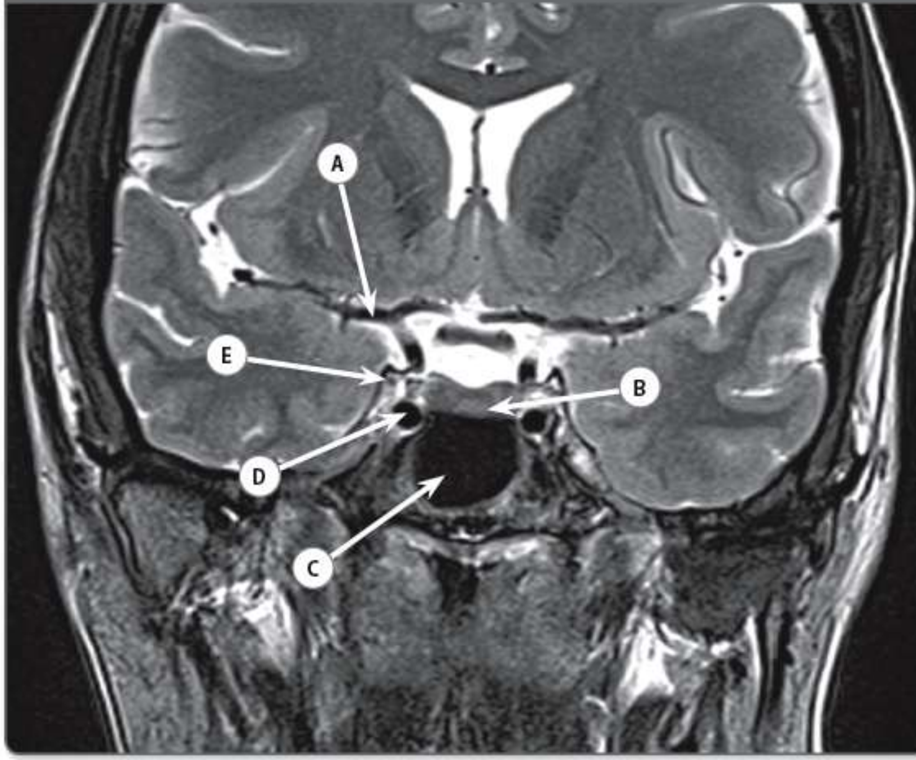
The trunks then cross the posterior triangle of the neck and form six divisions (three anterior and three posterior divisions), which pass posterior to the clavicle. The divisions then unite to form the three cords in the axilla:

Posterior cord	Formed by the posterior divisions of all three trunks
Lateral cord	Formed by the anterior divisions of the upper and middle trunks
Medial cord	Formed by the anterior division of the lower trunk

The cords then continue to form the nerves of the upper limb:

Posterior cord	Axillary nerve
	Radial nerve
Lateral cord	Musculocutaneous nerve
Medial cord	Ulnar nerve
Lateral and medial cord	Median nerve

Case 1.6



Case 1.6

	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 cranial nerve labelled E.	

Case 1.6

A Right middle cerebral artery

B Pituitary gland

C Sphenoid sinus

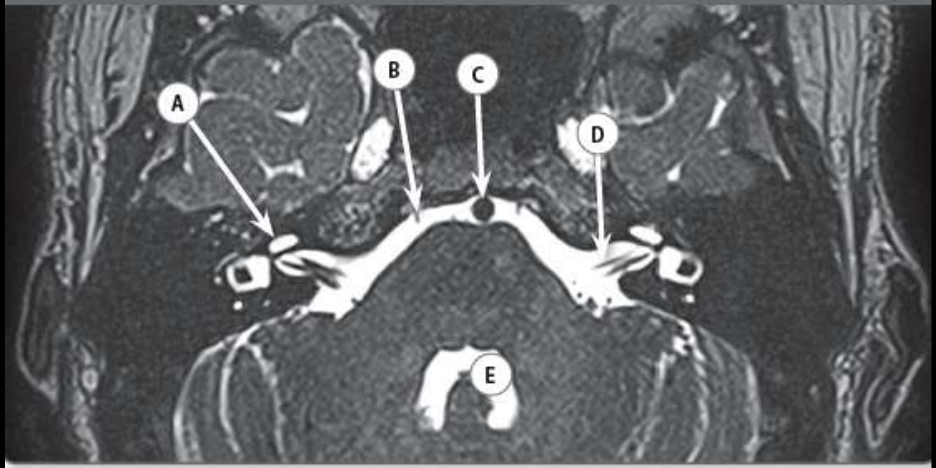
D Cavernous portion of the right internal carotid artery

E Oculomotor nerve (CN III)

Cavernous sinuses are paired extradural venous channels situated on either side of the pituitary fossa. They communicate posteriorly with the transverse sinuses and serve as a pathway for the internal carotid artery and the III, IV, V1, V2 and VI cranial nerves.

The oculomotor nerve is the uppermost cranial nerve in the cavernous sinus, and is located lateral to the cavernous portion of the carotid artery. CN IV, V1, V2, VI lie inferior to CN III, in that order.

Case 2.2



Case 2.2

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 CSF space labelled E.	

Case 2.2

A Right cochlea

B Right abducens (VI) nerve

C Basilar artery

D Left facial (VII) nerve

E Fourth ventricle

3D SPACE is a heavily T2-weighted sequence which renders high quality images depicting the origin and interim course of the cranial nerves arising from the surface of the brain, brainstem and superior spinal cord. Three cranial nerves (VI, VII and VIII) are depicted in this image.

As illustrated in **Figure 2.1**, the anatomical course of the above nerves is as follows:

- VI nerve, which travels to the Dorello canal in the clivus, is the more anterior and thinner one in relation to the VII and VIII cranial nerves

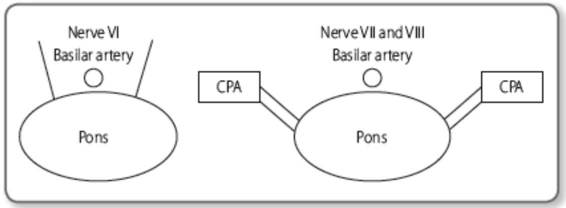
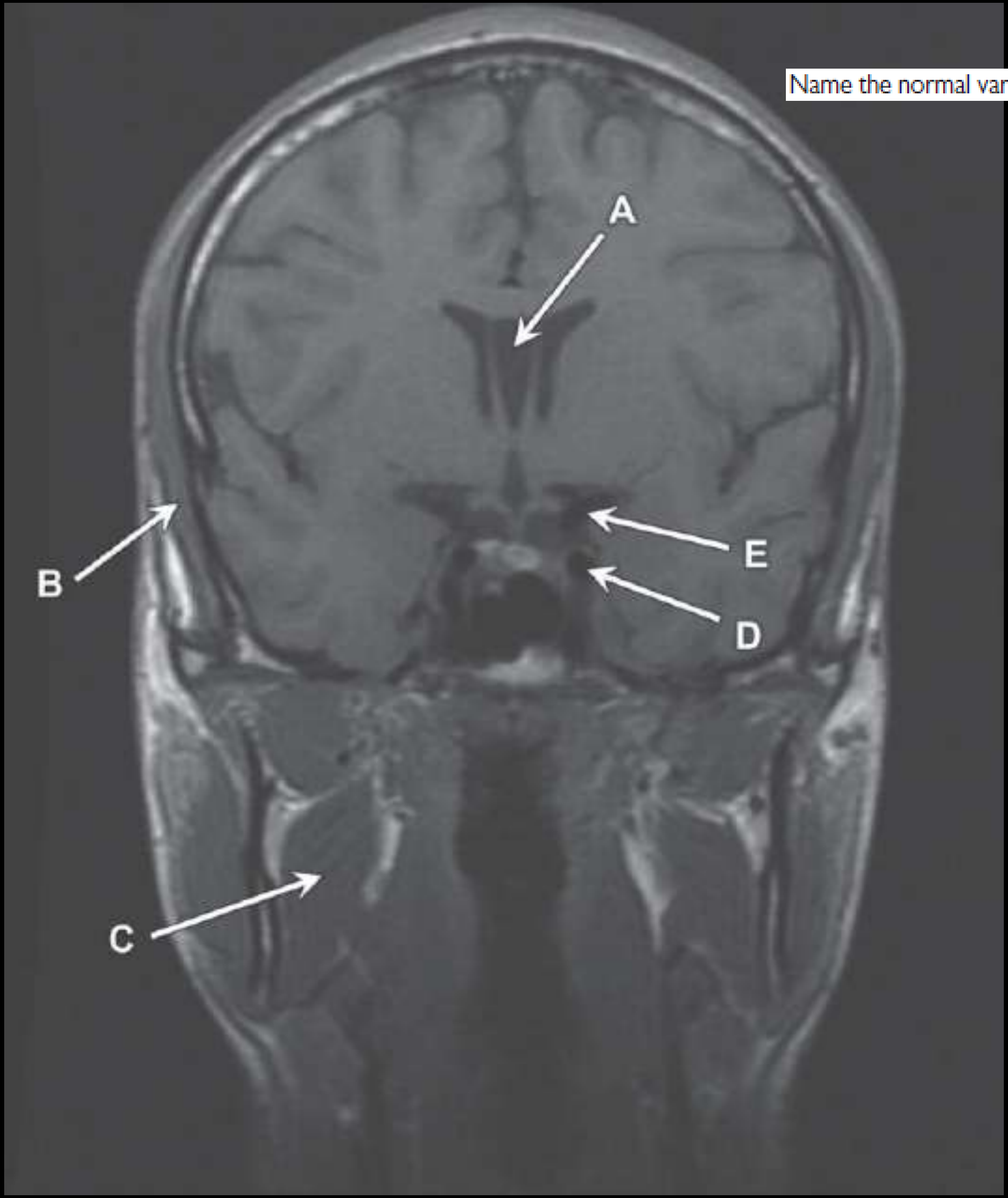


Figure 2.1 Schematic illustration of the cisternal segments of VI, VII and VIII cranial nerves. CPA, cerebellopontine angle.

- VII and VIII nerves, which travel in parallel anterolaterally, course towards the internal auditory meatus, are thicker and situated laterally and posteriorly in relation to the VI nerve
- The basilar artery (BA) and the cerebellopontine angle (CPA) are important anatomic landmarks for orientating yourself.



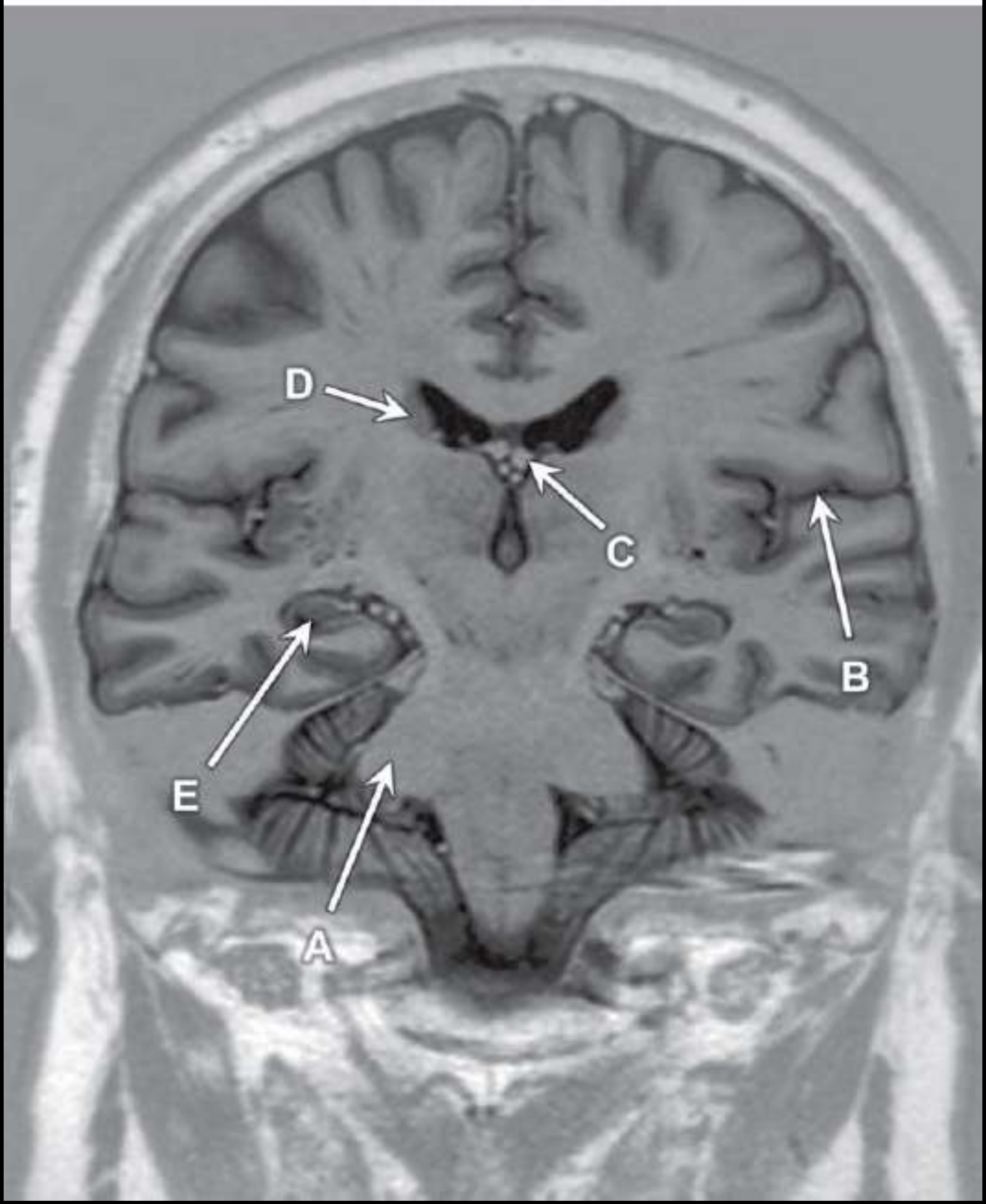
Name the normal variant

Case 8

MRI brain. T1W coronal section.

1. Cavum septum pellucidum
2. Right temporalis muscle
3. Right medial pterygoid muscle
4. Left internal carotid artery
5. Chiasmatic cistern

Candidates will be expected to be familiar with common normal variants such as the cavum seputum pellucidum above.

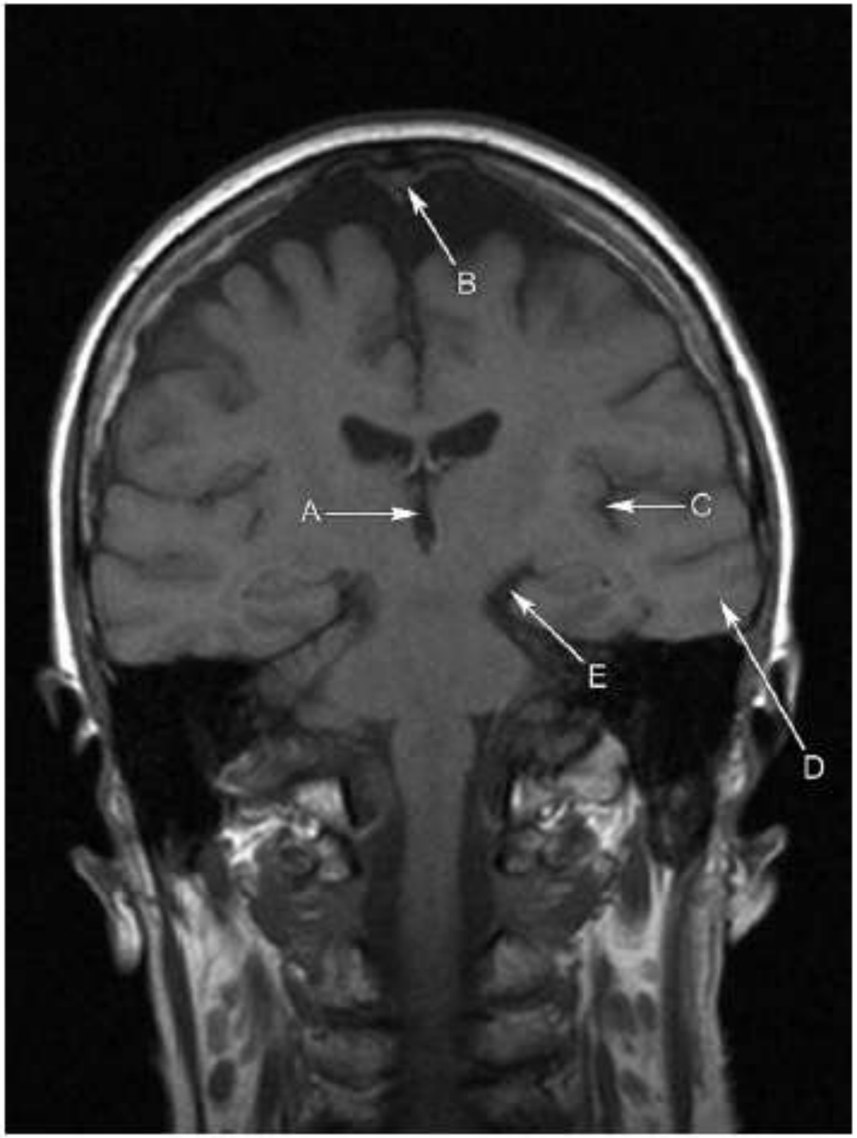

D
C
B
E
A

Case 12

MRI brain. Coronal section.

1. Right middle cerebellar peduncle
2. Left Sylvian fissure
3. Left fornix
4. Head of right caudate nucleus
5. Right hippocampus

Question 2.5



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

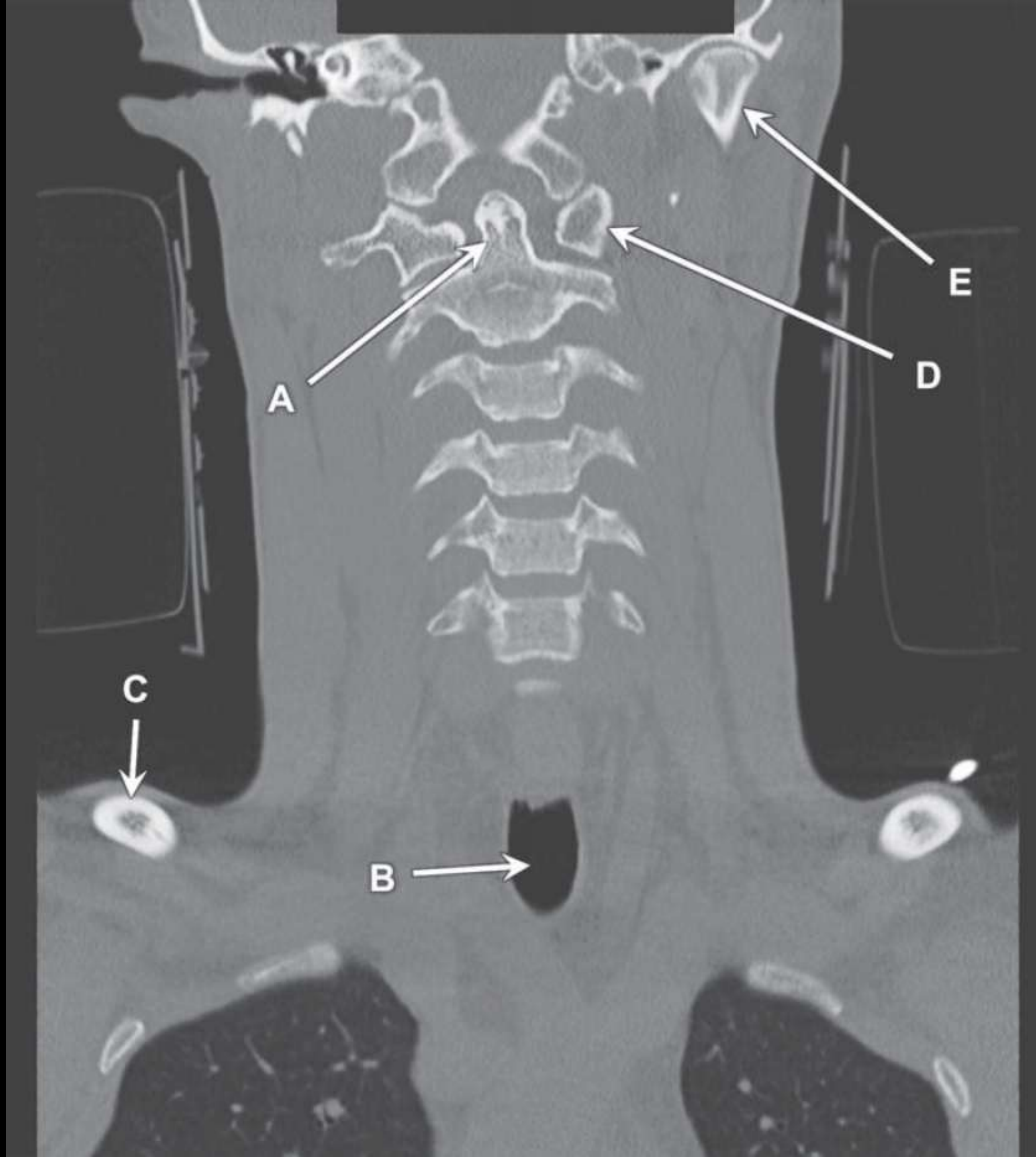
2.5 Coronal T1 MRI of the brain

A Third ventricle.
B Superior sagittal sinus.
C Left sylvian fissure.
D Left temporal lobe.
E Left ambient cistern.

The surface of the cerebral hemispheres is divided with fissures and sulci. Fissures involve the entire thickness of the cerebral wall, while sulci only affect the surface of the wall. The sylvian fissure lies superior to the temporal lobe and divides the frontal and parietal lobe. It is an important landmark when reviewing area on CT scans to look for evidence of subarachnoid haemorrhage.

Cisterns are cerebrospinal-fluid-filled subarachnoid spaces in the brain. Starting from inferiorly to superiorly these are:

Cisterna magna	Also known as the cerebellomedullary cistern The largest of the cisterns and located between the posterior surface of the medulla oblongata and the cerebellum
Prepontine cistern	Located anterior to the pons
Suprasellar cistern	The cistern located just superior to the pituitary fossa Continuous posteriorly with the interpeduncular cistern
Interpeduncular cistern	Located between the cerebral peduncles Continuous anteriorly with the suprasellar cistern and inferiorly with the prepontine cistern
Ambient cistern	Basically, a thin extension of the quadrigeminal cistern Extends laterally from the quadrageminal cistern around the midbrain of the brainstem to connect to the interpeduncular cistern
Quadrigeminal cistern	Also known as the superior cistern or the cistern of the great cerebral vein as it contains the great cerebral vein Located between the superior surface of the cerebellum and the splenium of the corpus callosum
Cistern of the velum interpositum	Also known as the cavum velum interpositum A triangular space seen on axial CT Located just superior to the quadragminal cistern, with which it is continuous

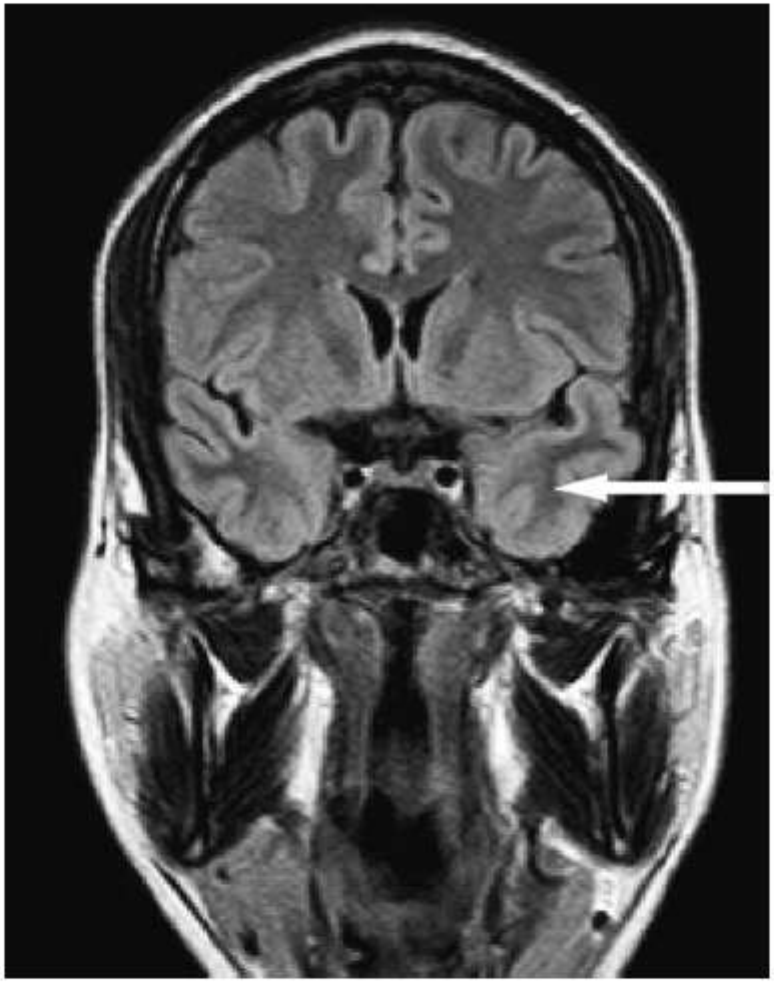

E
D
A
C
B

Case 6

CT C-spine. Coronal section.

1. Dens/ odontoid peg
2. Trachea
3. Right clavicle
4. Left lateral mass of C1 vertebra
5. Left mandibular condyle

■ **Question 31:**

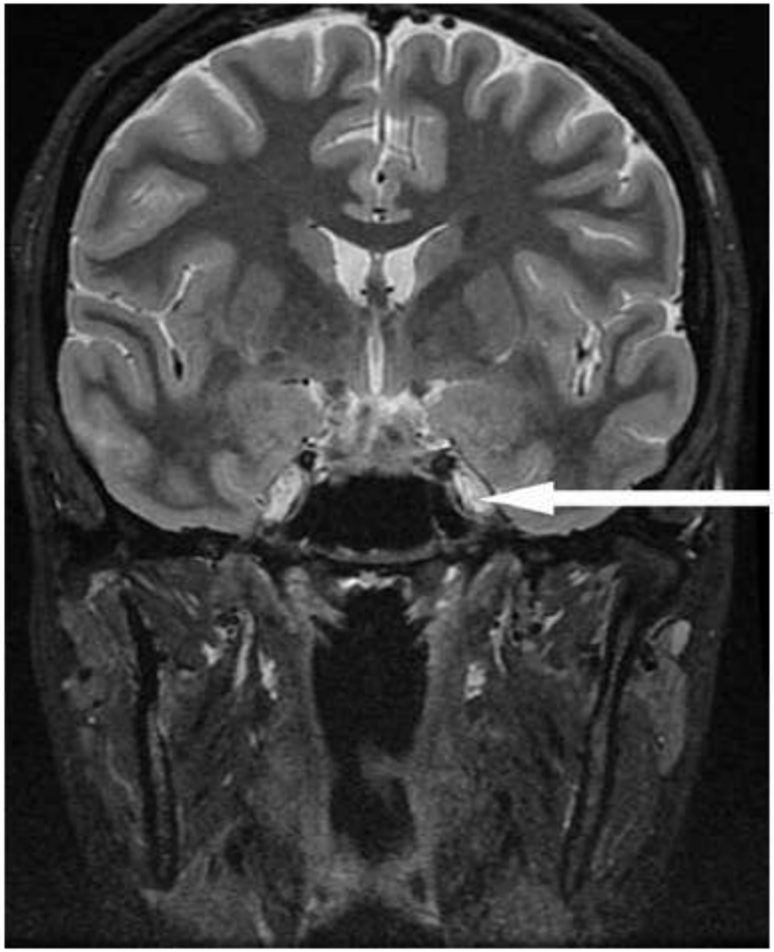


Question 31: Coronal MRI of the brain

Answer: Left temporal lobe (white matter)

- The temporal lobes are the most inferior lobes of the cerebral cortex.
- The temporal lobes occupy the middle cranial fossae.
- They are separated from the superior frontal lobes by the Sylvian (lateral) fissures (pictured).
- They contain the limbic system.

- Question 40:

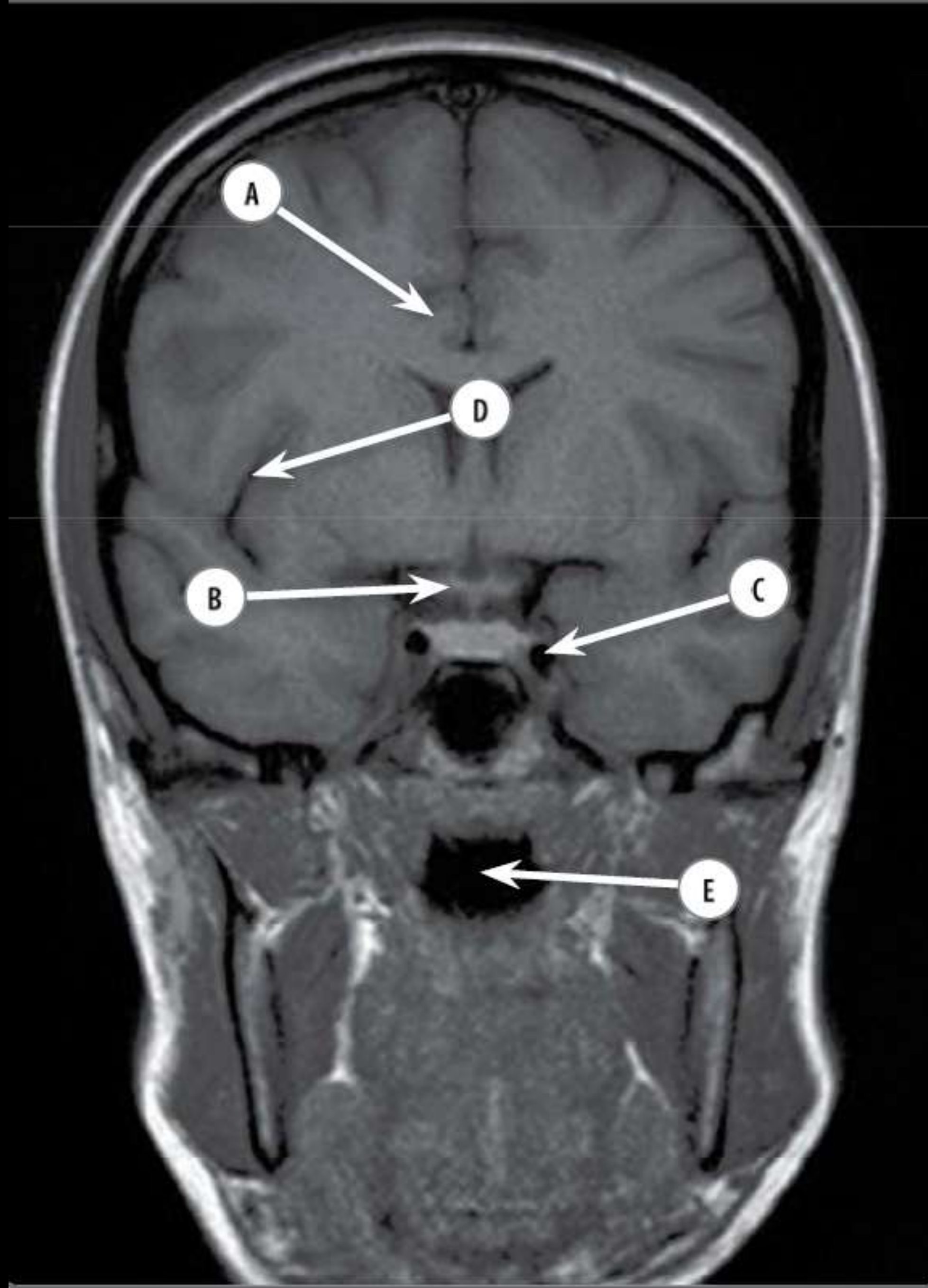


Question 40: Coronal T2-weighted MRI of the brain

Answer: Left Meckel's cave (trigeminal cave)

- Meckel's cave is a pouch containing cerebrospinal fluid formed by two layers of dura mater derived from the tentorium cerebelli.
- It contains the trigeminal nerve roots and ganglion.
- It lies adjacent to the posterolateral aspect of the cavernous sinus and lateral to the sphenoid bones.
- It is lateral to the internal carotid arteries.

Case 1.11



Case 1.11

A Right cingulate gyrus

B Optic chiasm

C Left internal carotid artery

D Right Sylvian fissure

E Sphenoidal sinus

Coronal T1-weighted MRI of the brain.

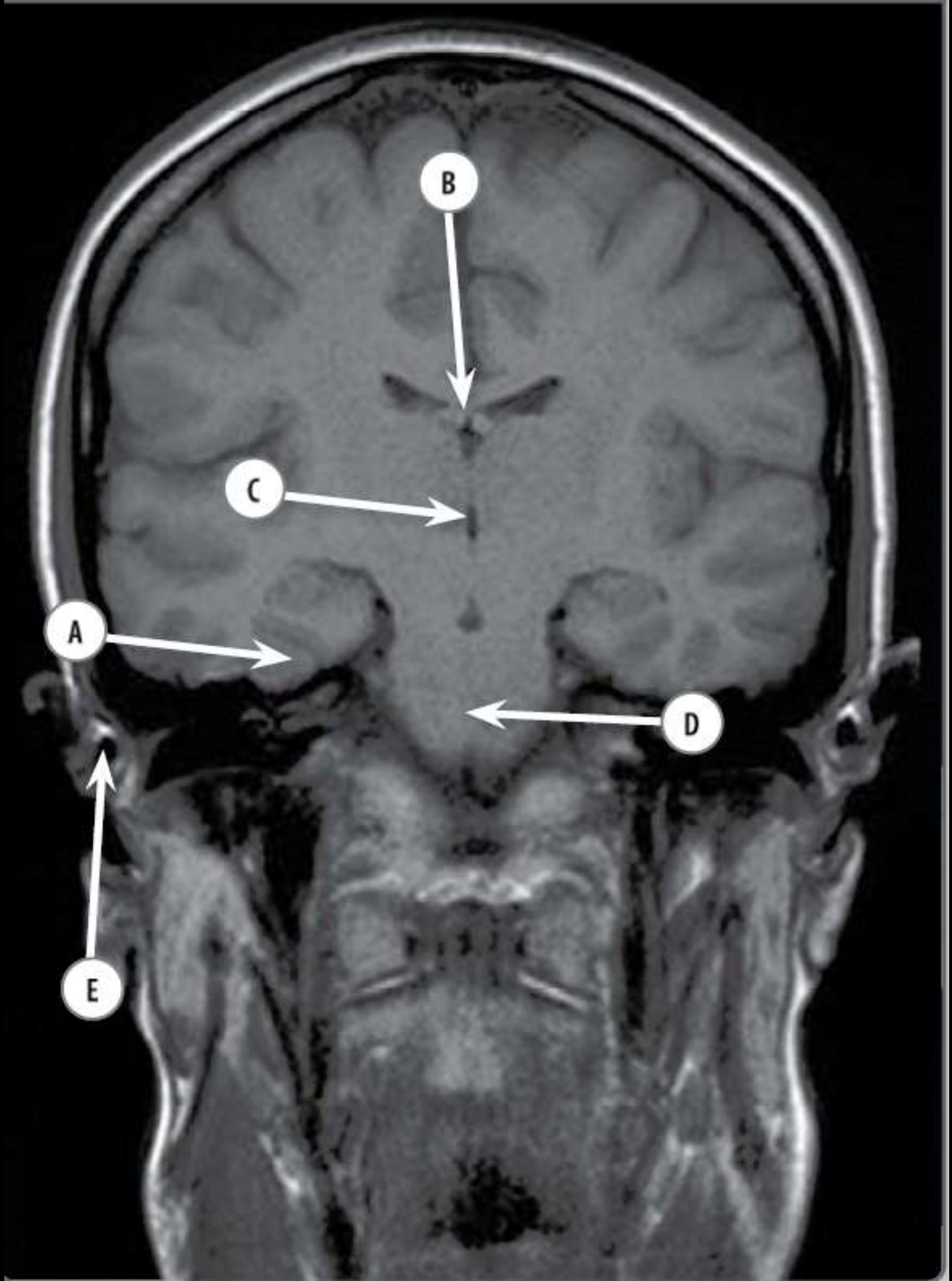
In this image we see the internal carotid artery in the cavernous sinus. Note that on a T1-weighted MRI, rapidly flowing blood is displayed as black signal voids. The internal carotid artery is a branch of the common carotid artery and receives 70% its blood flow. It arises approximately at the level of the C3 vertebral body and en the skull through the carotid canal. This marks the onset of the petrous segment. passes through the foramen lacerum where the laceral segment begins. It is a sho segment and it ends at the petrolingual ligament, where the cavernous segment begins. The cavernous segment ends at the proximal dura ring.

The optic chiasm is where the optic nerves partially cross. It lies anterior to the pituitary stalk and superomedially to the cavernous sinuses. The body of the sphenoid bone contains the sphenoidal sinuses which provide a route for surgica access to the pituitary gland via the nose.

By reviewing the coronal images we can appreciate the sylvian fissure separates t superior surface of the temporal lobe from the anterior surface of the frontal lobe and the anterior surface of the parietal lobe.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 48–49.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging. Edinburgh: Saunders, 2004: 59.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 45.

Case 1.12



Case 1.12

A Right hippocampus

B Fornix

C Third ventricle

D Pons

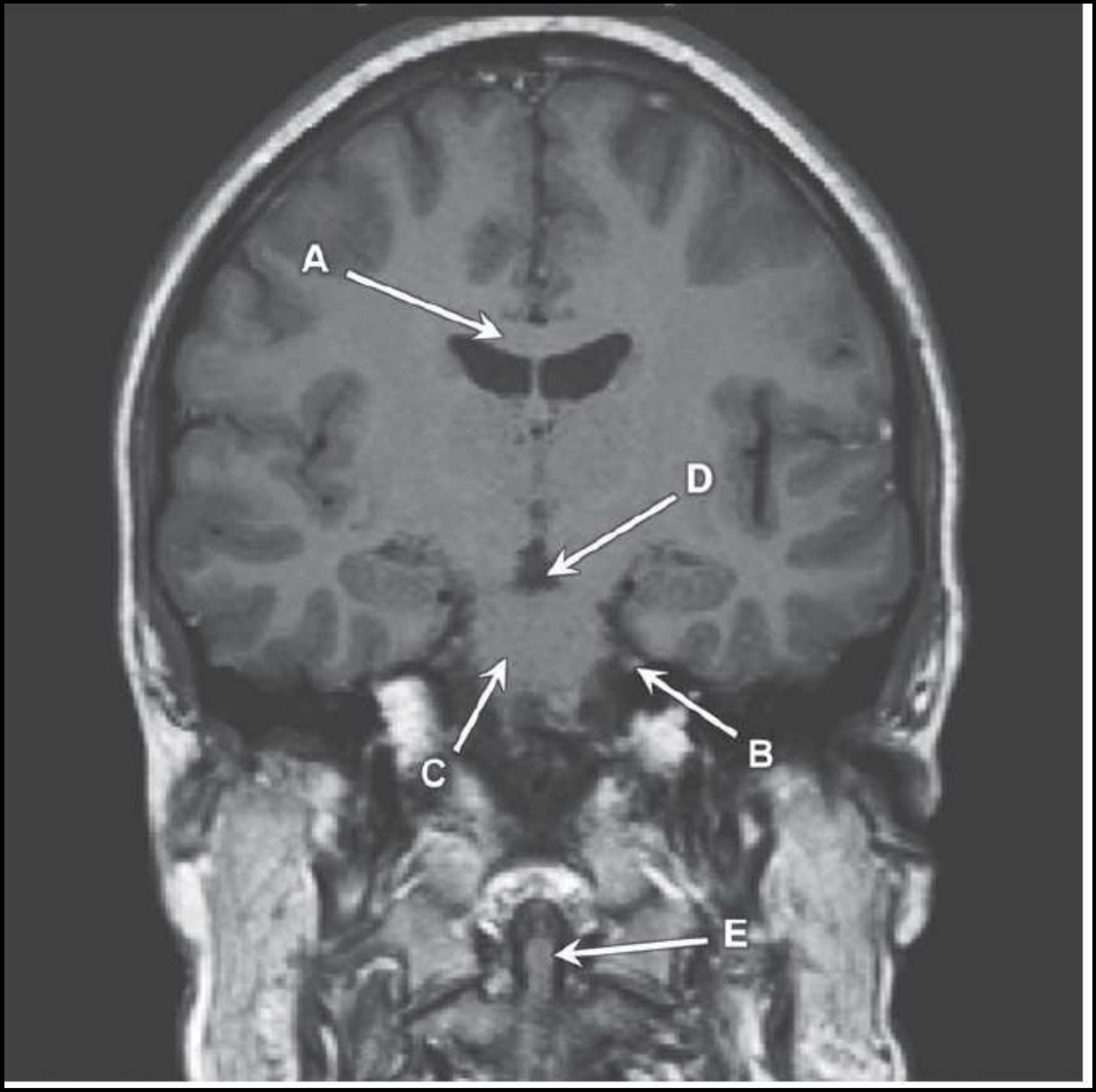
E Left external acoustic meatus

Coronal T1-weighted MRI of the brain.

The limbic system is composed of functionally related structures which surround the corpus callosum at the medial surface of the cerebral hemispheres. You may be asked to identify parts of the limbic system such as the cingulate, splenial and parahippocampal gyri, the hippocampus, the dentate gyrus and the fornix. It is worth spending some time studying diagrams of the limbic system and reviewing its appearance on coronal and parasagittal MRIs.

The thalami are bodies of grey matter that lie in the lateral walls of the third ventricle. The external acoustic (or auditory) meatus is part of the external ear. It is a tube that runs medially to the tympanic membrane.

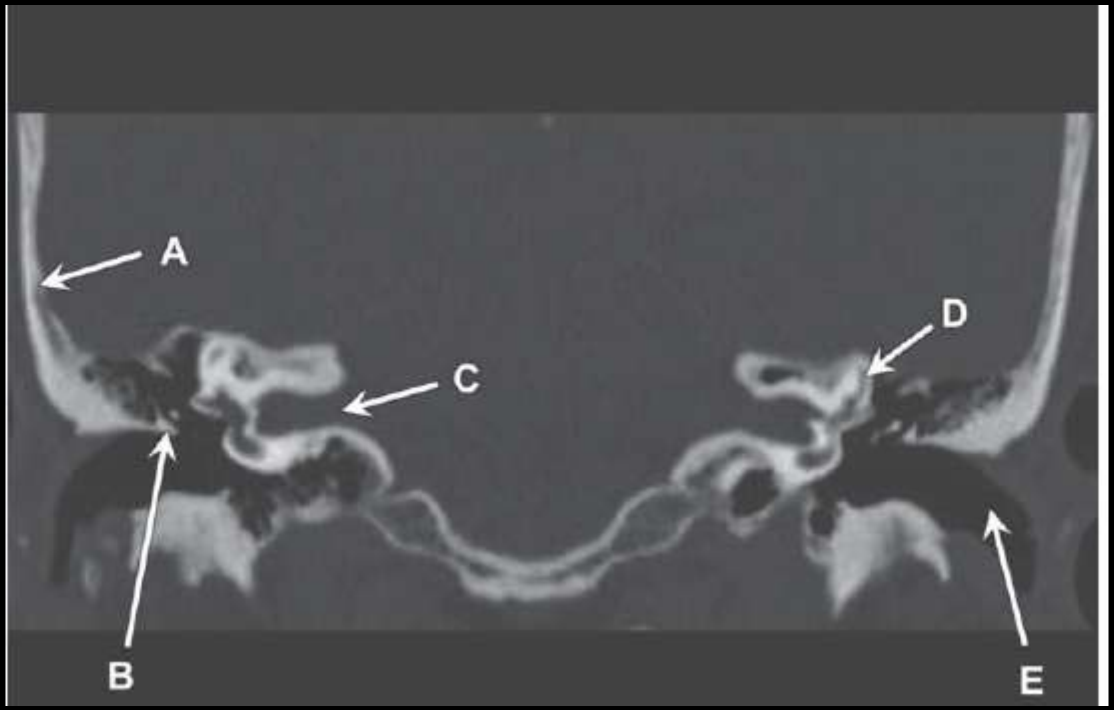
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 48–49.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging. Edinburgh: Saunders, 2004: 59.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 45.


A
D
C
B
E

Case 20

MRI brain. T1W coronal section.

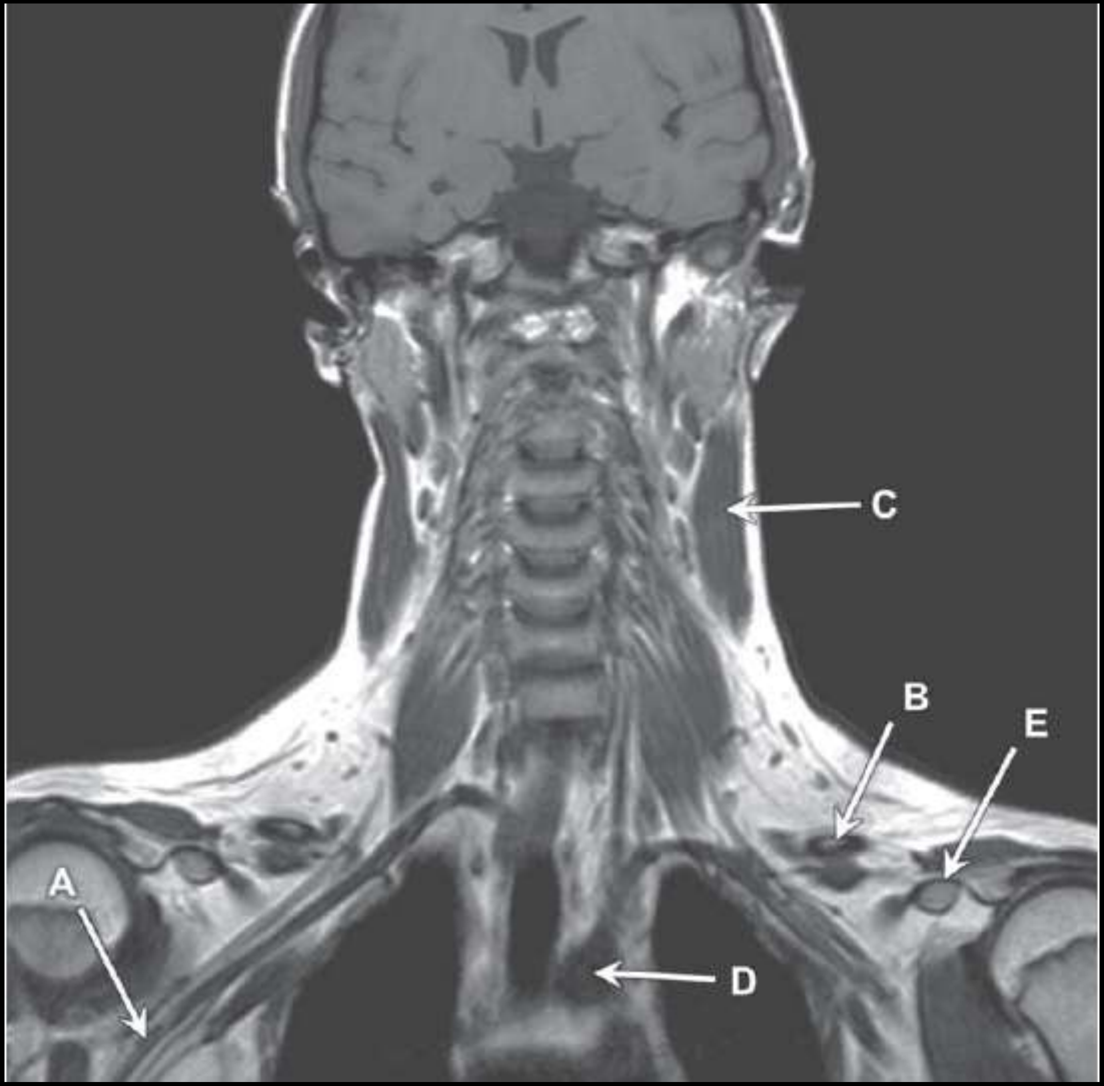
1. Corpus callosum
2. Left trigeminal nerve
3. Pons
4. Interpeduncular cistern
5. Odontoid process (peg) of C2


A
B
C
D
E

Case 16

CT temporal bones. Coronal reconstruction.

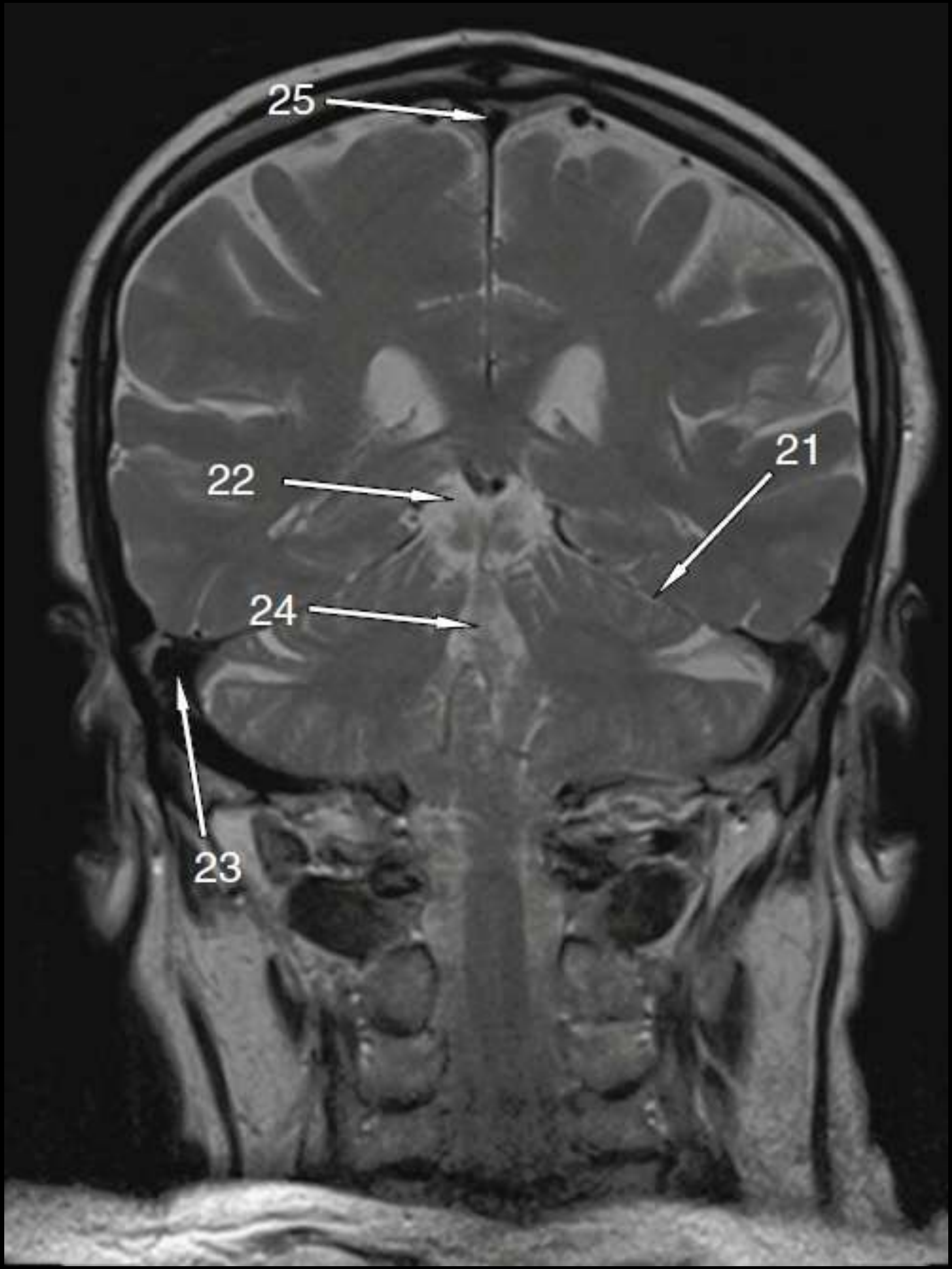
1. Right squamous temporal bone
2. Right scutum
3. Right internal auditory meatus
4. Left superior semicircular canal
5. Left external auditory meatus


C
B
E
A
D

Case 19

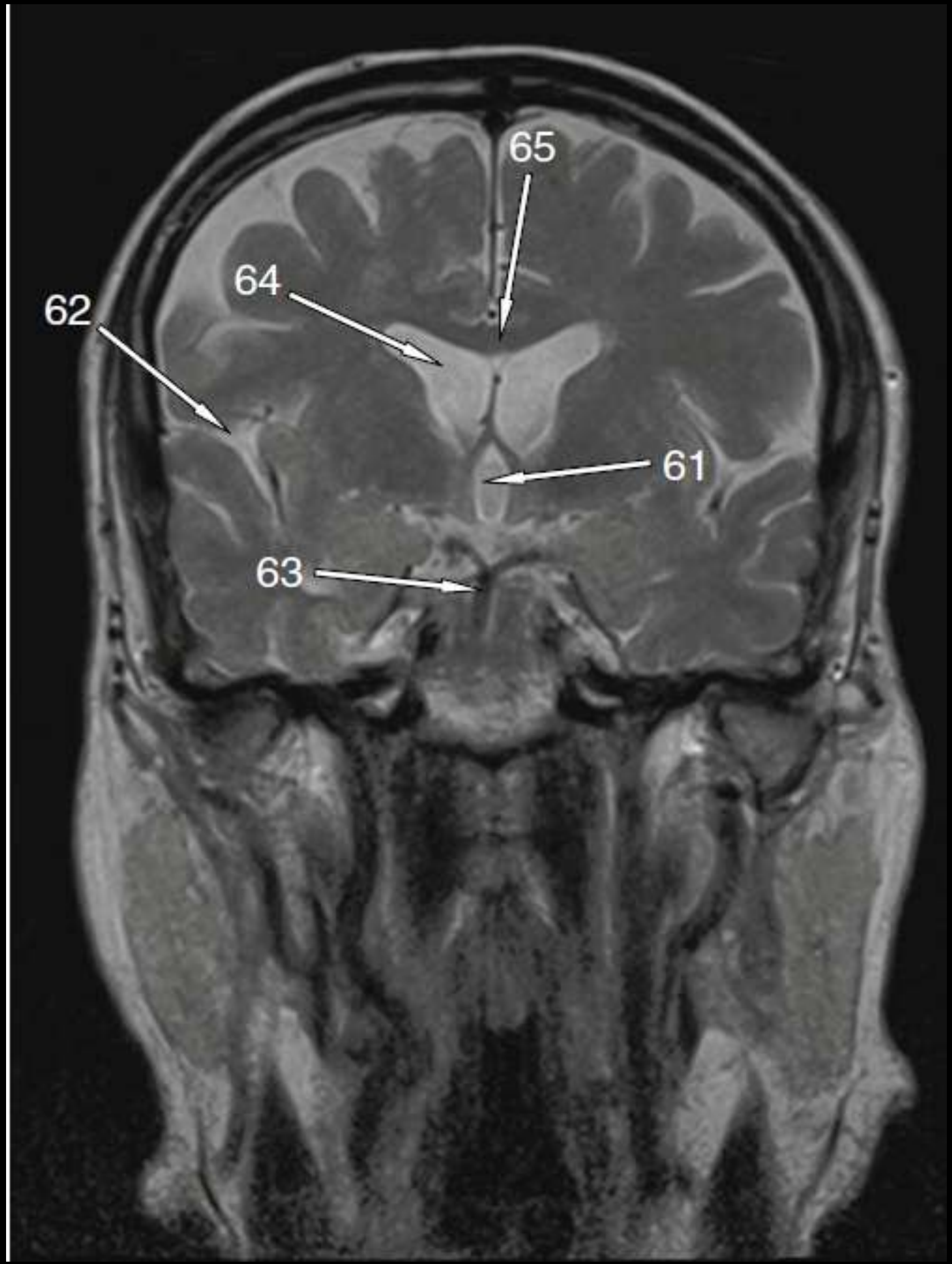
MRI neck. T1W coronal section.

1. Right axillary artery
2. Left clavicle
3. Left sternocleidomastoid muscle
4. Aortic arch
5. Left coracoid process of scapula


25
22
21
24
23

MRI Head

21. Tentorium cerebelli (Left)
22. Quadrigeminal cistern
23. Right sigmoid sinus
24. Fourth ventricle
25. Superior sagittal sinus



65
64
62
61
63

MRI Head

61. Third ventricle
62. Right Sylvian fissure
63. Basilar artery
64. Right lateral ventricle (body of)
65. Body of corpus callosum

The Sylvian fissure divides the frontal and parietal lobe above from the temporal lobe below. It appears around the 14th week of gestation and is one the most prominent fissures of the brain. The M1 segment of the middle cerebral artery lies within this fissure.

Question 2.10

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

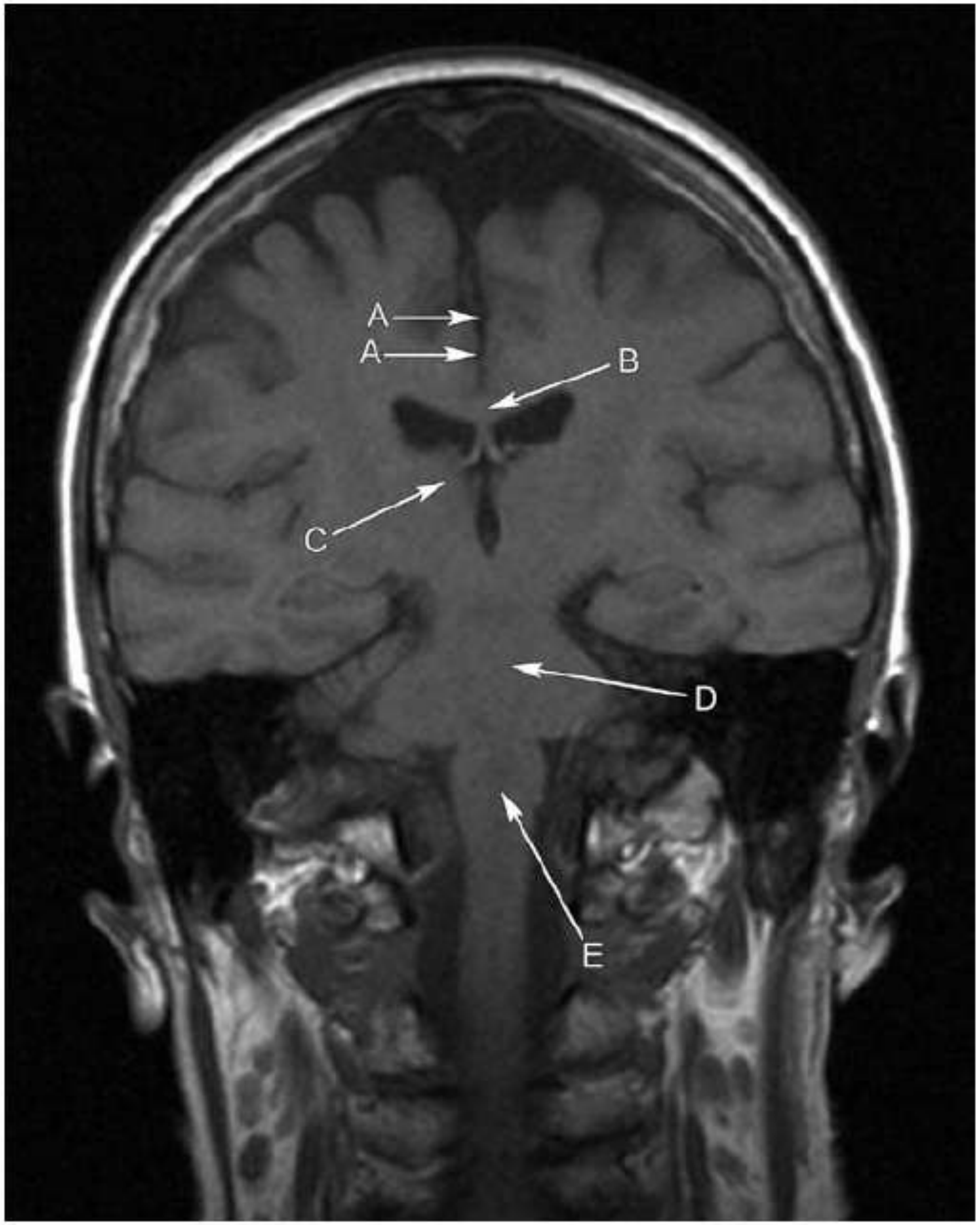
2.10 Coronal STIR MRI of the neck

A Right sternocleidomastoid muscle.
B Odontoid peg.
C Pons.
D Left parotid gland.
E Left lateral mass of C1.

The pons is part of the brain stem and lies between the midbrain and the medulla oblongata. It can be recognized on axial and sagittal imaging by the broad anterior bulge on axial imaging and the lateral bulge on the coronal imaging. It is connected to the cerebellum by the cerebellar peduncles.

The parotid gland is the largest of the salivary glands. It is located anterior to the ear where it extends over the ramus of the mandible and then inferiorly over the angle of the mandible. The gland is divided into a larger superficial part and a smaller deep part. The facial nerve (CN VII) runs in a plane through the gland superficial to the main intraparotid vessels, the external carotid artery and the retromandibular vein. On MRI the gland has higher signal intensity on T2 and T1 weighted imaging than the surrounding muscle due to the increased water and fat content.

Question 5.3



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

5.3 Coronal T1 MRI of the brain

A Interhemispheric fissure.
B Body of the corpus callosum.
C Right thalamus.
D Pons.
E Medulla.

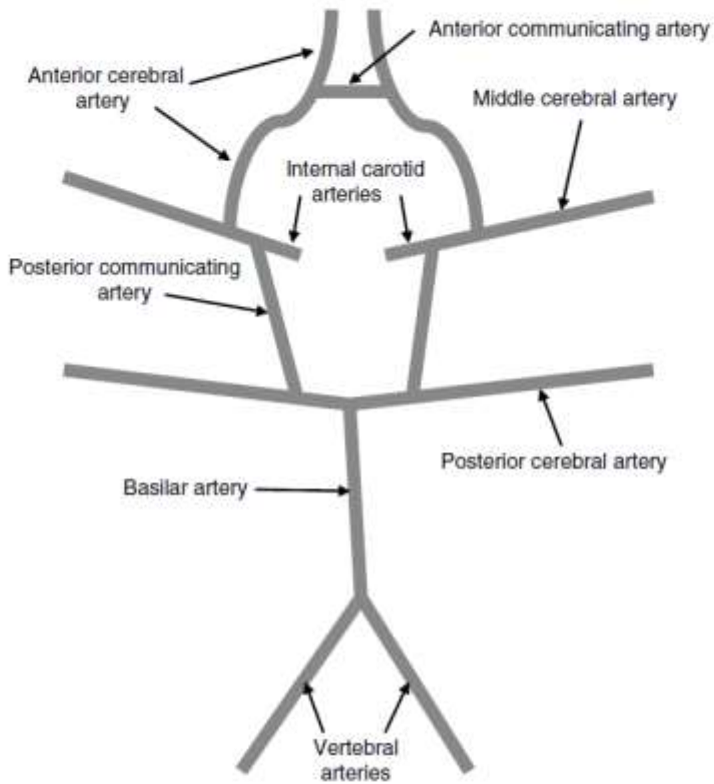
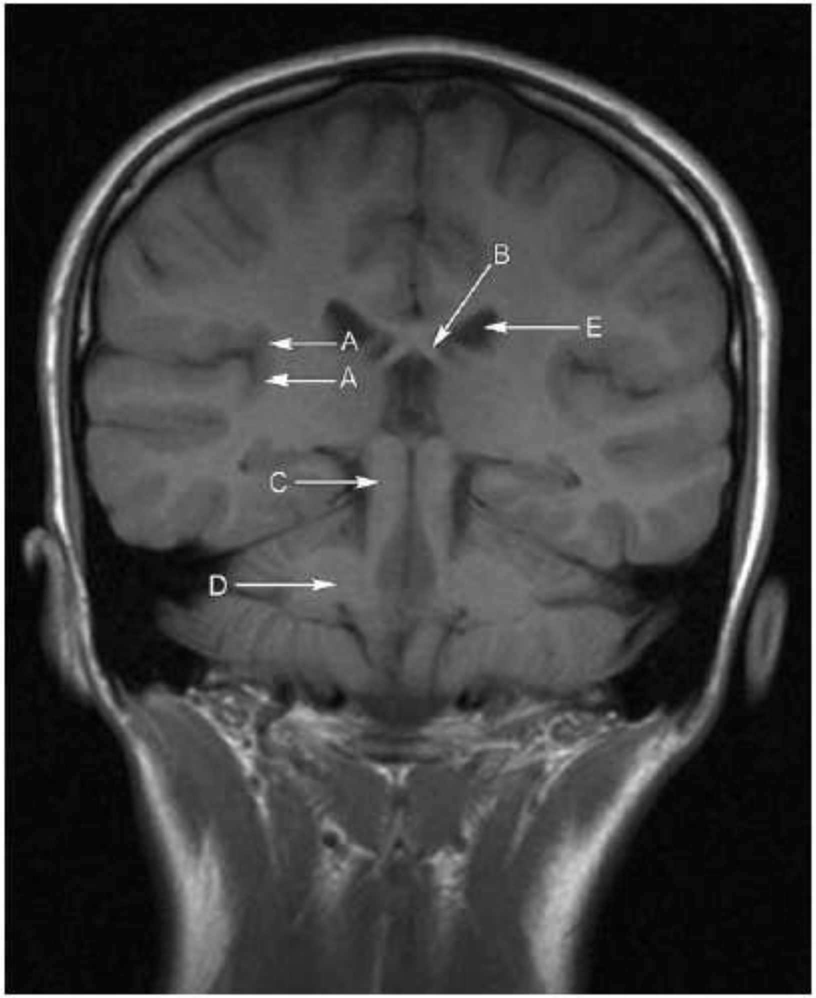


Figure 5.1 The circle of Willis

The coronal T1 sequence is part of the standard imaging protocol for MRI assessment of the brain. The interhemispheric fissure separates the two hemispheres of the brain. The falx cerebri is the arched fold of dura mater that runs vertically within the interhemispheric fissure. The thalami are paired midline structures that lie on either side of the third ventricle. When viewed in sagittal section (Question 5.4) the middle of the body of the corpus callosum can be seen to lie over the line of the brainstem.

Question 6.2



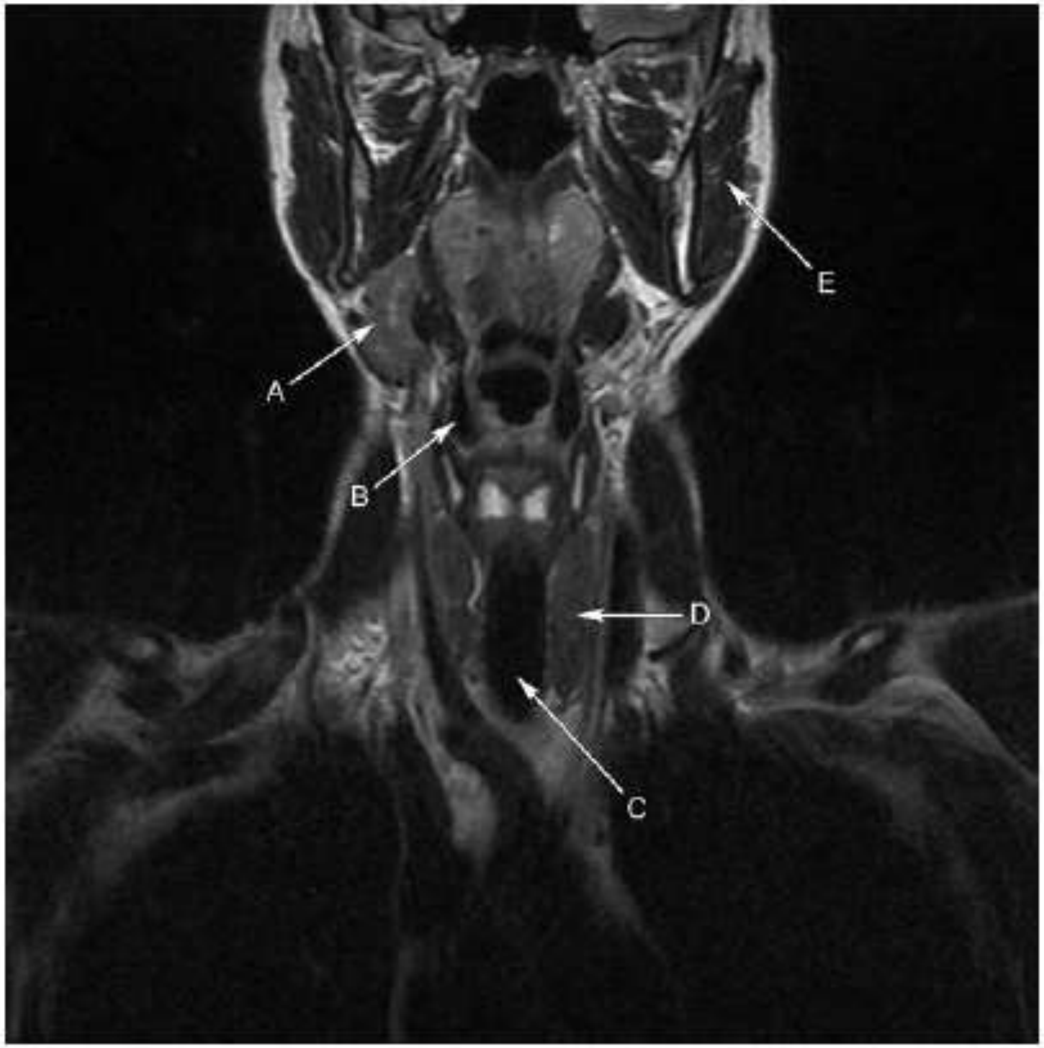
Name the structures labelled **A** to **E**.

6.2 Coronal T1 MRI of the brain

A Right insula.
B Left fornix.
C Midbrain.
D Right middle cerebellar peduncle.
E Left lateral ventricle.

The insula is an area of pronounced grey-white differentiation readily seen on CT and MRI. It is located between the sylvian fissure and external capsule, and is supplied by small perforating branches of the middle cerebral artery. Loss of the insular stripe is an early sign of middle cerebral artery (MCA) territory stroke. The fornix is a C-shaped bundle of white matter fibres that connects the hippocampus to the mammillary bodies and septal nuclei. The fibres at the hippocampus are known as the fimbria. The separate left and right sides are known as the crus of the fornix, and where they come together in the midline is called the body of the fornix.

Question 6.3



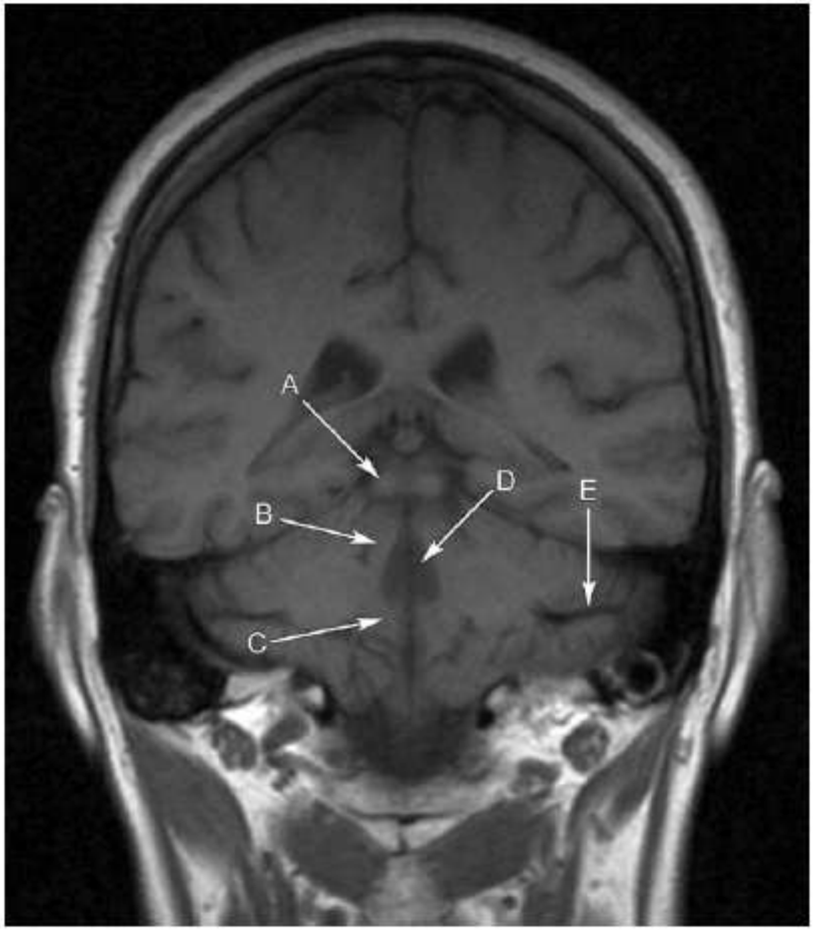
Name the structures labelled **A** to **E**.

6.3 Coronal T1 MRI of the neck

A Right submandibular gland.
B Right piriform fossa.
C Trachea.
D Left lobe of the thyroid.
E Left masseter muscle.

The submandibular glands lie in the floor of the mouth anterior to the angle of the mandible and superior to the digastric muscles. Each submandibular gland is divided into superficial and deep lobes, which are separated by the mylohyoid muscle. The piriform fossae are recesses on either side of the larynx and a common site for food trapping. They are bounded medially by the aryepiglottic fold and laterally by the thyroid cartilage and hyothyroid membrane. The masseter is a muscle of mastication running from the zygomatic process and arch to the mandible.

Question 6.5



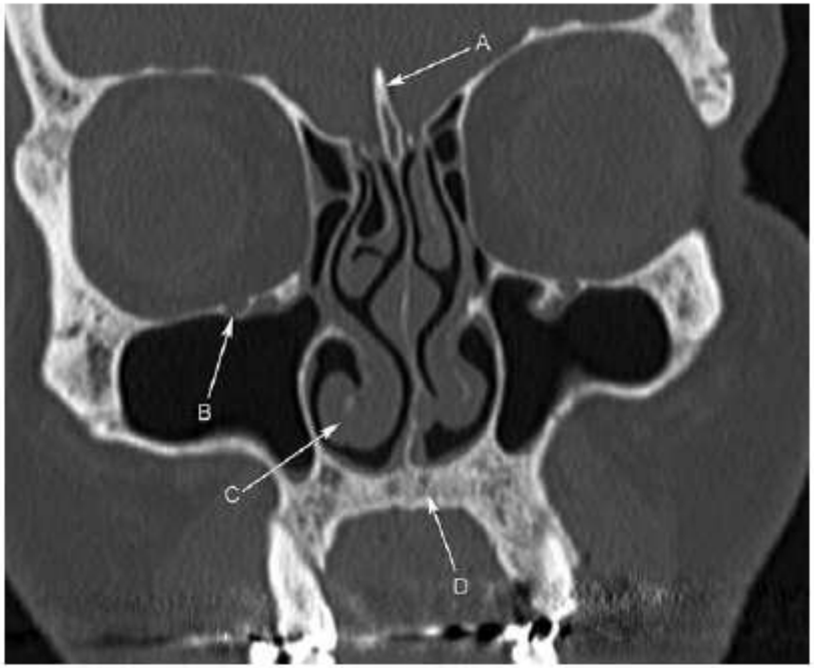
Name the structures labelled **A** to **E**.

6.5 Coronal T1 MRI of the brain

A Right inferior colliculus.
B Right superior cerebellar peduncle.
C Right inferior cerebellar peduncle.
D Fourth ventricle.
E Left horizontal fissure of the cerebellum.

There are four colliculi located on the anterior half of the midbrain – two superior and two inferior. Together they form part of the corpora quadrigemina. The superior colliculi are above the trochlear nerve and are visual processing centres. The inferior colliculi are involved in auditory processing.

Question 7.1



Name the structures labelled **A** to **D**.
E Name a structure that passes through **B**.

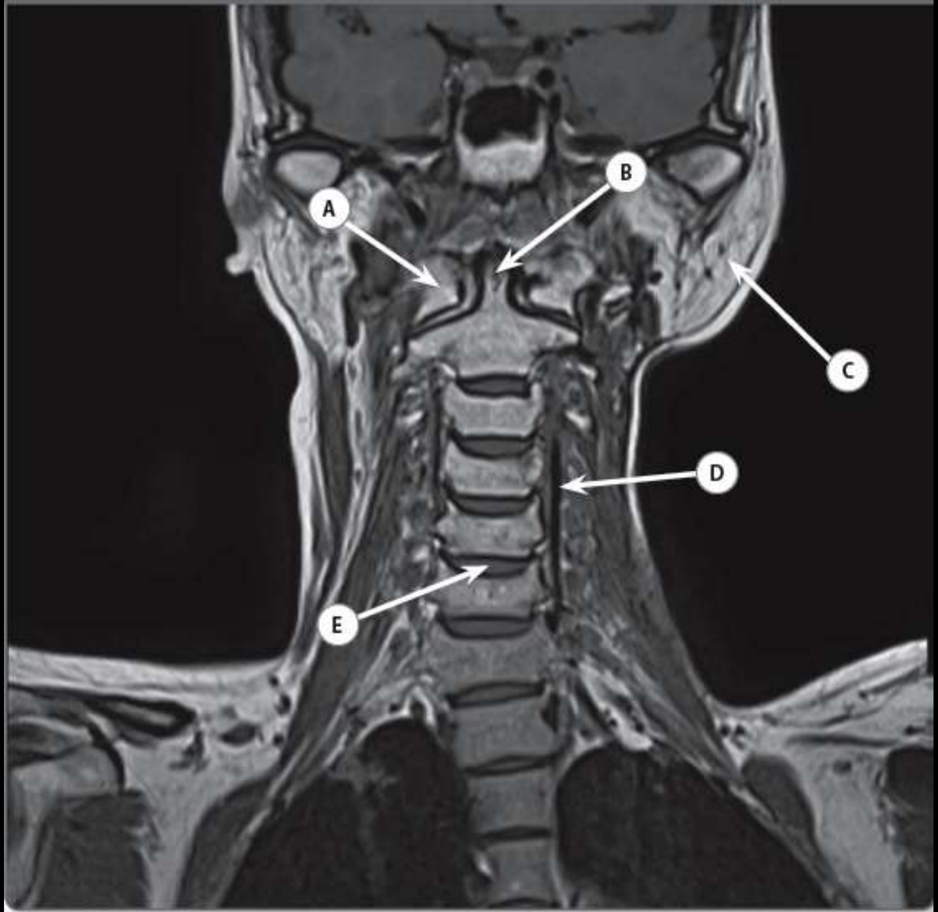
7.1 Coronal CT of the sinuses

A Crista galli.
B Right infraorbital foramen.
C Right inferior turbinate.
D Hard palate.
E Right infraorbital nerve, artery or vein.

'Crista galli' is Latin for 'crest of the cock'. It is a midline ridge of bone that projects from the cribriform plate of the ethmoid bone. The falx cerebri attaches here, and the olfactory bulbs lie on either side. The infraorbital foramen transmits the infraorbital nerve, artery and vein, which can be damaged or compressed in orbital blow-out fractures. The infraorbital nerve is a branch of the maxillary nerve, which is the second division of the trigeminal nerve (CN V).

There are three turbinates; superior, middle and inferior. They function to control the flow of air and ensure that even air humidification and warming takes place over an increased surface area. The osteomeatal complex is a functional entity that includes the middle turbinate, uncinate process, bulla ethmoidalis, hiatus semilunaris and ethmoid infundibulum. It is the common pathway for drainage and ventilation of the frontal, maxillary and ethmoid sinuses.

Case 2.16



Case 2.16

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 2.16

A Right lateral mass of atlas

B Odontoid process (peg) of axis

C Left parotid gland

D Left vertebral artery

E C5/6 intervertebral disc

The craniocervical junction consists of the occipital condyles and the first two cervical vertebrae: the atlas (C1) and axis (C2).

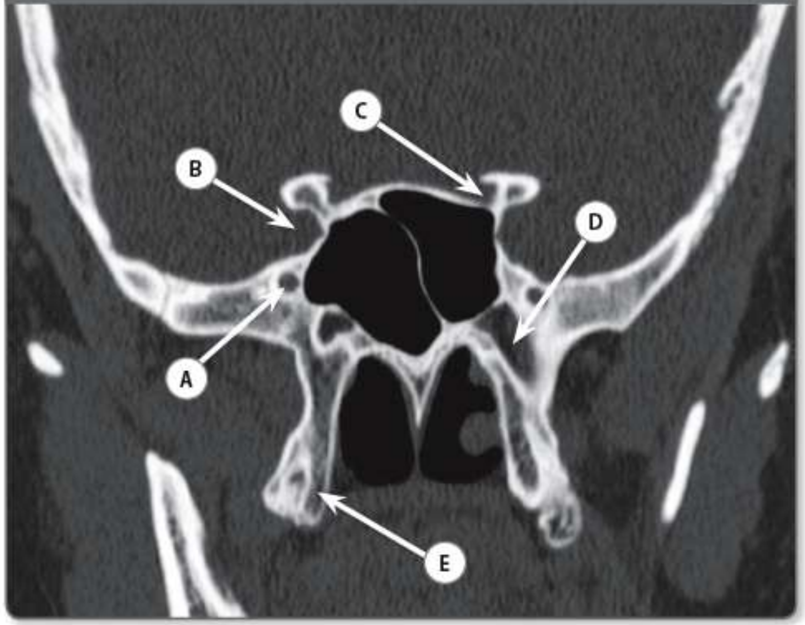
The atlas (C1) is an osseous ring with no true body. Its name is derived from the Greek mythological character Atlas, known for carrying the world on his shoulders. This analogy is similar to the human atlas which essentially carries the head on

its lateral masses. The atlas articulates with the occipital condyles at the atlanto-occipital joints and with the axis at the atlanto-axial joints.

The axis (C2) has a superior process called the odontoid peg (dens), which is a remnant of the body of C1. There are three articulations between C1 and C2:

- Paired atlanto-axial joints between the lateral masses of C1 and C2 bilaterally
- Unpaired joint between anterior arch of C1 and odontoid process of C2.

Case 3.6



Case 3.6

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

Case 3.6

A Right foramen rotundum

B Right superior orbital fissure

C Left optic canal

D Left pterygopalatine fossa

E Right medial pterygoid plate

With a bit of imagination, the sphenoid bone on coronal CT resembles a circus be
with its hind legs pointing upwards (**Figure 3.1**):

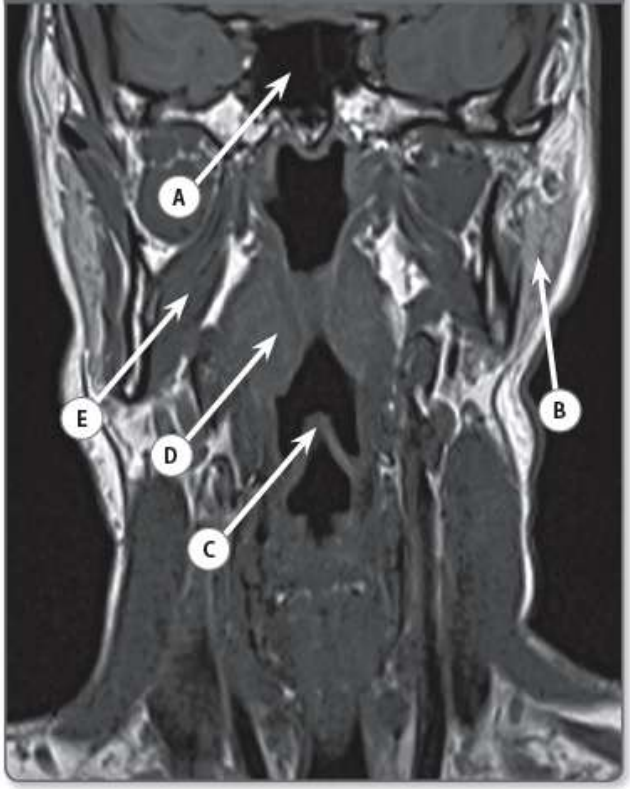
- **Ears** – anterior clinoid processes

Figure 3.1 The sphenoid bone at
level of the sphenoid sinus.

Answers

- **Hind legs** – greater wings of the sphenoid bone
- **Front legs** – medial and lateral pterygoid plates
- **Muzzle** – sphenoid sinus

Case 4.9



Case 4.9

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 structure labelled E.	

Case 4.9

A Sphenoid sinus

B Superficial lobe of the left parotid gland

C Epiglottis

D Right palatine tonsil

E Right medial pterygoid muscle

The pharynx is divided into three levels – the nasopharynx, oropharynx and hypopharynx – in accordance with its communication with the nasal, oral and laryngeal cavities respectively.

The pharyngeal mucosal space, as delineated in **Figure 4.1,** is a fascial space which surrounds the pharynx and contains the pharyngeal constrictor muscles, the extrinsic muscles of the pharynx and lymphoid tissue (the adenoids and tonsils).

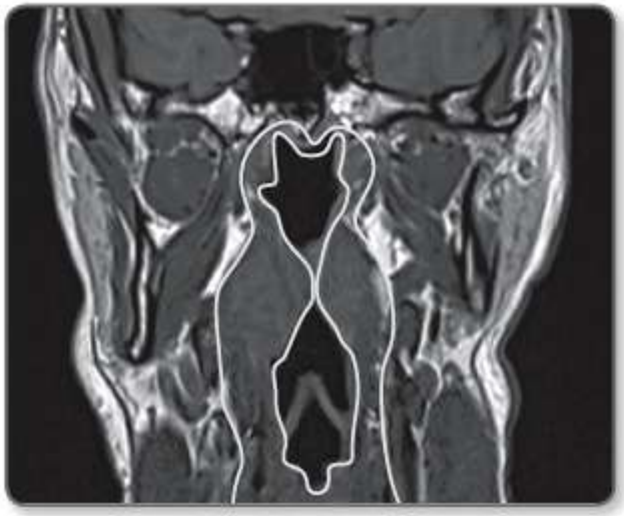
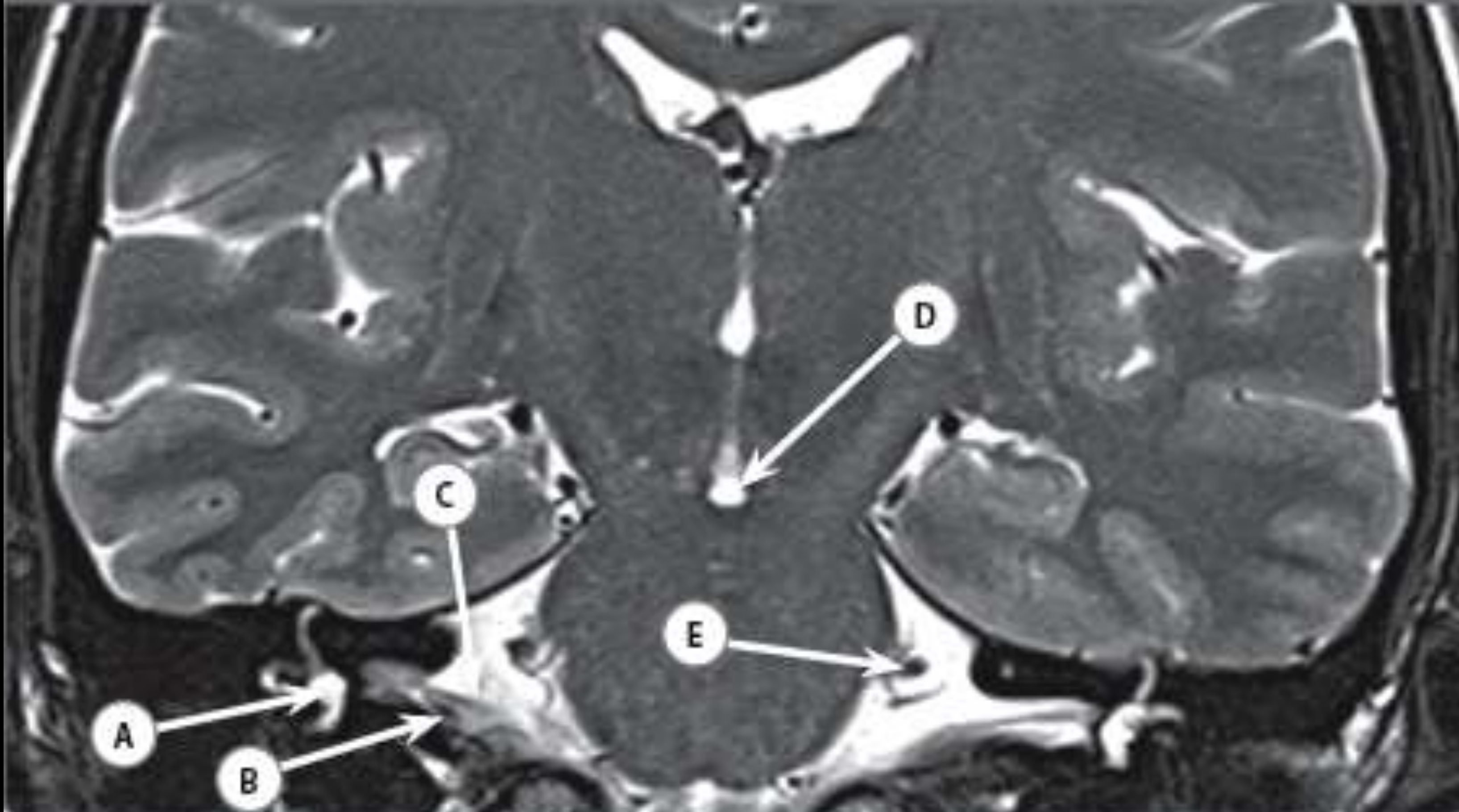


Figure 4.1 Coronal T1-weighted MRI illustrating the pharyngeal mucosal space.

Case 5.17



Case 5.17

A Right vestibule

B Cochlear branch of the right vestibulocochlear nerve (VIII)

C Right facial nerve (VII)

D Interpeduncular cistern

E Left trigeminal nerve (V)

Four nerves pass through the internal auditory meatus (IAM):

- Facial nerve, and

Three branches of the vestibulocochlear nerve:

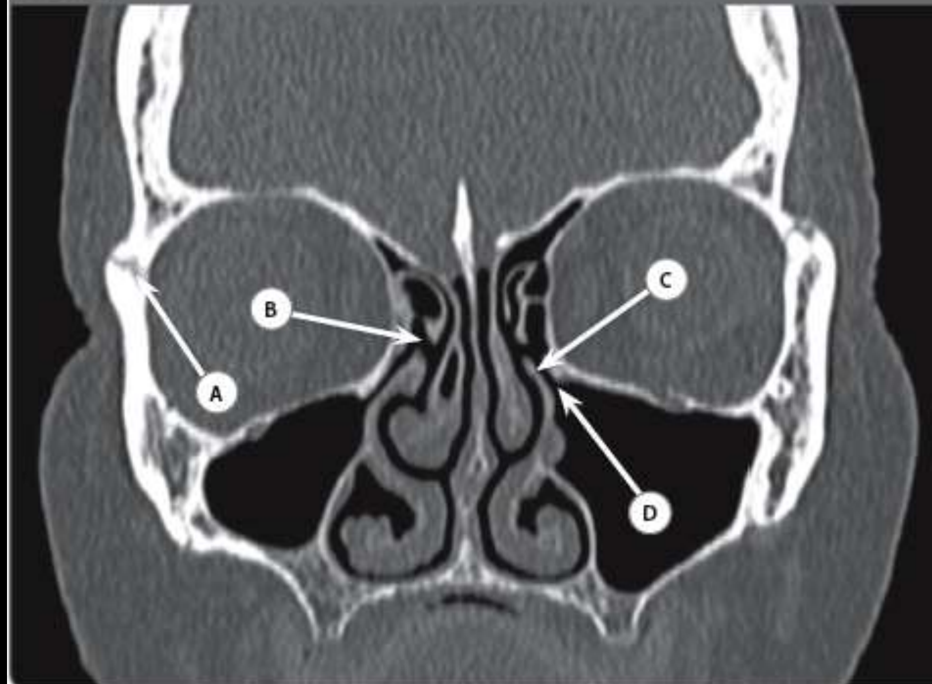
- Cochlear nerve
- Superior vestibular branch
- Inferior vestibular branch.

Vestibular nerves occupy the posterior part of the IAM. The facial and cochlear nerves are situated in the anterior portion of the IAM, with the facial nerve running superiorly and the cochlear nerve inferiorly. The following mnemonic is useful for remembering their relative positions, 'Seven up, Coke down':

Seven **up** – Seventh (VII) nerve **superior**

Coke **down** – Cochlear nerve **inferior**

Case 6.3



Case 6.3

QUESTION		WRITE YOUR ANSWER HERE
A	Name the structure labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	What is the common final pathway for drainage of the maxillary, frontal and anterior/ middle ethmoid sinuses called?	

Case 6.3

A Right frontozygomatic suture

B Right ethmoid infundibulum

C Left uncinate process

D Left maxillary sinus ostium

E Ostiomeatal complex

The ostiomeatal complex is a common pathway for the maxillary, frontal and anterior/middle ethmoid sinuses as illustrated in **Figure 6.1**. It consists of:

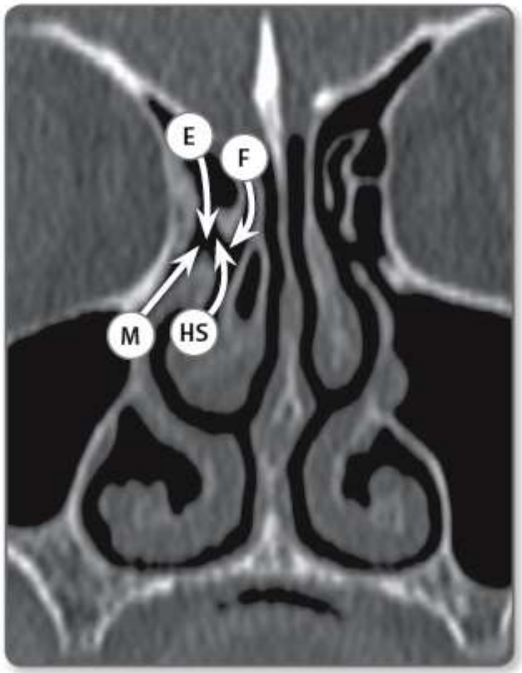
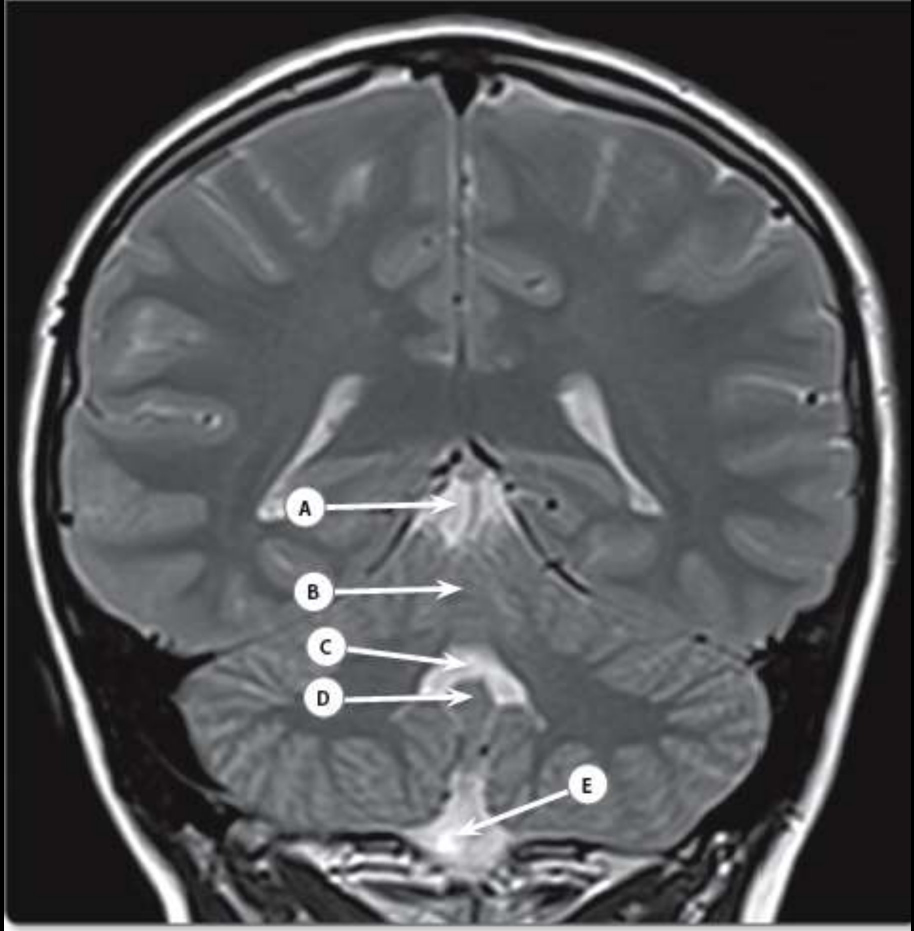


Figure 6.1 The ostiomeatal complex in coronal plane. M, maxillary sinus ostium; E, ethmoid infundibulum; F, frontal recess; HS, hiatus semilunaris.

- **Maxillary sinus ostium** – aperture of the maxillary sinus (M)
- **Ethmoid infundibulum** – opening of the anterior/middle ethmoid cells (E)
- **Frontal recess** – ostium for frontal sinus (F)
- **Hiatus semilunaris (HS)** – a crescentic groove forming a common location of the above openings

Case 6.14



Case 6.14

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 structure labelled D.	
E	Name the structure labelled E.	

Case 6.14

- A Quadrigeminal cistern
- B Cerebellar vermis
- C Fourth ventricle
- D Nodule of cerebellum
- E Cisterna magna

With a bit of imagination the cerebellum and CSF spaces at this level resemble a face of a sad man with moustache (**Figure 6.3**): lateral ventricles form the eyes; quadrigeminal cistern – nose; fourth ventricle – mouth and cerebellar hemispheres – big moustache.

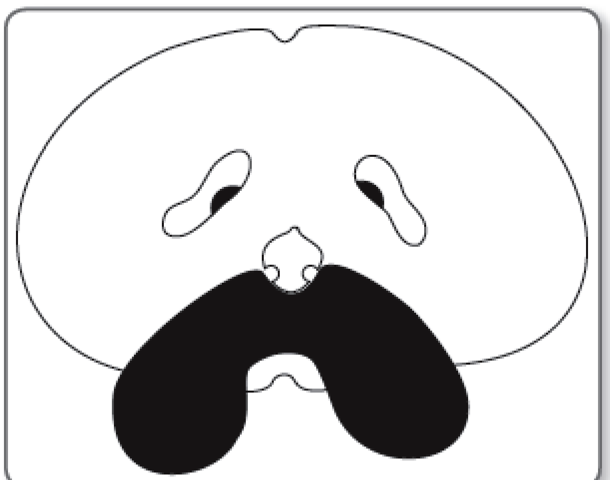
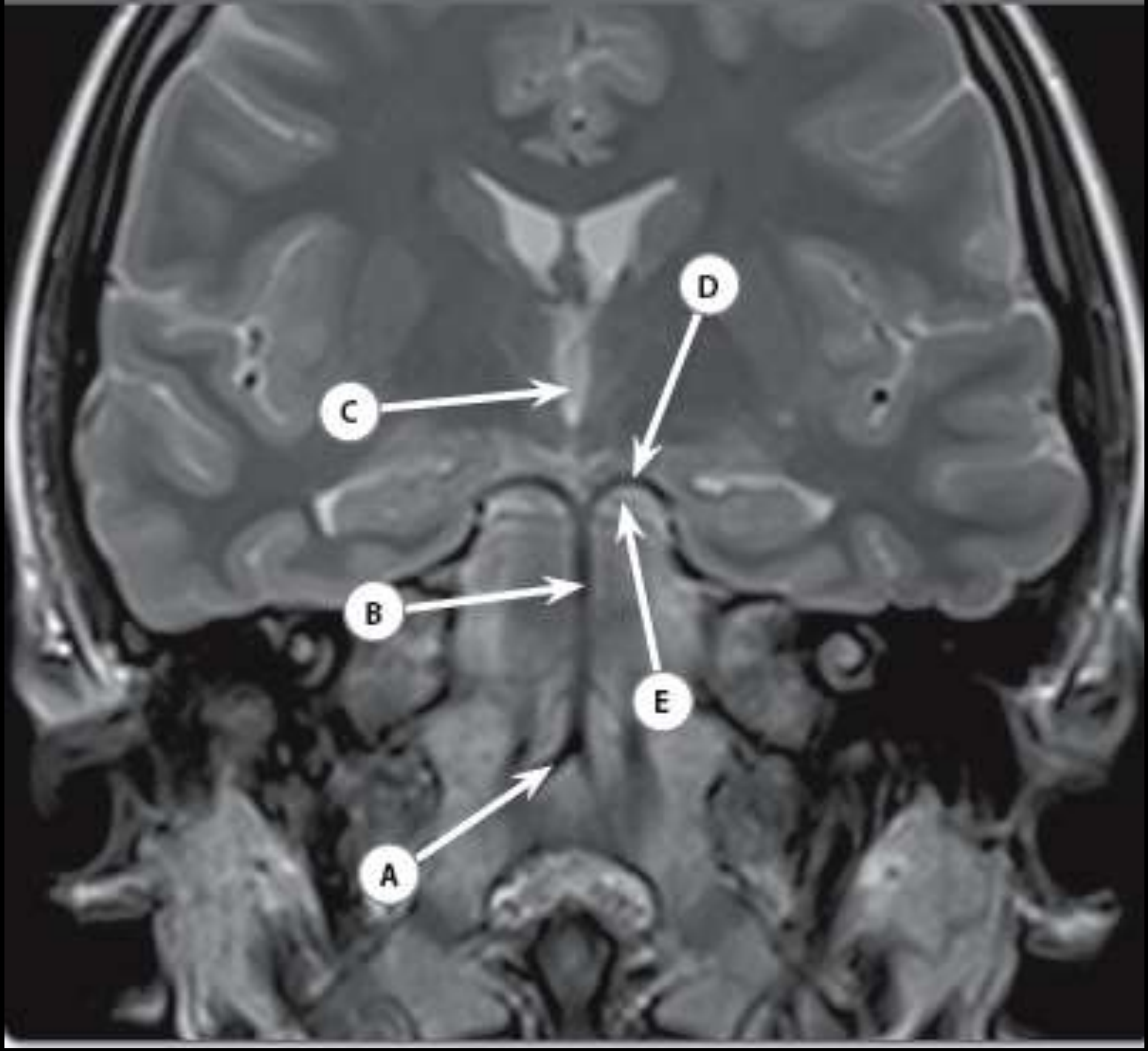


Figure 6.3 'Sad man with moustache' schematic illustration of the relationship between cerebellum and neighbouring CSF spaces in the coronal plane.

Case 9.4



Case 9.4

A Right vertebral artery

B Basilar artery

C Third ventricle

D Left posterior cerebral artery

E Left oculomotor nerve

This is a standard view for the visualisation of the cisternal portion of the oculomotor nerve. The characteristic shape of the vascular structures resembles a 'man in glasses', as depicted in **Figure 9.1**, with oculomotor nerves being eyes, posterior cerebral arteries and superior cerebellar arteries forming glasses, basilar artery as body, anterior inferior cerebellar arteries as hands and vertebral arteries as legs of the man.

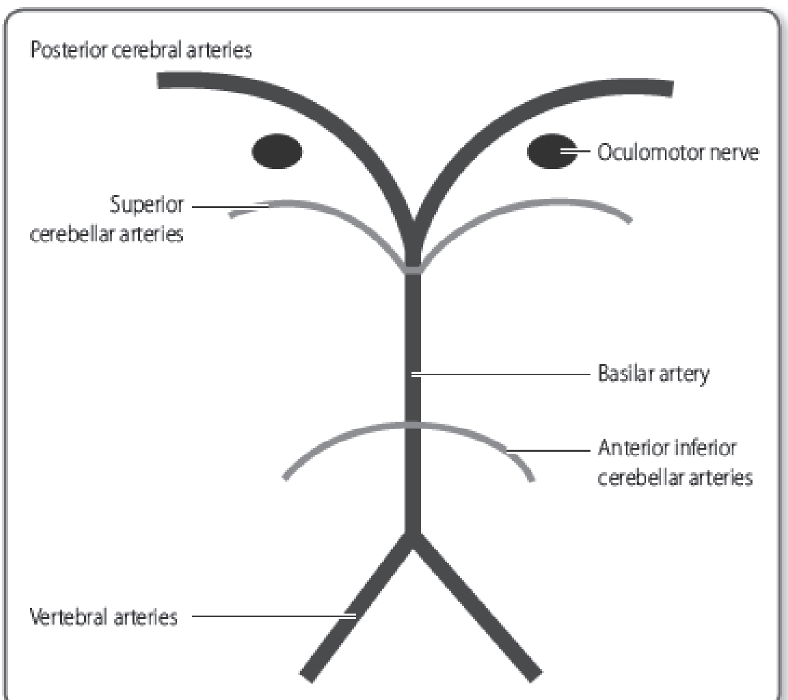
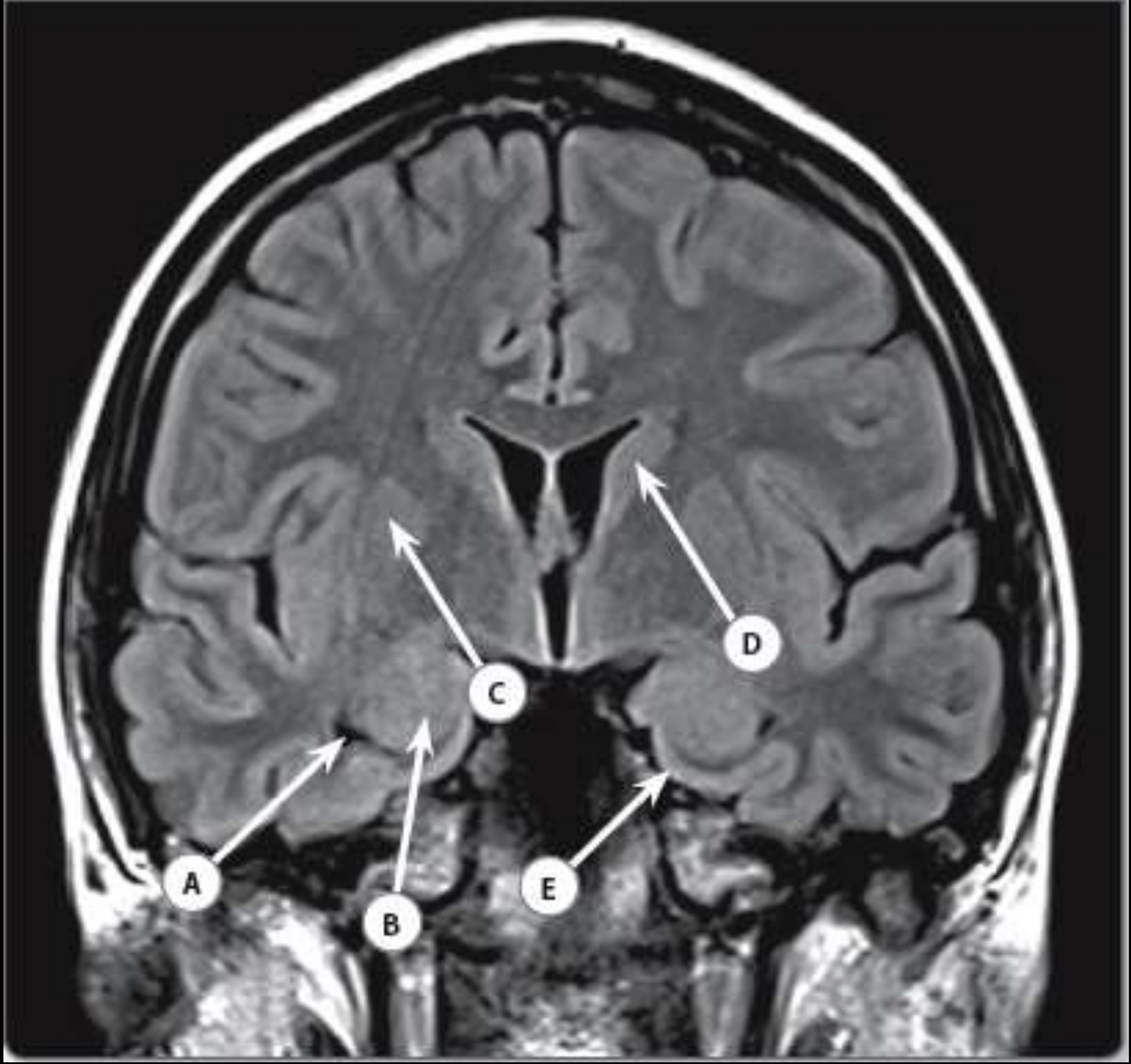


Figure 9.1 'Man in glasses' schematic illustration of the characteristic shape of posterior circulation vessels and their relation to the oculomotor nerve.

Case 10.11



Case 10.11

A Temporal horn of the right lateral ventricle

B Right hippocampus

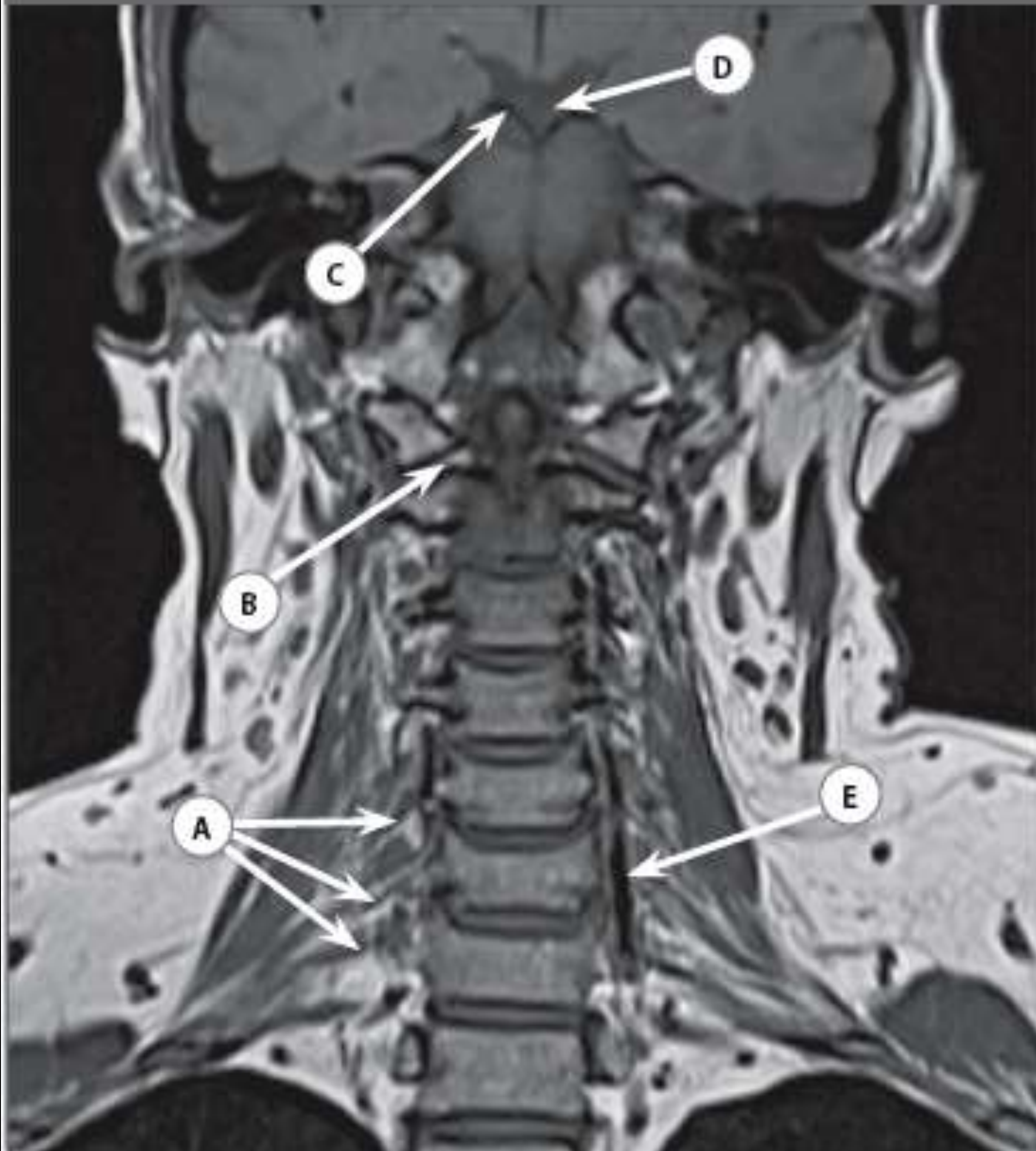
C Right lentiform nucleus

D Head of the left caudate nucleus

E Left parahippocampal gyrus

Coronal images nicely depict the medial temporal lobe, especially the hippocampus and parahippocampal gyrus, which are parts of the limbic system. The hippocampus is the area of grey matter which lies adjacent to the temporal horn of the lateral ventricle, forming part of its floor. The parahippocampal gyrus forms the medial aspect of the temporal lobe.

Case 10.13



Case 10.13

A. Nerves of the right brachial plexus

B. Right atlanto-axial joint

C. Right posterior cerebral artery

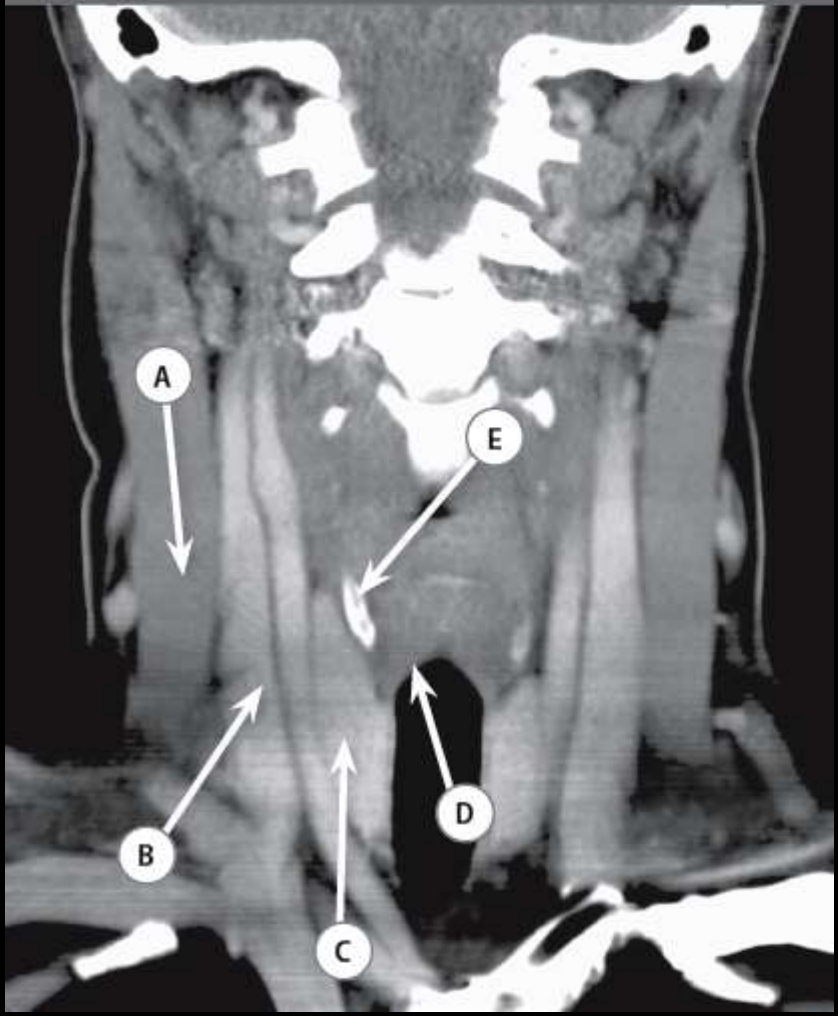
D. Interpeduncular cistern

E. Left vertebral artery

The brachial plexus is formed from the anterior rami of the C5–T1 spinal nerve roots. The components of the brachial plexus have a constant relationship with specific anatomical landmarks, which are easily identifiable on MRI. These include:

- scalene muscles
- atlanto-occipital joint
- cervical portion of the vertebral artery

Case 14.19



Case 14.19

A Right sternocleidomastoid muscle

B Right internal jugular vein

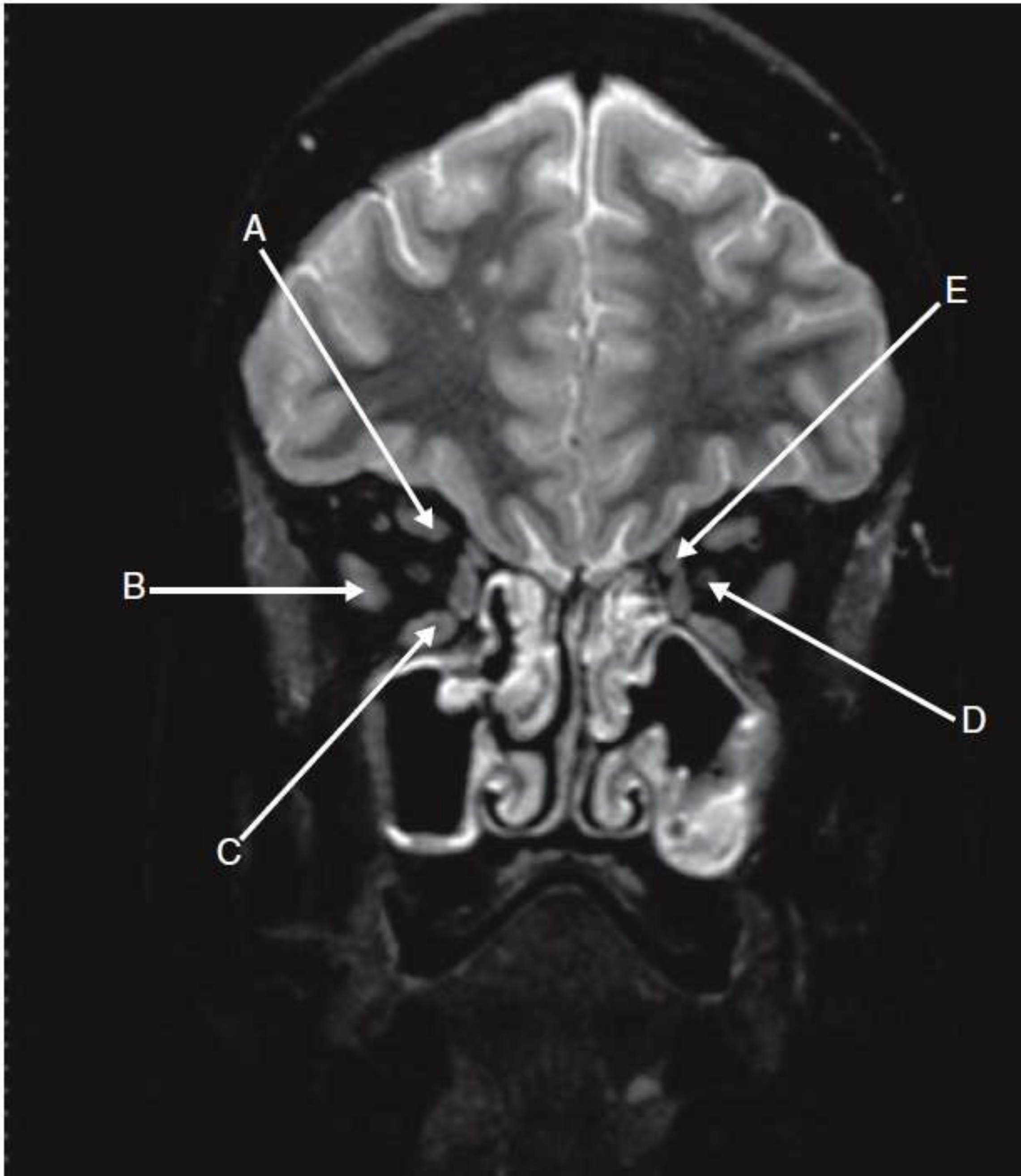
C Right lobe of the thyroid gland

D Right true vocal cord

E Thyroid cartilage

The two lobes of the thyroid gland lie on either side of the trachea and appear chevron-shaped on coronal imaging. The thyroid gland appears relatively dense on non-enhanced CT due to the presence of iodine. The thyroid is directly related to the larynx medially and the carotid space (containing the vagus nerve (CN X), common carotid artery and internal jugular vein) laterally.

Case 4.13



4.13 Coronal MR brain: orbital muscles

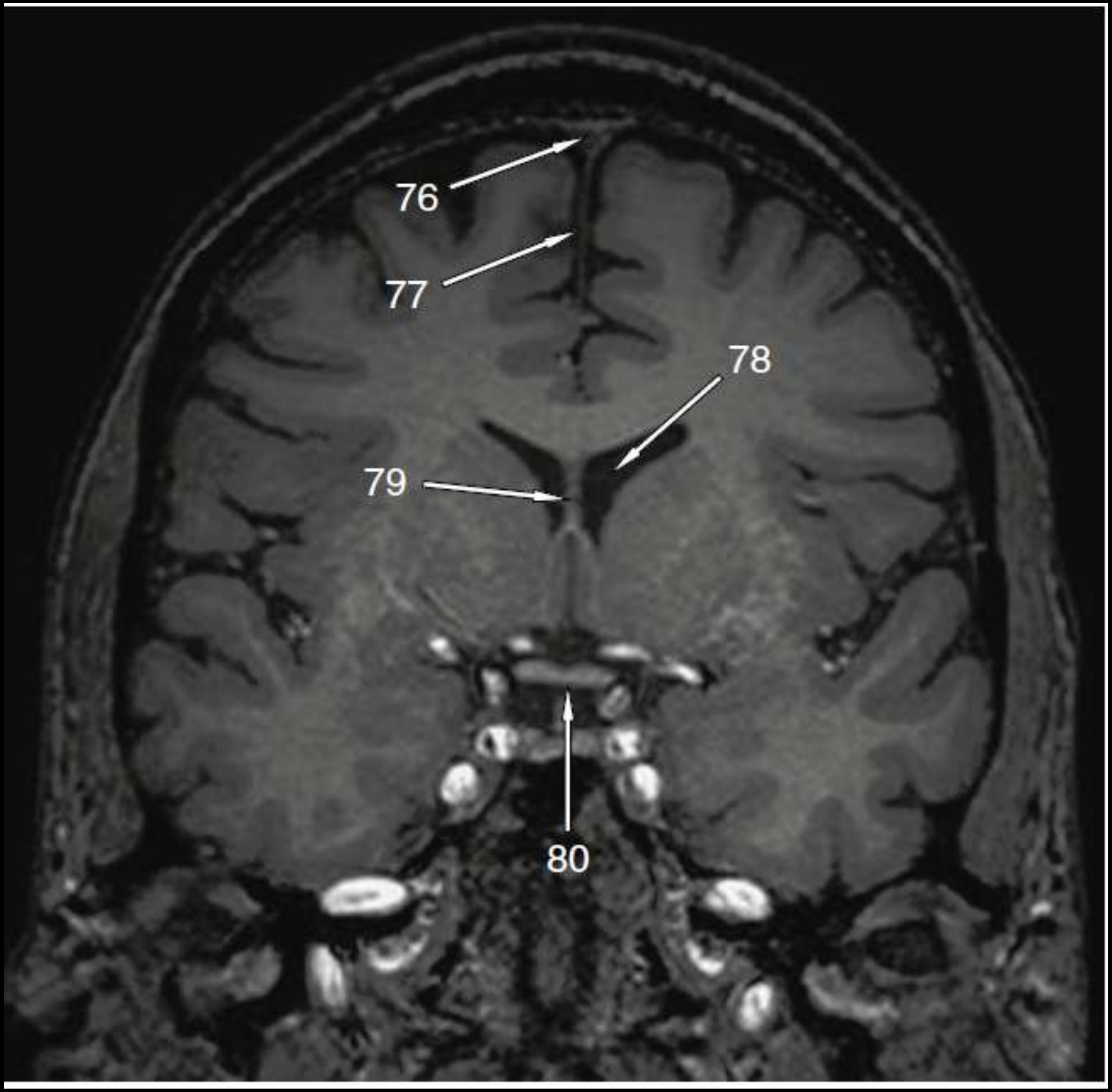
(a) Right superior rectus muscle.
(b) Right lateral rectus muscle.
(c) Right inferior rectus muscle.

(d) Left optic nerve.
(e) Left superior oblique muscle.

There are six extrinsic ocular muscles that insert into the sclera: four rectus muscles (superior, inferior, medial and lateral recti), the superior oblique and inferior oblique. These can be visualized on CT or MRI.

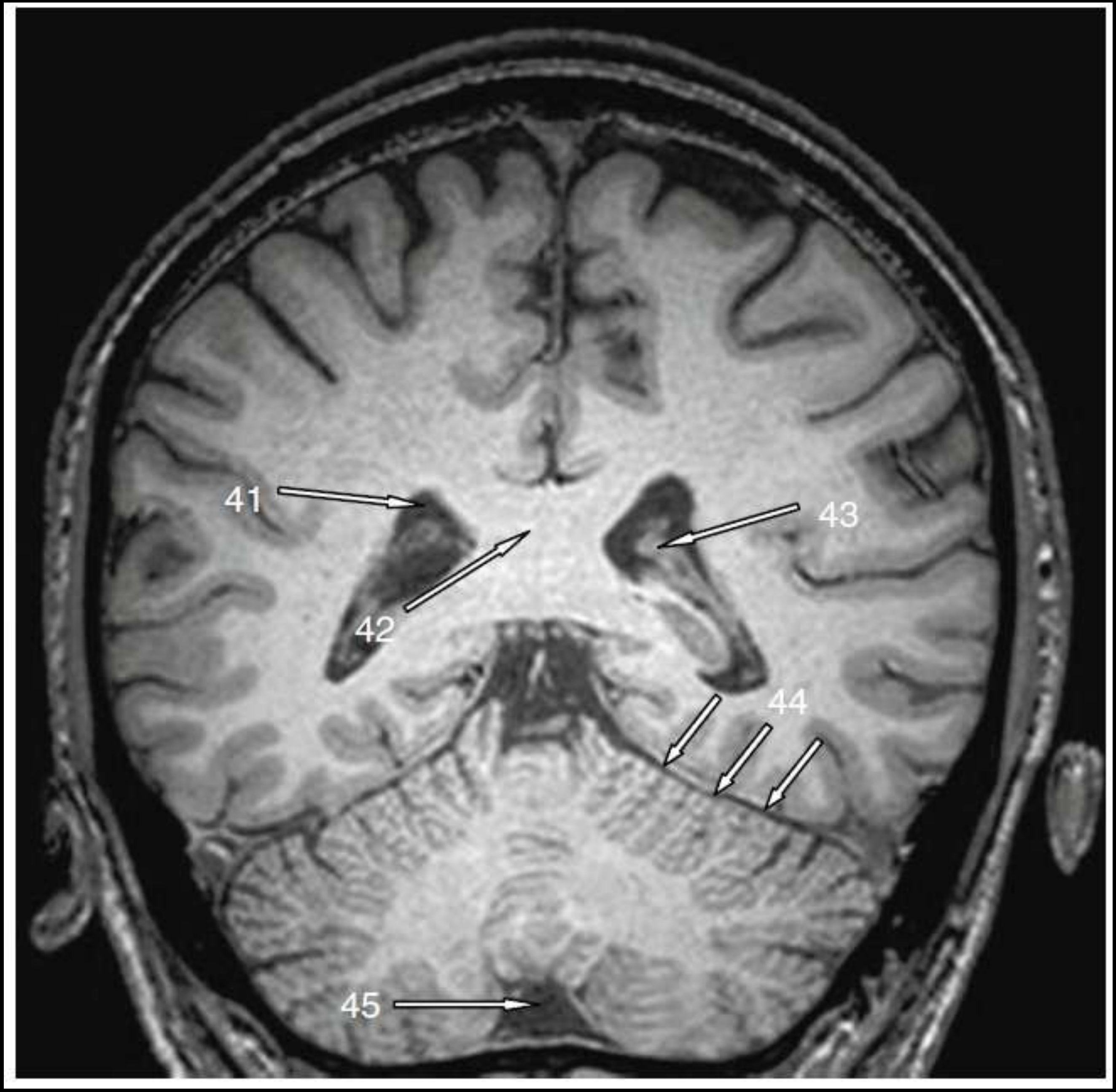
Ocular muscles may be affected in thyroid eye disease, in one or both orbits. The inferior and medial rectus muscles are more likely to be involved first (mnemonic that gives the order of extraocular muscle involvement – I'M SLow – inferior, medial, superior, lateral). Swelling occurs involving the belly of the muscles but sparing of the tendon, whereas in orbital pseudotumour or myositis, the anterior tendinous portion is also involved.

Note the presence of mucosal thickening in the maxillary sinuses.


76
77
78
79
80

MRI Brain

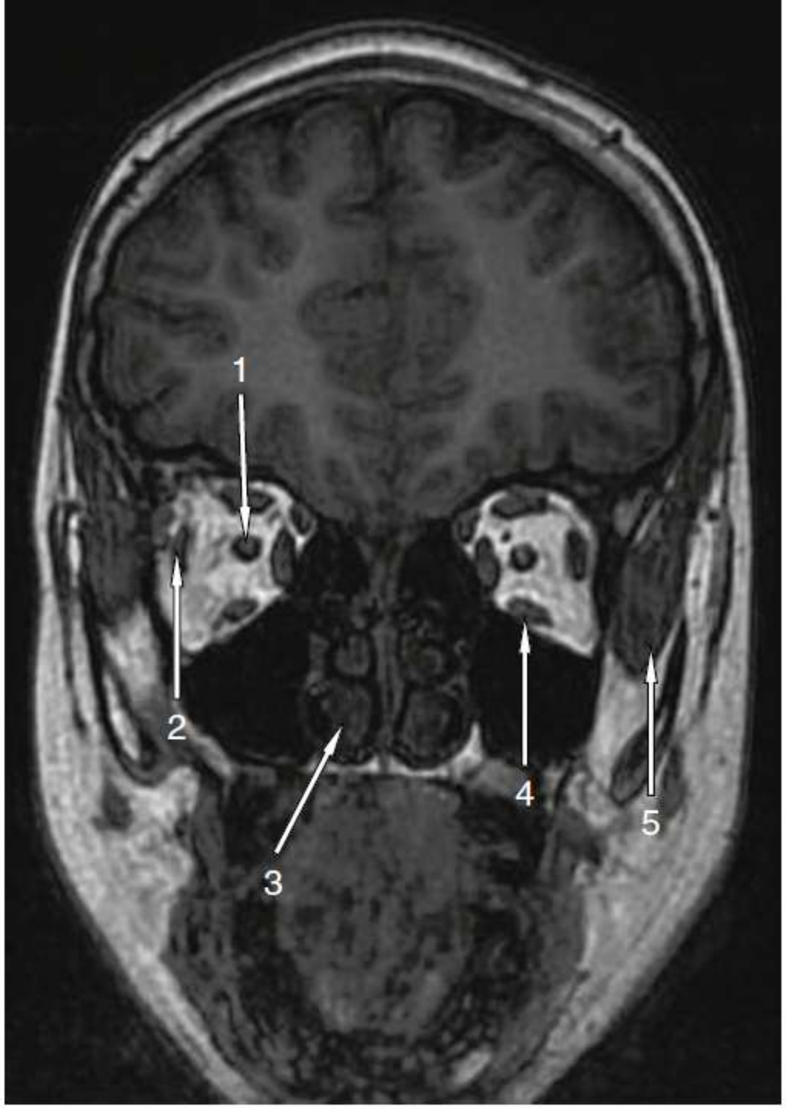
76. Superior sagittal sinus
77. Falx cerebri
78. Left lateral ventricle
79. Septum pellucidum
80. Optic chiasm


41
43
42
44
45

MRI Brain

41. Right trigone of lateral ventricle
42. Splenium of corpus callosum
43. Choroid plexus (within the left lateral ventricle)
44. Tentorium cerebelli
45. Cisterna magna (cerebellomedullary cistern)

The choroid plexus is found in the lateral and third ventricles. It is responsible for CSF production.

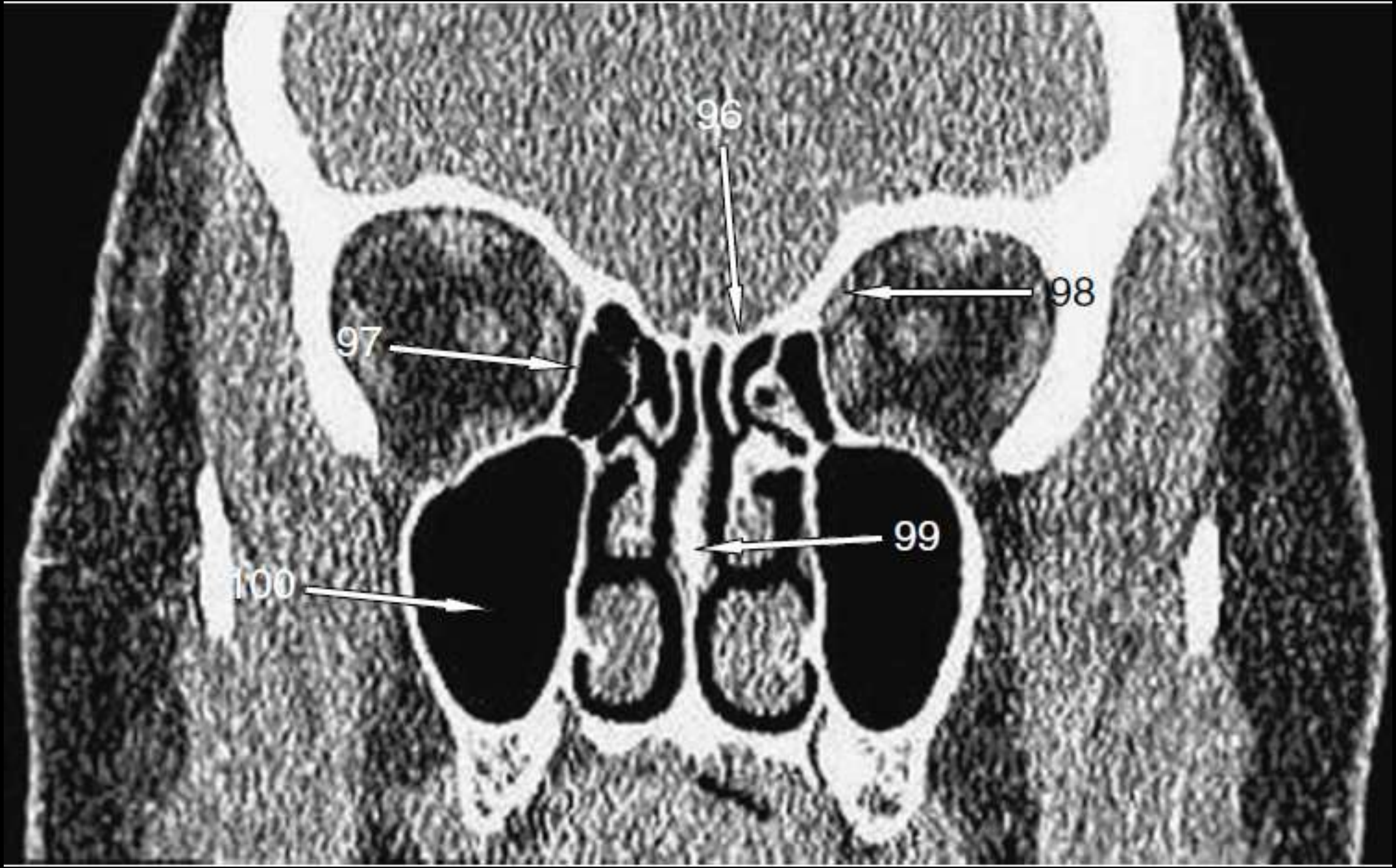


Questions	
1.	Name the structure labelled 1.
2.	What nerve supplies the structure labelled 2?

MRI Head

1. Right optic nerve
2. Right abducens nerve
3. Right inferior concha/turbinate
4. Left inferior rectus muscle
5. Left temporalis muscle

Innervation of the muscles of the eye: *Lr6SO4*, *L*ateral *r*ectus cranial nerve VI (abducens nerve), *S*uperior *O*blique cranial nerve IV (trochlear nerve). The other muscles (superior, medial and inferior recti and inferior obliques) are supplied by cranial nerve III (oculomotor nerve).



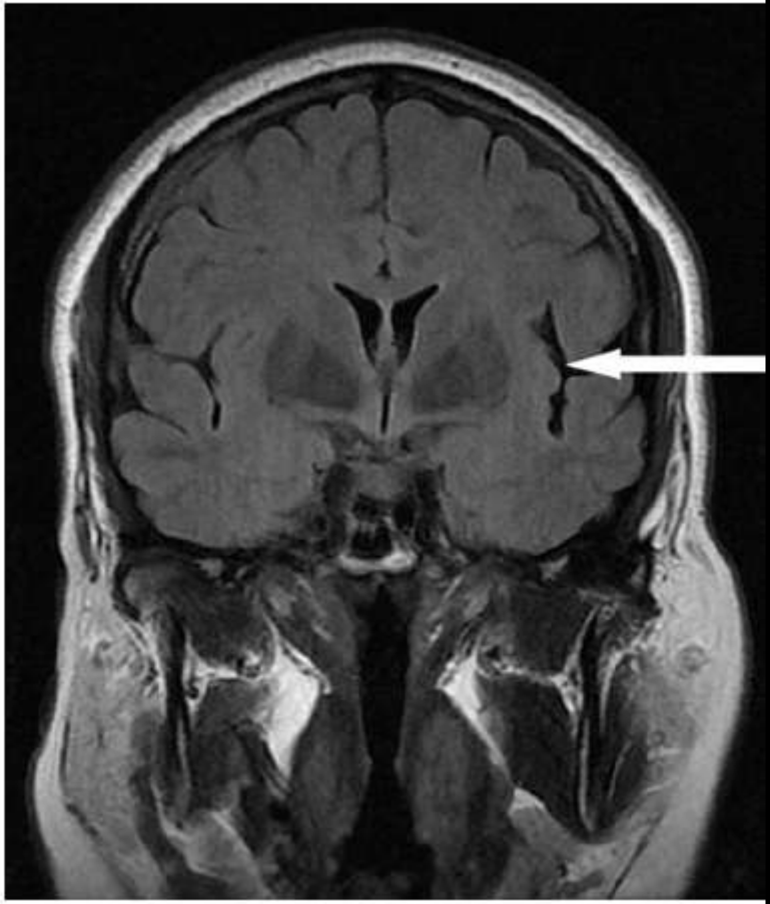
96
98
97
99
100

CT Sinuses

96. Left cribriform plate
97. Right lamina papyracea
98. Left superior oblique muscle
99. Nasal septum
100. Right maxillary sinus

The lamina papyracea/orbital lamina forms a large part of the medial wall of the orbit and is part of the ethmoid bone. Its name refers to the fact that it is paper thin and fractures easily.

Question 24:

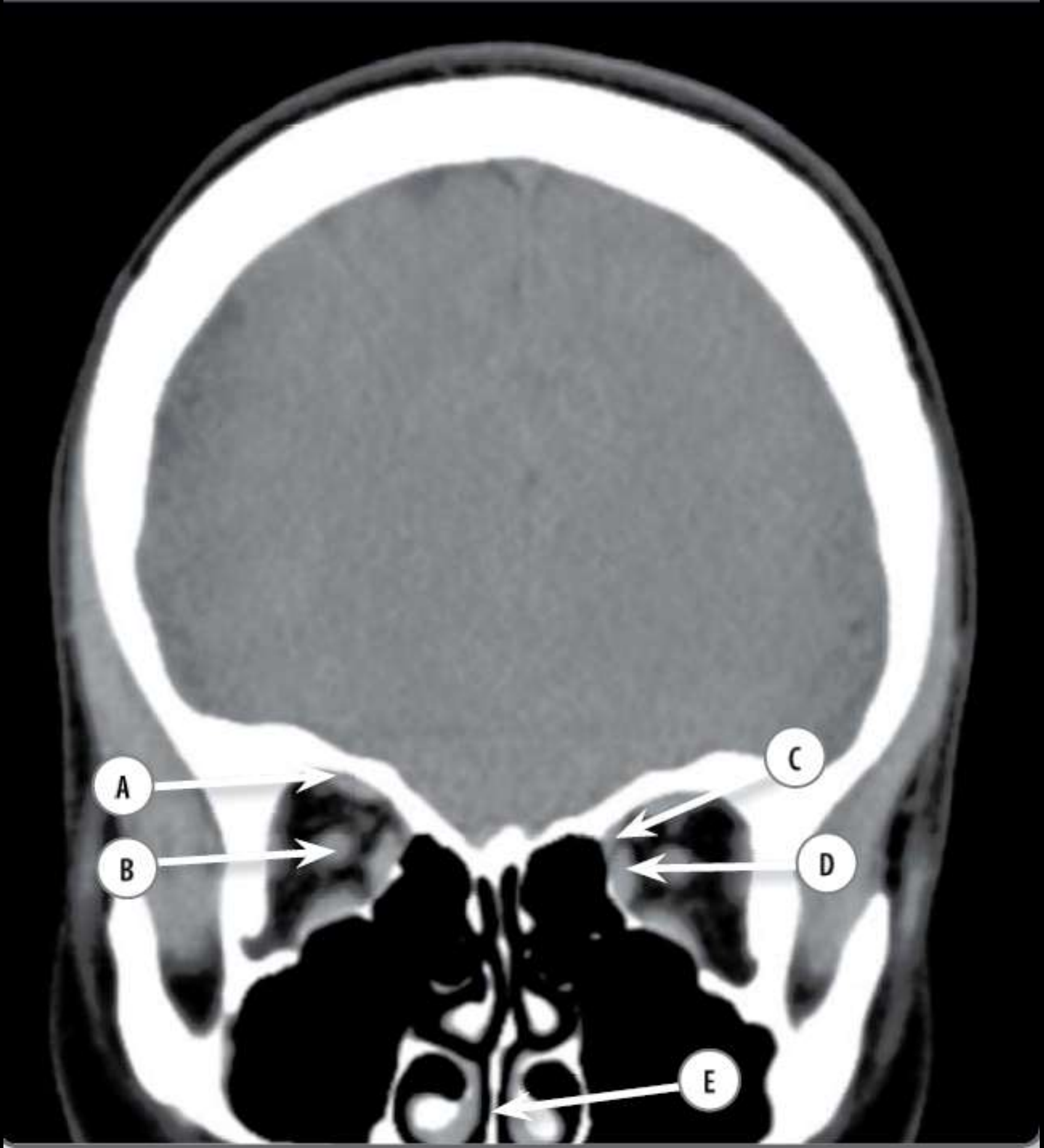


Question 24: Coronal MRI of the brain

Answer: Left Sylvian fissure (lateral sulcus)

- The Sylvian fissure is easily identifiable as the deepest and most prominent paired cortical sulcus.
- It separates the frontal and parietal lobes from the temporal lobe inferiorly.
- The Sylvian fissure is lateral to the insular gyrus.
- It contains the M1 and M2 segments of the middle cerebral artery.

Case 1.20



Case 1.20

A Right superior rectus

B Right optic nerve

C Left superior oblique

D Left medial rectus

E Vomer

Coronal soft tissue CT through the orbits.

Six extrinsic ocular muscles insert into the sclera. The four rectus muscles arise from a common tendinous ring (annulus of Zinn) that surrounds the optic canal and part of the superior orbit fissure. They insert onto the globe anterior to the equator and have the following functions:

- **medial rectus** rotates the pupil medially
- **lateral rectus** rotates the pupil laterally
- **superior rectus** rotates the pupil superiorly
- **inferior rectus** rotates the pupil inferiorly

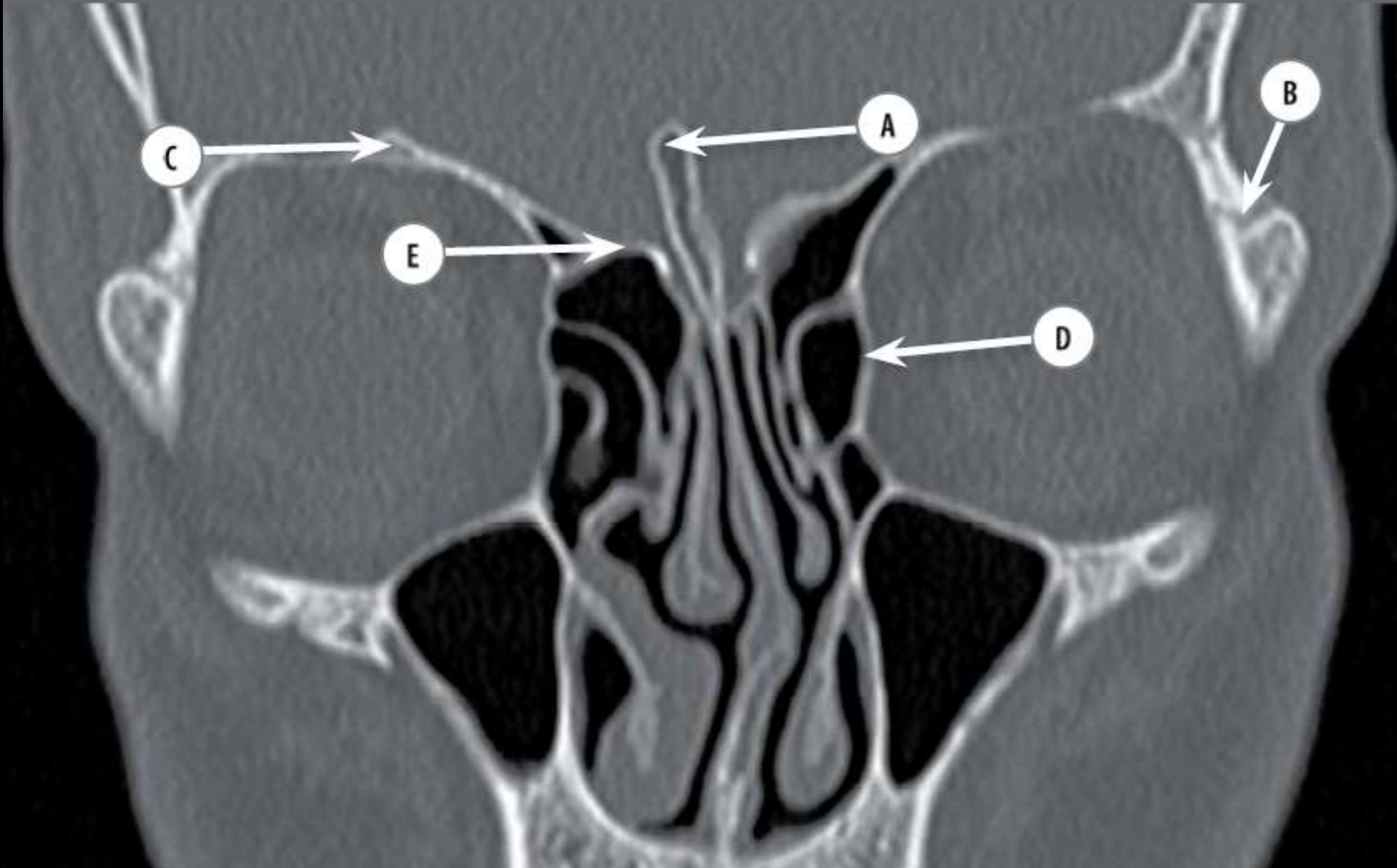
The superior oblique arises from the sphenoidal bone superomedial to the optic foramen. It passes through the trochlea to insert onto the upper outer surface posterior to the equator, directing the pupil inferiorly and laterally.

The inferior oblique arises from the orbital floor to insert onto the lower outer part posterior to the equator, directing the pupil laterally and superiorly.

The vomer forms the bony part of the nasal septum and separates the choanae.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 889.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 27.

Case 1.36



Case 1.36

A Crista galli

B Left frontozygomatic suture

C Right frontal bone

D Left lamina papyracea

E Cribriform plate

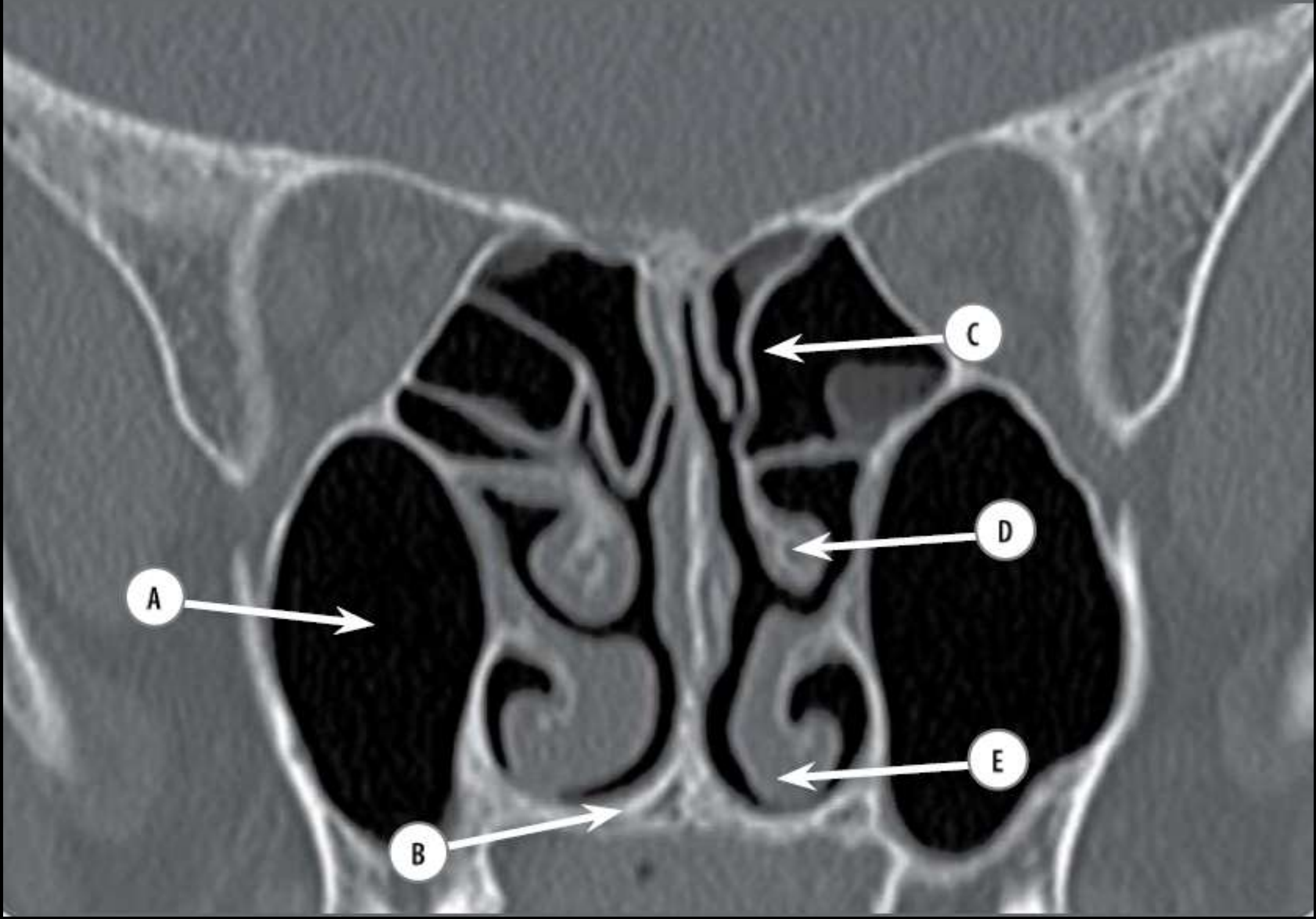
Coronal CT of the paranasal sinuses.

The cribriform plate of the ethmoid is 'sieve-like' to allow the olfactory nerves to access the nasal cavity from the olfactory bulbs of the brain. The crista galli is the superior continuation of the perpendicular plate of ethmoid above the cribriform plate.

The frontozygomatic suture is the suture between the frontal and zygomatic bones.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 11.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 868.

Case 1.37



Case 1.37

A Right maxillary sinus

B Hard palate

C Ethmoid air cell

D Left middle turbinate (concha)

E Left inferior turbinate (concha)

Coronal CT of the paranasal sinuses.

The superior, middle and inferior nasal turbinates (conchae) divide the nasal cavity into four passages:

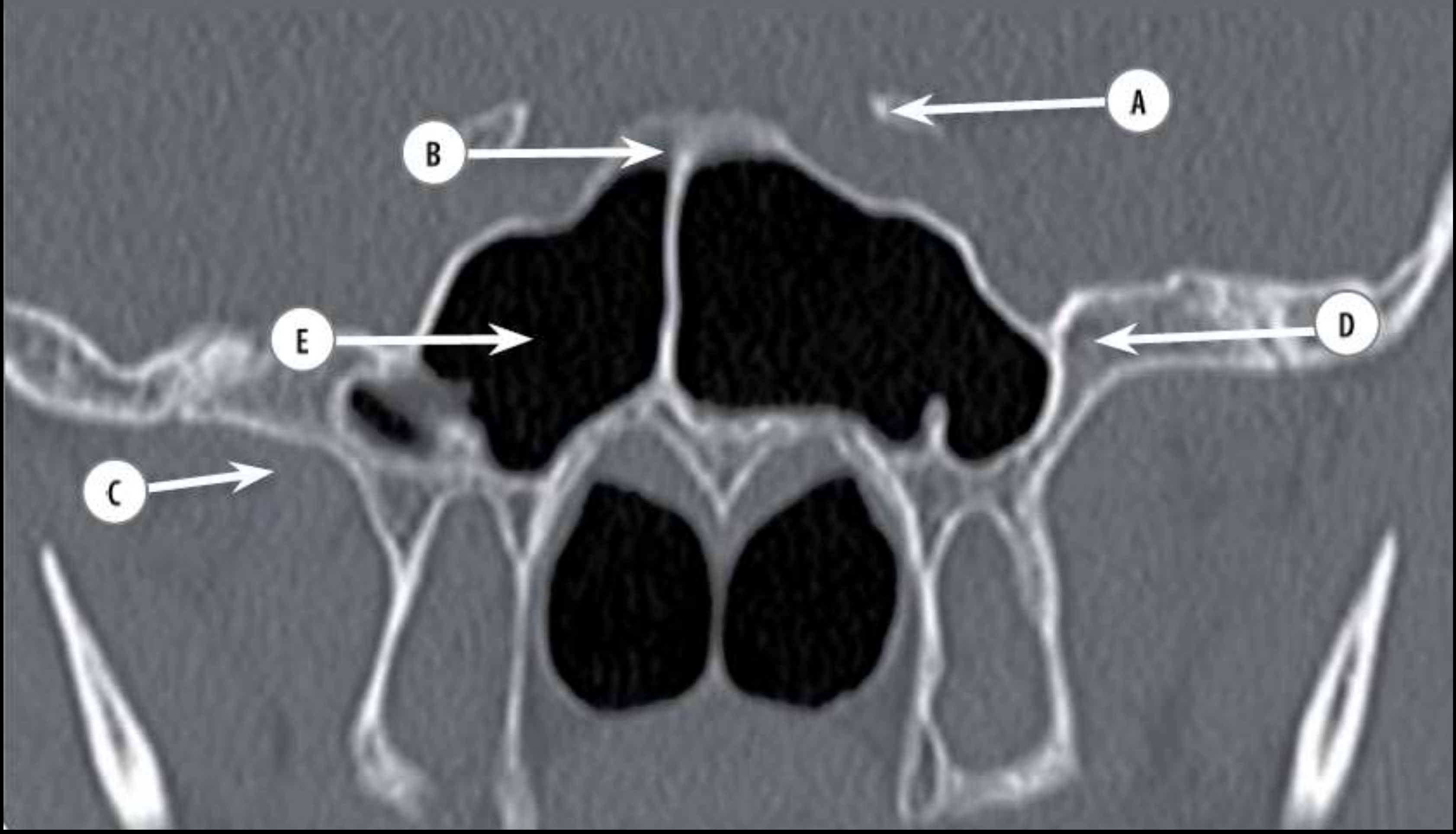
- **sphenoethmoidal recess** into which the sphenoidal sinus drains
- **superior meatus** into which the posterior ethmoidal air cells drain
- **middle meatus,** where the frontal sinus drains into the anterior opening; the anterior ethmoid air cells and maxillary sinus drain into the middle meatus at the hiatus semilunaris, below the ethmoid bulla

- **inferior meatus** into which the nasolacrimal duct drains tears from the lacrimal sac.

The greater palatine, superior labial branch of the facial and ethmoidal branches of the ophthalmic artery supply the nasal cavity. Little's area is a vascular area of mucosa prone to epistaxis in the anterior and inferior septum.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 11.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 825.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 28.

Case 1.38



Case 1.38

A Left anterior clinoid process

B Planum sphenoidale

C Right infratemporal fossa

D Left greater wing of sphenoid

E Right sphenoidal sinus

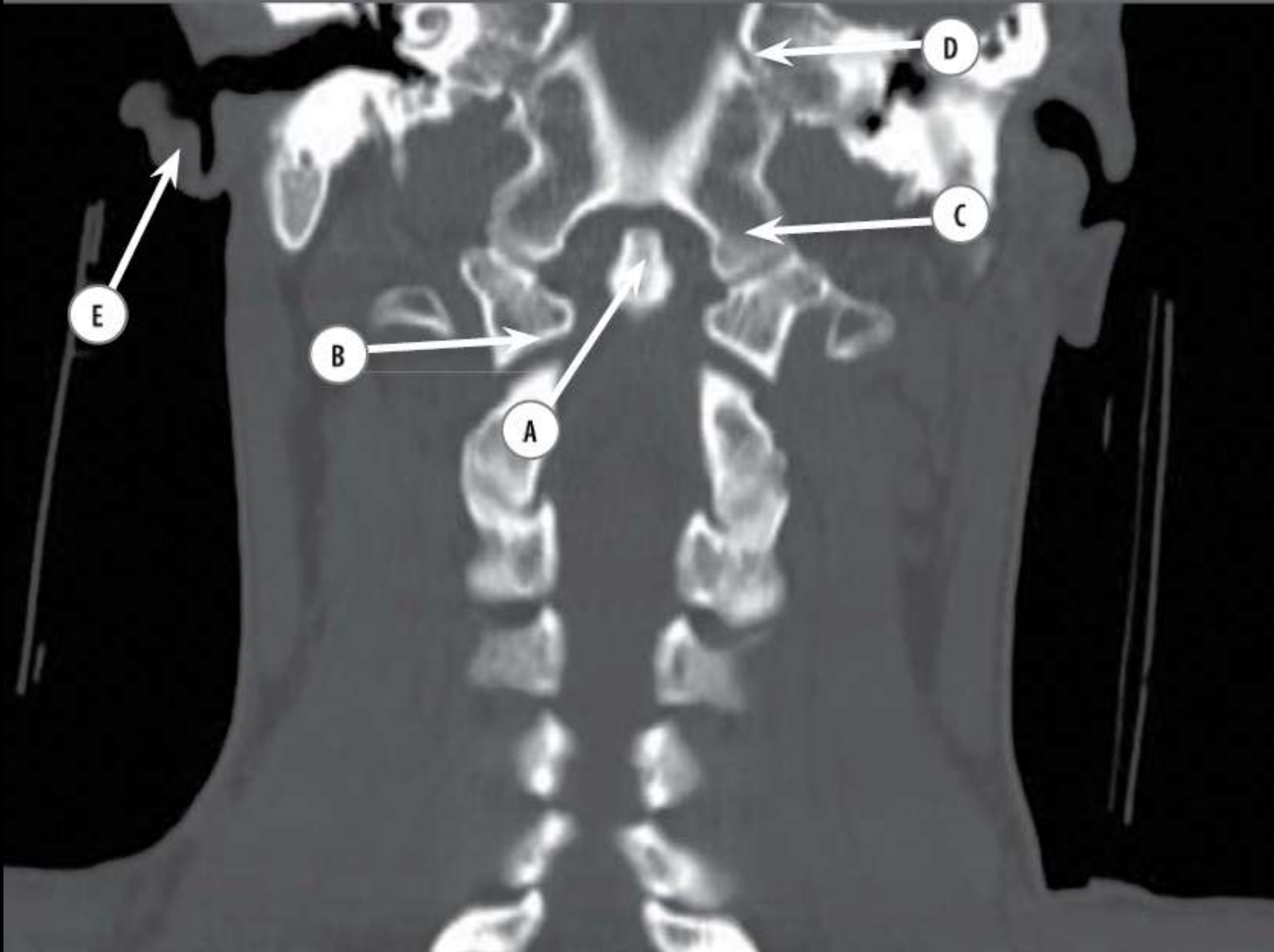
Coronal CT at the level of the sphenoid sinus.

The clinoid processes are the bony prominences surrounding the sella turcica. The planum sphenoidale forms the roof of the sphenoid sinus.

The sphenoid sinuses are in the body of the sphenoid and are separated by a bony septum. They may extend into the wings of the sphenoid. The sella turcica and optic chiasm are superior. The cavernous sinus runs adjacent to the lateral walls of the sphenoid sinuses; the roof of the nasopharynx is formed by its floor.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 11.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 823.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 28.

Case 1.41



Case 1.41

A Odontoid peg

B Right inferior facet of atlas

C Left occipital condyle

D Left petro-occipital suture

E Pinna of right ear

Coronal CT section of the bones of the neck.

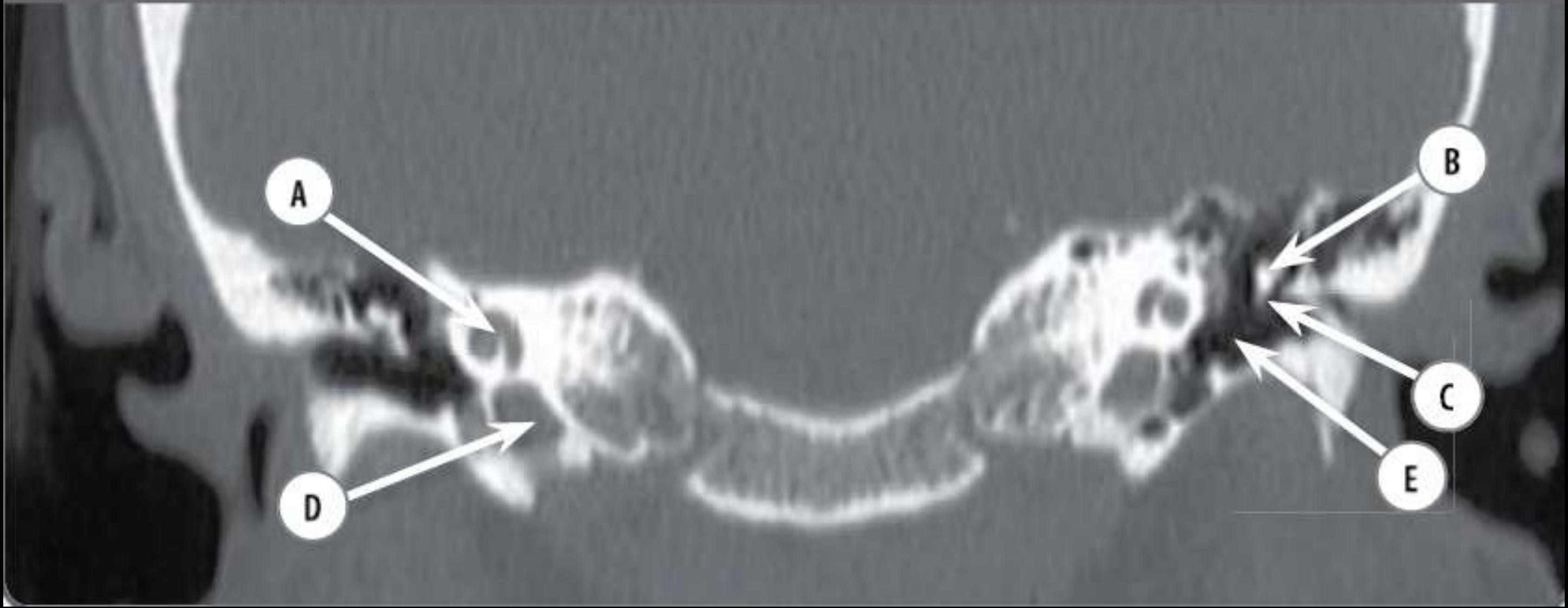
The cervical vertebrae have the foramen transversarium which transmit the vertebral arteries. The C1 vertebral body, the atlas (Atlas, in Greek mythology, supported the weight of the earth on his shoulders) supports the weight of the skull. The occipital condyles of the foramen magnum rest on the superior articular facets of C1 to transmit the weight of the skull to the vertebral column. The atlas has anterior and

posterior arches, and not a spinous process or body. The body is fused with that of the axis to become the odontoid process.

The C2 vertebral body, the axis, has two large superior articular facets which allow the atlas to rotate on it. The dens, or odontoid process, projects superiorly from the body, and acts as the pivot around which the axis rotates.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 440.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 91–92.

Case 1.45



Case 1.45

A Right cochlea

B Left malleus

C Left incus

D Right carotid canal

E Left hypotympanum

High-resolution CT (coronal reformat) of the temporal bone.

There are three ossicles which transmit vibrations from the tympanic membrane to the oval window. The malleus is attached to the tympanic membrane, and articulate with the incus at the incudomallear joint. The incus articulates with the stapes, which is attached to the oval window. The round window is inferior and allows pressure equalisation within the vestibule.

Tensor tympani, supplied by the mandibular nerve, inserts onto the malleus to tense the tympanic membrane in the presence of loud sounds.

The inner ear lies medial to the middle ear (**Figure 1.11**). The bony labyrinth consists of a vestibule, which is a communication between the anterior cochlea, and the posterior semicircular canals. The vestibular duct opens into the posterior fossa.

The cochlea is spiral, consisting of 2.5–2.75 turns, and is the hearing apparatus. The cochlear duct passes parallel to the internal auditory meatus to open in the posterio fossa.

The three semicircular canals (anterior, posterior and lateral) are the balance apparatus.

The internal auditory meatus transmits the facial (anteriorly) and vestibulocochlear nerves (posteriorly) from the posterior fossa.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 14.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 972.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 28–32.

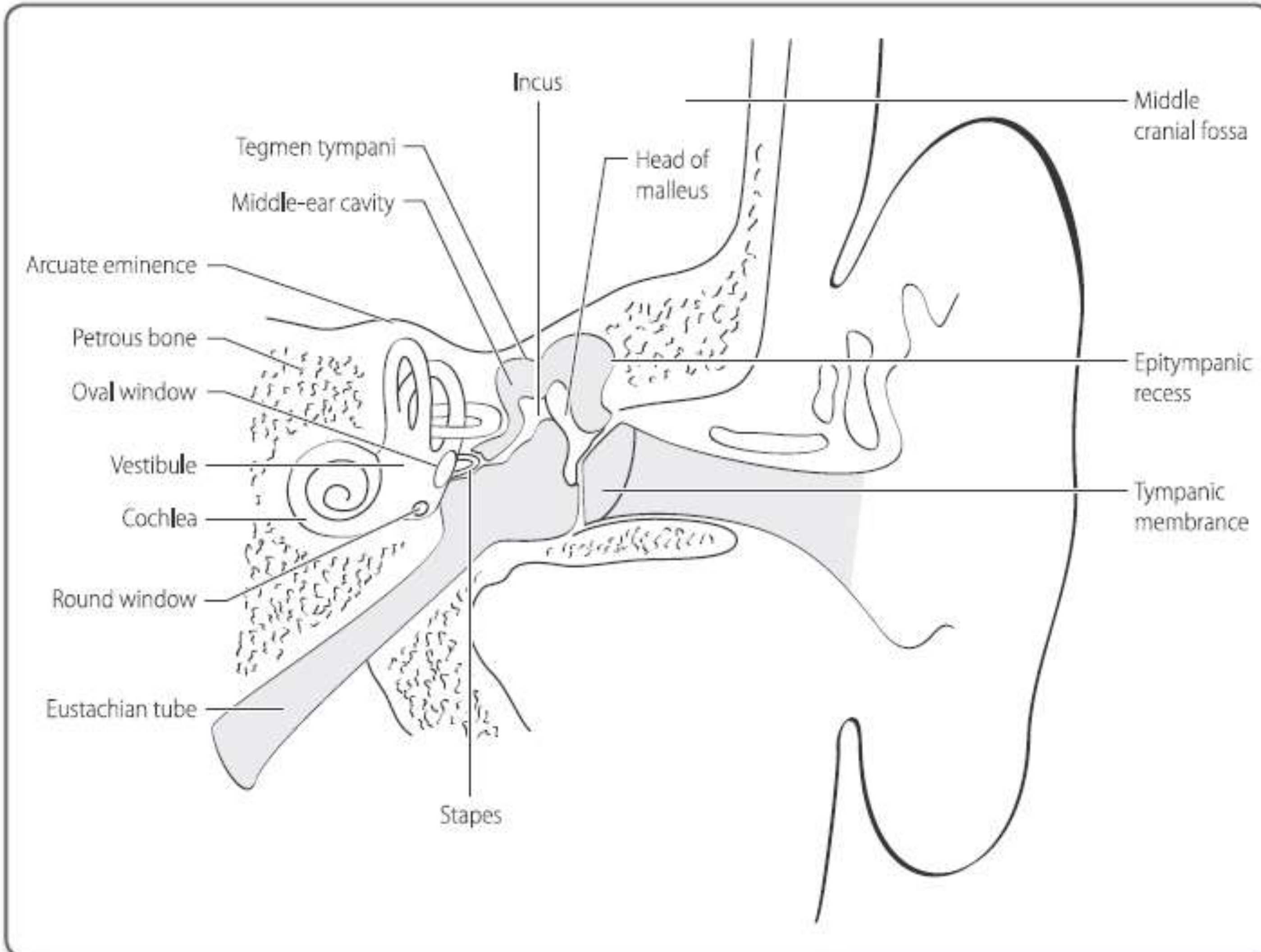
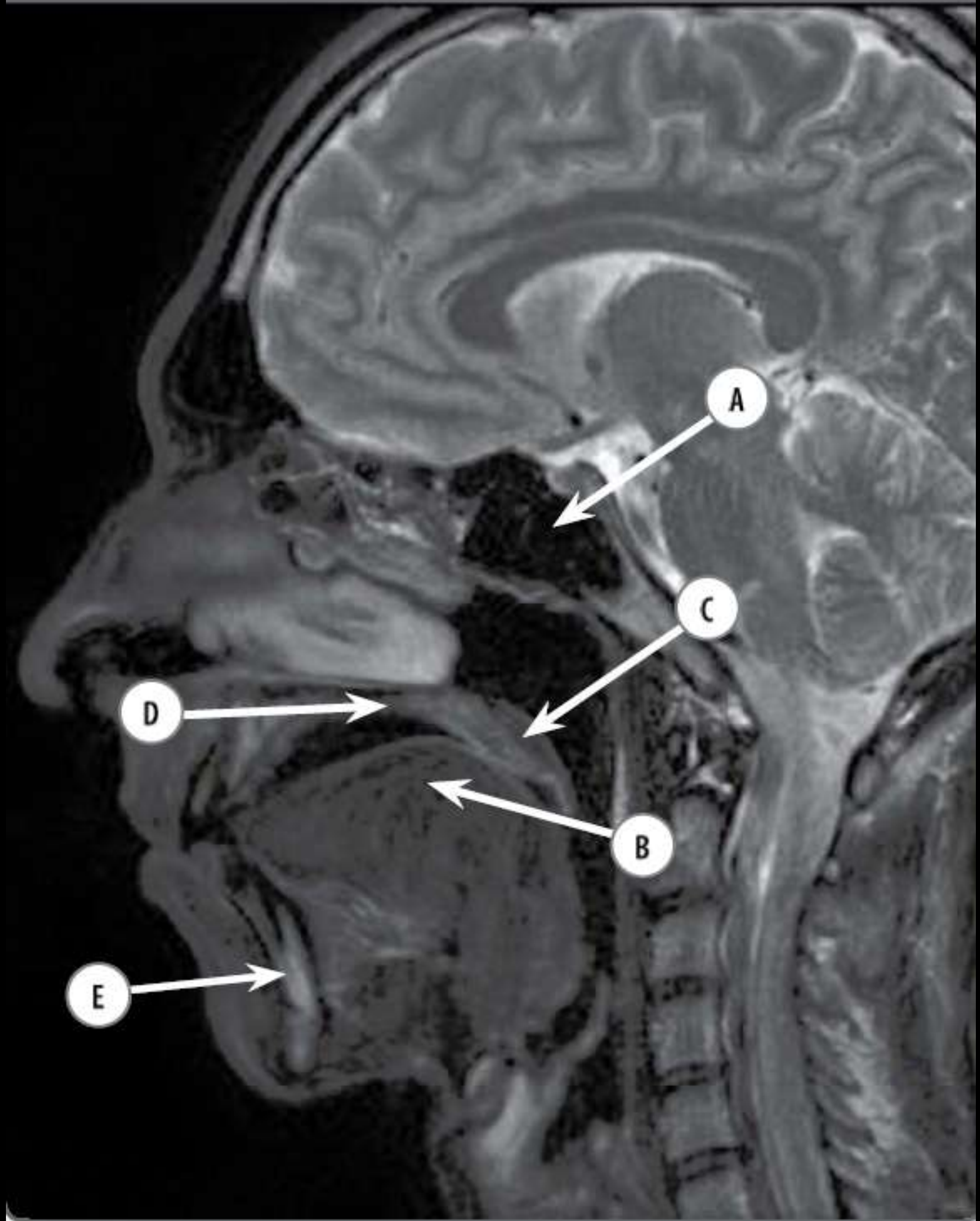


Figure 1.11 The inner ear.

SAGGITAL

Case 1.49



Case 1.49

A Sphenoid sinus

B Intrinsic muscle of tongue

C Soft palate

D Hard palate

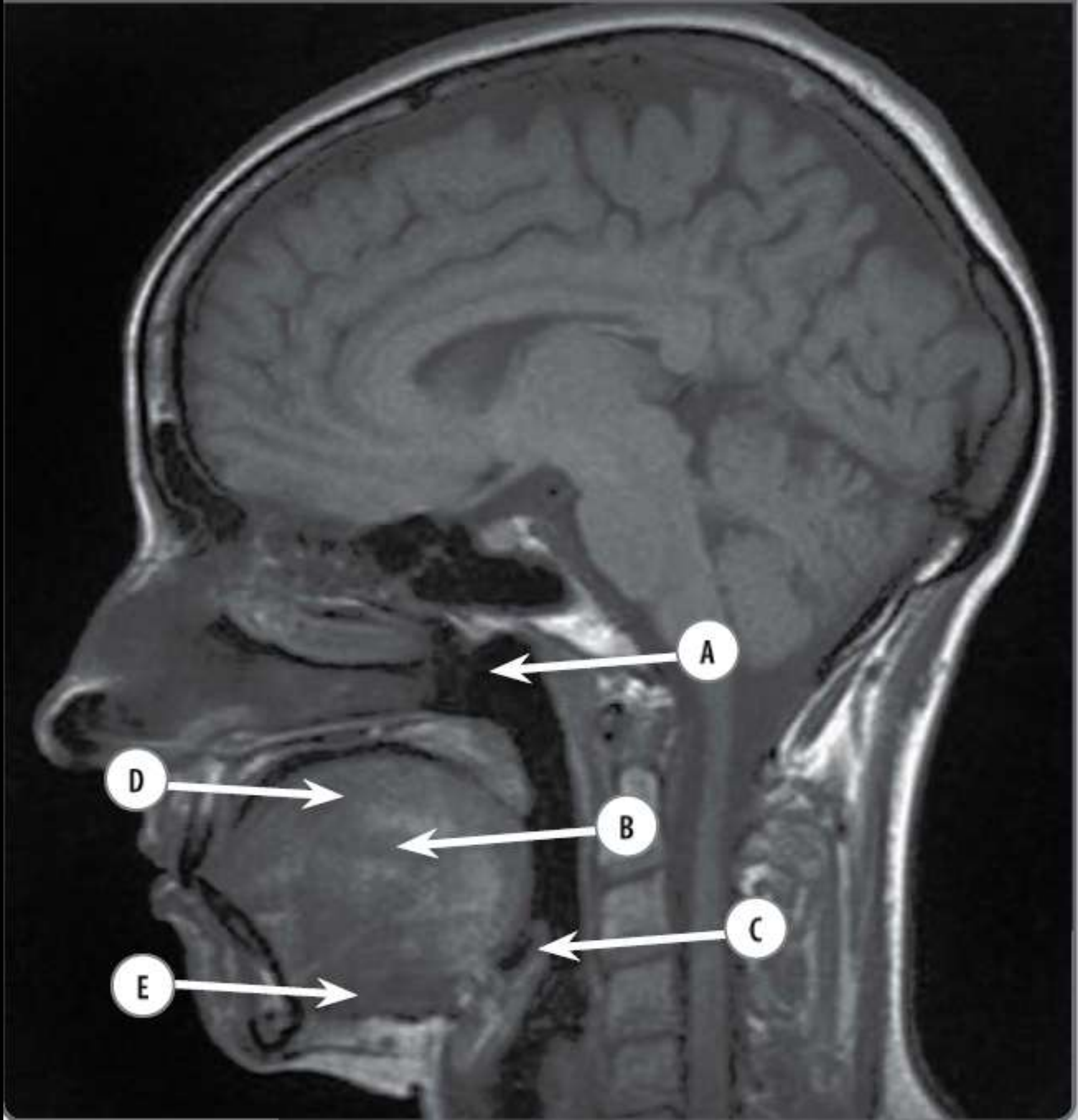
E Mandible

Midline sagittal T2-weighted MRI of the head and neck.

The nasopharynx is the space between the posterior choanae and the soft palate. It communicates with the oropharynx and the nasal cavity.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 30–31.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 940.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 33.

Case 1.50



Case 1.50

A Nasopharynx

B Genioglossus

C Epiglottis

D Intrinsic muscle

E Mylohyoid

Midline sagittal MRI of the head and neck.

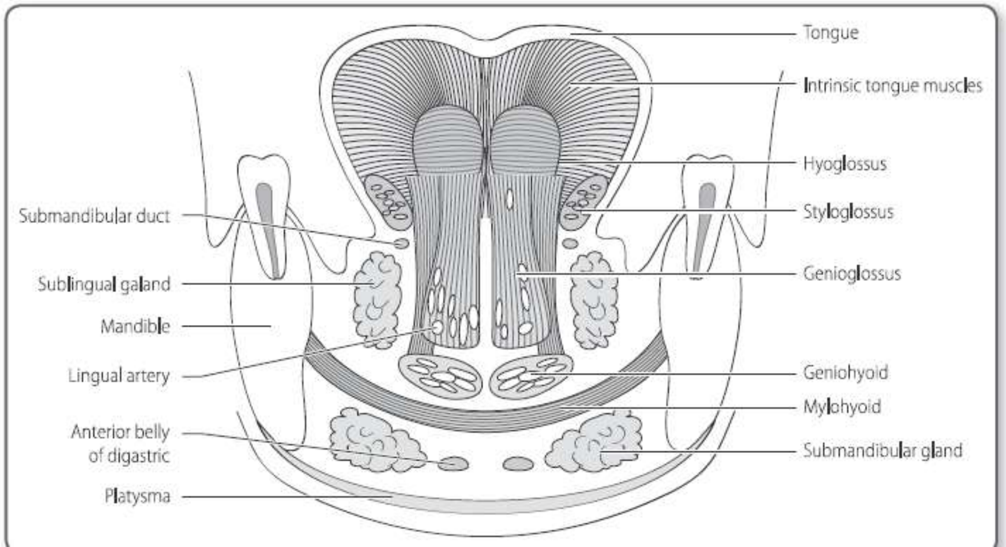
The muscles of the tongue work synergistically in order to perform movement. The tongue is formed from two groups of muscles which are split down the middle by the fibrous lingual septum. **Extrinsic muscles** alter the position of the tongue; they originate outside the tongue and attach to it. They are the:

- **genioglossus**
- **hyoglossus**
- **styloglossus**
- **palatoglossus**

Intrinsic muscles alter the shape of the tongue; they are confined to the tongue.

The tongue is also supported by the muscles of the floor of the mouth (**Figures 1.13 and 1.14**):

- **mylohyoid** forms the floor of the mouth. A muscular sling from the mylohyoid line on the inner aspect of the mandible to the hyoid bone



Case 1.50

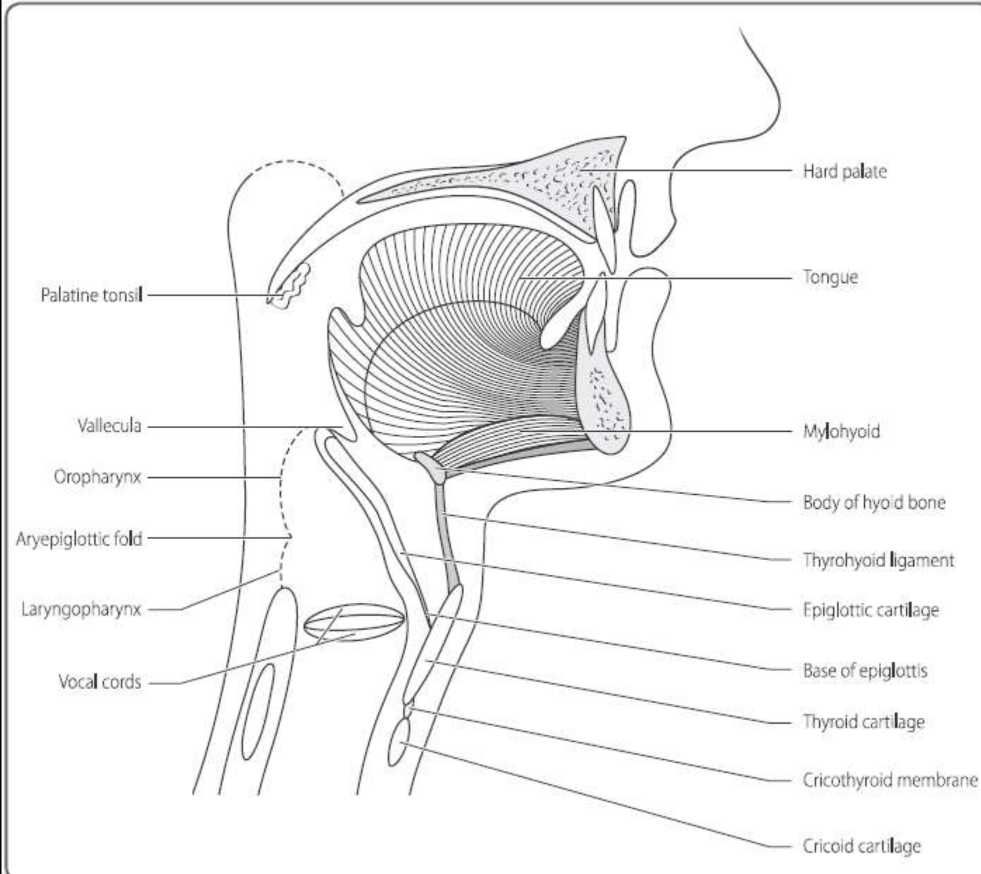


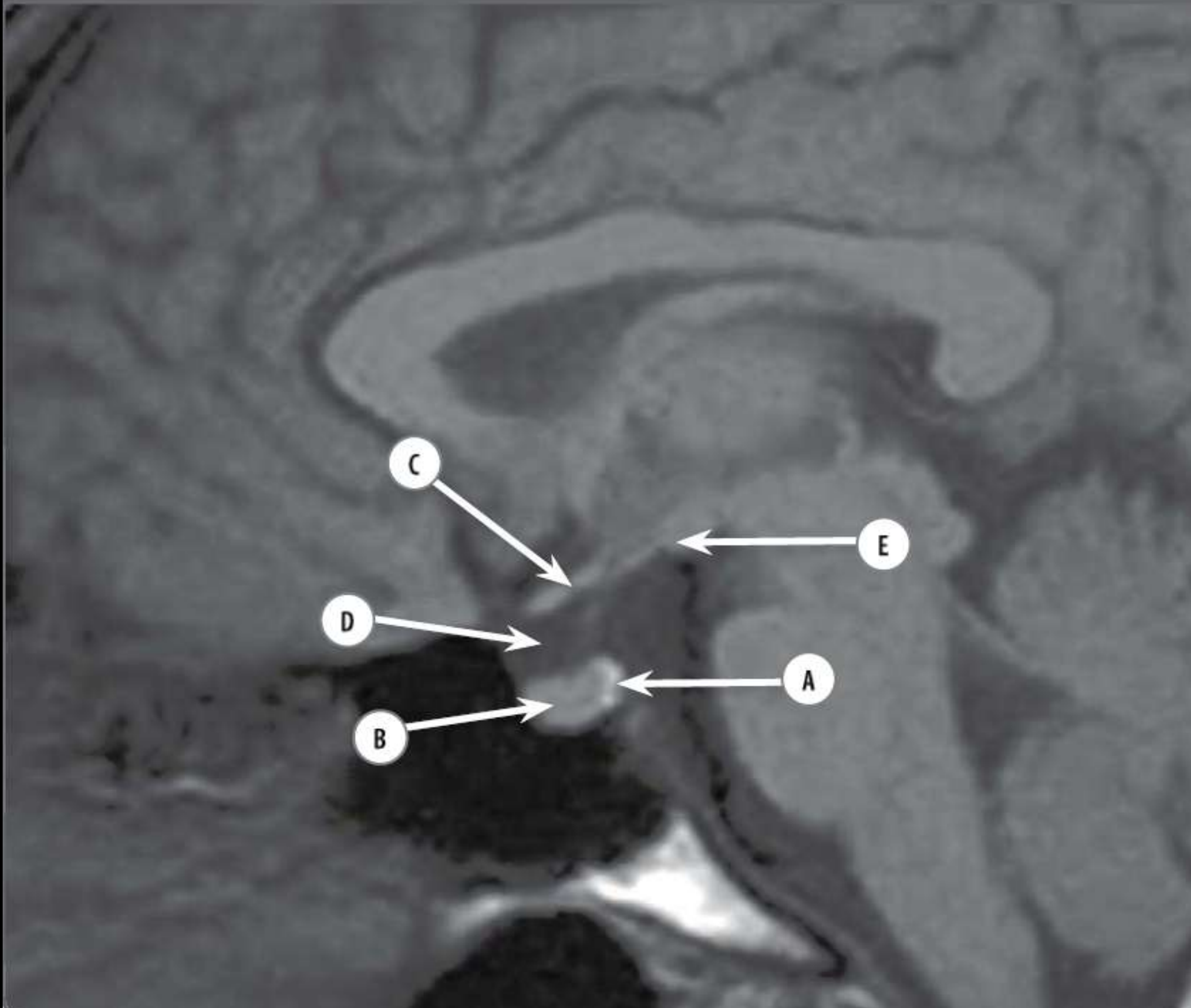
Figure 1.14 Sagittal anatomy of the tongue and pharynx.

- **geniohyoid**, superior to mylohyoid, reinforces the floor of the mouth
- **digastricus** has two bellies. The anterior runs from the mastoid process to the hyoid bone. The posterior from the anterior mandible to the hyoid bone
- **stylohyoid** runs parallel and lateral to the poster digastric, from the styloid process to the hyoid bone.

The epiglottis is attached to the posterior aspect of the thyroid cartilage and protects the larynx by directing swallowed matter laterally into the piriform fossa.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 30–31.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 940.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 33.

Case 1.51



Case 1.51

A Posterior pituitary

B Anterior pituitary

C Optic tract

D Suprasellar cistern

E Mammillary body

Coronal T1-weighted MRI through the pituitary fossa.

The optic chiasm can be seen just superior to the pituitary gland.

The suprasellar cistern is the subarachnoid cistern just superior to the pituitary, between the third ventricle and the diaphragma sellae. It is continuous with the sylvian cistern laterally and the interpeduncular cistern posteriorly. Part of the anterior circle of Willis and optic chiasm sit in the suprasellar cistern.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 54.
Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 887.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 66.

- **Question 4:**

Question 4: Sagittal CT of the brain

Answer: Clivus

- *Clivus* is Latin for 'slope'.
- It slopes obliquely in the midline.
- It lies posterior to the dorsum sellae and sphenoid sinus and anterior to the basilar artery and pons.
- It includes the posterior aspect of the body of the sphenoid bone and the basilar portion of the occipital bone.

Q18

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 vertebral level at which the C5 spinal nerve exits the vertebral canal

Q18 Answers

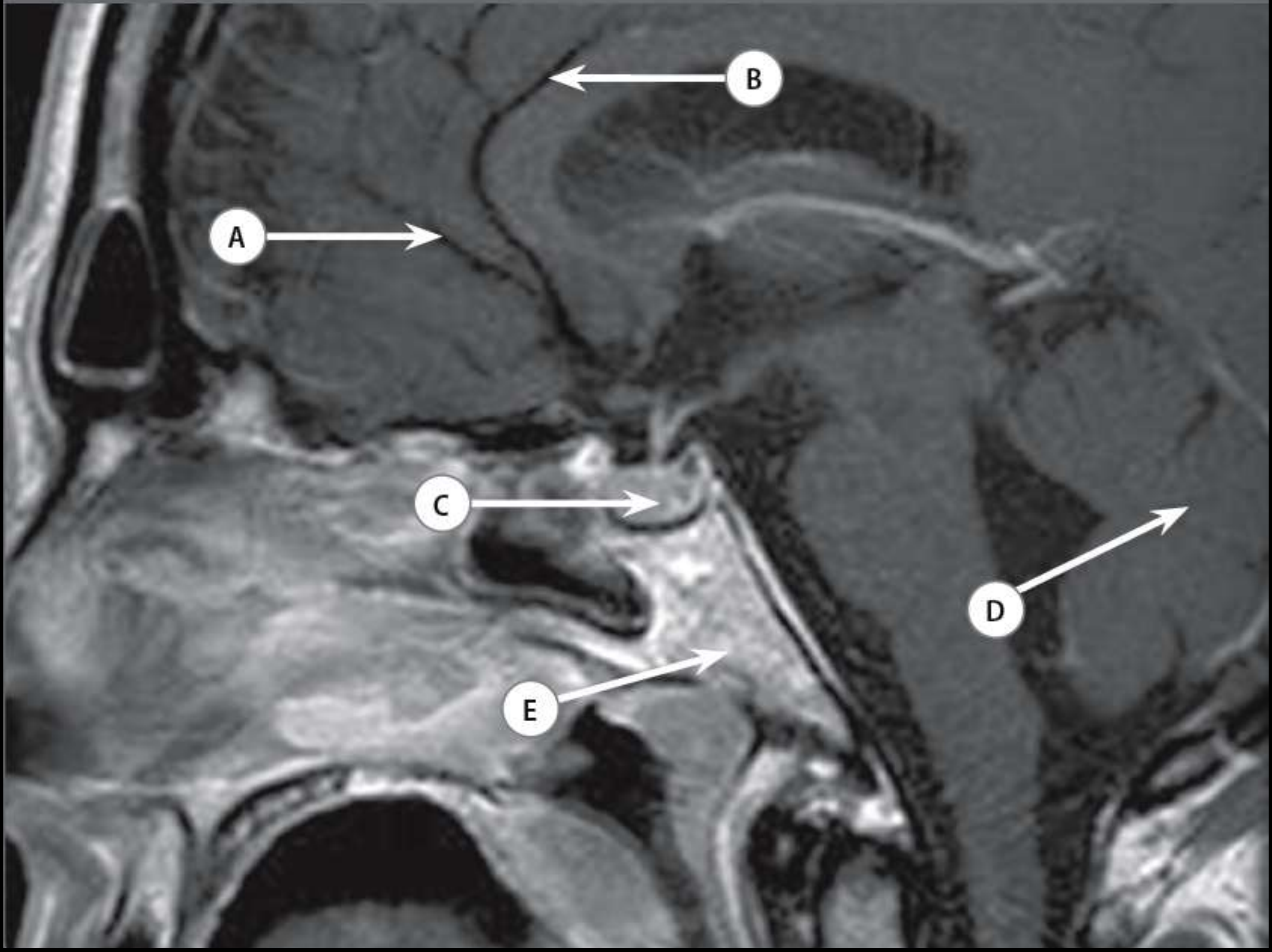
a Anterior lobe of the cerebellum
b Clivus
c Uvula
d Posterior arch of C1
e C4/5 level

T2W MRI of neck, midline sagittal section

On this view the anterior lobe of the cerebellum is visible divided from the posterior lobe by the CSF filled primary fissure. The third major lobe of the cerebellum is the flocculonodular lobe which lies antero-inferiorly.

There are thirty-one pairs of spinal nerves. These exit the spinal canal through the intervertebral foramen which are formed from notches in the superior and inferior pedicles of adjacent vertebrae. The individual nerves are named relative to these adjacent vertebrae; cervical nerves are named relative to the inferior pedicle of their foramen, however since there are eight cervical nerves but only seven cervical vertebrae, the eighth cervical spinal nerve exits below the seventh cervical vertebra. The remaining spinal nerves (thoracic, lumbar and sacral) are named relative to the superior pedicle of their foramen, i.e. T7 exits at the T7/8 level.

Case 5.9



Case 5.9

A Frontopolar artery

B Pericallosal artery

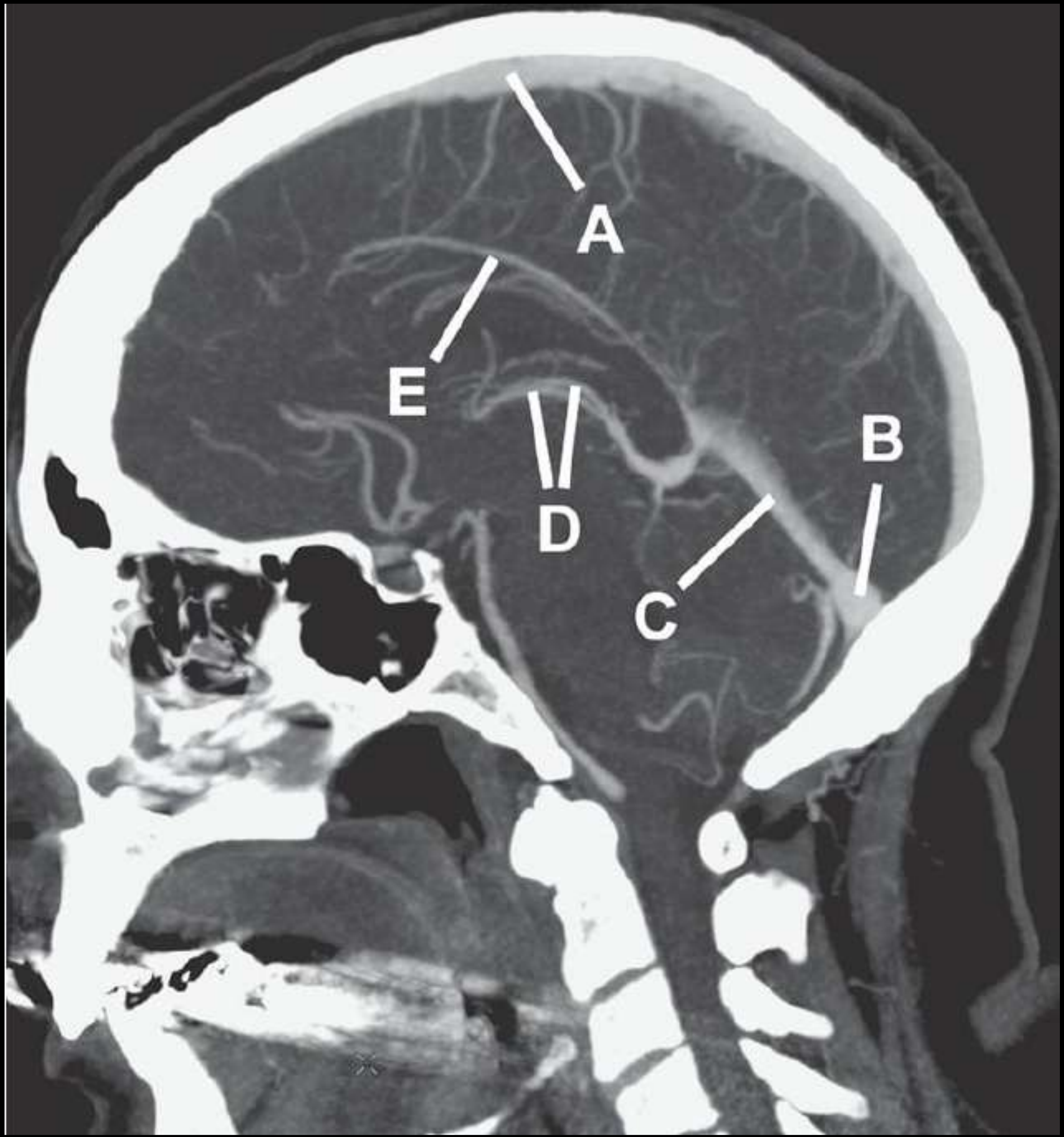
C Pituitary gland

D Cerebellar vermis

E Clivus

Midline sagittal T1-weighted MRI of the brain.

For further discussion see Chapter 1, Cases 1.1–1.5.


A
E
B
D
C

Q11 Answers

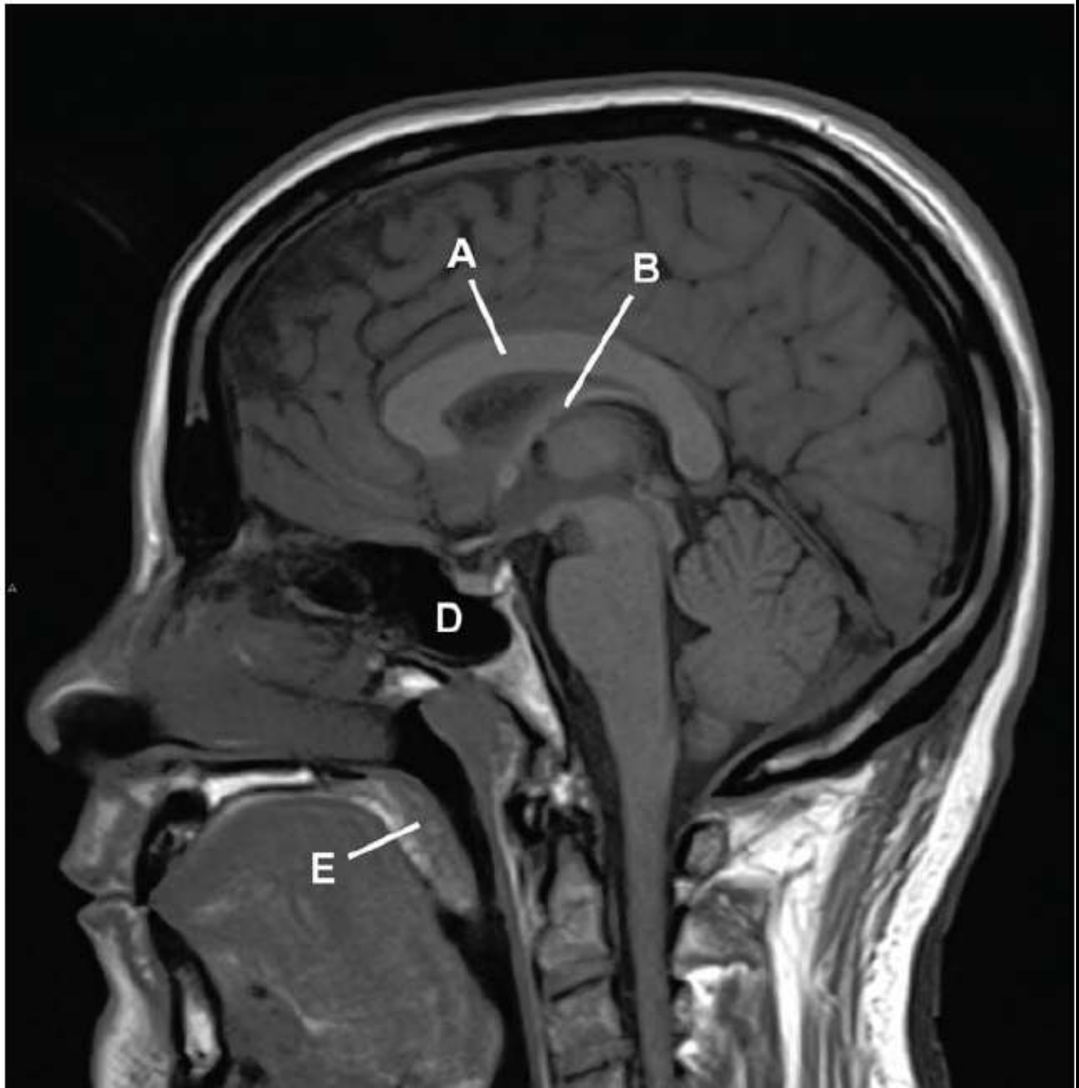
a Superior sagittal sinus
b Confluence of sinuses
c Straight sinus
d Internal cerebral veins
e Inferior sagittal sinus

CT venogram, maximum intensity projection, midline sagittal view

The dural venous sinuses exist between the two layers of dura and allow drainage of blood from the brain. Superficial cerebral veins coalesce into larger vessels (e.g. the superior anastomotic vein of Trolard, and the inferior anastomotic vein of Labbe) and then tend to drain via the superior sagittal or transverse sinuses. Deep cerebral veins such as the internal cerebral veins coalesce to form the great cerebral vein (of Galen) which combines with the inferior sagittal sinus to form the straight sinus. The superior sagittal sinus combines with the straight sinus at the confluence of sinuses. From here, venous blood drains via the transverse sinuses (one side is usually dominant and therefore larger), through the sigmoid sinuses and into the internal jugular veins bilaterally. Anteriorly, venous blood from the ophthalmic and superficial middle cerebral veins as well as from the sphenoparietal sinus collects in the cavernous sinuses. The cavernous sinuses are situated on either side of the body of sphenoid and each contains the first intracranial part of the internal carotid artery and the abducent nerve (CN VI). The occulomotor (CN III), trochlear (CN IV), plus ophthalmic and maxillary branches of the trigeminal nerve (CN V) course through the lateral wall of the cavernous sinuses. Blood ultimately drains from the cavernous sinuses through the superior and inferior petrosal sinuses. The superior petrosal runs along the anterior margin of the tentorium cerebelli at the petrous ridge to reach the distal transverse sinus where it continues as the sigmoid sinus. The inferior petrosal drains more inferiorly joining the distal sigmoid sinus as it becomes the internal jugular vein.

Q18

a Name the constituent parts of the structure labelled A
b Name the structure labelled B
c Name the structure situated between A and B
d Name the structure labelled D
e Name the structure labelled E



Q18 Answers

a Rostrum, genu, body and splenium of the corpus callosum
b Fornix
c Septum pellucidum
d Sphenoid sinus
e Soft palate

TW1 MRI, midline sagittal section

The corpus callosum is the largest of the commissural white matter tracts. The genu (or knee) is the bend at its anterior end. Inferior to the genu is the rostrum, posterior to the genu running horizontally is the body of the corpus callosum, whi the splenium is its bulbous posterior part.

The fornices are white matter tracts which run from the hippocampi postero-laterally to converge on the thalamus anteriorly near the midline.

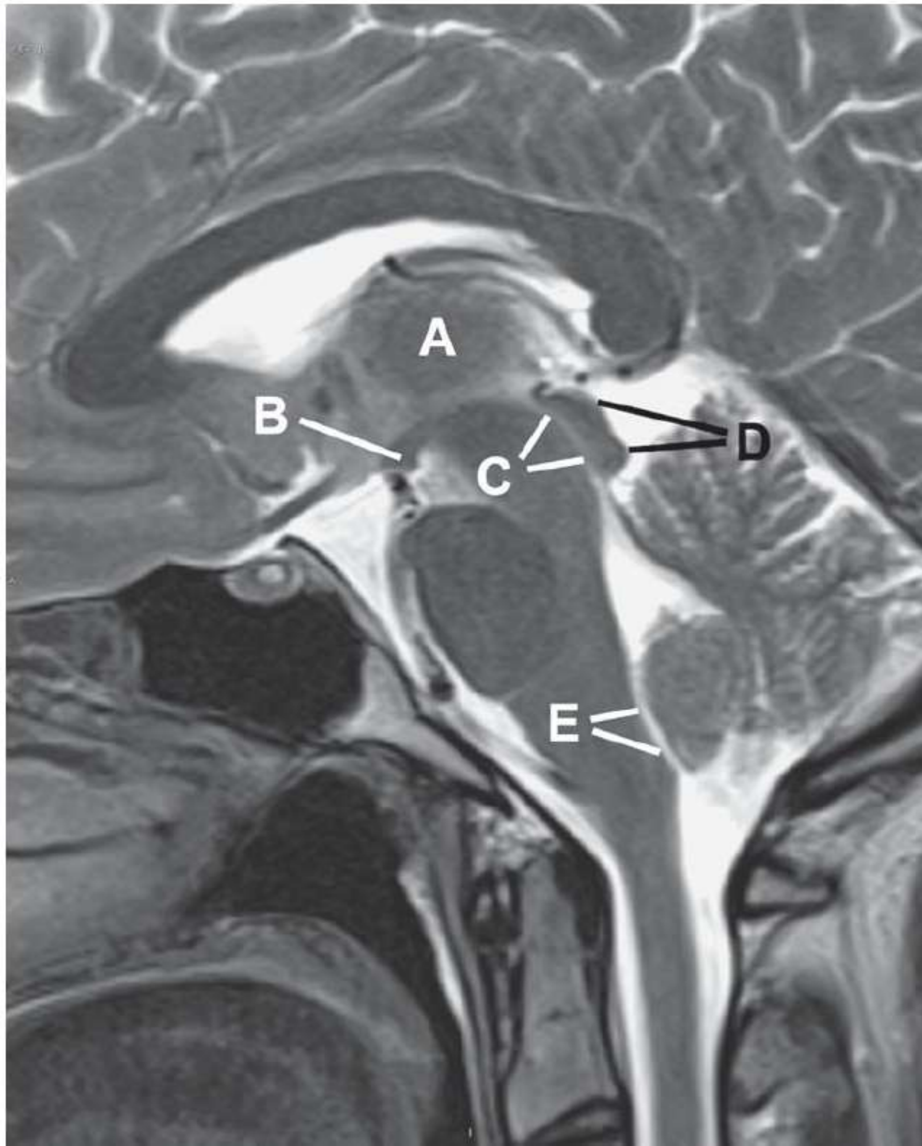
Between the corpus callosum and the fornices lies the septi pellucidum. These paper thin structures form the medial wall of the lateral ventricles. Often the two septi pellucidum are opposed anteriorly in the midline; if there is a CSF filled spac between them it is known as cavum septum pellucidum.

Of the four paired paranasal sinuses, the sphenoid and frontal sinuses are visibl in the midline.

The roof of the oral cavity is known as the palate and is composed of hard and soft parts. The hard palate is formed by the palatine processes of the maxillae and the paired palatine bones and composes the anterior two thirds of the palate. The soft palate is a mobile fibro-muscular continuation of the hard palate which prevents food from passing up into the nasal cavity during swallowing.

Q20

a Name the structure labelled A
b Name the structure labelled B
c Name the structure labelled C and what it connects
d Name the structures labelled D
e Name the structure labelled E



Q20 Answers

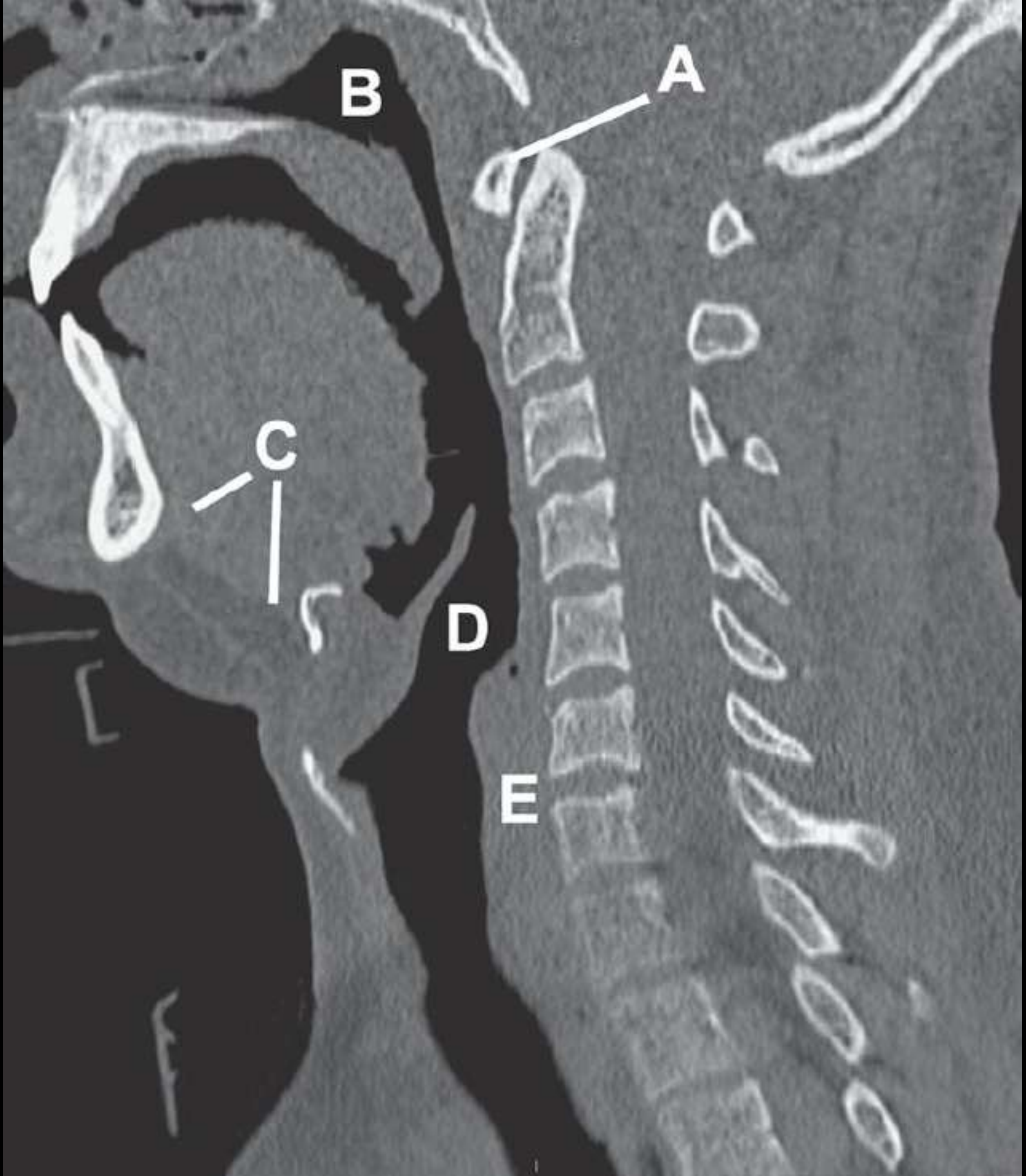
a Massa intermedia of thalamus
b Mamillary body
c Cerebral aqueduct (of Sylvius) allows CSF to flow from 3rd to 4th ventricles
d Superior and inferior colliculi
e Median aperture (of Magendie)

T2W MRI of brain zoomed up image, midline sagittal section

The massa intermedia connects the left and right thalami in the midline. CSF within the third ventricle flows around the massa intermedia within the third ventricle.

The mamillary bodies are part of the limbic system and connect with the fornices bilaterally. The mamillary bodies are in the roof of the interpeduncular cistern.

The colliculi are paired as two superior and two inferior. They form four masses of tissue situated as the corners of a square on the posterior aspect of the tectal plate of the midbrain. Functionally, the colliculi are concerned with reflexes by acting as relay pathways; the superior relate to vision, the inferior to hearing.


A
B
C
D
E

Q32 Answers

- **a** Anterior arch of C1 vertebra
- **b** Nasopharynx
- **c** Mylohyoid muscle
- **d** Laryngopharynx
- **e** Oesophagus

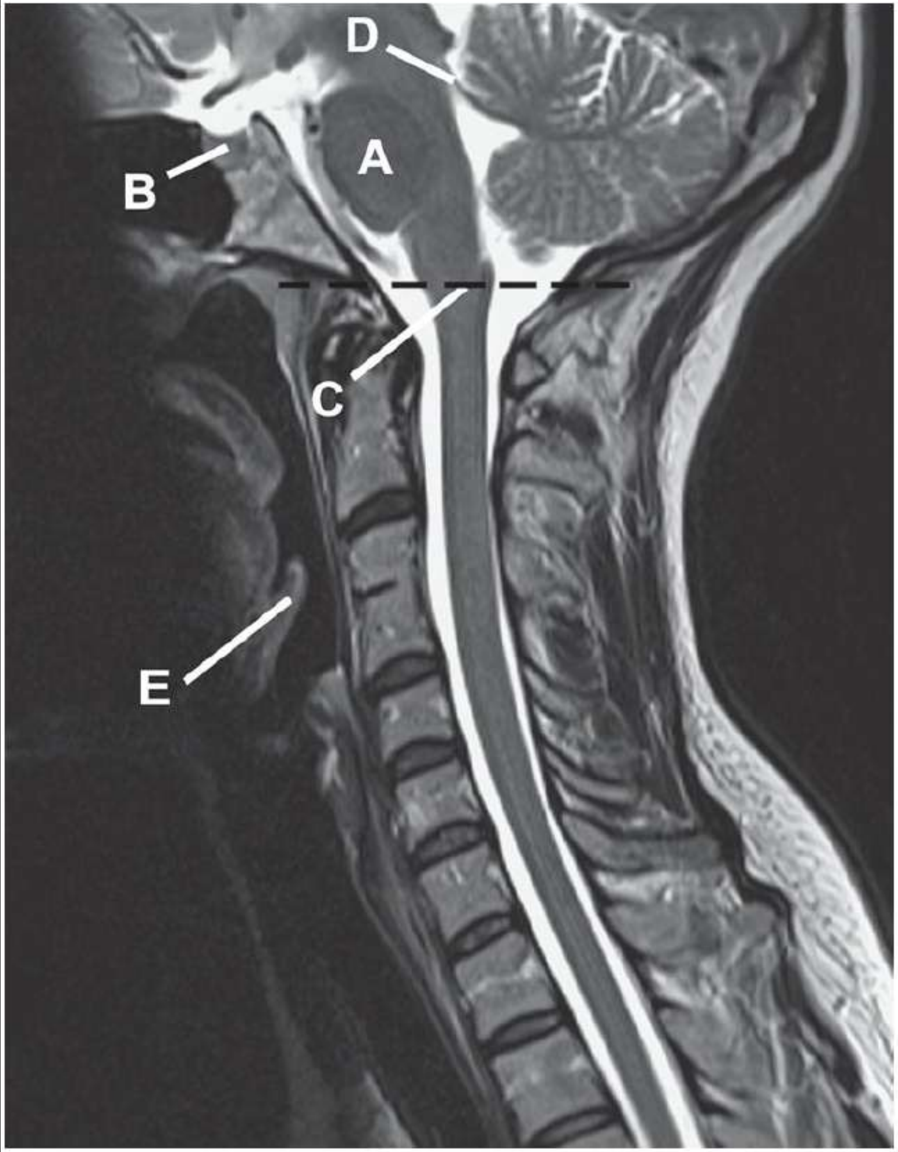
CT of neck with bone windows, midline sagittal section

The nasopharynx is the posterior extension of the nasal cavity and lies superior to the soft palate; it begins at the nasal chaonae which are the posterior openings of the nasal cavity. The oropharynx is continuous with the oral cavity and extends to the epiglottis. Inferior to the epiglottis, in continuity with and extending to the trachea is the laryngopharynx. The larynx contains the vocal cords.

The floor of the mouth is formed by the mylohyoid muscle which closes the inferior opening of the mandible and functionally acts to elevate the tongue, floor of mouth and hyoid when swallowing and speaking.

Q35

a Name the structure labelled A
b Name the structure labelled B
c What is the significance of the line drawn and labelled C
d Name the structure labelled D
e Name the structure labelled E



Q35 Answers

- **a** Pons
- **b** Pituitary fossa containing the pituitary gland
- **c** Skull base lines (McRae's line defines the opening of the foramen magnum) enable confirmation that cranial contents remain within the skull and also that there is not invagination of the dens of C2 from below.
- **d** Superior medullary velum
- **e** Epiglottis

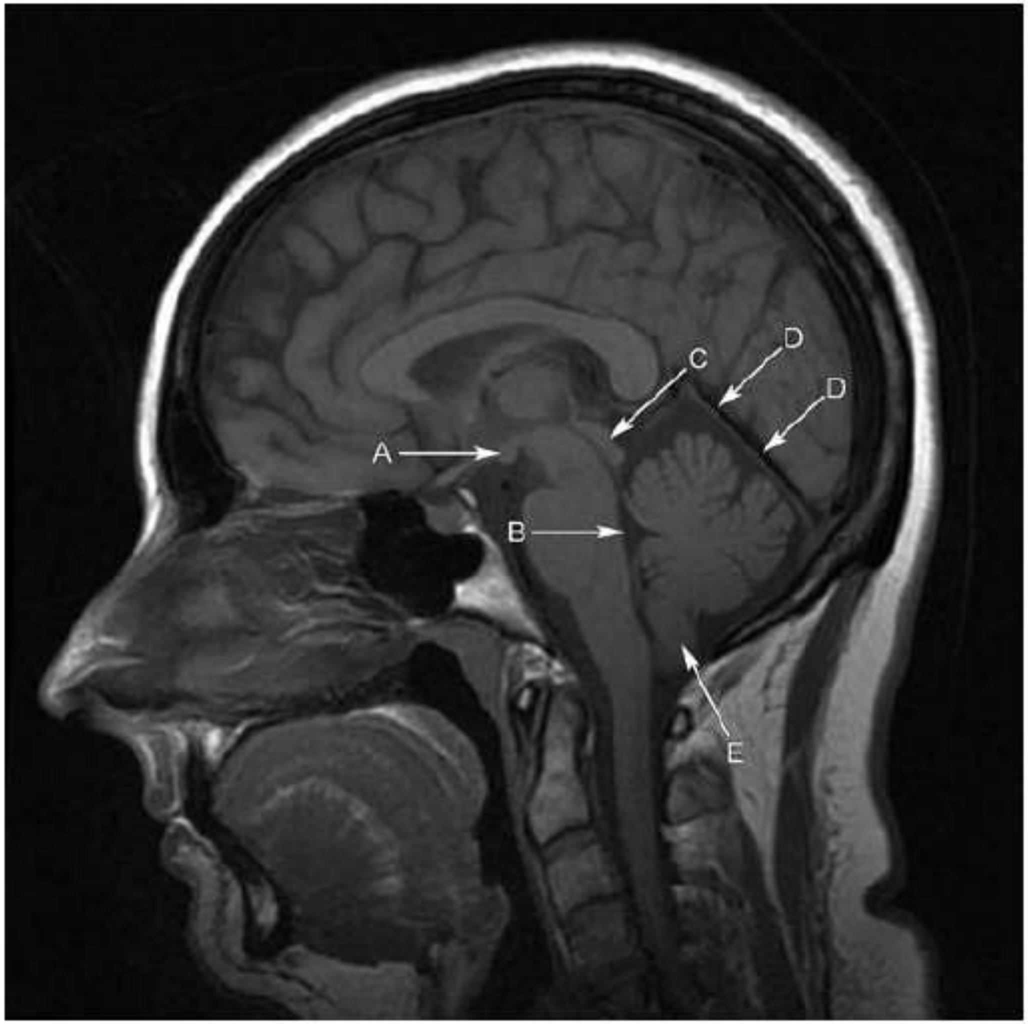
T2W MRI, midline sagittal section

The pons is recognizable on midline sagittal section by its large anterior bulge ('pot belly'); this is composed of the cerebellopontine fibres which extend postero-laterally on either side to form the middle cerebellar peduncles.

The pituitary gland is a midline structure which rests within the bony sella turcica on the superior aspect of the sphenoid. On T1W weighted MR imaging the posterior lobe of the pituitary gland is normally high signal.

A thin layer of tissue extends between the superior cerebellar peduncles to form the roof of the 4th ventricle; this is known as the superior medullary velum.

Question 8.1



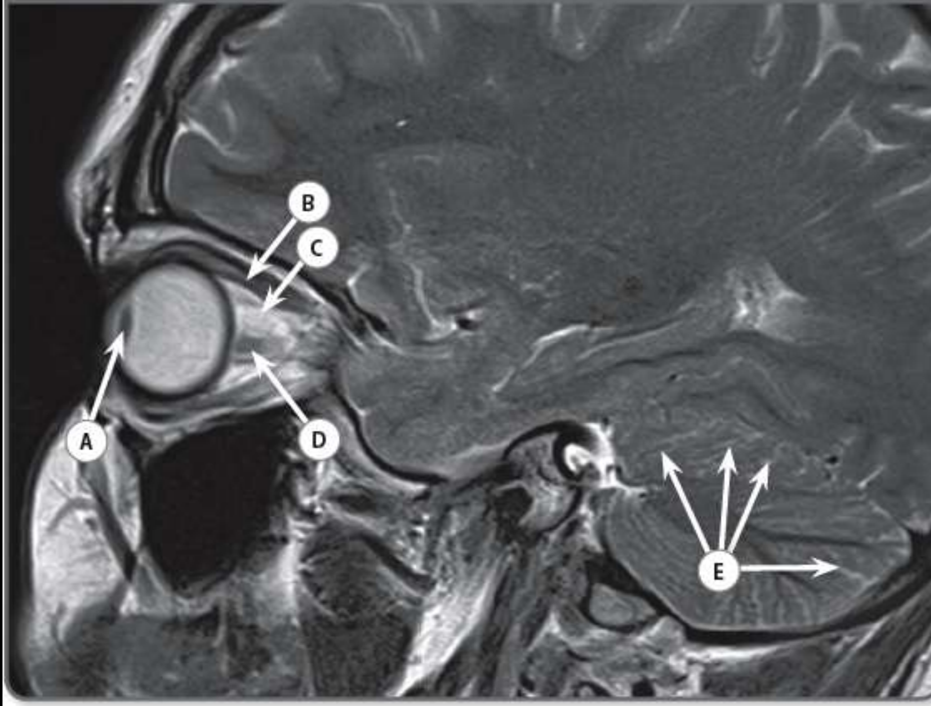
Name the structures labelled **A** to **E**.

8.1 Sagittal T1 MRI of the brain

A Mammillary body.
B Fourth ventricle.
C Tectum of the midbrain.
D Tentorium cerebelli.
E Cerebellar tonsil.

The mammillary bodies are a pair of rounded prominences at the anterior arches of the fornix. They are part of the limbic system. They can be damaged as a result of thiamine deficiency (Wernicke–Korsakoff syndrome). The fourth ventricle is the most inferior of the ventricular spaces and is diamond-shaped in cross section. It connects to the third ventricle via the aqueduct of Sylvius, and drains via the foramen of Luschka (two lateral tracts) and the foramen of Magendie (single midline tract). The tectum is located at the dorsal region of the midbrain and consists of superior (visual) and inferior (auditory) colliculi. There is a cerebellar tonsil on the undersurface of each cerebellar hemisphere in continuity with the uvula of the cerebellar vermis. It is helpful to assess these on sagittal section to look for elongation and descent of the cerebellar tonsils into the foramen magnum, which can be associated with raised intracranial pressure or congenital malformations (Chiari malformations).

Case 1.10



Case 1.10

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 spaces labelled E.	

Case 1.10

A Lens

B Superior rectus muscle

C Retro-orbital fat

D Optic nerve

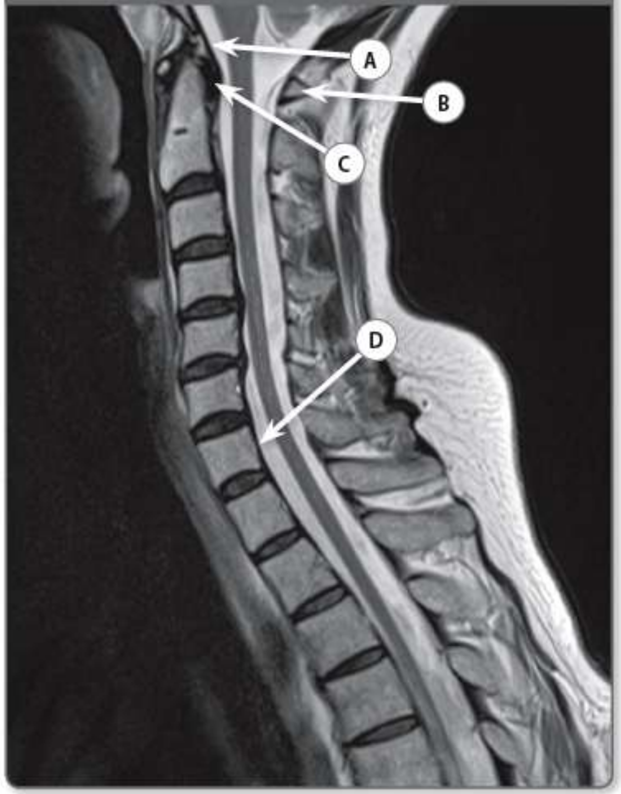
E Cerebellar folia

The striated extraocular muscles, responsible for eye movements, form the conus. The conus divides the orbit into intraconal and extraconal compartments.

The conus is bounded by seven muscles which insert anteriorly into the orbital sclera and posteriorly into the sheath of the optic nerve:

- four recti muscles: medial (the largest), lateral, superior and inferior
- two oblique muscles: superior and inferior
- levator palpebrae superioris.

Case 1.19



Case 1.19

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 labelled D.	
E	What name is given to the ligament connecting the laminae of adjacent vertebrae?	

Case 1.19

A Tectorial membrane

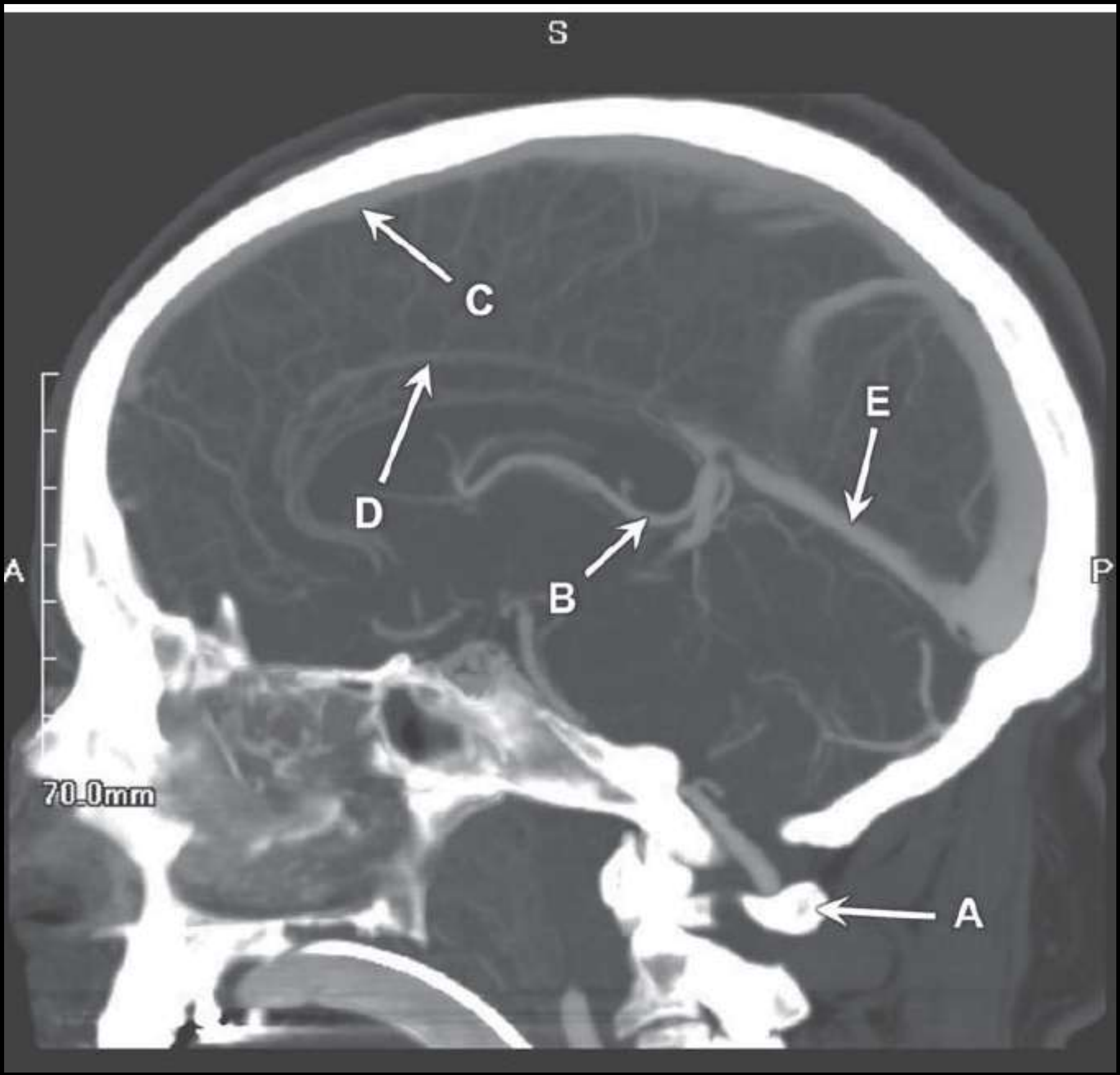
B Posterior arch of C1

C Transverse ligament

D Posterior longitudinal ligament

E Ligamentum flavum

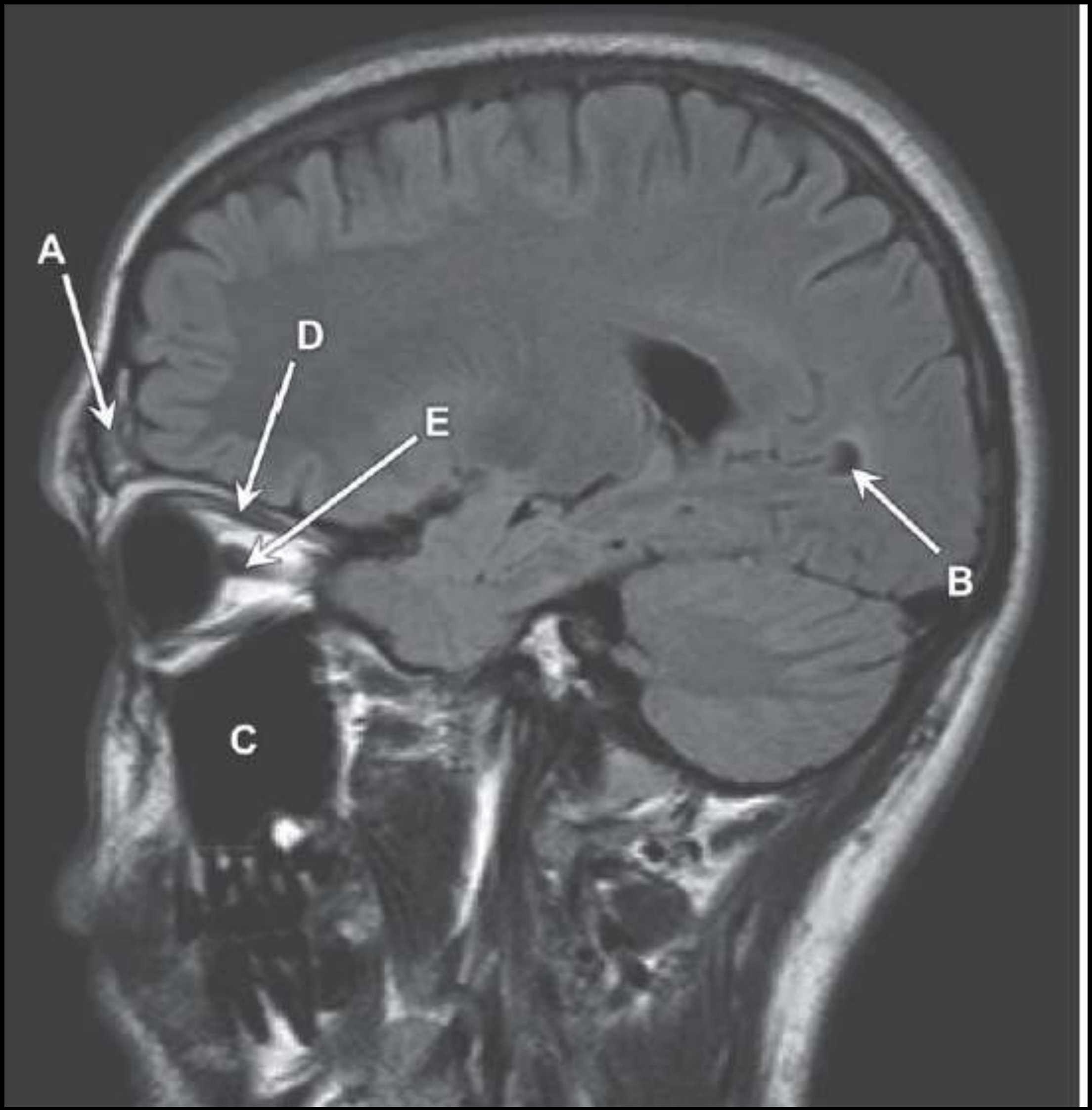
A range of ligaments are involved in maintaining the stability of the spine and in particular the craniocervical junction. The posterior longitudinal ligament runs up the posterior aspects of the vertebral bodies and intervertebral discs, being continuous with the tectorial membrane superiorly which blends with dura at the level of foramen magnum. The transverse ligament arches across the C1 ring to support the odontoid peg. Fibres from the midpoint of this ligament pass superiorly and inferiorly to form the cruciate ligament. Ligamentum flavum connects laminae of adjacent vertebrae from the level of C2–S1. Hypertrophy of this ligament may be evident on MRI as a potential cause of neurological symptoms.


S
A
P
C
D
B
E
A
70.0mm

Case 15

CT cerebral venogram. Sagittal MIP.

1. Posterior arch of C1 vertebra
2. Great cerebral vein (of Galen)
3. Superior sagittal sinus
4. Inferior sagittal sinus
5. Straight sinus

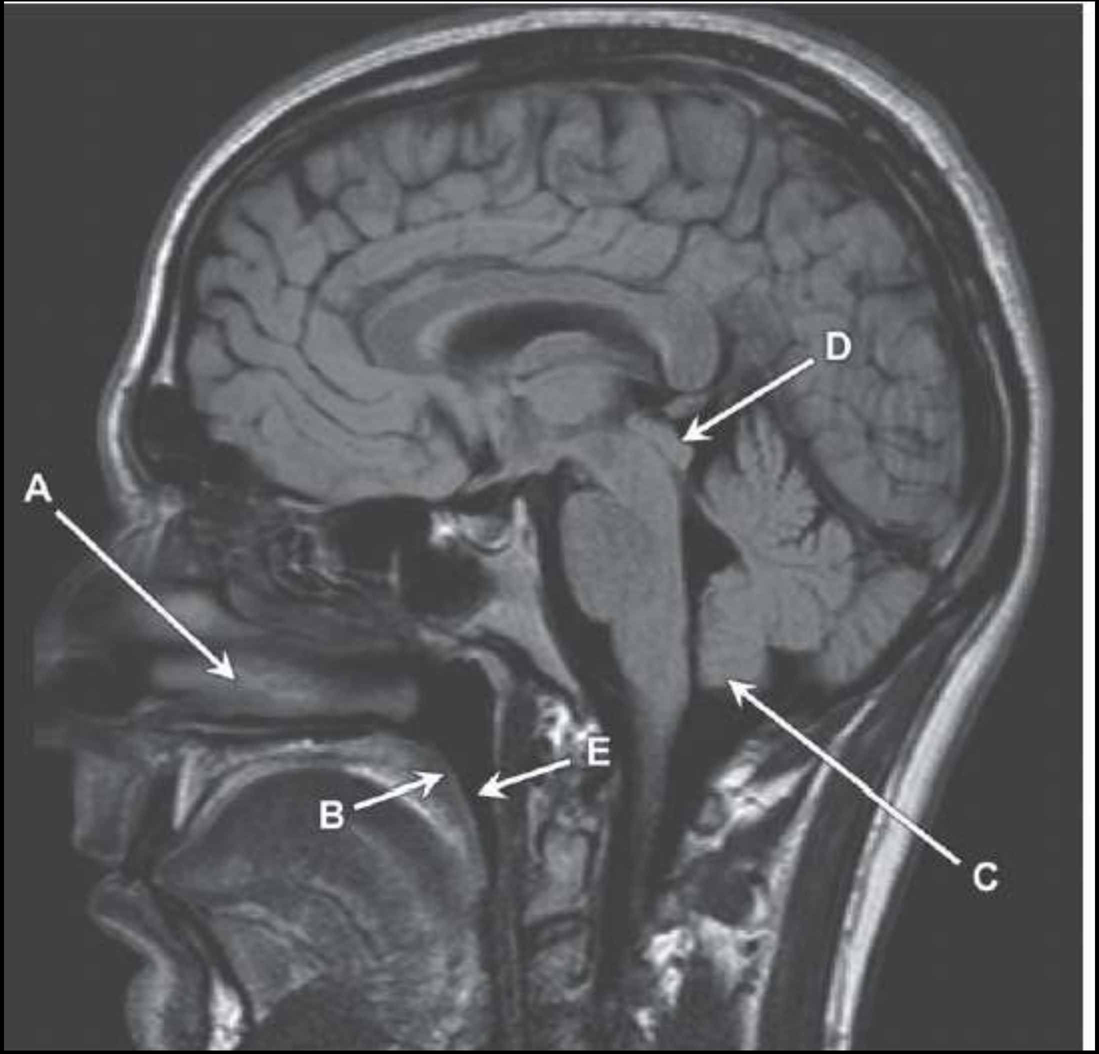

A
D
E
B
C

Case 16

MRI head. T1W parasagittal section.

1. Frontal sinus
2. Occipital horn of the lateral ventricle
3. Maxillary sinus
4. Superior rectus muscle
5. Optic nerve

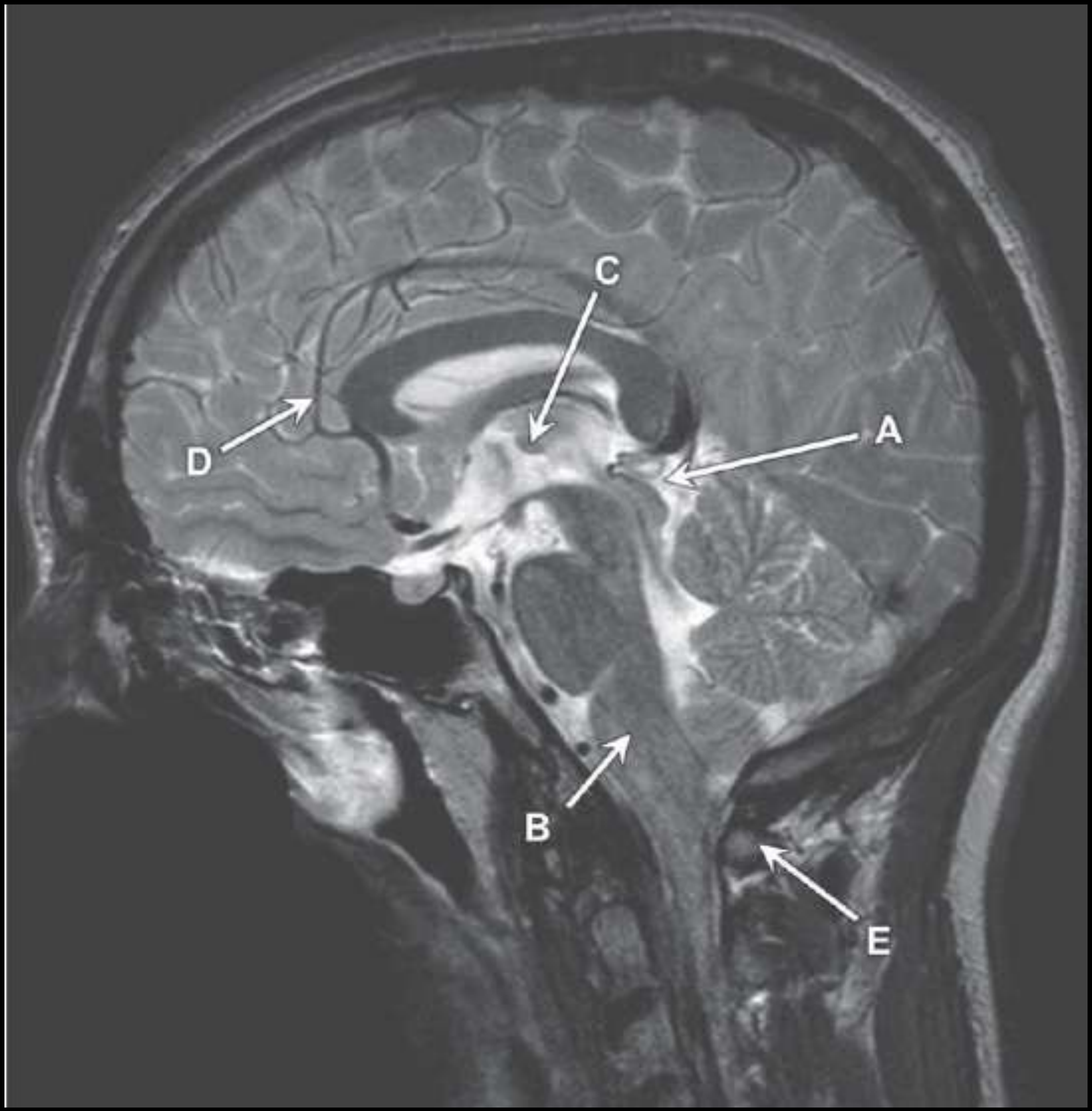
It is not possible to determine the side (left or right) based on the image.


A
D
E
B
C

Case 6

MRI brain. T1W midsagittal section.

1. Inferior turbinate
2. Soft palate
3. Cerebellar tonsil
4. Tectum of midbrain
5. Nasopharynx


C
D
A
B
E

Case 10

MRI brain. T2W sagittal section.

1. Quadrigeminal cistern
2. Medulla oblongata
3. Massa intermedia
4. Pericallosal artery
5. Posterior arch of atlas (C1)

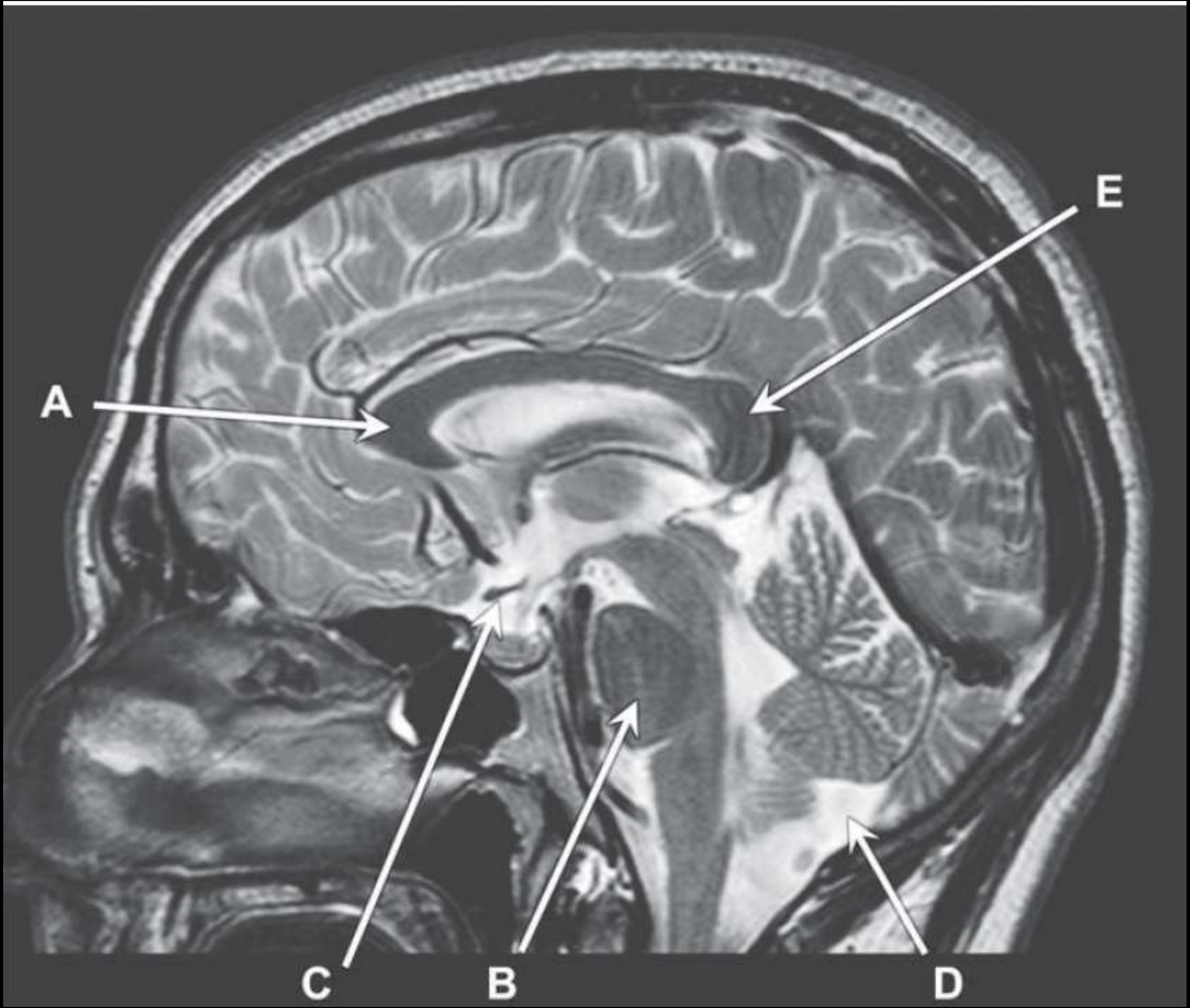
Question 1.2

Name the structures labelled A to E.

1.2 Sagittal T1 MRI scan of the brain

A Frontal sinus.
B Optic chiasm.
C Pons.
D Prepontine cistern.
E Soft palate.

The paired frontal sinuses lie superior to the nose and orbits and are located between the inner and outer tables of the frontal bone. The two optic nerves partially decussate at the optic chiasm in the middle cranial fossa. The brainstem consists of the medulla oblongata, pons and midbrain. The pons can be recognized on sagittal imaging by its bulging anterior surface, in front of which is the prepontine cistern (one of the sub-arachnoid basal cisterns, located between the pons and the clivus). The palate forms the roof of the mouth and is formed by the soft and hard palates. The posterior third (fibromuscular part) forms the soft palate and the anterior two-thirds (bony part) forms the hard palate.

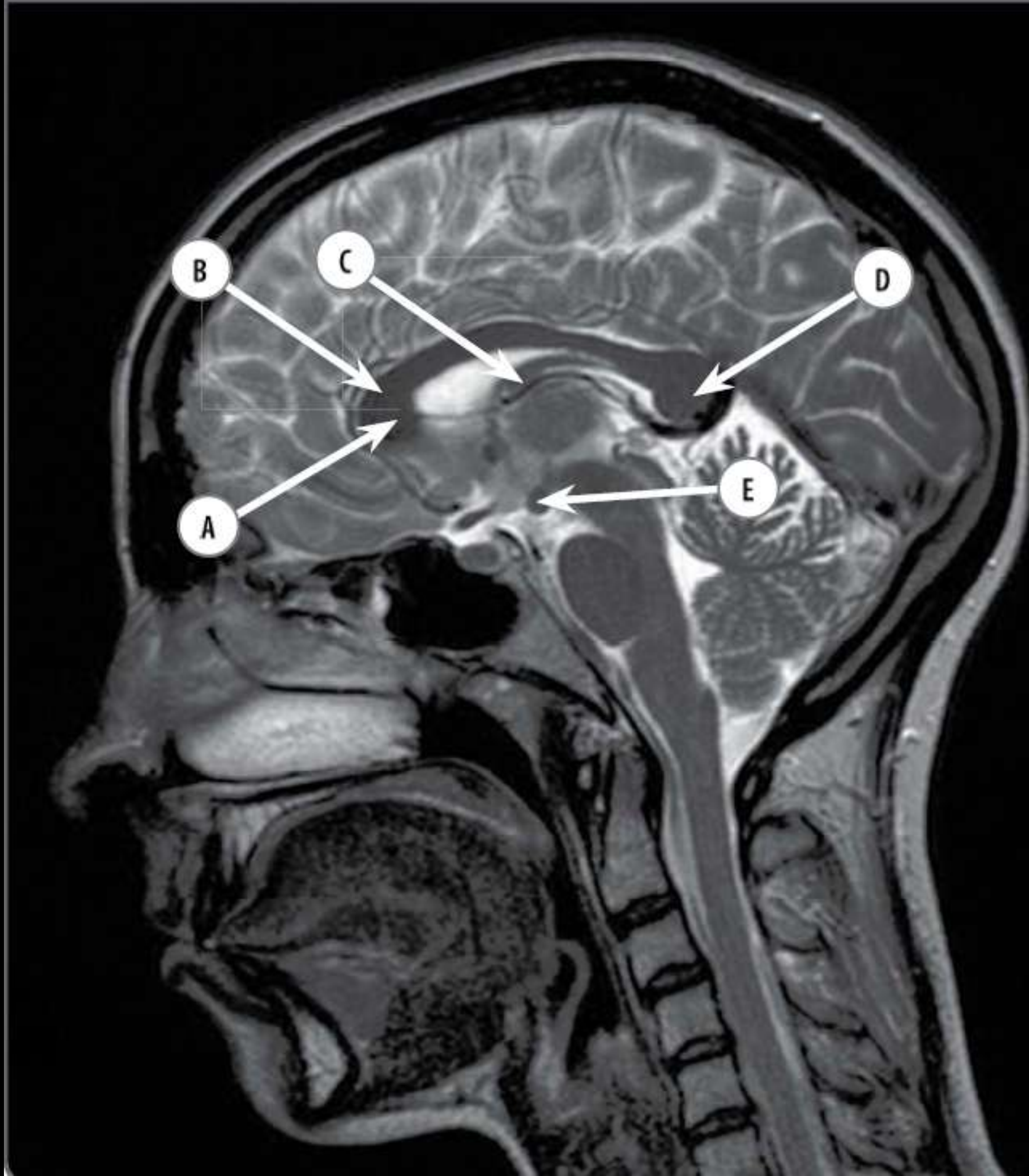

A
B
C
D
E

Case 5

MRI brain. T2W sagittal section.

1. Genu of the corpus callosum
2. Pons
3. Optic chiasm
4. Cisterna magna
5. Splenium of the corpus callosum

Case 1.1



Case 1.1

A Rostrum of the corpus callosum

B Genu of the corpus callosum

C Body of the fornix

D Splenium of the corpus callosum

E Mamillary body of the hypothalamus

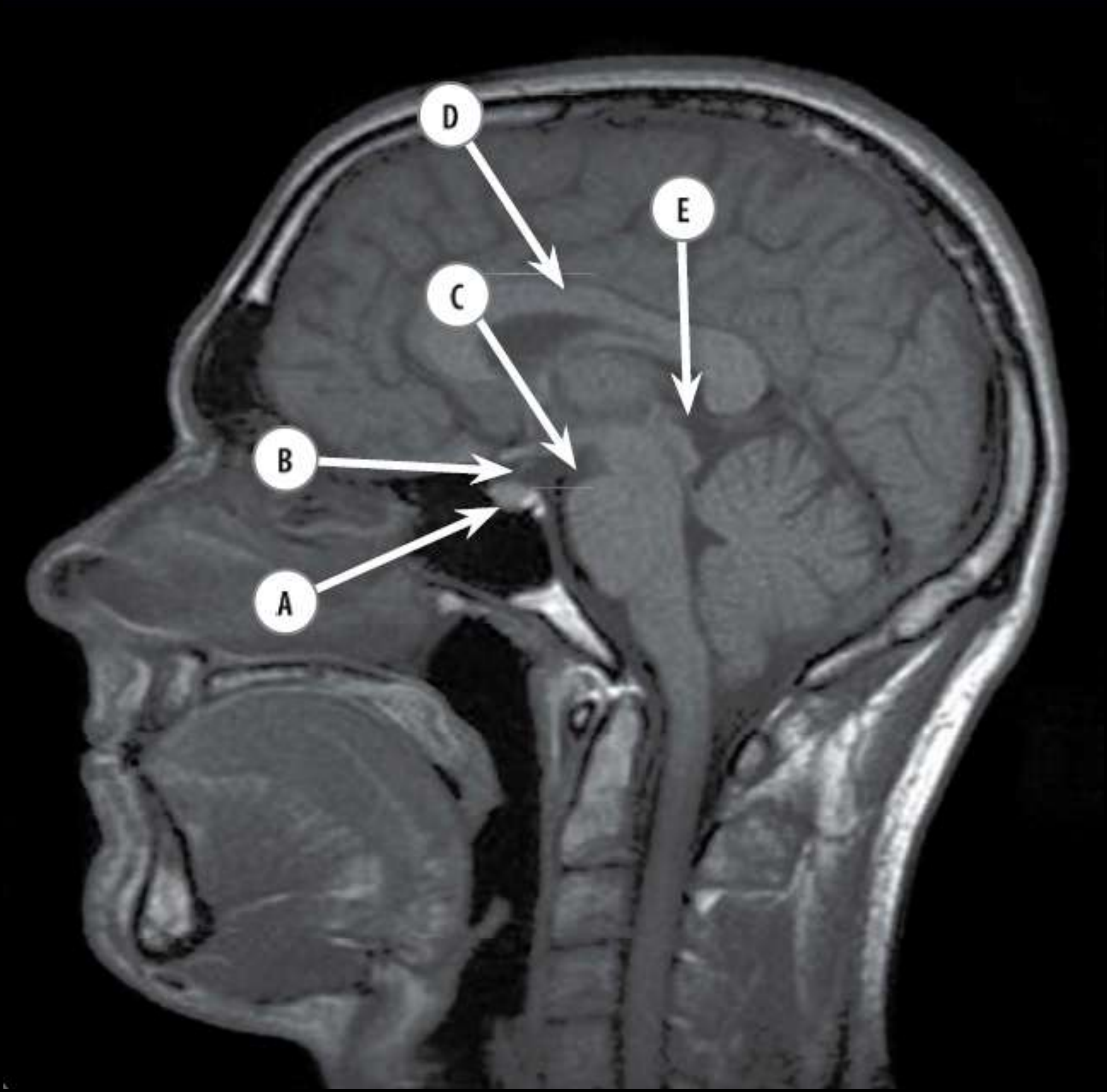
Midline sagittal MRI of the brain.

The corpus callosum lies in the depths of the great longitudinal fissure (interhemispheric fissure). It is composed of commissural fibres that unite corresponding regions of the two cerebral hemispheres. In this image we can identify the major parts of the corpus callosum. From rostral to caudal these are: rostrum, genu, body and splenium.

The fornix is a C-shaped fascicle of fibres that links the hippocampus with the mamillary body of the hypothalamus. The horizontal bundles of fibres that come together in the midline form the body of the fornix. The upper surface of this structure provides attachments to the septum pellucidum, a membrane that separates the anterior horns of the lateral ventricles.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 47.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 57.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 36.

Case 1.2



Case 1.2

A Anterior pituitary (adenohypophysis)

B Infundibulum

C Interpeduncular cistern

D Body of corpus callosum

E Pineal gland

Midline sagittal MRI of the brain.

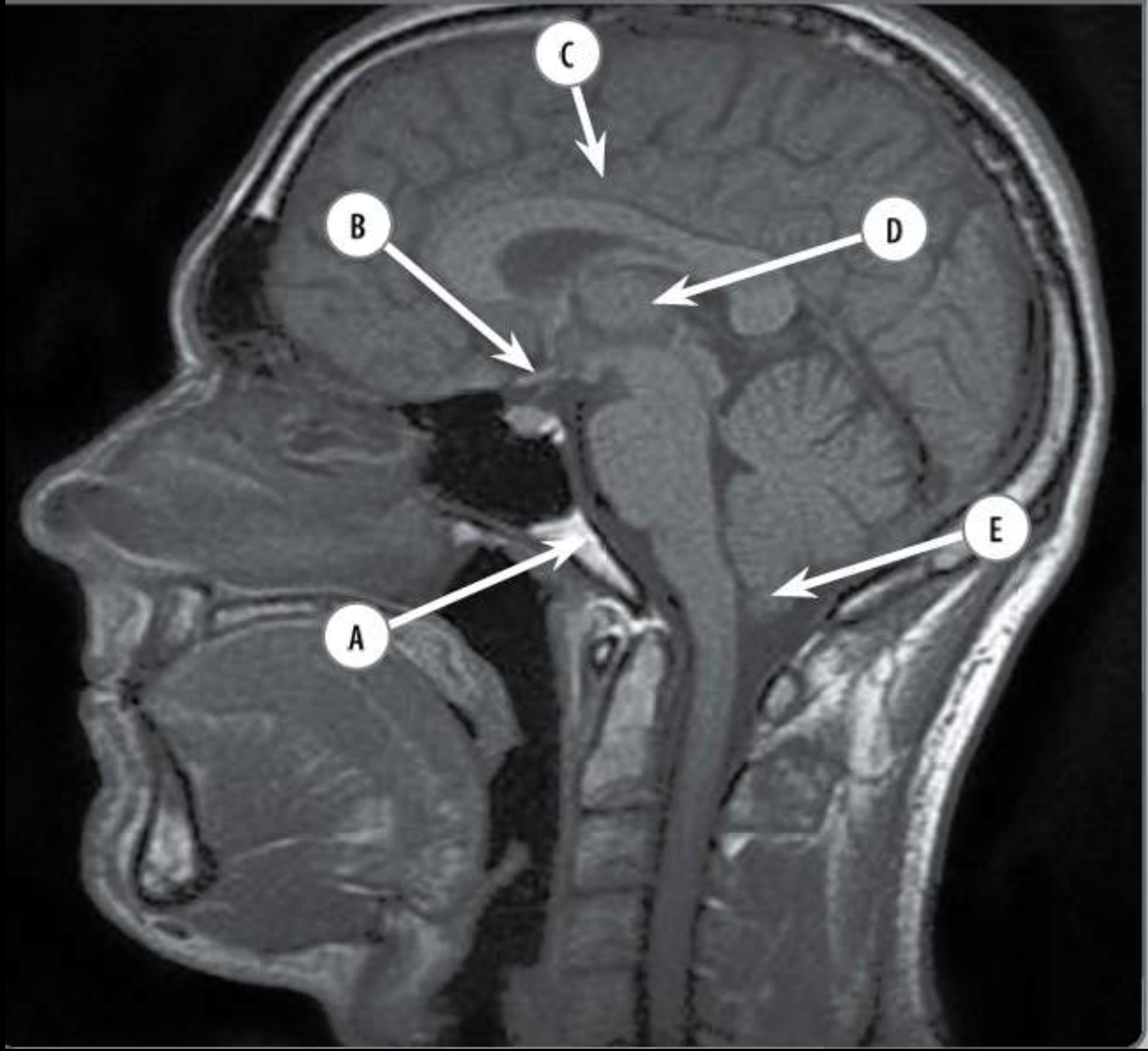
The pituitary gland is a pea-sized structure that sits in the sella turcica of the sphenoid bone. It consists of the posterior pituitary (neurohypophysis) and the anterior pituitary (adenohypophysis). The posterior pituitary is a neuronal structure and can be considered as an expansion of the distal part of the infundibulum (pituitary stalk). On a T1-weighted MRI such as this one, the posterior pituitary is bright (high signal). This helps to identify it with confidence. The anterior pituitary is larger.

The interpeduncular cistern is located at the base of the brain, spanning the space between the temporal lobes. It is deepest between the cerebral peduncles of the midbrain, hence the name. It contains the optic chiasm where the optic nerves partially cross.

The pineal gland (also called pineal body) lies in the midline immediately rostral to the superior colliculi of the midbrain. It is part of the epithalamus which is one of the four main subdivisions of the diencephalon. The hypothalamus is the most ventral part of the diencephalon and lies inferior to the thalamus and ventromedial to the subthalamus.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 47.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 57.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 36.

Case 1.3



Case 1.3

A Clivus

B Optic chiasm

C Cingulate gyrus

D Massa intermedia of thalami

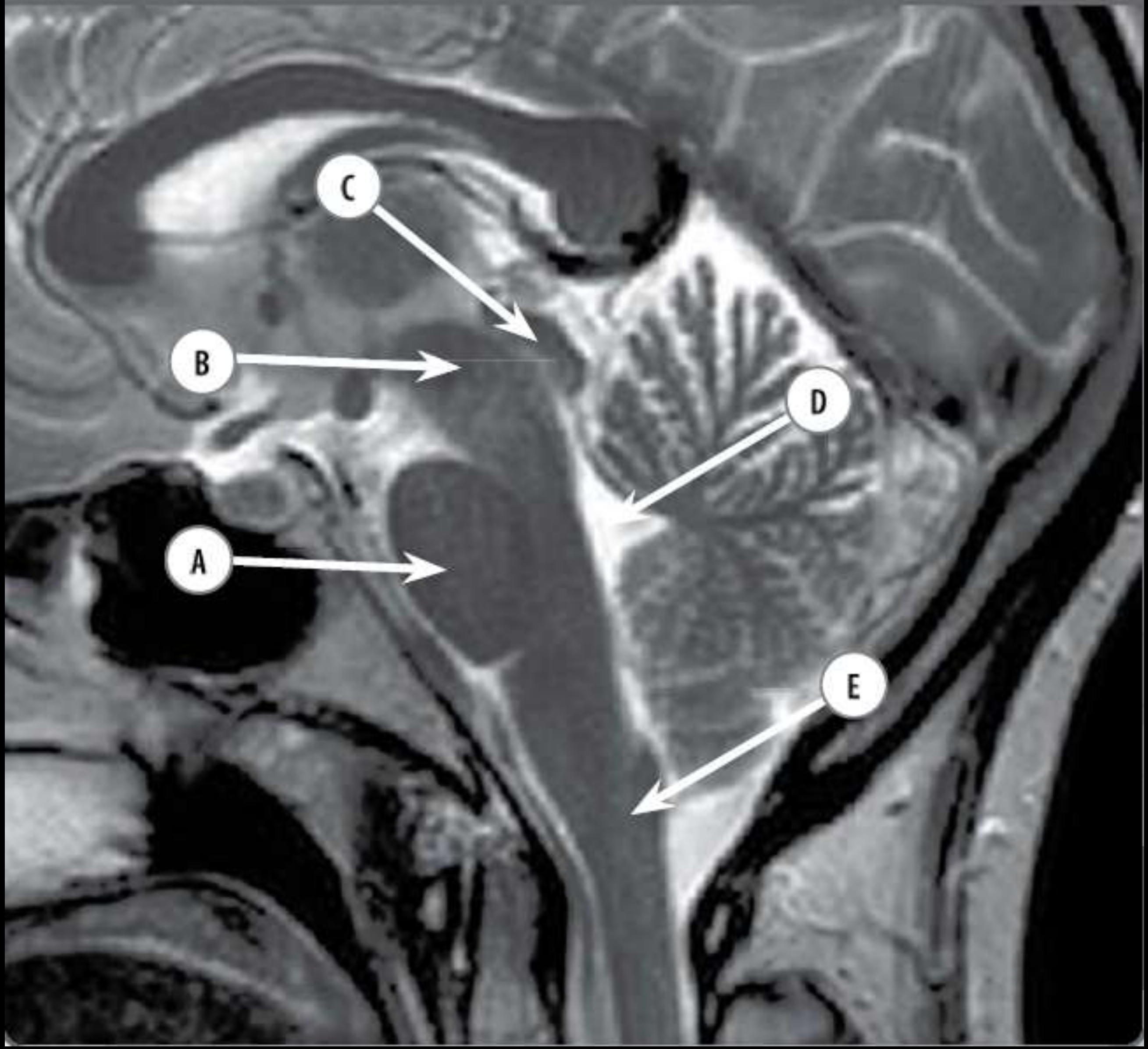
E Tonsil of cerebellum

Midline sagittal MRI of the brain.

The clivus (Latin for 'slope') is a shallow depression behind the dorsum sellae. It forms a sloping process at the junction of the occipital and sphenoid bones. The optic chiasm is where half of the fibres of the optic nerve cross to the other side. A mass in the pituitary or the suprasellar fossa can compress this structure. The cingulate gyrus lies above the corpus callosum. It is considered as part of the limbic system and it is thus separate to the frontal and parietal lobes. The thalamus resembles a small hen's egg. Together with the hypothalamus, it forms the lateral wall of the third ventricle. The cerebellar tonsils are the most antero-inferior part of the cerebellar hemispheres. They lie close to the midline and therefore can be seen in a midline sagittal image.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 47.

Case 1.4



Case 1.4

A Pons

B Ventral midbrain (tegmentum)

C Quadrigeminal plate (tectum)

D 4th ventricle

E Medulla oblongata

Midline sagittal MRI of the brain.

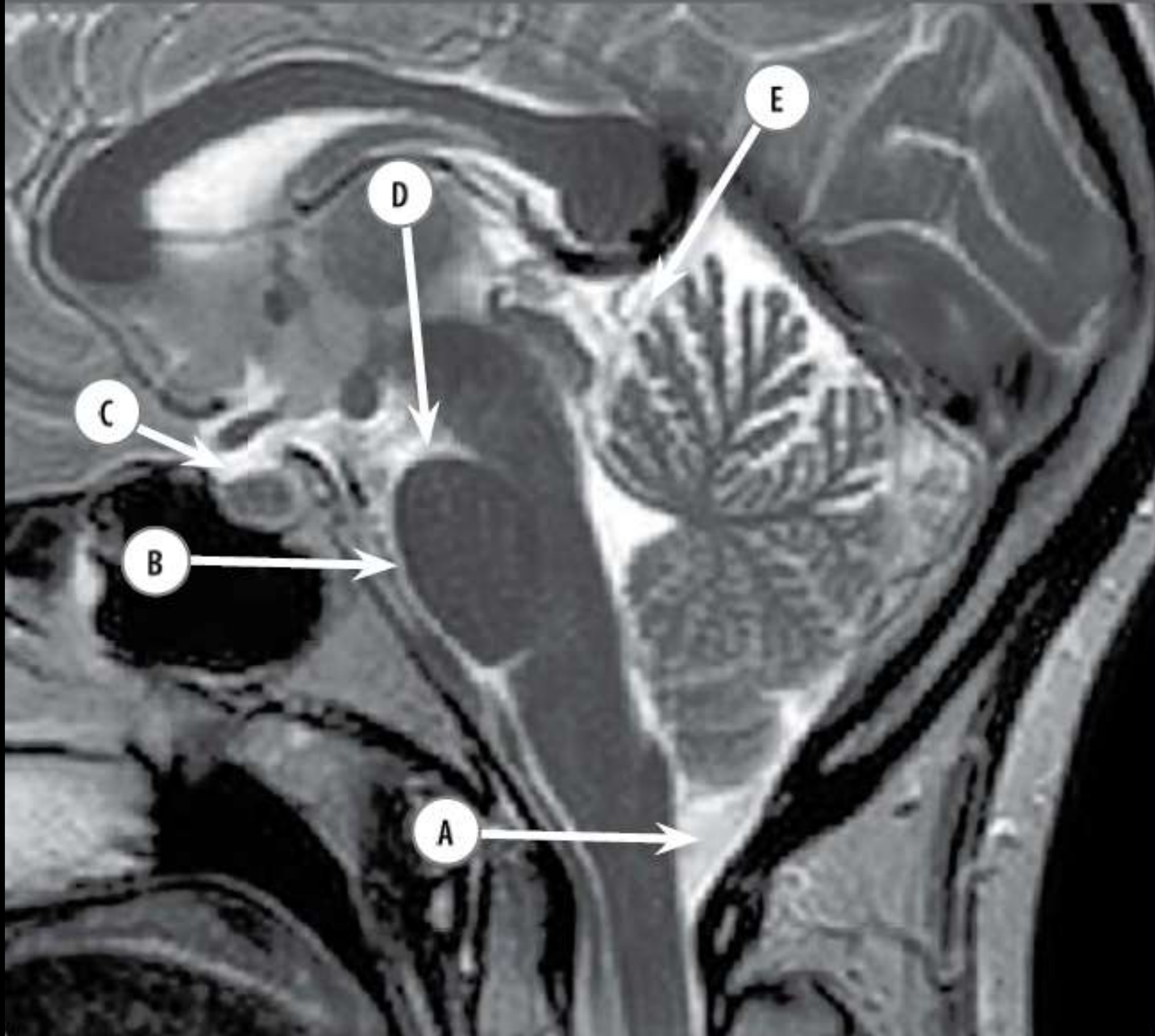
The brainstem connects the cerebral hemispheres with the spinal cord. It consists of three parts: the midbrain, the pons and the medulla.

The midbrain is the most superior part of the brainstem. The quadrigeminal plate is the dorsal part of the midbrain. It is also referred to as tectum (Latin for 'roof'). It is separated from the ventral midbrain (tegmentum) by the cerebral aqueduct (aqueduct of Sylvius), which connects the 3rd and 4th ventricles.

The pons is the widest part of the brainstem. It has a bulbous anterior part. Its posterior part forms the upper part of the floor of the 4th ventricle. The lower part of the floor of the 4th ventricle is formed by the posterior surface of the medulla.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 47.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 57.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 36.

Case 1.5



Case 1.5

A Cisterna magna

B Pontine cistern

C Suprasellar cistern

D Interpeduncular cistern

E Quadrigeminal cistern

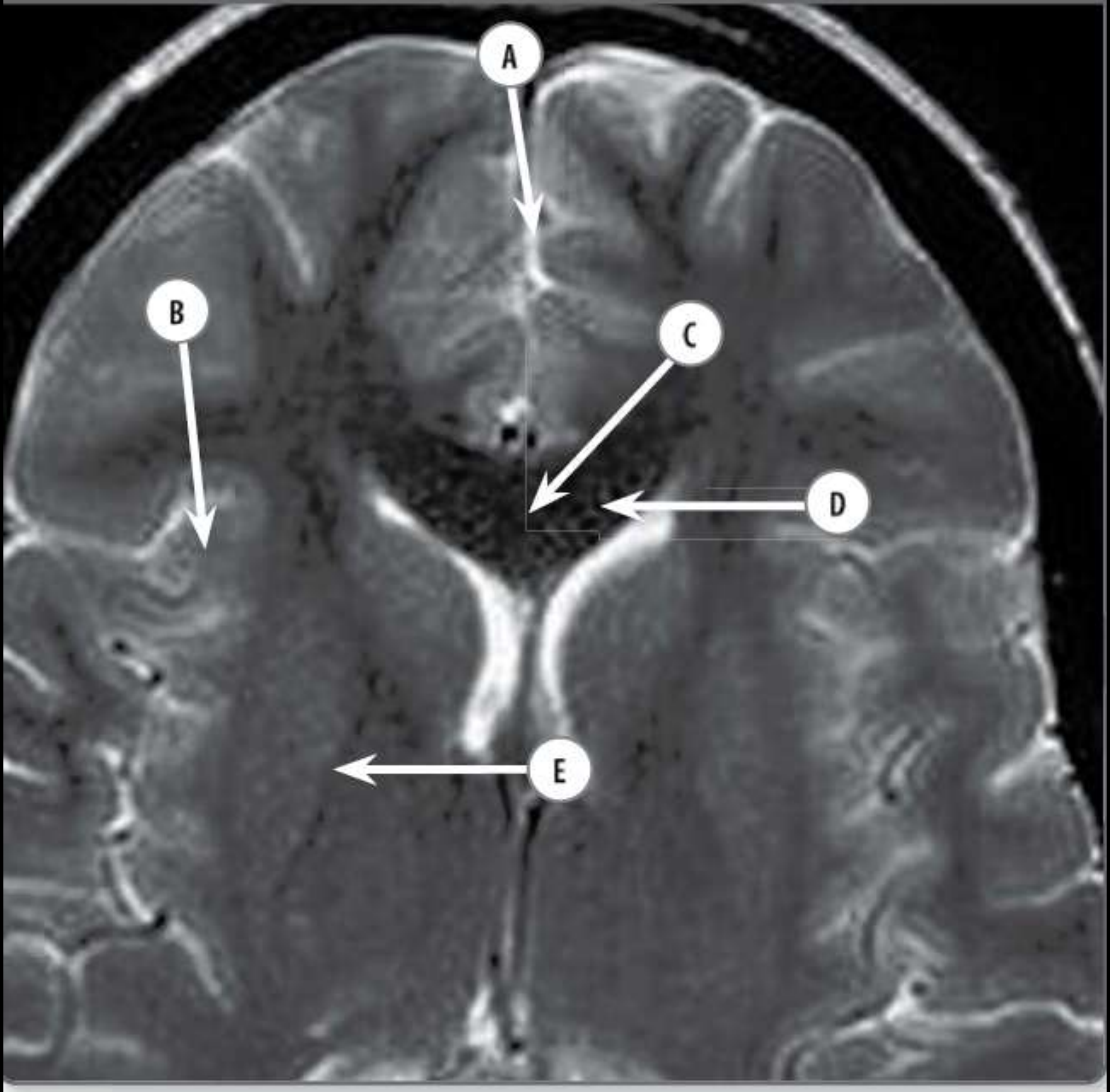
Midline sagittal MRI of the brain.

The subarachnoid space is deep in several places, particularly around the base of the brain. These spaces are referred to as subarachnoid cisterns and are named according to nearby structures. The cistern magna lies below the cerebellar hemispheres and behind the medulla. The pontine cistern lies between the pons and the clivus. The interpeduncular cistern lies between the temporal lobes and is widest between the cerebral peduncles of the midbrain.

The quadrigeminal cistern lies posterior to the quadrigeminal plate, between the splenium of the corpus callosum and the vermis of the cerebellum. The suprasellar cistern lies above the pituitary fossa. It is continuous posteriorly with the quadrigeminal cistern.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 47.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 74.

Case 1.8



Case 1.8

A Interhemispheric fissure

B Right insular cortex

C Splenium of corpus callosum

D Left tapetum

E Posterior limb of the internal capsule

Axial MRI of the brain at the level of the lateral ventricles.

The Sylvian fissure (or lateral sulcus) separates the frontal from the temporal lobes.

Lateral to the putamen, there is a thin sheet of grey matter known as the claustrum. It is sandwiched between two layers of white matter: the external capsule medially and the extreme capsule laterally. Lateral to the extreme capsule and in the floor of the lateral sulcus, lies the cortex referred to as the insula (of Reil).

The left and right cerebral hemispheres fill the cranial vault above the tentorium cerebelli. They are connected in the midline by the corpus callosum which lies deep in the interhemispheric fissure (median longitudinal fissure). The corpus callosum is a large mass of commissural fibres. The genu is its most anterior part. Fibres extending laterally from the body of the corpus callosum are called the tapetum. They form part of the roof and lateral wall of the lateral ventricle.

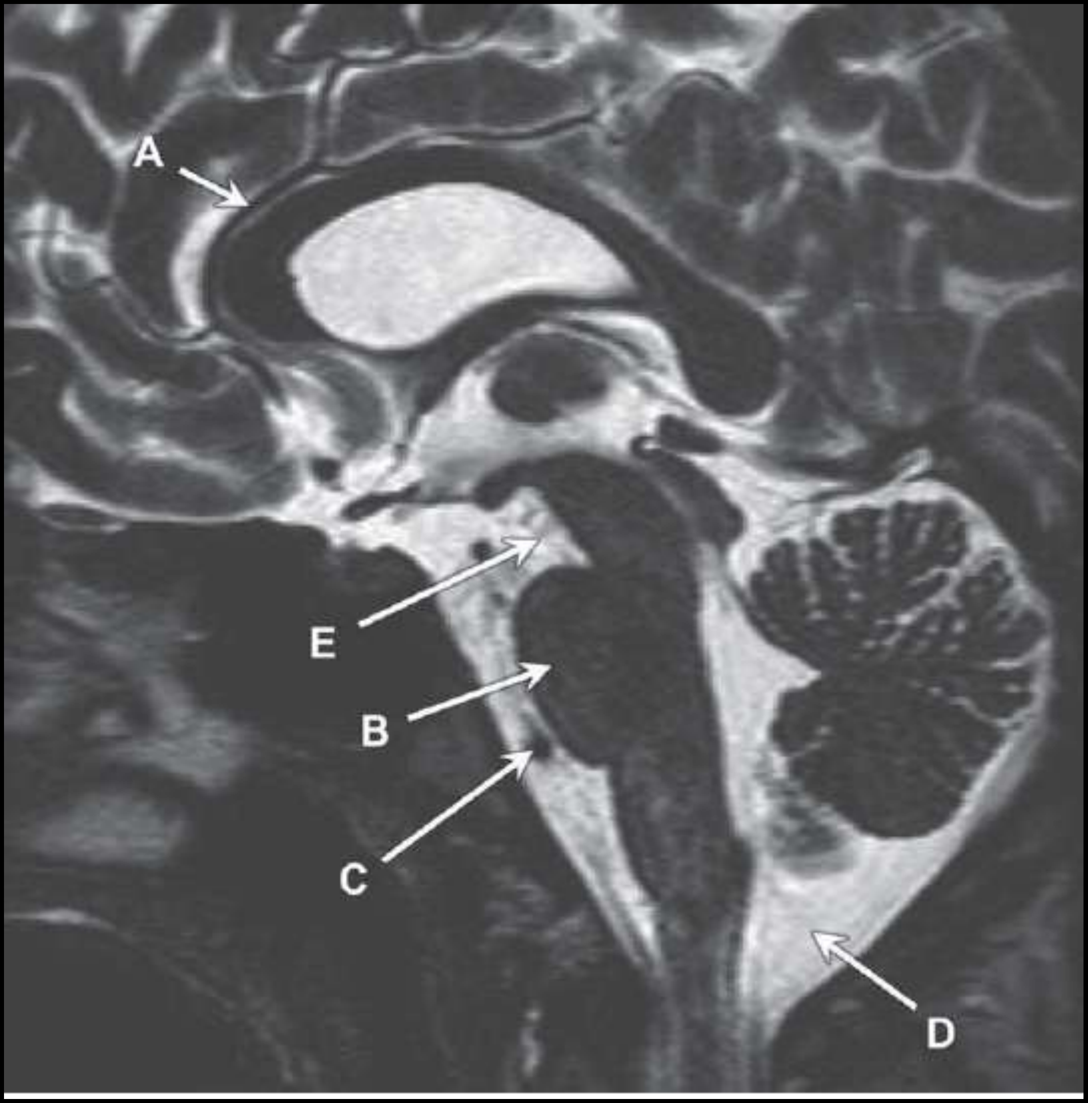
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 44.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 56.


E
A
D
C

Case 8

MR C-spine, T2-weighted, sagittal.

1. Posterior longitudinal ligament
2. Ligamentum flavum
3. Trachea
4. Oesophagus
5. Fourth ventricle

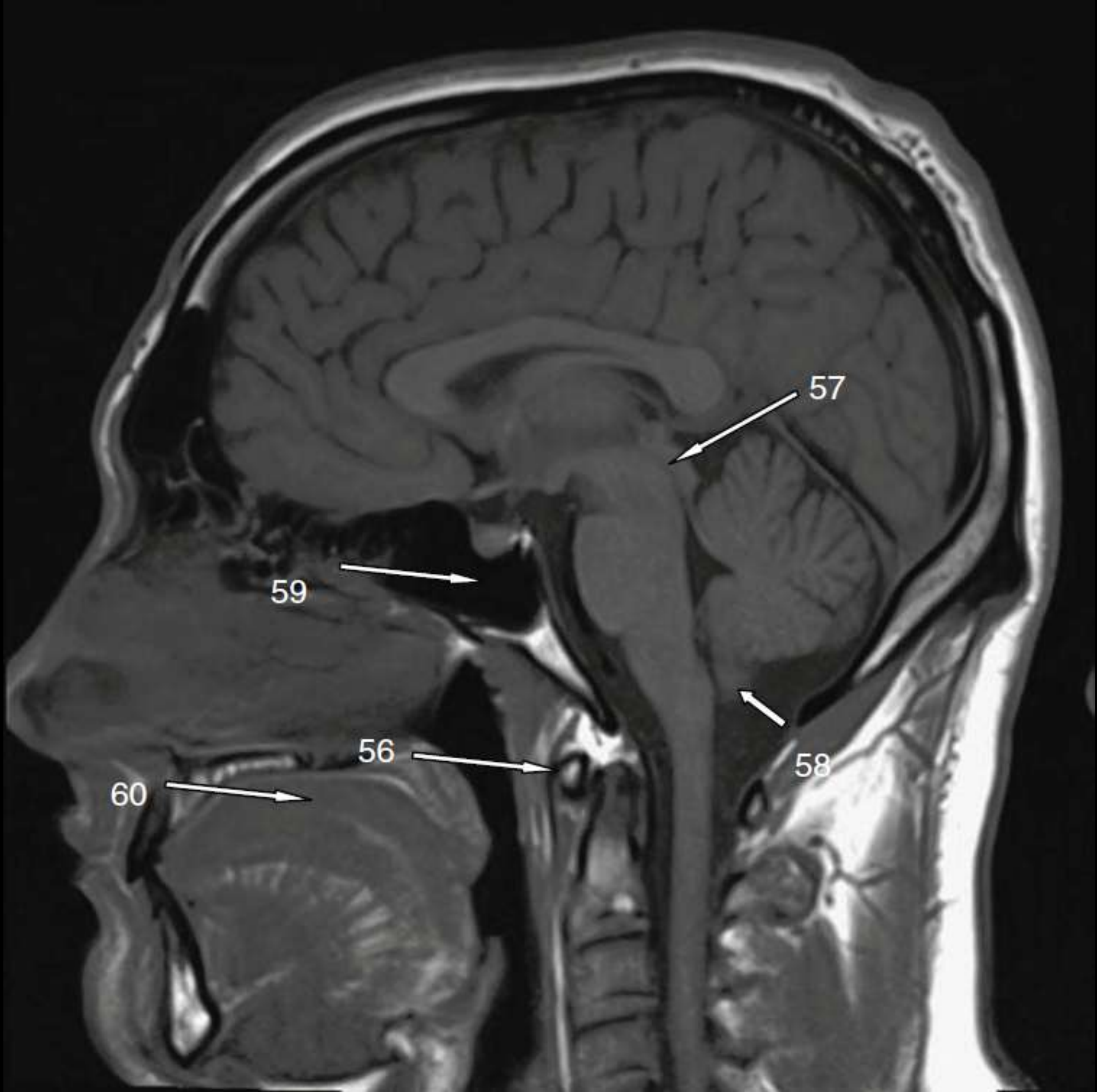

A
E
B
C
D

Case 3

MRI cerebral aqueduct. Sagittal section.

1. Pericallosal artery
2. Pons
3. Basilar artery
4. Cisterna magna
5. Interpeduncular cistern

The basilar artery often takes a slightly tortuous course and is, therefore, seen in cross section on this sagittal image.



57
59
56
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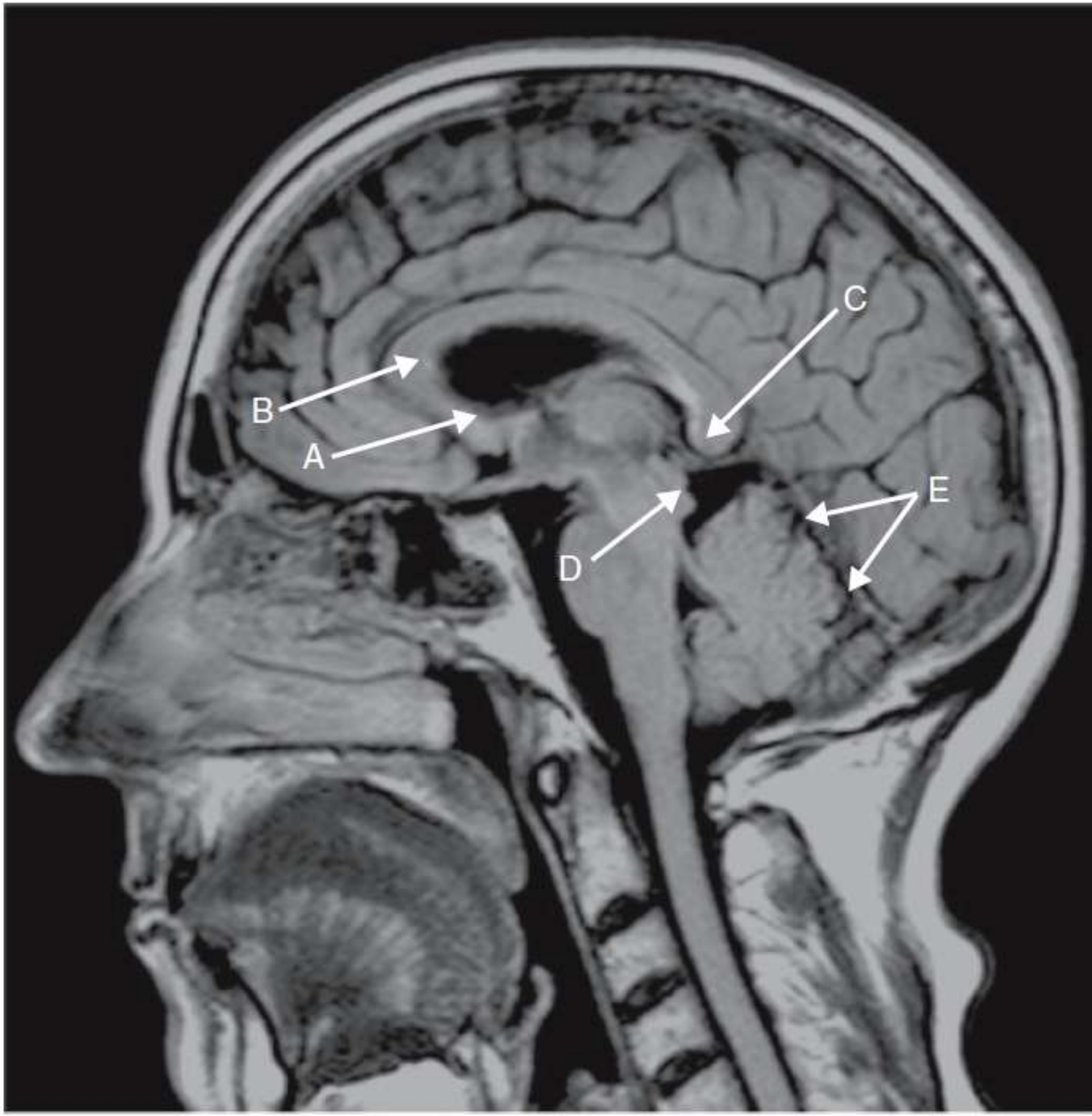
MRI Head

56. Anterior arch of atlas
57. Quadrigeminal plate
58. Cerebellar tonsil
59. Sphenoid sinus
60. Tongue

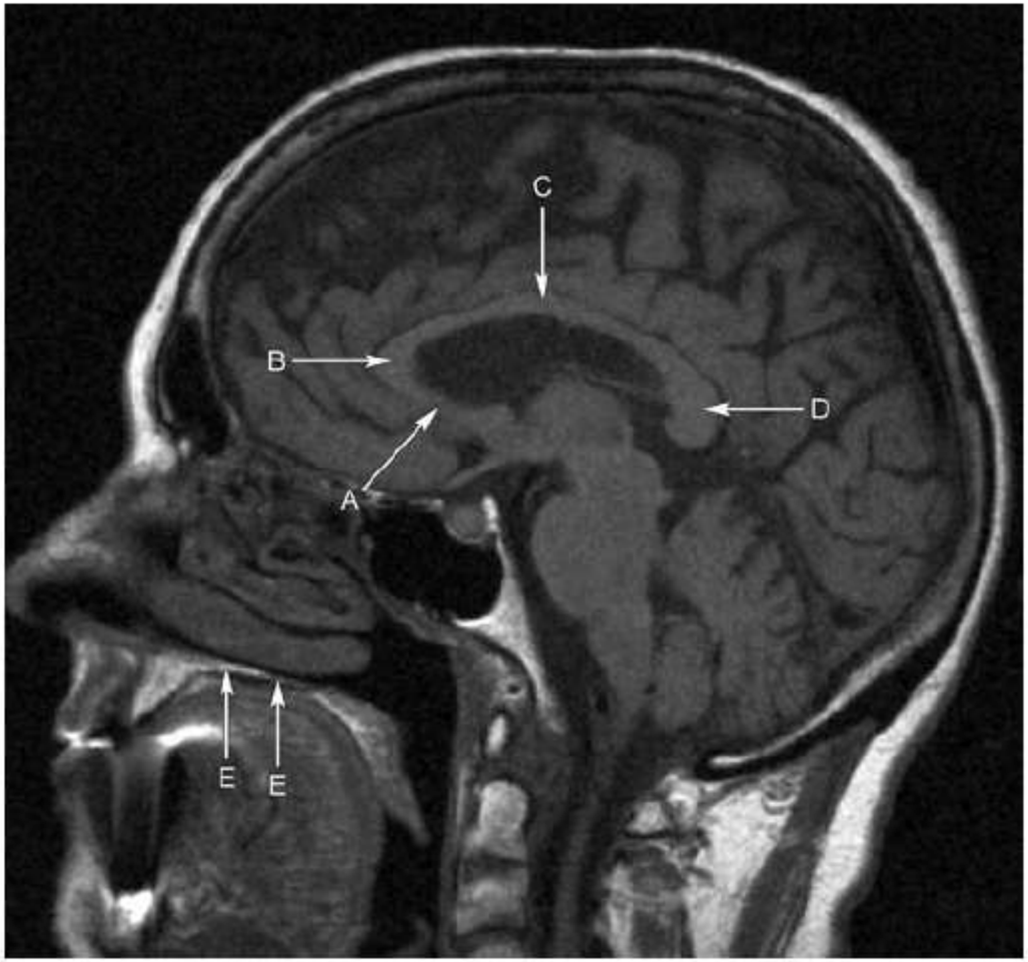
Case 5.4



5.4 Sagittal MR brain (FLAIR sequence)

(a) Rostrum of the corpus callosum. This is the first part of the corpus callosum which extends from the anterior commissure.
(b) Genu of the corpus callosum. This is the most anterior part of the corpus callosum where it bends sharply backwards. Fibres extending from the genu into the frontal cortex are called forceps minor.
(c) Splenium of the corpus callosum. This is the thickened posterior end of the corpus callosum. Fibres extending posteriorly from the splenium into the occipital lobes are called forceps major.
(d) Quadrigeminal plate. This is also known as the tectum, and forms part of the midbrain lying posterior to the cerebral aqueduct (of Sylvius).
(e) Tentorium cerebelli. This is an extension of dura mater, separating the cerebellum from the inferior portion of the occipital lobes. The upper surface, in the midline, attaches to the posterior surface of the falx cerebri and the straight sinus runs in this location.

Question 5.4



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

5.4 Sagittal T1 MRI of the brain

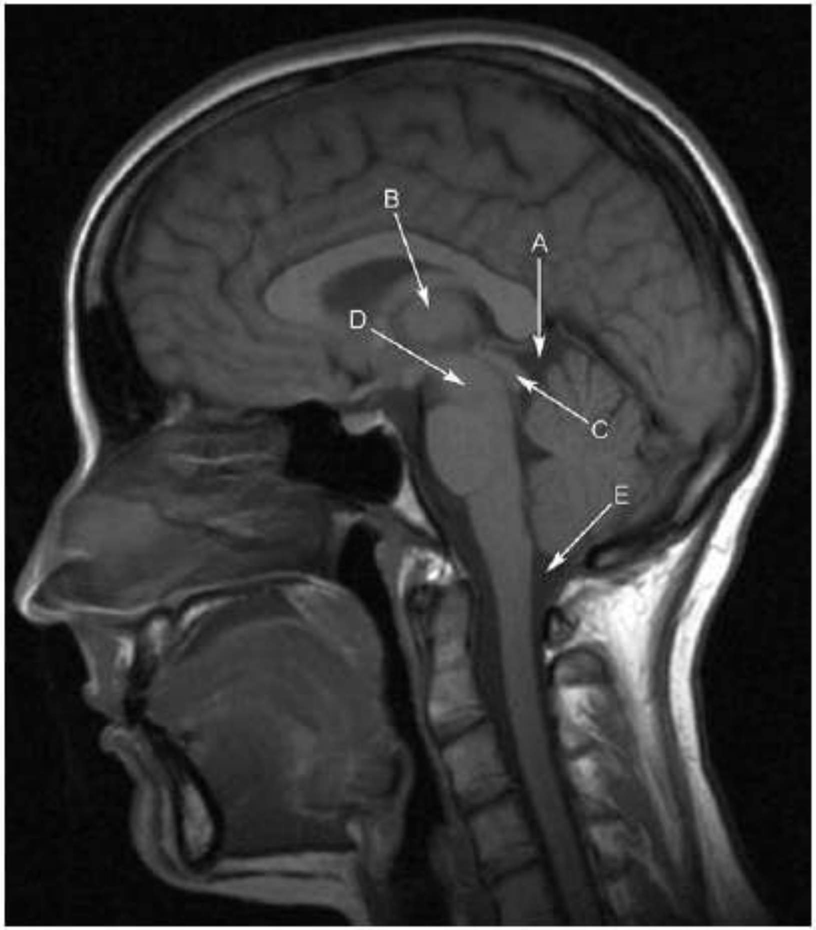
A Rostrum of the corpus callosum.
B Genu of the corpus callosum.
C Body of the corpus callosum.
D Splenium of the corpus callosum.
E Hard palate.

The corpus callosum is the largest white matter structure of the brain. It connects the cerebral hemispheres of the brain and allows communication between them.

The corpus callosum is divided into five parts:

Genu	Anterior portion of the corpus callosum Genu is Latin for knee: this part can be seen to resemble a bent knee
Splenium	Posterior part of the corpus callosum PoSterior for Splenium
Body	Lies between the genu and the splenium
Isthmus	Thin posterior part between the body and the splenium
Rostrum	Rostrum is Latin for rooster: the rostrum is supposed to resemble the crest on a rooster Extends inferiorly and posteriorly from the genu

Question 6.4



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

6.4 Sagittal T1 MRI of the brain

A Quadrigeminal cistern.
B Massa intermedia.
C Tectum (quadrigeminal plate).
D Midbrain.
E Cisterna magna.

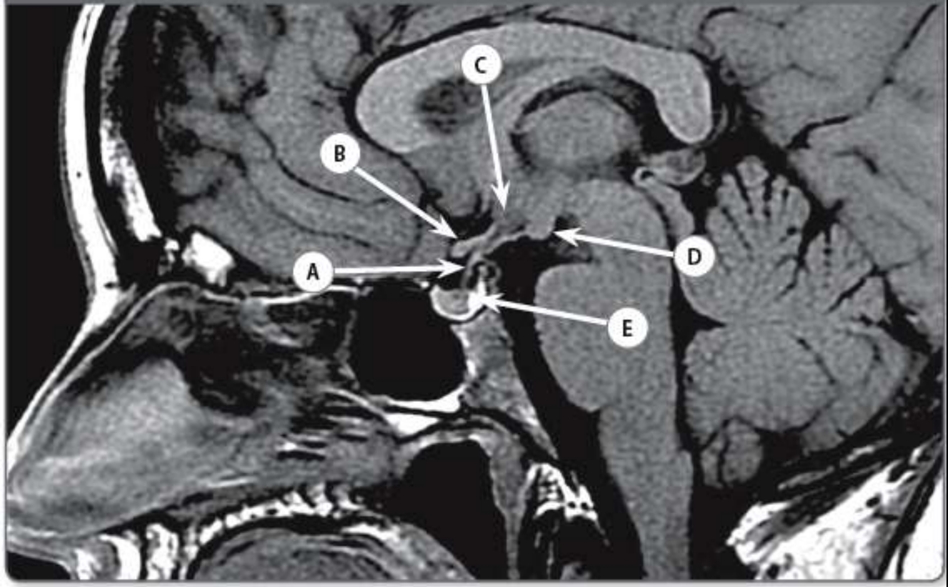
The thalami form the majority of the lateral walls of the third ventricle. In 70–80% of people there is a midline interthalamic adhesion known as the massa intermedia. It is made up of nerve cell bodies and a few nerve fibres. The exact function of this adhesion is not known and its absence does not cause any functional defects.

The cerebellum is also well demonstrated on this image. It is divided into two hemispheres, which are then further subdivided by the deep fissures into lobules. The primary fissure (fissura prima) defines the anterior cerebellar lobe from the posterior lobe.

It is worth having a general understanding of the blood supply to the cerebellum. There are three main arteries that supply it:

Superior cerebellar artery (SCA – branch of the distal basilar artery)	Superior surface of the cerebellar hemispheres down to the horizontal fissures Superior vermis Dentate nucleus Majority of the cerebellar white matter
Anterior inferior cerebellar artery (AICA – branch of the proximal basilar artery)	Middle cerebellar peduncle Flocculus Antero-inferior surface of the cerebellum
Posterior inferior cerebellar artery (PICA – branch of the distal vertebral arteries)	Postero-inferior cerebellar hemispheres to the horizontal fissure Inferior vermis

Case 3.11



Case 3.11

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 3.11

A Pituitary infundibulum (stalk)

B Optic chiasm

C Hypothalamus

D Mamillary body

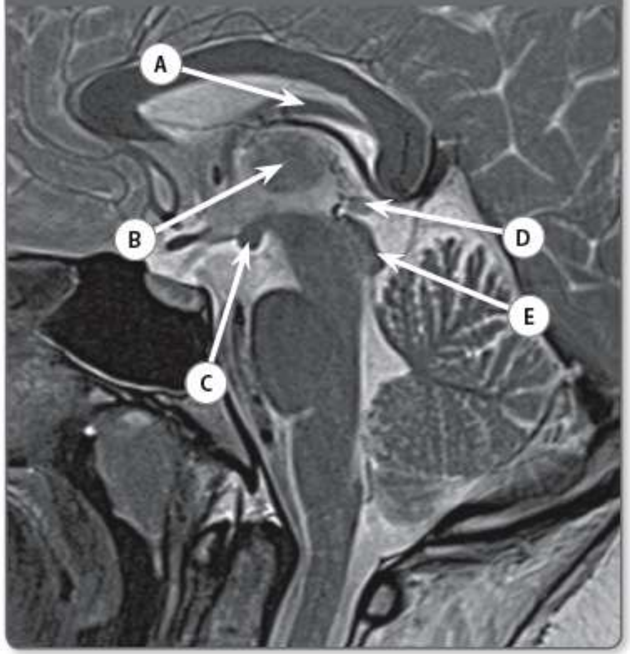
E Posterior lobe of the pituitary gland

The pituitary gland consists of two functionally and anatomically separate lobes: anterior and posterior. The lobes can be distinguished on a T1-weighted image, on which the posterior lobe returns characteristically bright signal due to the presence of neurosecretory granules.

The posterior pituitary lobe is connected to the hypothalamus by the infundibulum (stalk), which transports hormones from both the anterior and the posterior parts of the pituitary gland.

The mamillary bodies form the posterior part of the hypothalamus and separate it from the midbrain.

Case 4.3



Case 4.3

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

Case 4.3

A Fornix

B Massa intermedia

C Mamillary body

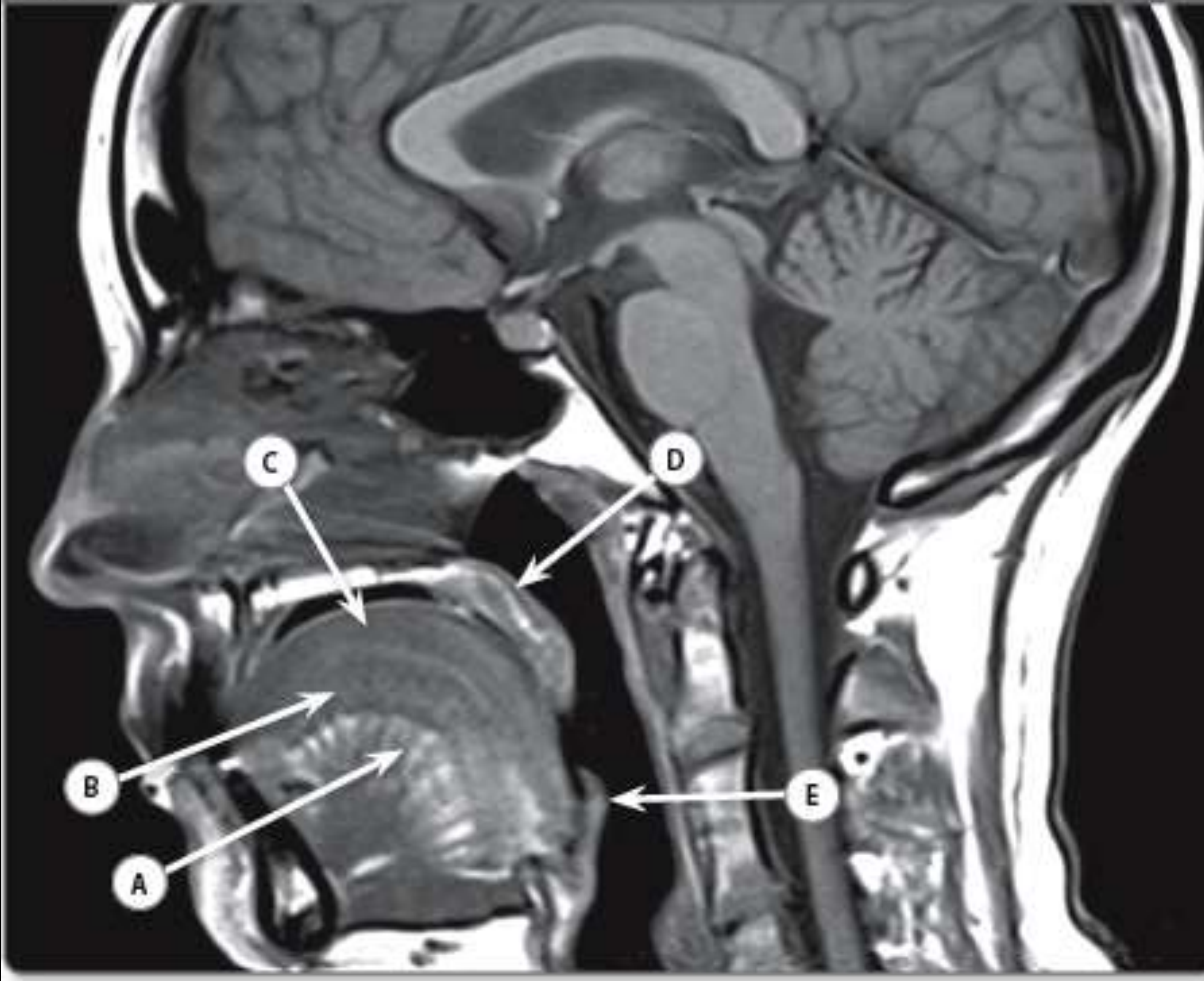
D Pineal gland

E Quadrigeminal (tectal) plate

The pineal gland (shaped like a pine cone, hence its name) is an ovoid structure situated in the posterior wall of the third ventricle, between the two superior colliculi, superior to the quadrigeminal (tectal) plate and anterior to the posterior commissure. Together with the thalamus, hypothalamus and habenula, it is part of the diencephalon.

Pineal gland calcification is present in almost 100% of the adult population.

Case 5.10



Case 5.10

A Genioglossus muscle

B Intrinsic transverse muscle of the tongue

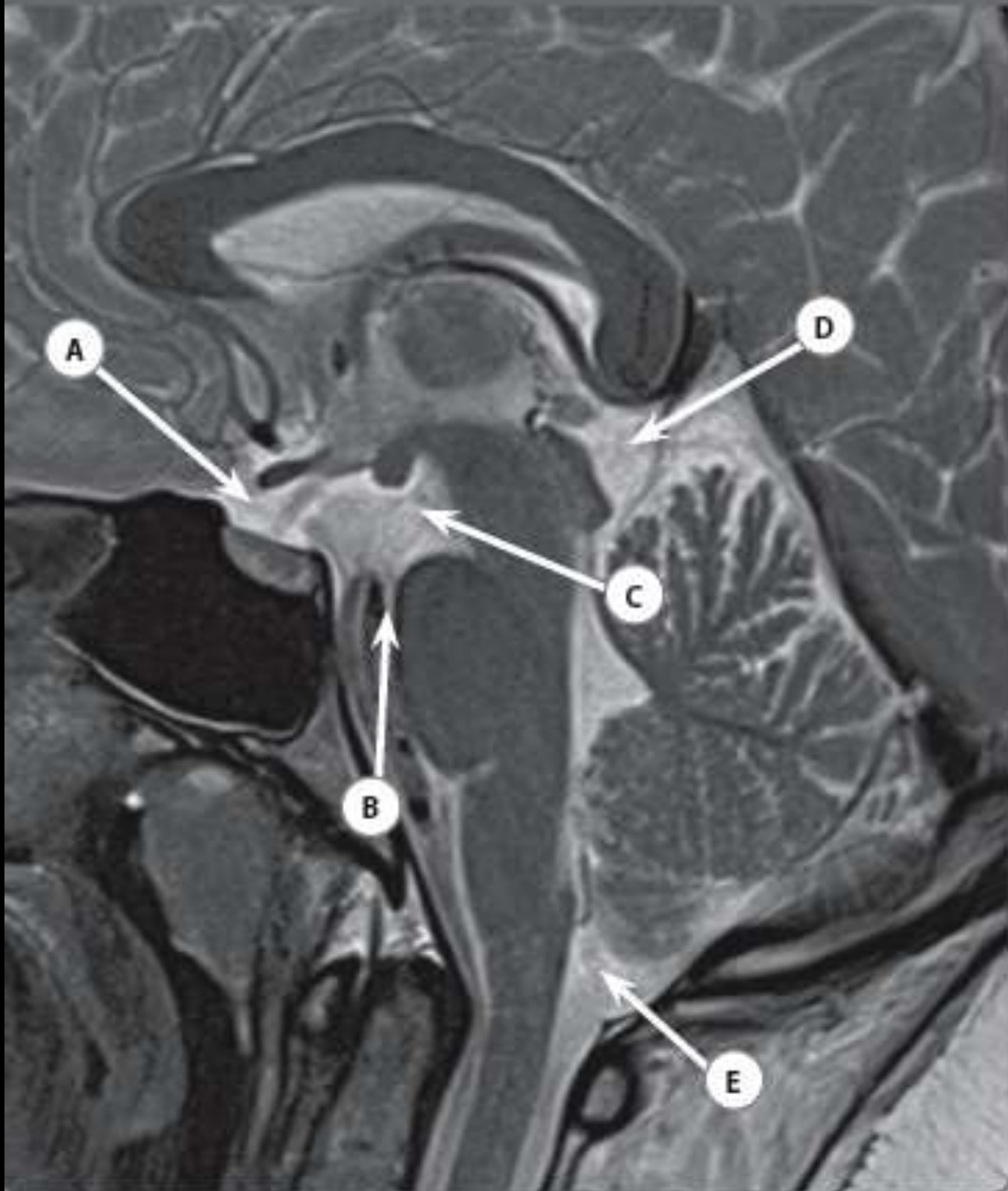
C Intrinsic longitudinal muscle of the tongue

D Soft palate

E Epiglottis

The tongue forms part of the floor of the mouth. It comprises intrinsic muscles which lie in three planes: transverse, longitudinal and vertical. The muscles are separated by fat planes which are important landmarks on imaging. The tongue is supported by three extrinsic muscles – styloglossus, genioglossus and hypoglossus – with the genioglossus muscle, running between the tongue and the posterior aspect of the mandible, being the largest.

Case 8.2



Case 8.2

A Suprasellar cistern

B Prepontine cistern

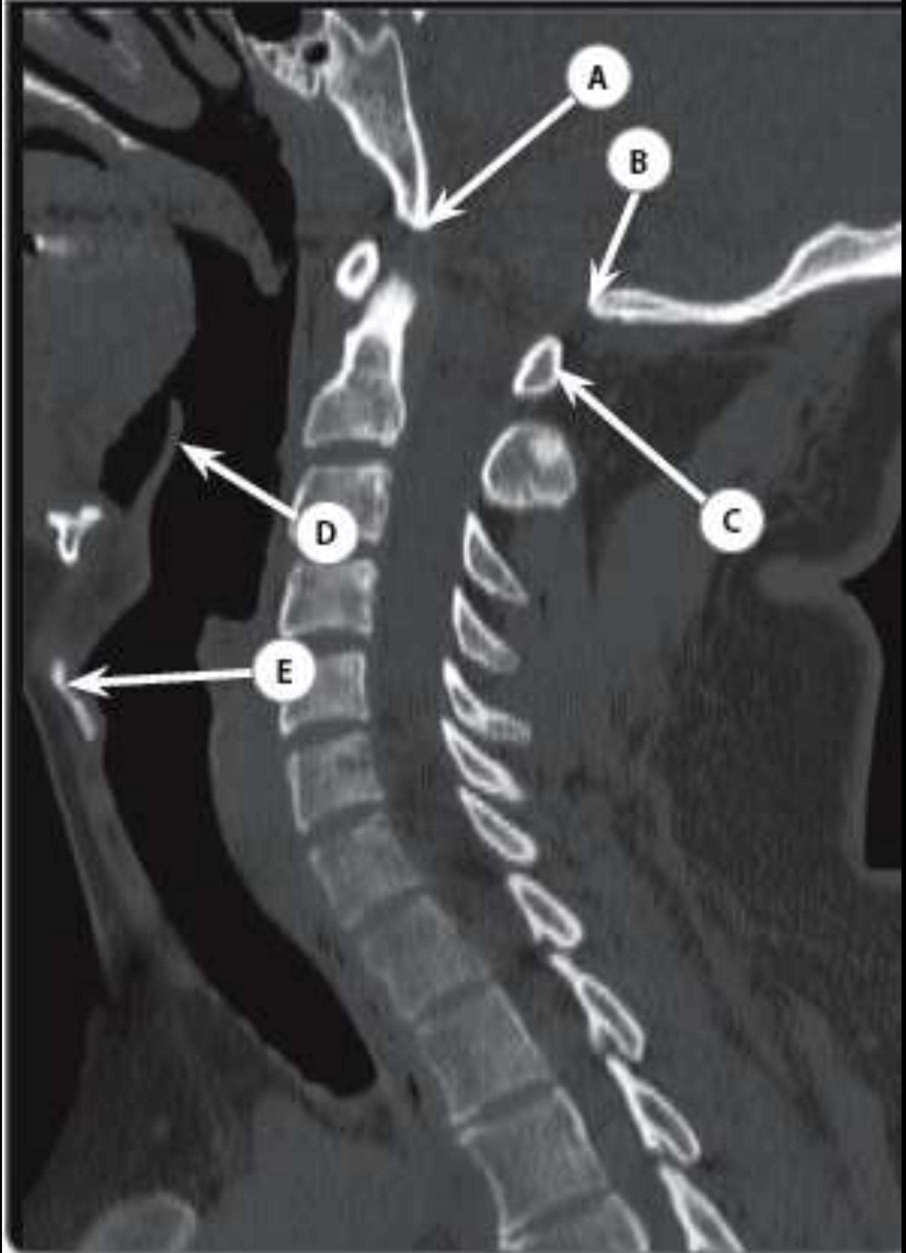
C Interpeduncular cistern

D Quadrigeminal cistern

E Cisterna magna

The arachnoid and pia matter are applied closely together but become separate at the base of the brain and around the brainstem to form a system of subarachnoid cisterns. The cisterns are usually named after their relationships with adjacent structures, such as the prepontine cistern (pons), suprasellar cistern (sella turcica) or cisterna magna (foramen magnum). The cisterns communicate with each other, thus allowing free flow of CSF between them. Some of the cerebral arteries and cranial nerves course within the cisterns.

Case 9.14

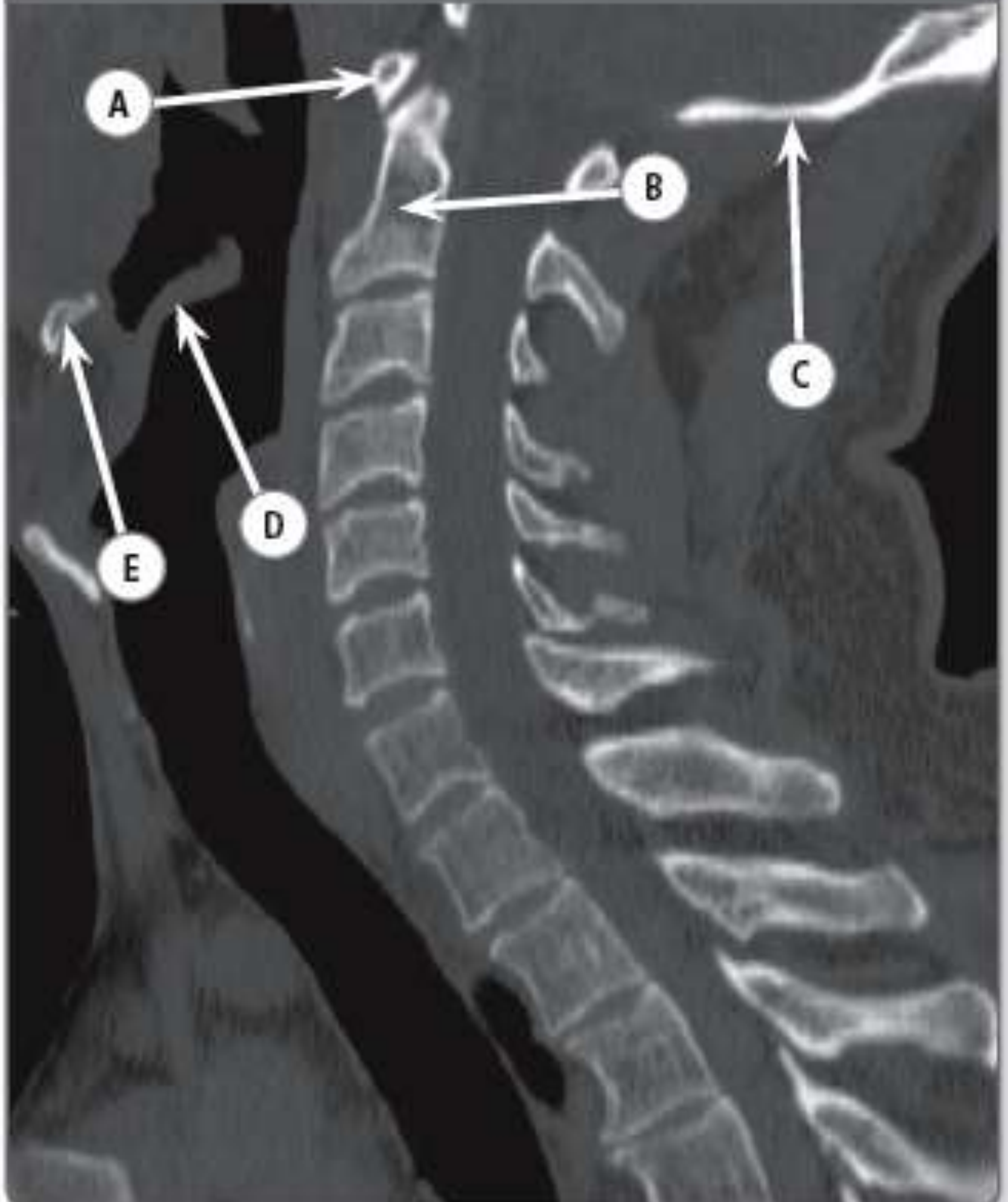


Case 9.14

- **A** Basion
- **B** Opisthion
- **C** Posterior arch of C1 vertebra
- **D** Epiglottis
- **E** Thyroid cartilage

Foramen magnum is an opening in the occipital bone and the largest aperture of the skull base. Its lateral borders are formed by the occipital condyles, which form part of the craniocervical junction. Anteriorly, it is bounded by the basilar part of the occipital bone, the middle and most inferiorly projected point of which is called the basion. Posteriorly, it is bounded by the squama occipitalis, the midpoint of which is called the opisthion. The basion and opisthion are used as cephalometric and anatomical landmarks.

Case 11.12



Case 11.12

A Anterior arch of C1

B Odontoid peg

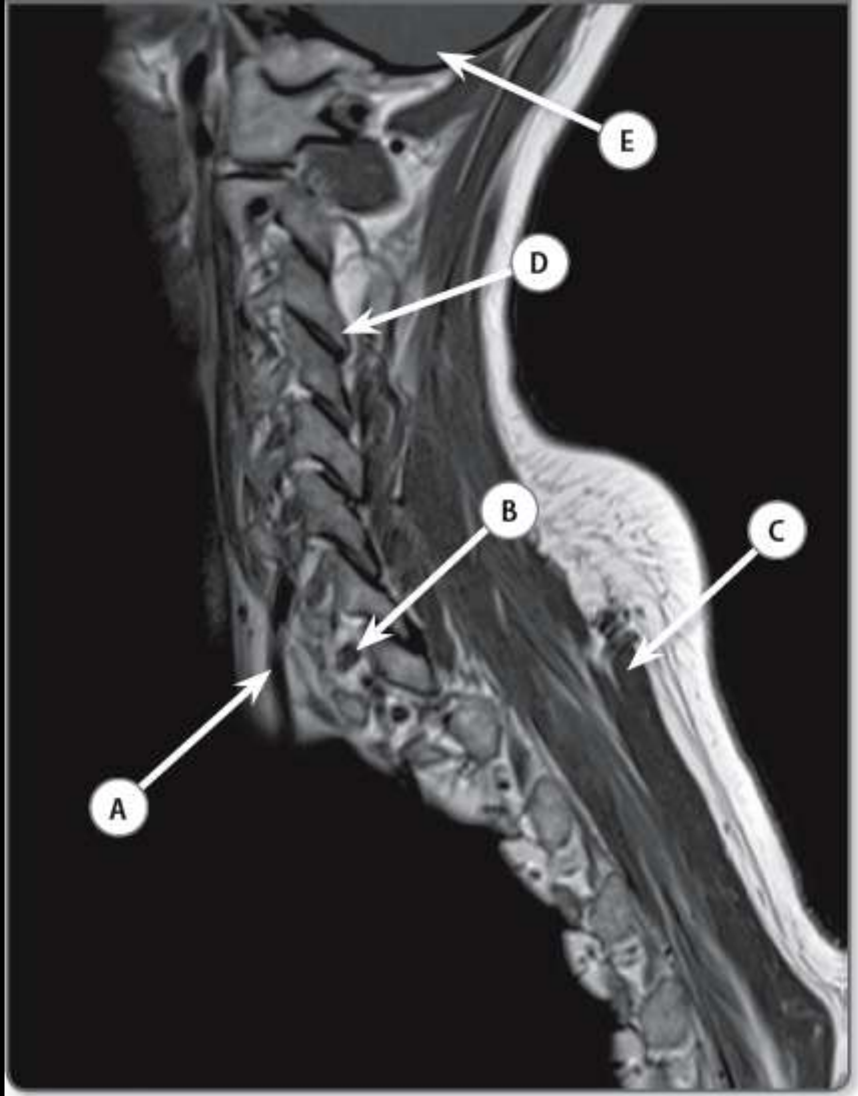
C Occipital bone

D Epiglottis

E Body of hyoid bone

The distance between the odontoid peg (dens) and the anterior arch of C1 is known as the atlantodental interval. In the context of trauma, an increase in the atlantodental interval to more than 3 mm in adults or 5 mm in children is suggestive of atlantoaxial subluxation. Sagittal reformats are also useful for examining the alignment of facet joints. Facet joint dislocation may be seen on sagittal views as 'perched' facets.

Case 12.5



A Left vertebral artery

B Exiting left T1 nerve root

C Left trapezius muscle

D Left inferior articular process of C4

E Left cerebellar hemisphere

The vertebral artery is seen here coursing superiorly after arising from the left subclavian artery. It passes through the foramina transversaria of C6 upwards before forming the basilar artery with its contralateral counterpart. The nerve root seen here exits below the left pedicle of T1 and accordingly will be the left T1 nerve root. The nerve root above this pedicle is the C8 nerve root, and more superiorly in the cervical spine the nerve root exits above its correspondingly numbered pedicle. The superior and inferior articular processes are clearly seen to articulate at the facet joints on this image.

Case 12.6

A Medial epicondyle ossification centre

B Olecranon ossification centre

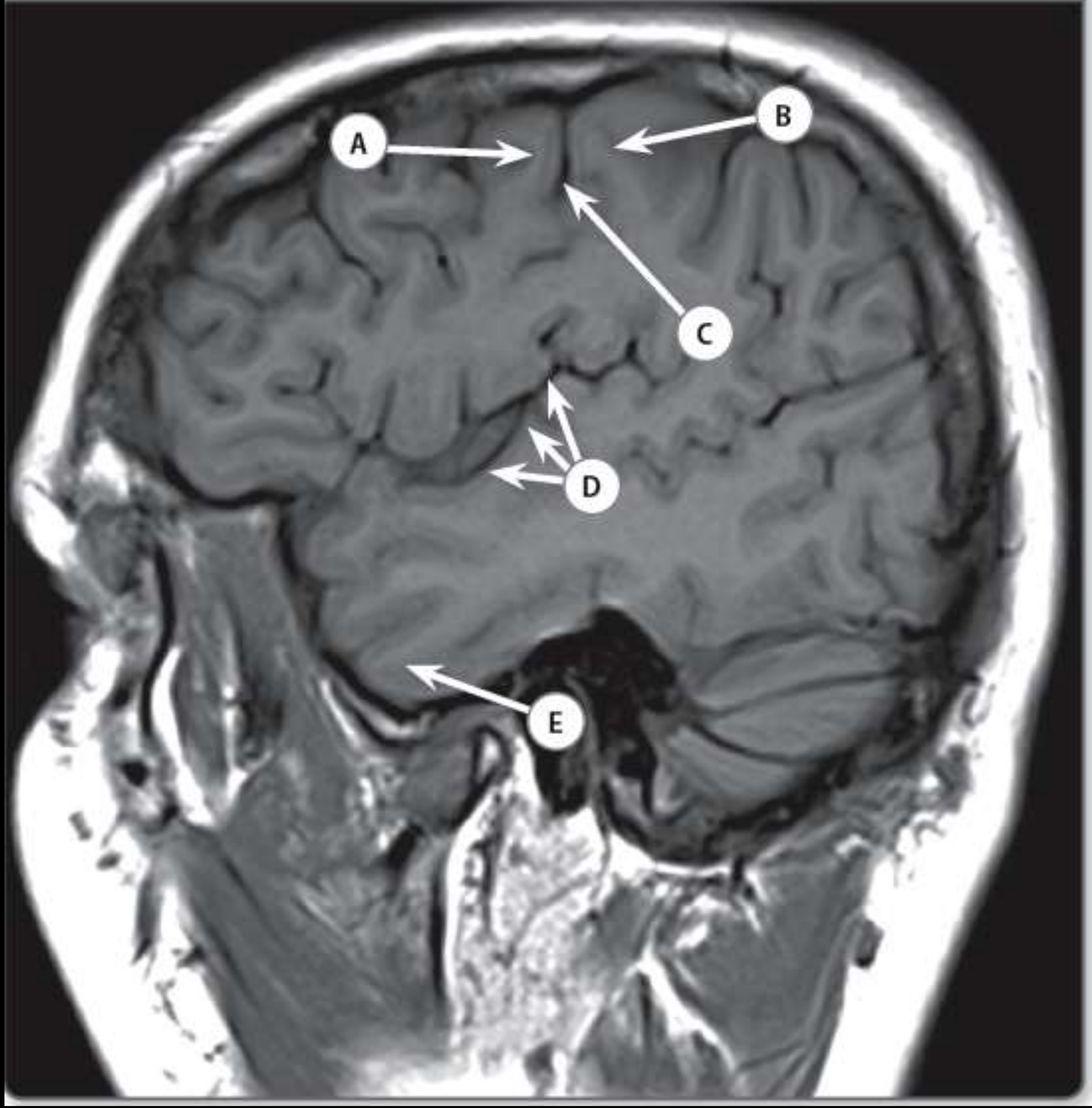
C Capitulum ossification centre

D Radial head ossification centre

E Anterior fat pad

The anterior fat pad corresponds to the intracapsular layer of fat located between the synovial membrane and the capsular ligament in the coronoid fossa – this is a normal finding. However, in the context of trauma, elevation of this fat pad, or visualisation of a posterior fat pad (i.e. intracapsular fat between the synovial membrane and capsular ligament in the olecranon fossa) is strongly suggestive of an elbow joint effusion and implies the presence of a fracture. The olecranon ossification centre (usually the penultimate ossification centre to be visualised, with the lateral epicondyle representing the last ossification centre to develop) is best appreciated on the lateral view. The medial epicondyle ossification centre should normally overlap the posterior aspect of the humerus on the lateral view; if not, avulsion should be suspected.

Case 12.7



Case 12.7

A Precentral gyrus

B Postcentral gyrus

C Central sulcus (Rolandic fissure)

D Lateral sulcus (Sylvian fissure)

E Inferior temporal gyrus

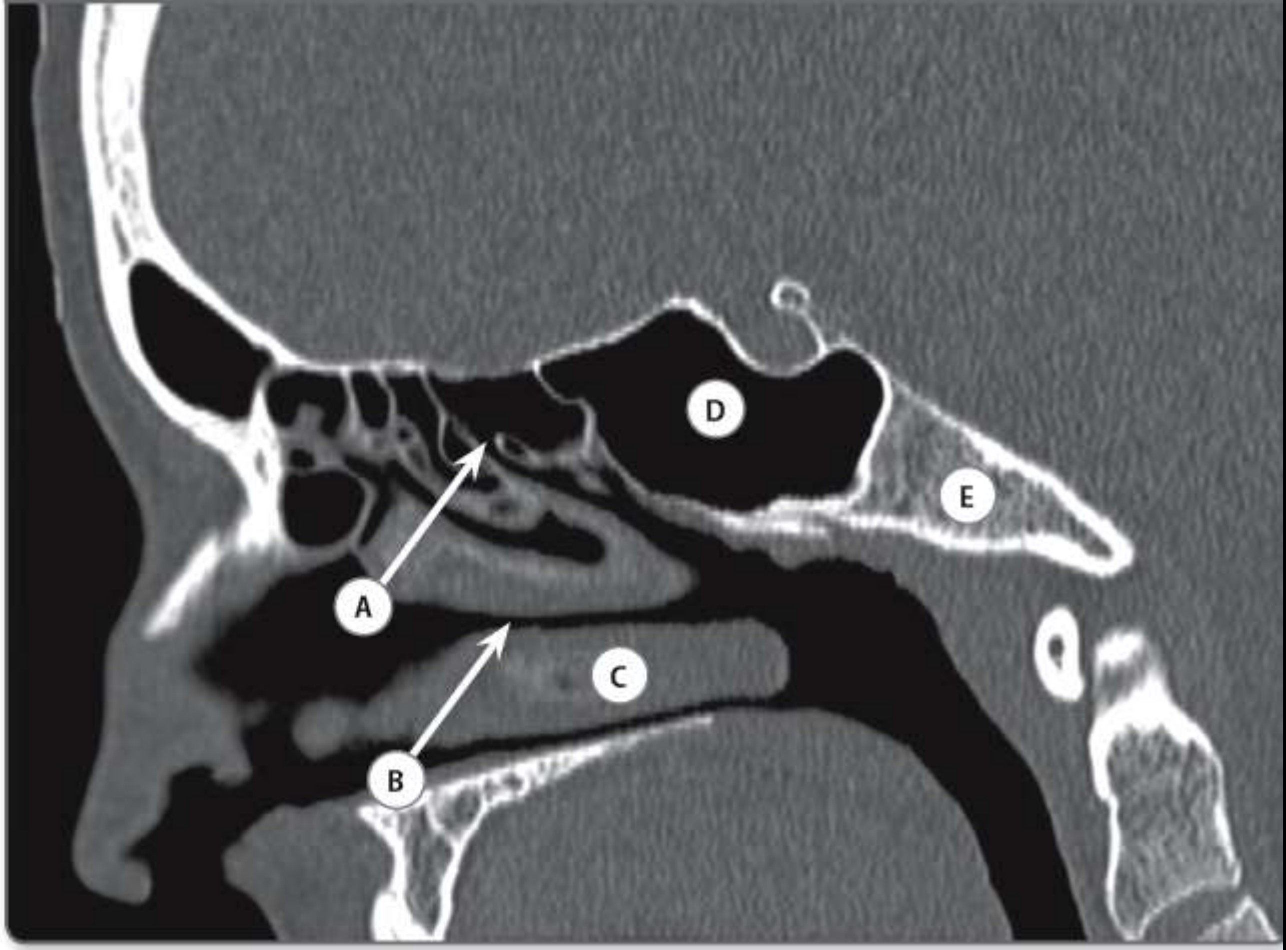
Cerebral hemispheres are divided into lobes by fissures. Each lobe is further subdivided into gyri by sulci. The most constant cortical sulci are as follows:

- **Central sulcus** (**Rolandic fissure**) – runs coronally and separates the frontal and parietal lobes
- **Parieto-occipital fissure** – divides parietal and occipital lobes
- **Temporo-occipital incisure** – marks the division between temporal and occipital lobes
- **Lateral sulcus** (**Sylvian fissure**) – separates temporal and parietal lobes

It is also useful to be able to recognise the most constant cortical gyri:

- Pre- and post-central gyri – lie on each side of the central sulcus
- Superior, middle and inferior temporal gyri
- Superior, middle and inferior frontal gyri

Case 14.14



Case 14.14

A Posterior ethmoid ostium

B Middle meatus

C Inferior turbinate (concha)

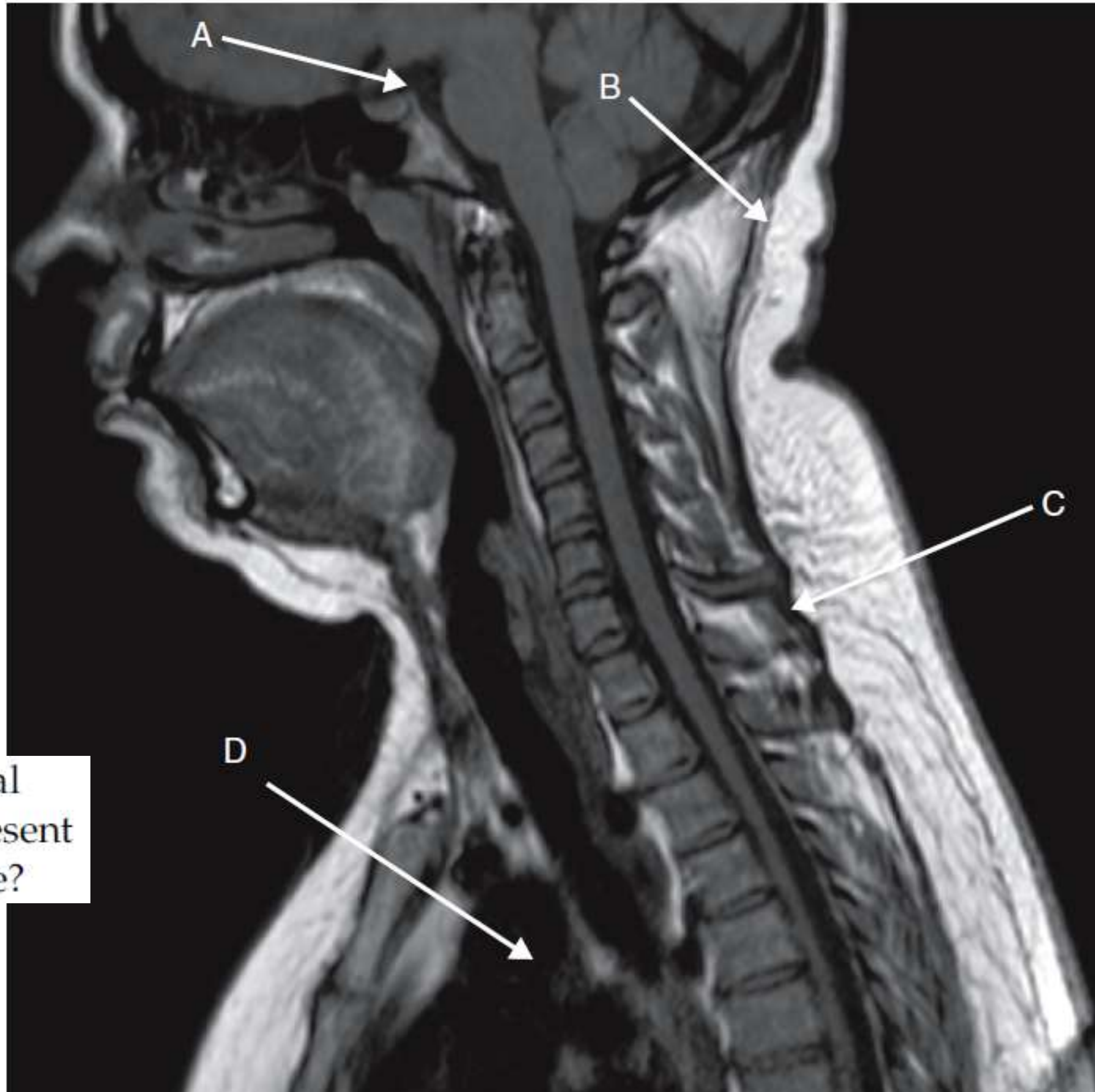
D Sphenoid sinus

E Clivus

Each lateral wall of the nasal cavity consist of three turbinates (conchae). These are osteocartilaginous projections which are covered by mucosa and separated by spaces known as meati:

- **Superior meatus** – site of drainage of the posterior ethmoidal cells
- **Middle meatus** – site of drainage of the anterior osteomeatal complex, a common route of drainage from the anterior and middle ethmoid air cells, maxillary and frontal sinuses
- **Inferior meatus** – site of drainage of the nasolacrimal duct

Case 1.16

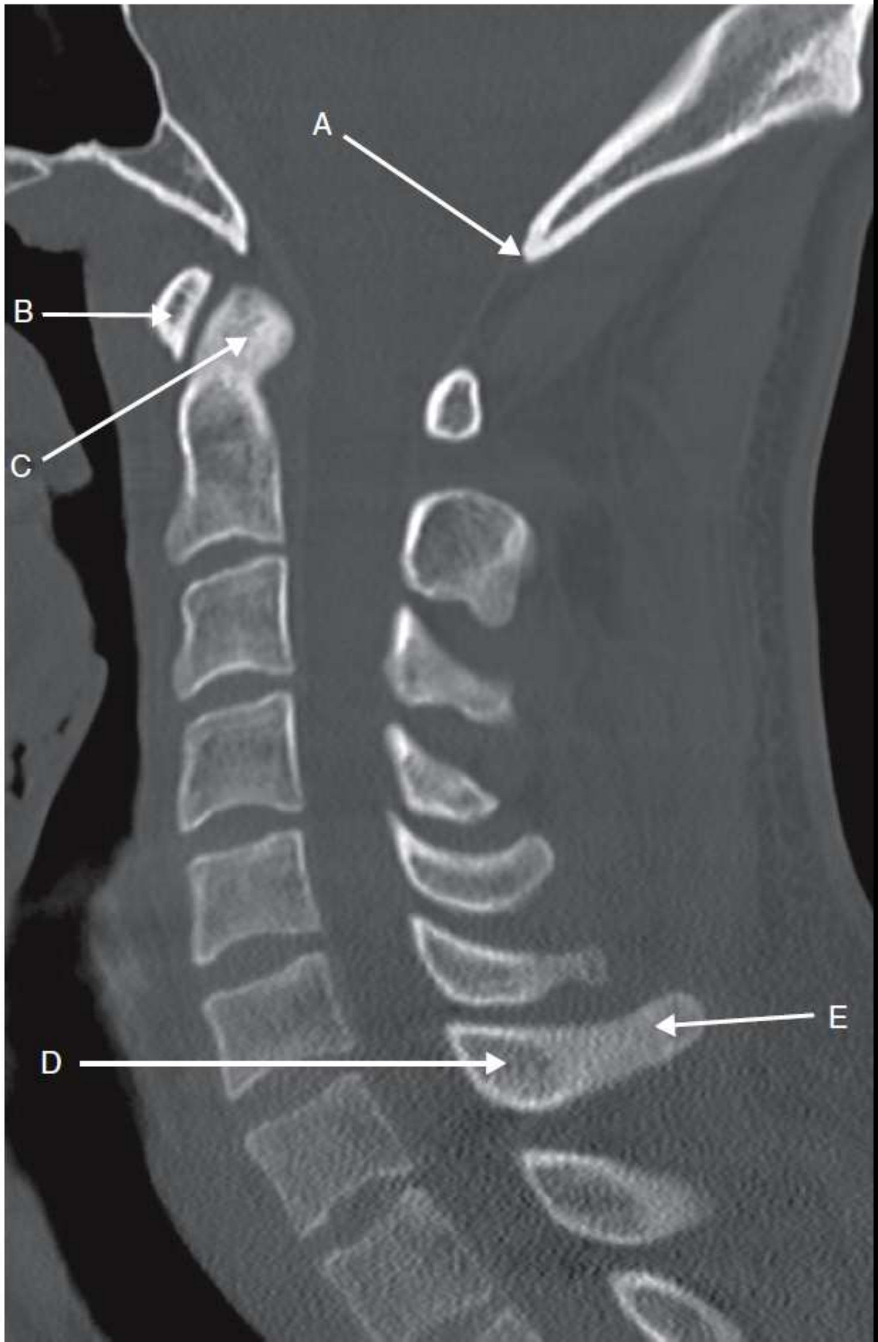


(e)	Which normal variant is present on this image?

1.16 Sagittal T1-weighted MR upper spine

(a) Optic chiasm.
(b) Nuchal ligament.
(c) Interspinous ligament.
(d) Aortic arch.
(e) Aberrant right subclavian artery. (Black spherical structure lying anterior to T2/T3.) Arterial blood flow on T1-weighted images produces a signal void. The blood vessel posterior to the oesophagus is the aberrant right subclavian artery. This is a normal variant if it is of normal calibre. When aneurysmal, this artery may cause dysphagia – the so-called *dysphagia lusoria*, which literally means 'unusual dysphagia'. An aberrant right subclavian artery causes a posterior impression on the oesophagus during a barium swallow.

Case 3.13



3.13 Sagittal CT C-spine

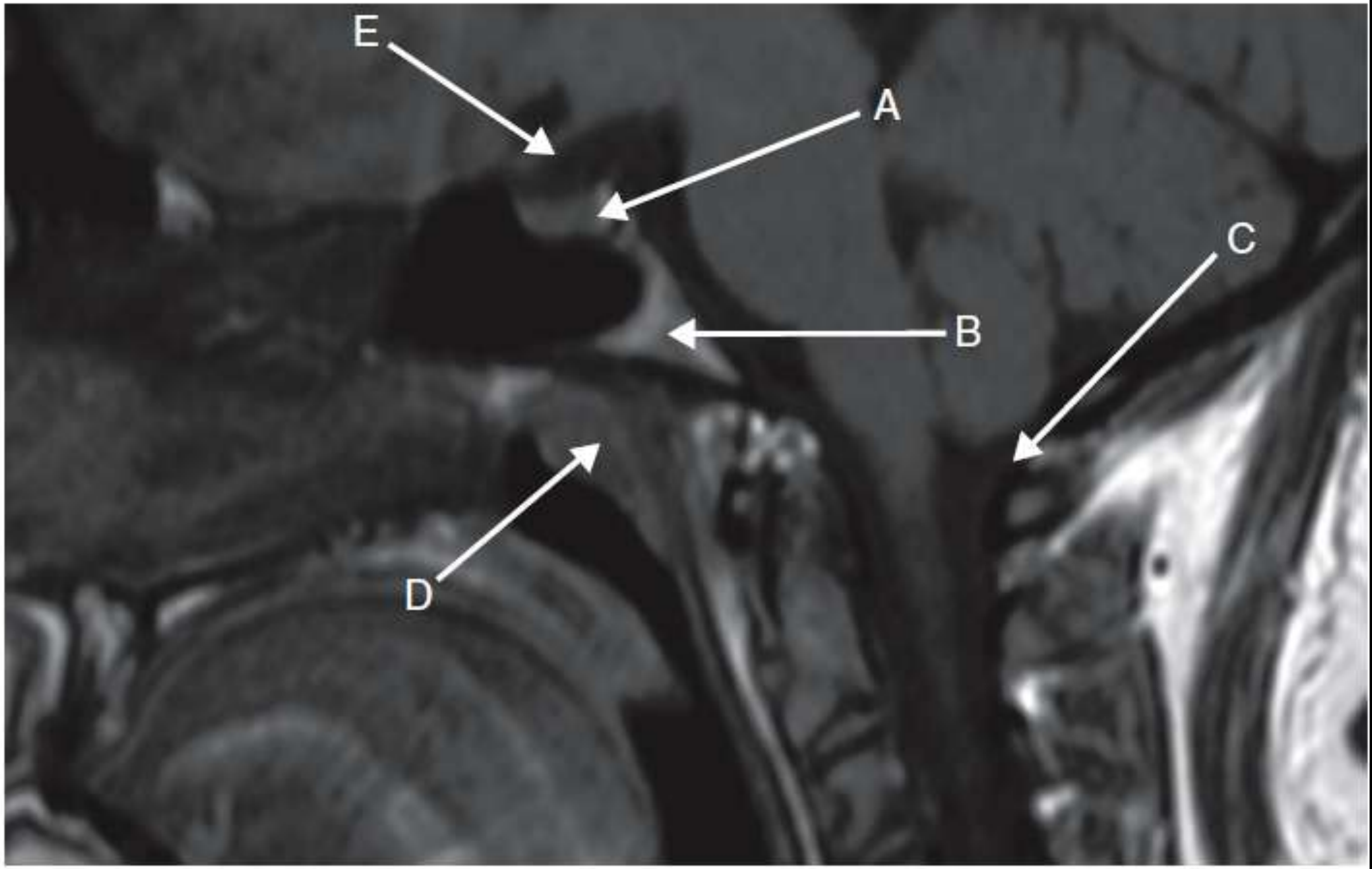
(a) Opisthion. This is the midpoint of the posterior aspect of the foramen magnum. Its anterior counterpoint is the basion.
(b) Anterior arch of C1 (or atlas). The C1 (atlas), C2 (axis) and C7 vertebrae are atypical.

C1 is a ring of bone with no body; the odontoid peg of C2 (dens) represents the body of C1. The articulation between C1 and C2 at the dens is called the atlanto-axial joint and is where rotation of the skull occurs. The articulation between the lateral masses of C1 and occipital condyles of the skull base is where nodding and lateral flexion occur.

(c) Odontoid peg (or dens).
(d) Posterior arch of C7.
(e) Spinous process of C7.

The C8 is a nerve root with no vertebral body. It exits the spinal canal between C7 and T1 vertebrae. Therefore, cervical roots exit above pedicles of the same numbered body. In the thoracic and lumbar spine, nerve roots exit below the pedicles of the same numbered body.

Case 3.16

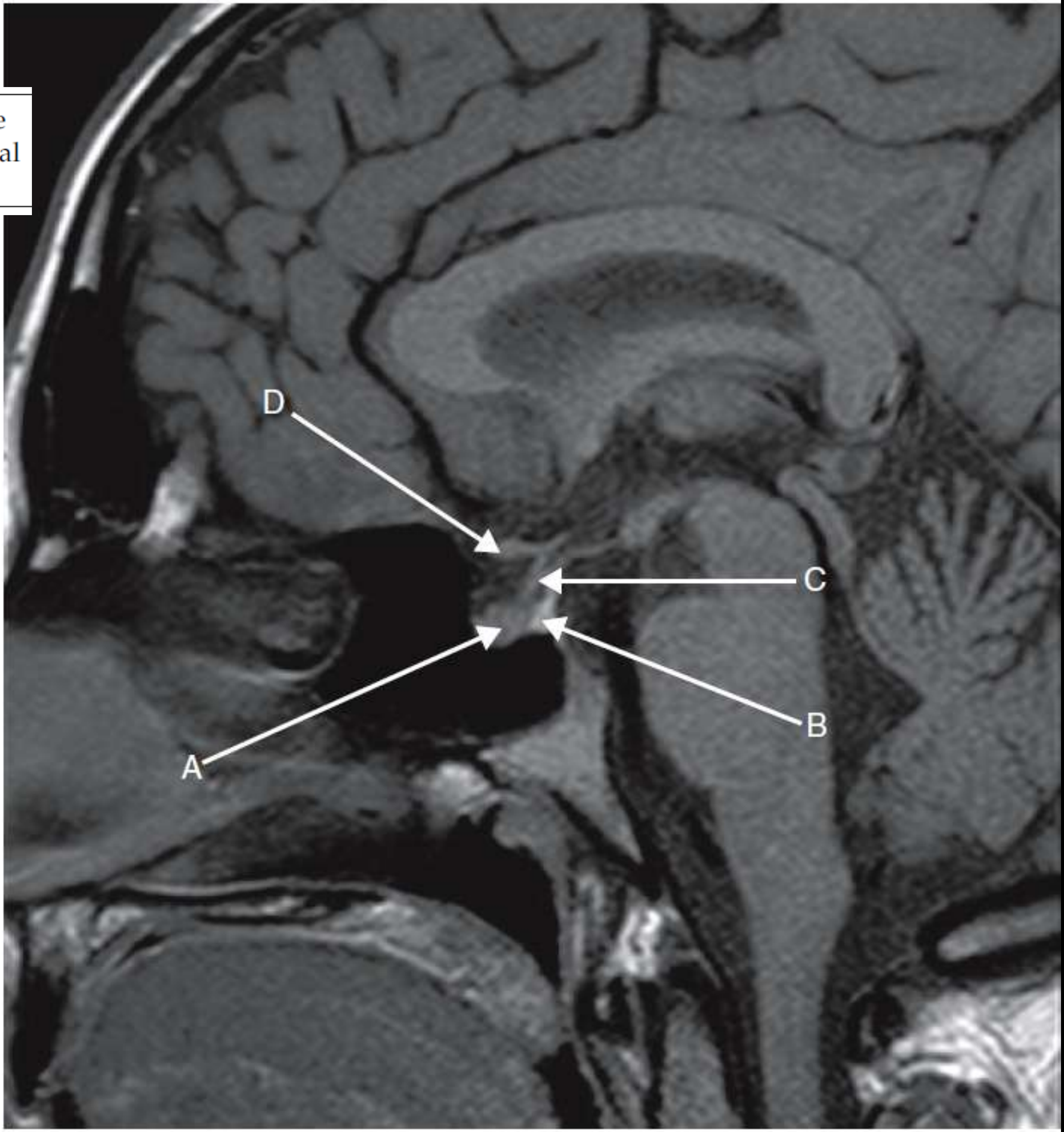


3.16 Sagittal MR pituitary

(a) Posterior pituitary. The pituitary gland has a distinct appearance on T1-weighted sagittal MRI images. The anterior gland is isointense with white matter. The posterior pituitary signal is high because of the presence of neuropeptides in this part of the gland.
(b) Clivus. The clivus has high signal on all sequences because of bone marrow.
(c) Opisthion. This is the posterior cortical margin of the foramen magnum.
(d) Adenoidal tissue.
(e) Optic chiasm.

Case 4.9

(e)	Why is the structure labelled B high signal on T1-weighted?



4.9 Sagittal T1-weighted MR pituitary

(a) Adenohypophysis or anterior pituitary gland. This is five times larger than the posterior lobe, and produces hormones in response to hypothalamic releasing factors that pass down a portal venous system into the lobe.

(b) Neurohypophysis or posterior pituitary gland. This is composed of nerve fibres, extending from the supraoptic and paraventricular nuclei of the hypothalamus. Thus hormones (vasopression, oxytocin) released by the posterior pituitary are actually manufactured in the hypothalamus.

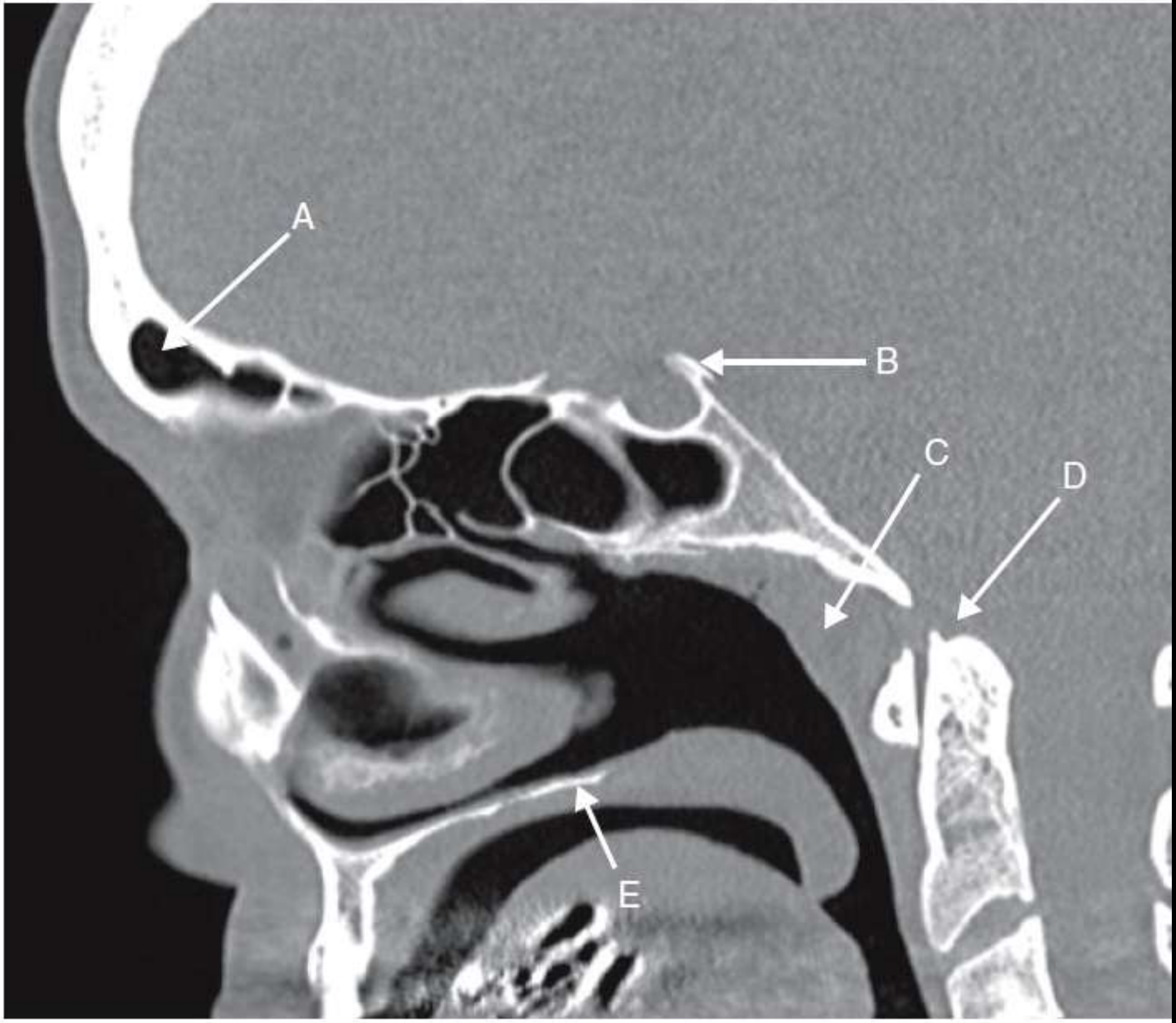
(c) Pituitary stalk. Also known as the infundibulum, this links the hypothalamus to the pituitary gland. It is composed of nerve fibres of the hypothalamohypophyseal tract and the venous portal system vessels that link the hypothalamus to the anterior pituitary.

(d) Optic chiasm. This is where the optic nerves (cranial nerve II) partially cross, and is located immediately below the hypothalamus. This is clinically important since a pituitary tumour can impinge on the chiasm leading to visual field disturbances.

(e) This is high signal because of the presence of neurosecretory granules in the neurohypophysis such as vasopressin and oxytocin. Other structures typically seen to be high signal on T1-weighted MR include:

MR contrast
melanin
fat
proteinaceous fluid
haemorrhage (due to methaemoglobin).

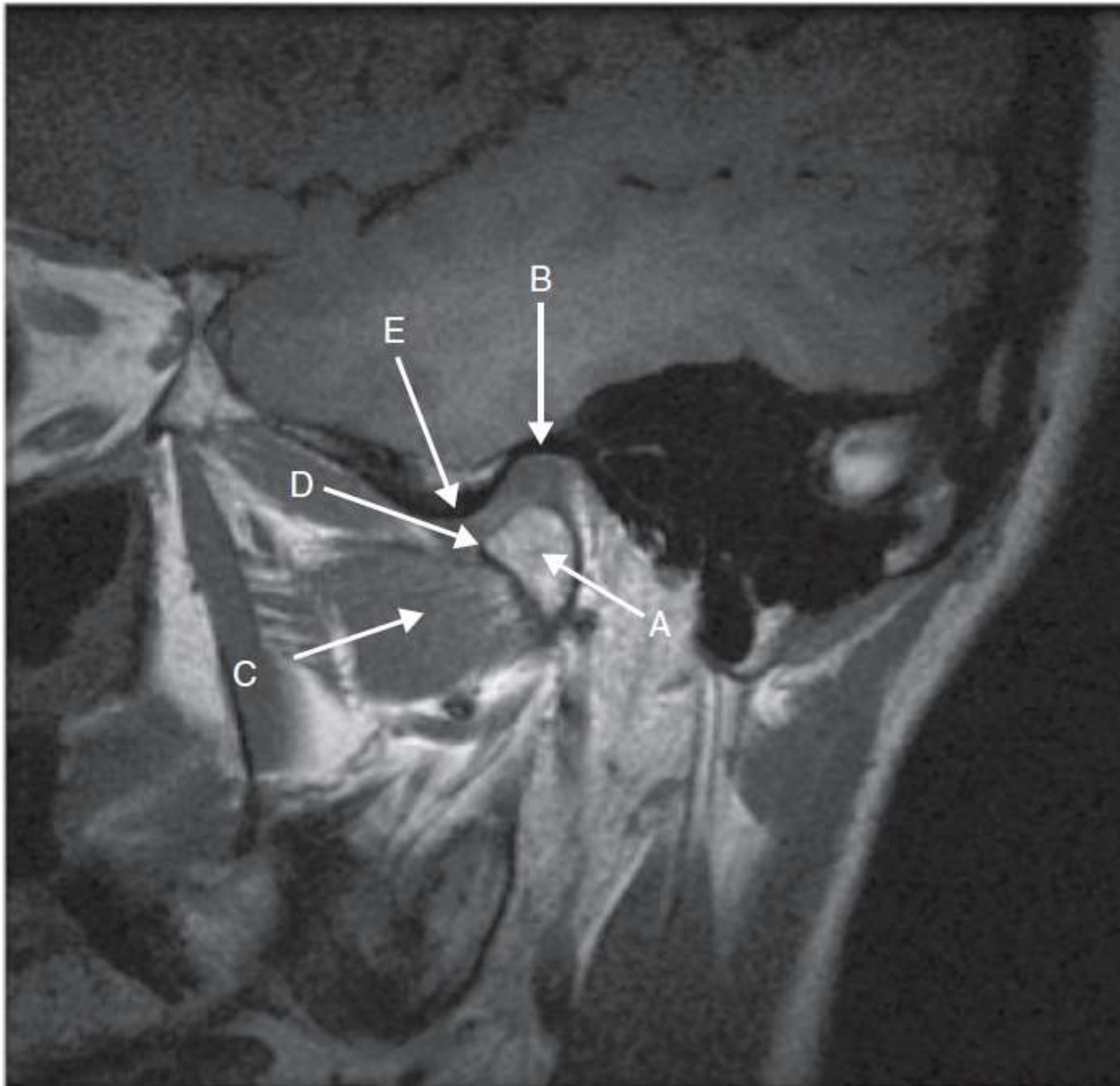
Case 4.18



4.18 Sagittal paranasal sinuses

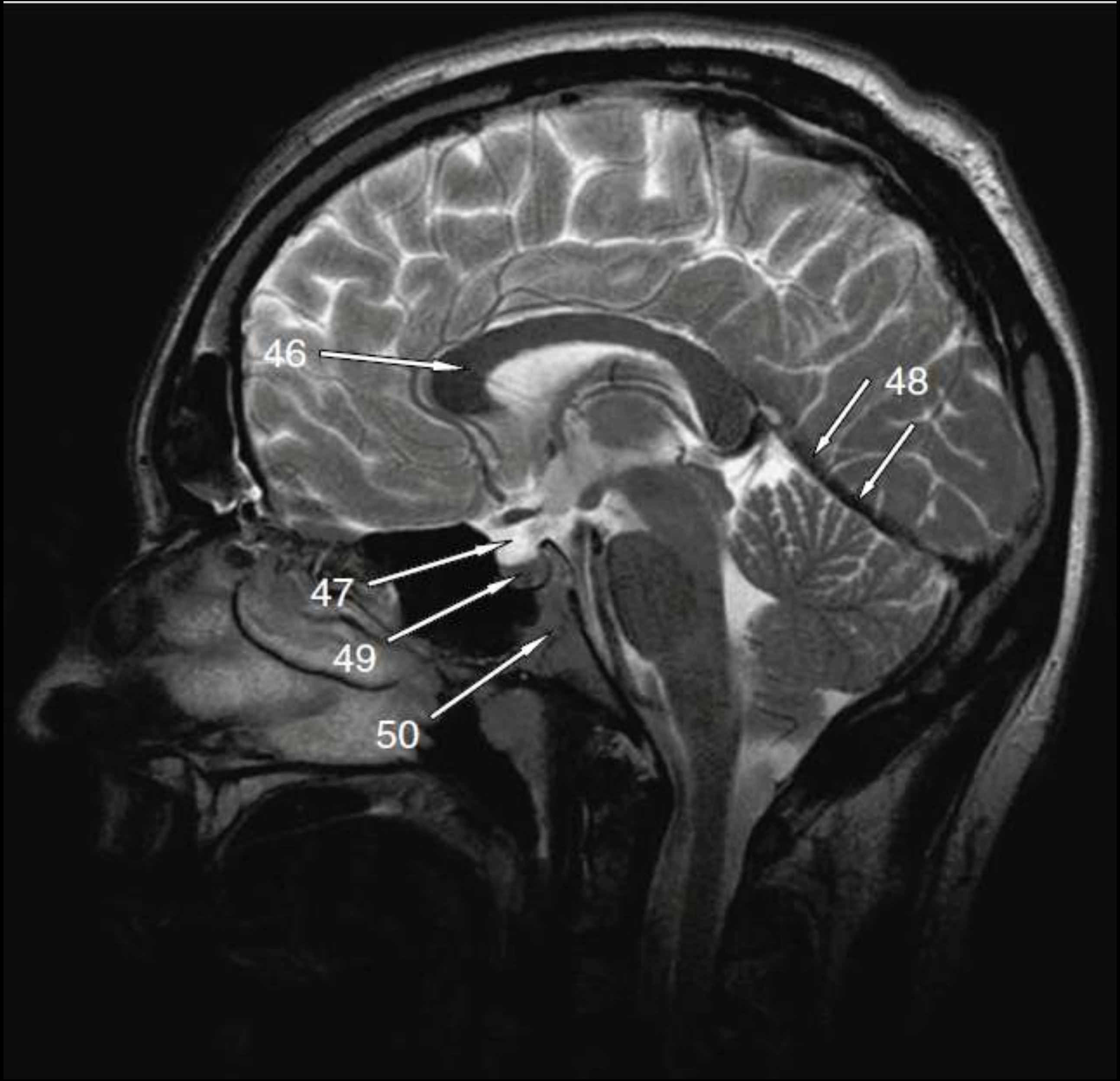
(a) Frontal sinus.
(b) Dorsum sellae.
(c) Adenoidal tissue.
(d) Cruciate ligament of atlas.
(e) Hard palate.

Case 8.17



8.17 Temporomandibular MRI

(a) Condylar head. The temporomandibular joint is a synovial joint between the condyle of the mandible and the articular fossa of the temporal bone.
(b) Articular fossa. The head of the mandible sits in the fossa at rest.
(c) Lateral pterygoid muscle. This attaches to the anterior band of the articular disc.
(d) Anterior band of the articular disc. The articular disc has an anterior and posterior band with a thin zone in the middle. The disc is attached to the joint capsule. The joint space is divided into upper and lower compartments by the disc.
(e) Articular eminence. The head of the condyle moves anteriorly against the eminence on jaw opening.



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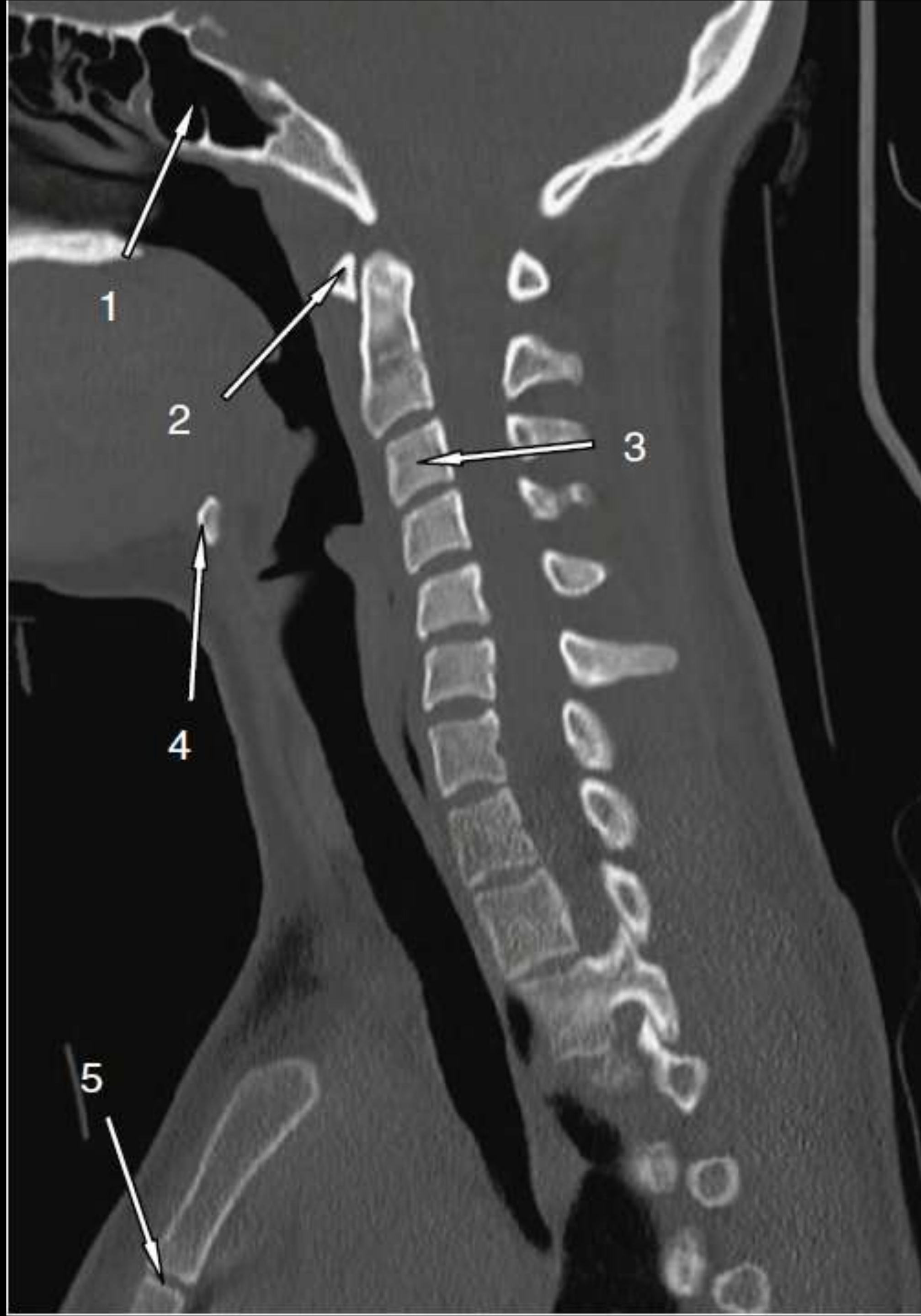
46. Genu of corpus callosum
47. Suprasellar cistern
48. Straight sinus
49. Pituitary gland
50. Clivus

The visible subarachnoid cisterns on a sagittal MRI of the brain include the suprasellar cistern, interpeduncular cistern, pontine cistern, cisterna magna and quadrigeminal cistern.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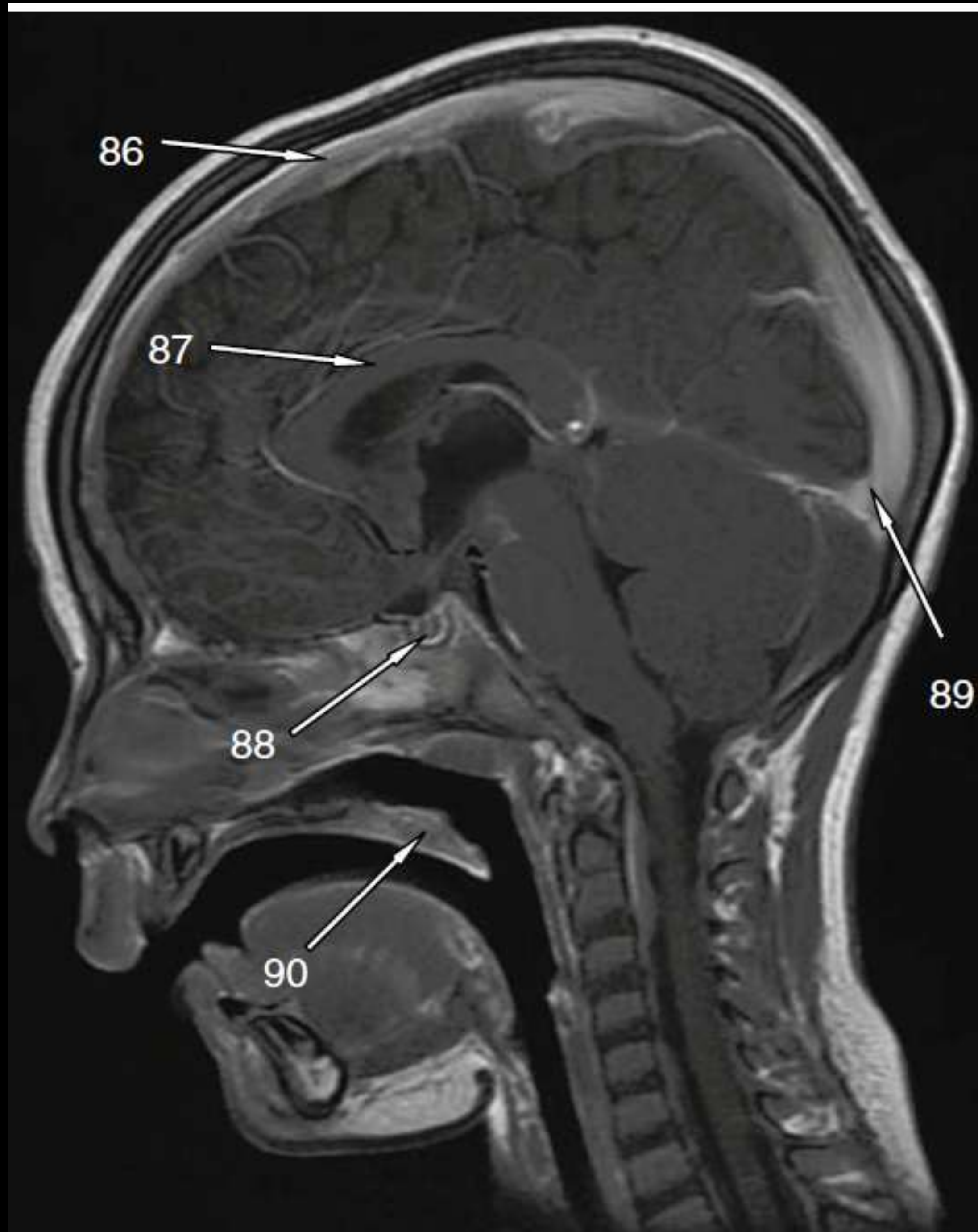
CT C-Spine

1. Sphenoid sinus
2. Anterior arch of atlas (C1 vertebra)
3. Body of C3 vertebra
4. Hyoid bone (body of)
5. Manubrio-sternal joint

When trying to identify the vertebral level on a lateral c-spine, the odontoid process (or odontoid peg or dens) of the C2 vertebra is a useful landmark.

The manubrio-sternal joint or angle of Louis is at the approximate level of the beginning and end of the aortic arch and the bifurcation of the trachea.


86
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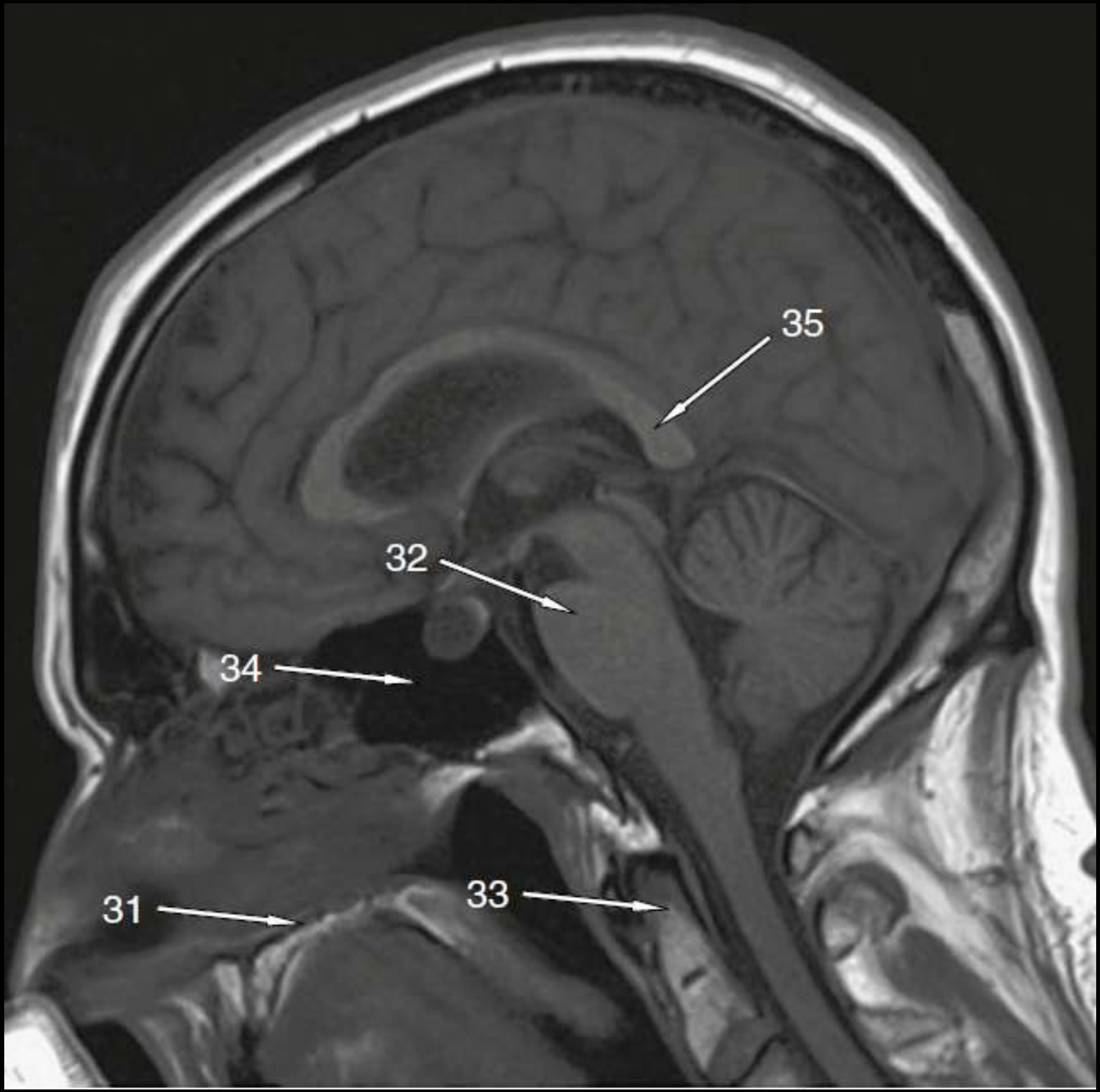
90

MRI Brain

86. Superior sagittal sinus
87. Body of corpus callosum
88. Pituitary gland
89. Torcula herophili (confluence of venous sinuses)
90. Soft palate



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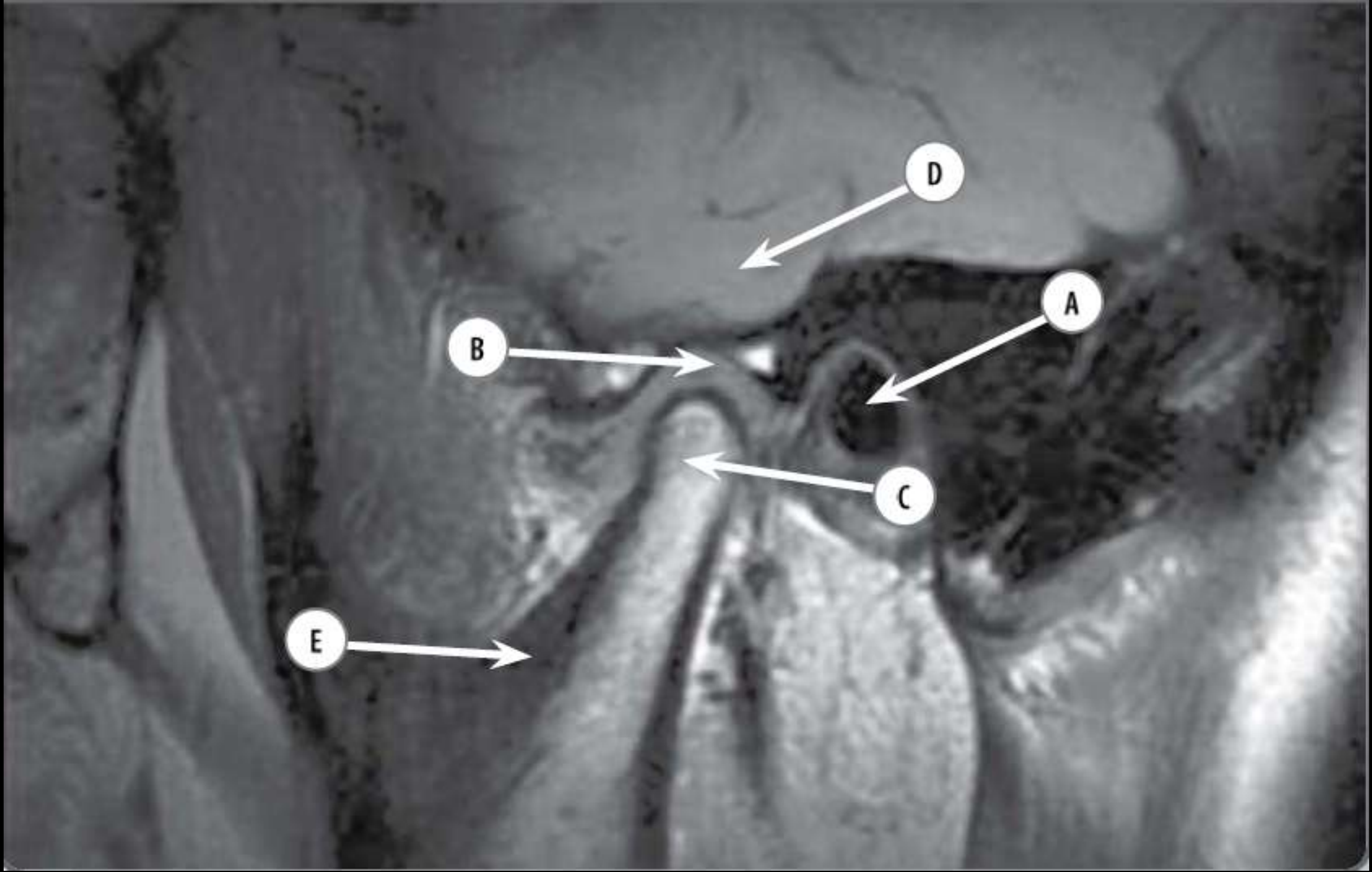
MRI Head

31. Hard palate
32. Pons
33. Odontoid process of C2 (axis) vertebrae
34. Sphenoid sinus
35. Splenium of corpus callosum

EAR/MISC

Case 1.24



Case 1.24

A External auditory meatus

B Articular disc

C Condyle of mandible

D Temporal lobe

E Lateral pterygoid muscle

MRI of the temporomandibular joint (TMJ).

The TMJ is a synovial joint, of which the articular surfaces are the articular tubercle of the temporal bone, the mandibular fossa, and the condyle of the mandible (**Figure 1.4**). These articular surfaces are covered in fibrous cartilage.

The joint is separated into superior and inferior compartments (both have a separate synovial membrane) by the fibrocartilaginous disc. Translational movements occur in the superior compartment, rotational in the inferior compartment. The condyle of the mandible sits in the fossa at rest, and slides anteriorly on to the articular tubercle when open.

Muscles producing mandibular movements at the temporomandibular joints are given in **Table 1.1**.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 916.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 7.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 17–18.

The joint is separated into superior and inferior compartments (both have a separate synovial membrane) by the fibrocartilaginous disc. Translational movements occur in the superior compartment, rotational in the inferior compartment. The condyle of the mandible sits in the fossa at rest, and slides anteriorly on to the articular tubercle when open.

Muscles producing mandibular movements at the temporomandibular joints are given in **Table 1.1**.

Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy, 6th edn. Philadelphia: Lippincott Williams & Wilkins, 2009: 916.
Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 7.
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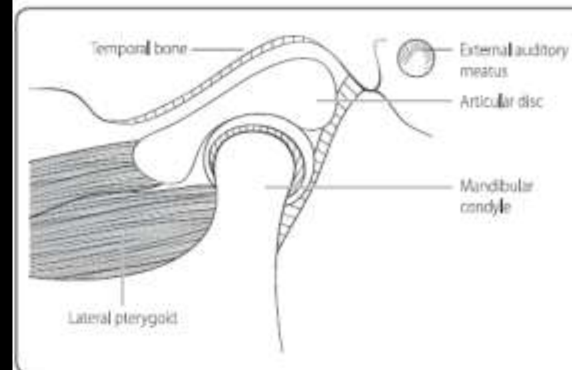
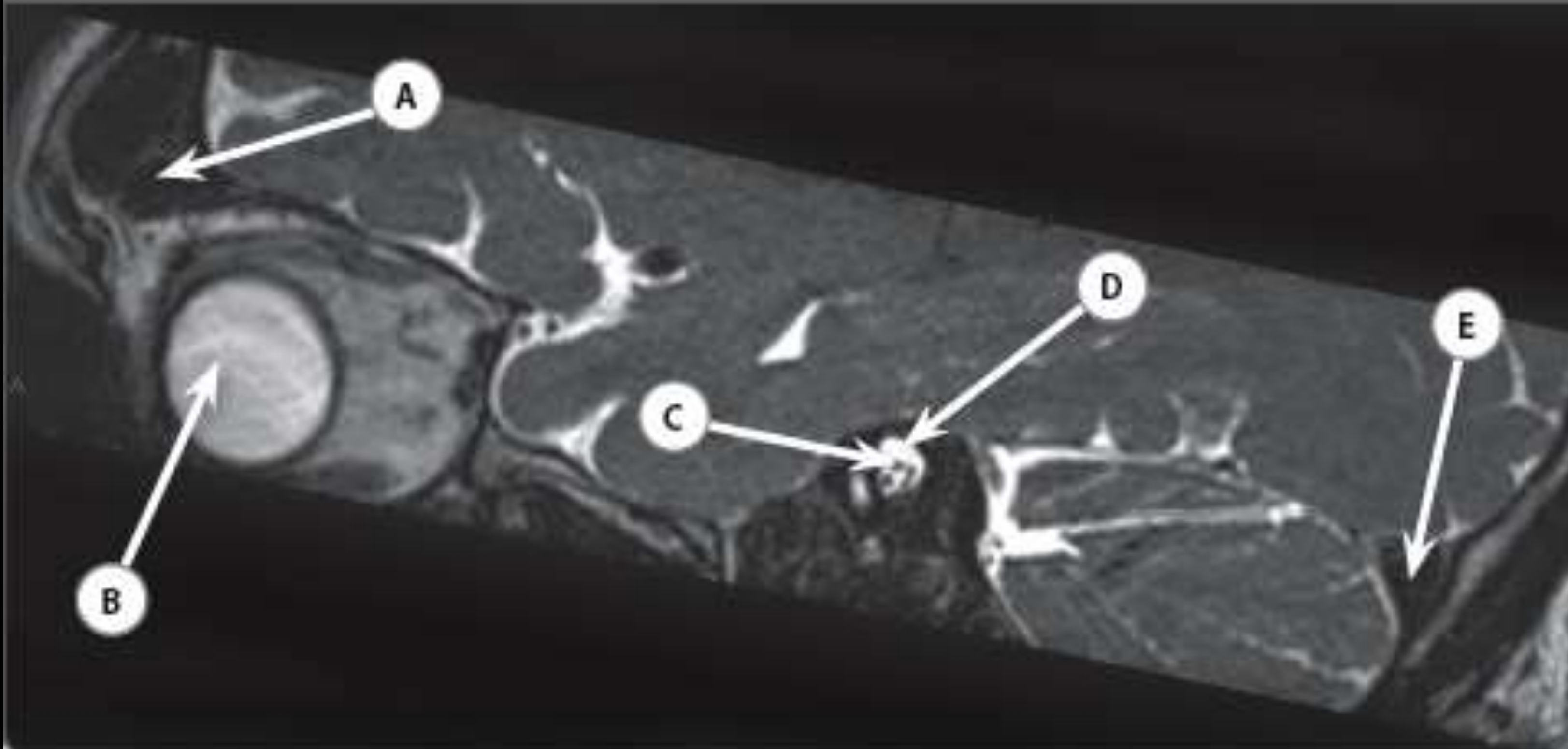


Figure 1.4 The temporomandibular joint.

Table 1.1 The types of mandibular movement at the temporomandibular joint and the muscles that control each one.

Mandibular movement	Muscles involved
Depression (open mouth)	• Suprahyoid • Infrahyoid • Lateral pterygoid
Protrusion	• Lateral pterygoid • Masseter • Medial pterygoid
Elevation (close mouth)	• Temporalis • Masseter • Medial pterygoid
Retrusion	• Temporalis • Masseter
Lateral movement	• Retractors of same • Protruders of opposite

Case 7.12



Case 7.12

A Frontal sinus

B Globe

C Facial nerve (VII)

D Internal acoustic meatus

E Transverse venous sinus

The facial nerve (VII) and three divisions of the vestibulocochlear nerve (VII) – cochlear nerve, superior vestibular branch and inferior vestibular branch – pass through the internal acoustic meatus (IAM). **Figure 7.2** depicts their relative positions in the IAM.

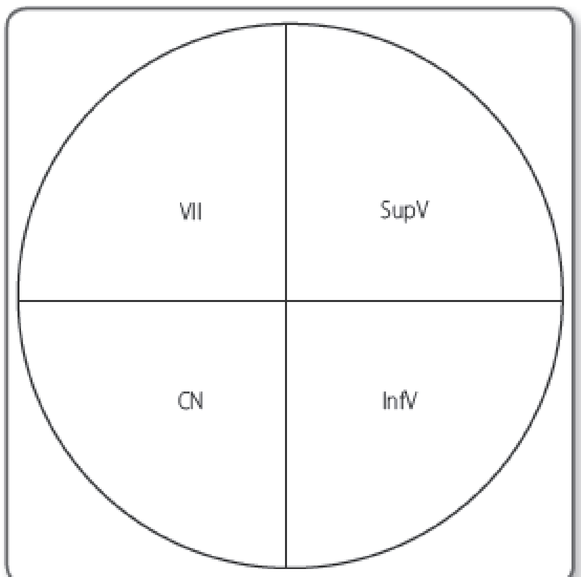


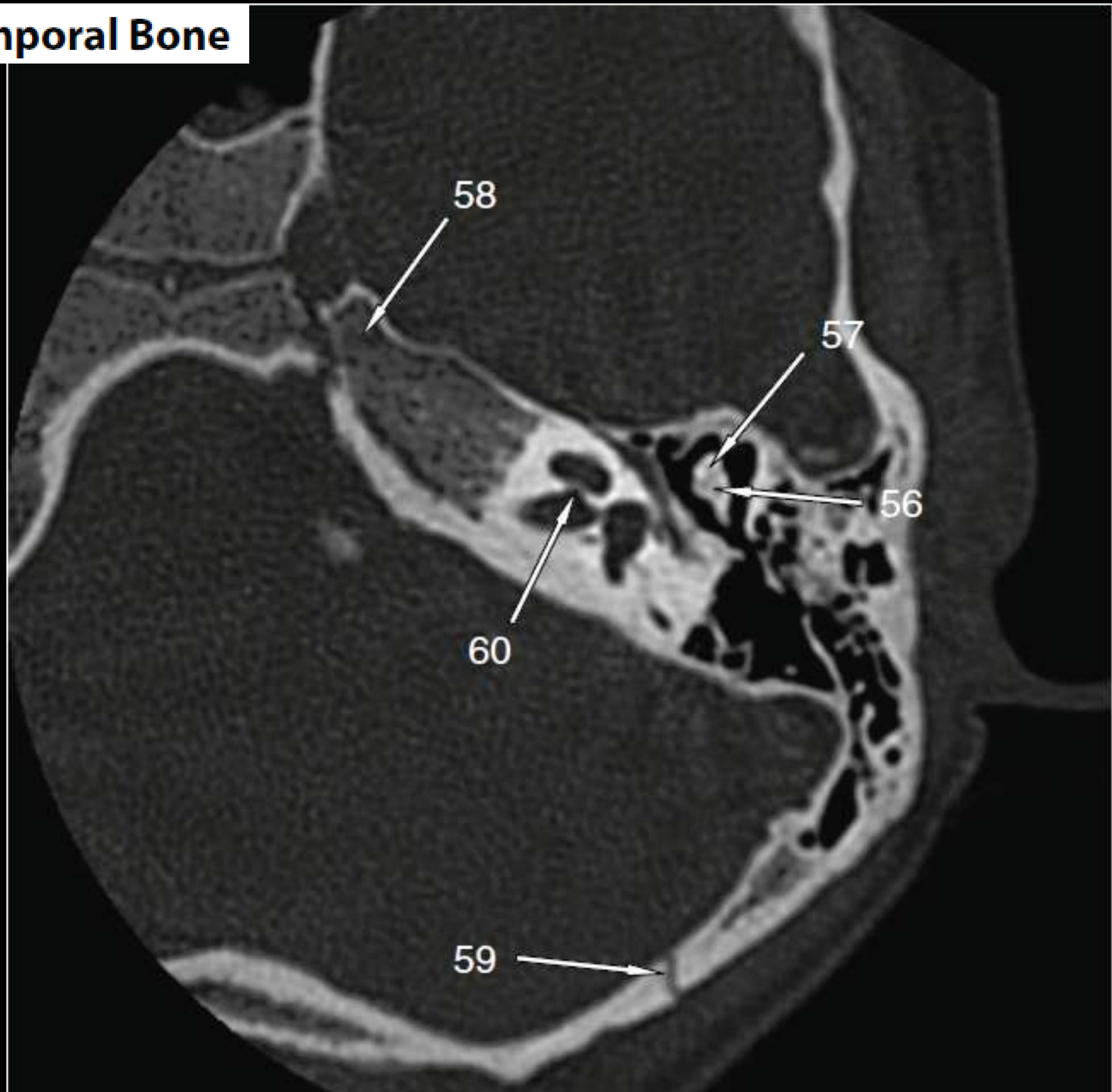
Figure 7.2 Relative positions of VII and VIII branches in the internal acoustic meatus. SupV, superior vestibular branch of vestibulocochlear nerve (VIII); CN, cochlear nerve; InfV, inferior vestibular branch VIII; VII, facial nerve.

Here, the mnemonic comes useful to remember their relative position: 'Seven up, Coke down'

Seven **up** – Seventh (VII) nerve is located **superiorly** and **anteriorly**

Coke **down** – The Cochlear nerve is located **inferiorly** and **anteriorly.**

CT Temporal Bone



CT Temporal Bone

56. Left incus
57. Left malleus
58. Apex of left petrous temporal bone
59. Left lambdoid suture
60. Left cochlear aperture

The incus is the cone and the malleus the ice cream. The cochlear aperture is the point of entry of the cochlear branch of the eighth cranial nerve into the cochlea. It may be small in congenital causes of sensorineural hearing loss.

Case 4.5

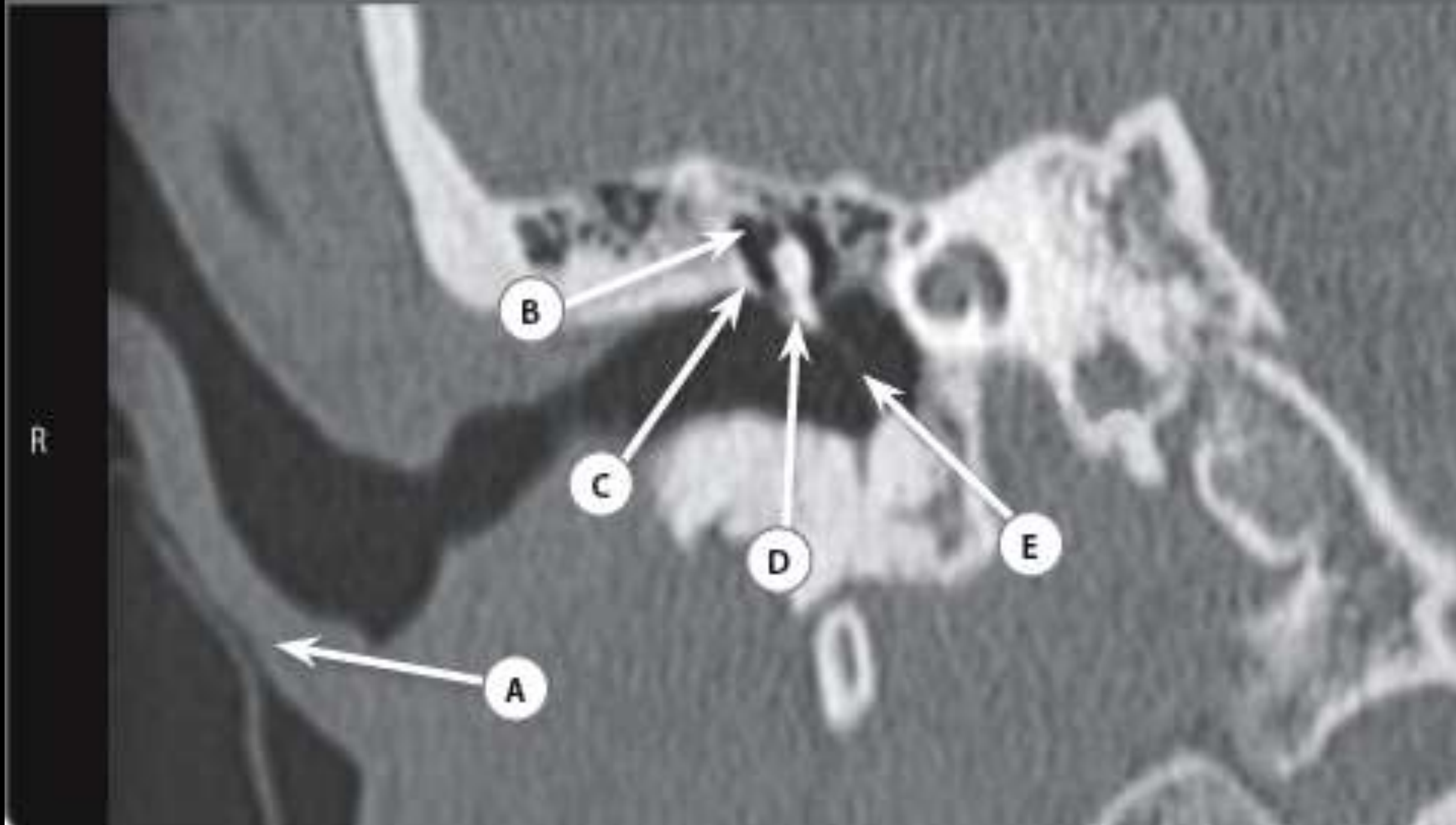
4.5 High resolution MR through the left IAM (internal auditory meatus)

(a) Left cochlea. This is situated anteriorly within the inner ear, and consists of a spiral canal and a cone-shaped modiolus.
(b) Left vestibule. This oval chamber is approximately 5 mm in length, and contains the utricle and saccule, which form the vestibular organ responsible for maintaining balance.
(c) Left lateral semicircular canal. The semicircular canals consist of lateral, anterior and posterior divisions, which communicate with the vestibule of the bony labyrinth.
(d) Left vestibulo-cochlear nerve (VIII cranial nerve). The cochlear branch of this is involved with hearing. The vestibular branch is involved with balance and is divided into superior and inferior vestibular nerves.

The nerve lying anterior to the vestibulo-cochlear nerve is the facial nerve.

(e) Left cerebellar peduncle. The dorsal and ventral cochlear nuclei are found on the lateral surface of the inferior cerebellar peduncle.

Case 8.18



Case 8.18 Axial CT at the level of C5

Case 8.18

- **A** Pinna of the right ear
- **B** Epitympanum
- **C** Scutum
- **D** Manubrium of the malleus
- **E** Tympanic membrane

The middle ear (tympanic) cavity is divided into three compartments (epitympanum, mesotympanum and hypotympanum) by lines drawn along the superior and inferior margins of the external auditory meatus.

The roof (tegmen tympani) separates the tympanic cavity and the middle cranial fossa. The scutum is a prominence at the lateral wall of the epitympanum to which the tympanic membrane attaches.

The auditory ossicles: malleus, incus and stapes articulate with each other in that order (from lateral to medial).

5.4 Sagittal MR brain (FLAIR sequence)

(a) Rostrum of the corpus callosum. This is the first part of the corpus callosum which extends from the anterior commissure.

(b) Genu of the corpus callosum. This is the most anterior part of the corpus callosum where it bends sharply backwards. Fibres extending from the genu into the frontal cortex are called forceps minor.

(c) Splenium of the corpus callosum. This is the thickened posterior end of the corpus callosum. Fibres extending posteriorly from the splenium into the occipital lobes are called forceps major.

(d) Quadrigeminal plate. This is also known as the tectum, and forms part of the midbrain lying posterior to the cerebral aqueduct (of Sylvius).

(e) Tentorium cerebelli. This is an extension of dura mater, separating the cerebellum from the inferior portion of the occipital lobes. The upper surface, in the midline, attaches to the posterior surface of the falx cerebri and the straight sinus runs in this location.

MRI Head

61. Third ventricle
62. Right Sylvian fissure
63. Basilar artery
64. Right lateral ventricle (body of)
65. Body of corpus callosum

The Sylvian fissure divides the frontal and parietal lobe above from the temporal lobe below. It appears around the 14th week of gestation and is one the most prominent fissures of the brain. The M1 segment of the middle cerebral artery lies within this fissure.