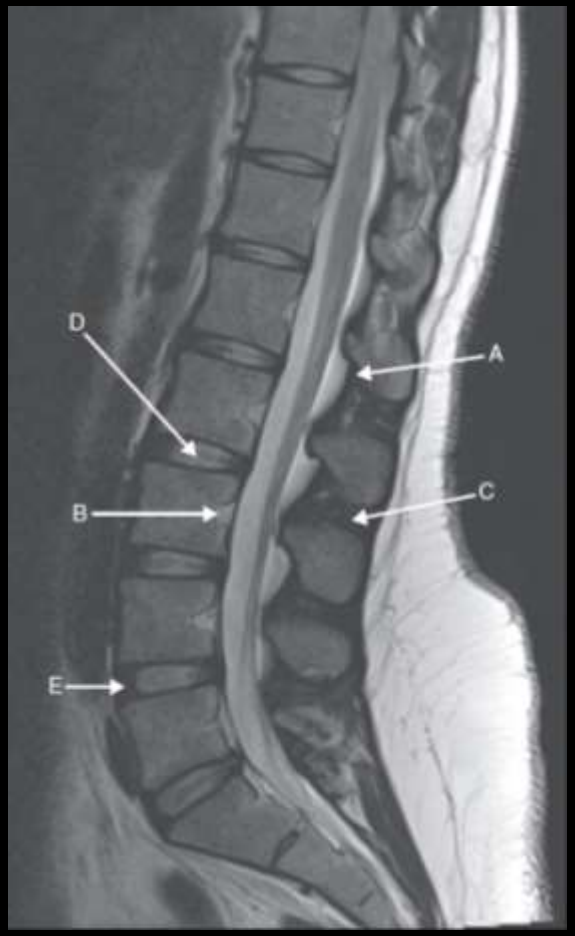
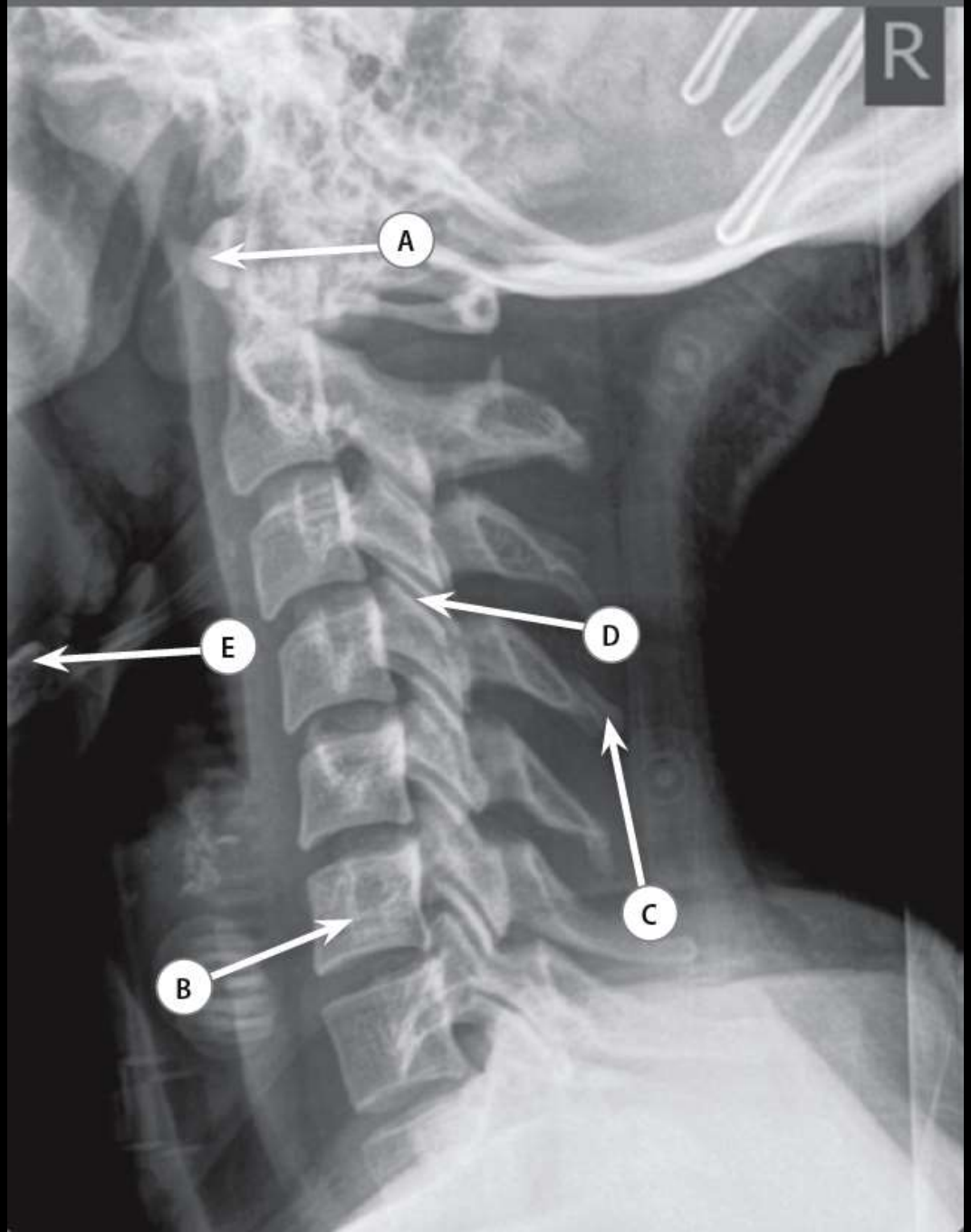
SPINE



CONTENTS

PLAIN FILM

Case 4.19



Case 4.19

A Anterior arch of the atlas

B Vertebral body of C6

C Spinous process of C4

D C3–C4 facet joint

E Hyoid bone

Lateral C-spine radiograph.

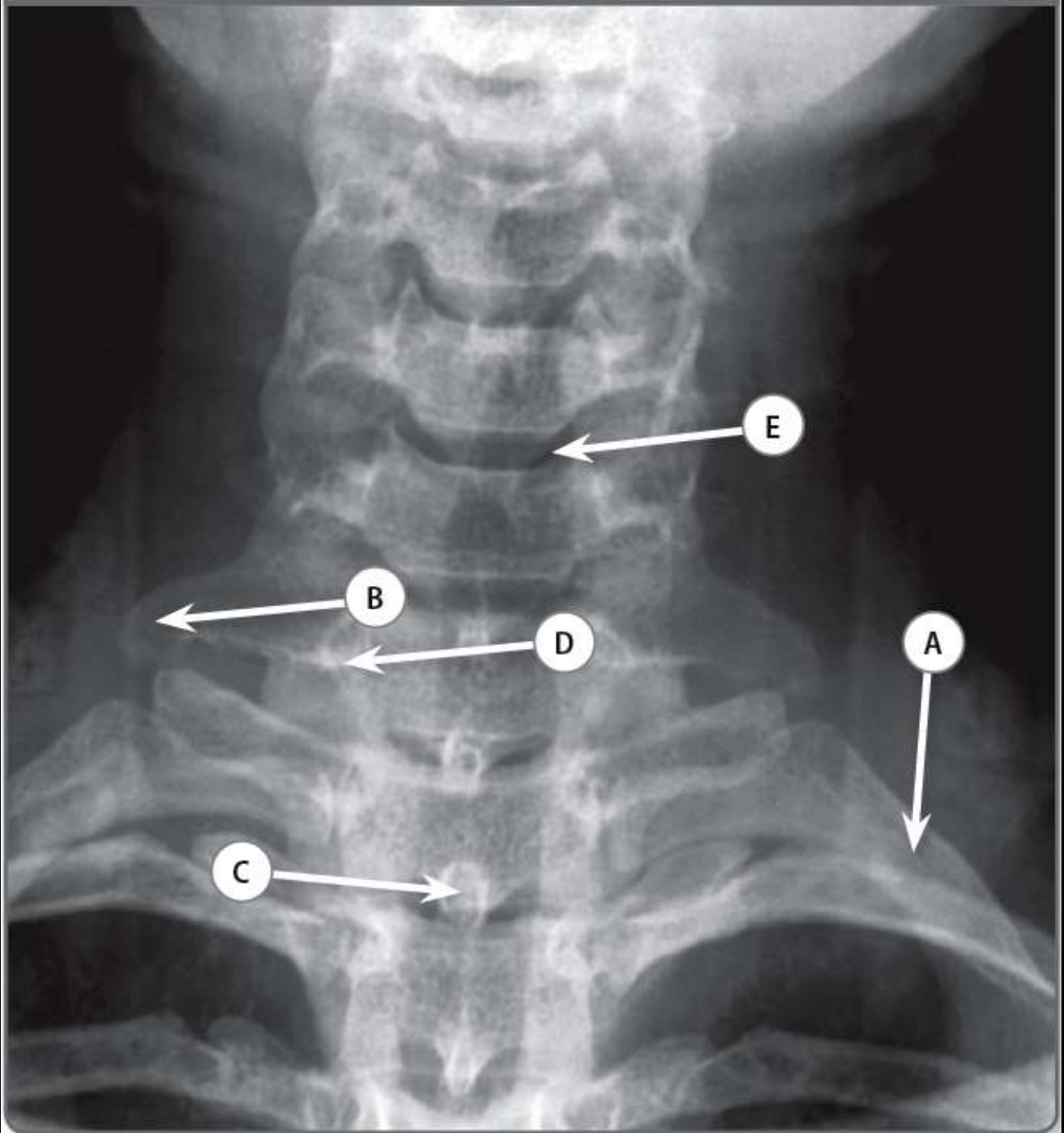
There are seven cervical vertebrae. The atlas (C1) does not have a body. It has a lateral mass on each side, an anterior and a posterior arch. The anterior arch of the atlas has a tubercle on its anterior surface and a facet posteriorly for articulation with the odontoid process.

Identifying a vertebral body and spinous process may appear straightforward but it is easy to lose marks by forgetting to number them. Numbering can be done by identifying the axis (C2) and counting from there. The axis has the odontoid process projecting upwards from its body.

The hyoid is a U shaped bone which lies below the floor of the mouth anterior to the C3 vertebral body. It consists of a body and four processes: two great cornua (singular cornu) and two lesser cornua. The great cornua project backwards from the lateral limits of the body and have a tubercle at the posterior end. The lesser cornua project upwards and backwards at the junction of the body of the hyoid with the great cornua.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 57.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 315–316.

Case 4.20



Case 4.20

A Left first rib

B Right transverse process of C 7

C Spinous process of T1

D Right pedicle of C7

E Left uncovertebral joint C5–C6

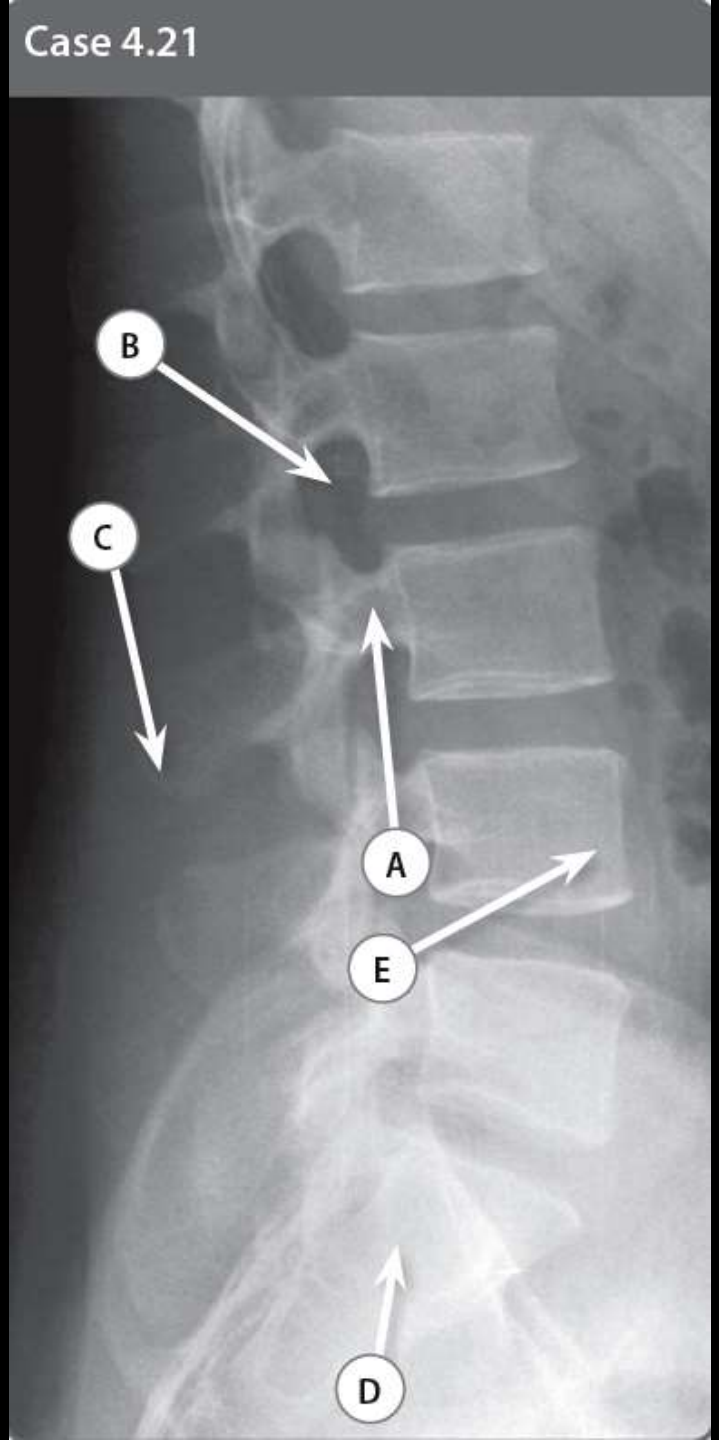
Anteroposterior C-spine radiograph.

From C3 to C7 the vertebral bodies progressively increase in size from superior to inferior. On each side of the superior aspect of the vertebral body is the uncinate process: a bony ridge projecting superiorly from the lateral margin. The uncinate process articulates with a bevelled notch on the posterolateral surface of the vertebra above. This is called the uncovertebral joint.

The transverse processes of a cervical vertebra are short and end laterally with an anterior and a posterior tubercle. The transverse processes enclose the foramen transversarium with transmits the vertebral artery, accompanying veins and sympathetic nerves. The foramen transversarium of C7 may be absent. If present it is small and usually only transmits vertebral veins (not the vertebral artery).

Weir J, Abrahams P. Imaging Atlas of Human Anatomy. Edinburgh: Mosby, 2003: 56.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 315–316.

Case 4.21



Case 4.21

A Pedicle of L3

B Inferior vertebral notch of L2 (exit foramen of the L2 nerve root)

C Spinous process of L3

D Sacrum

E Vertebral body of L4

Lateral lumbar spine radiograph.

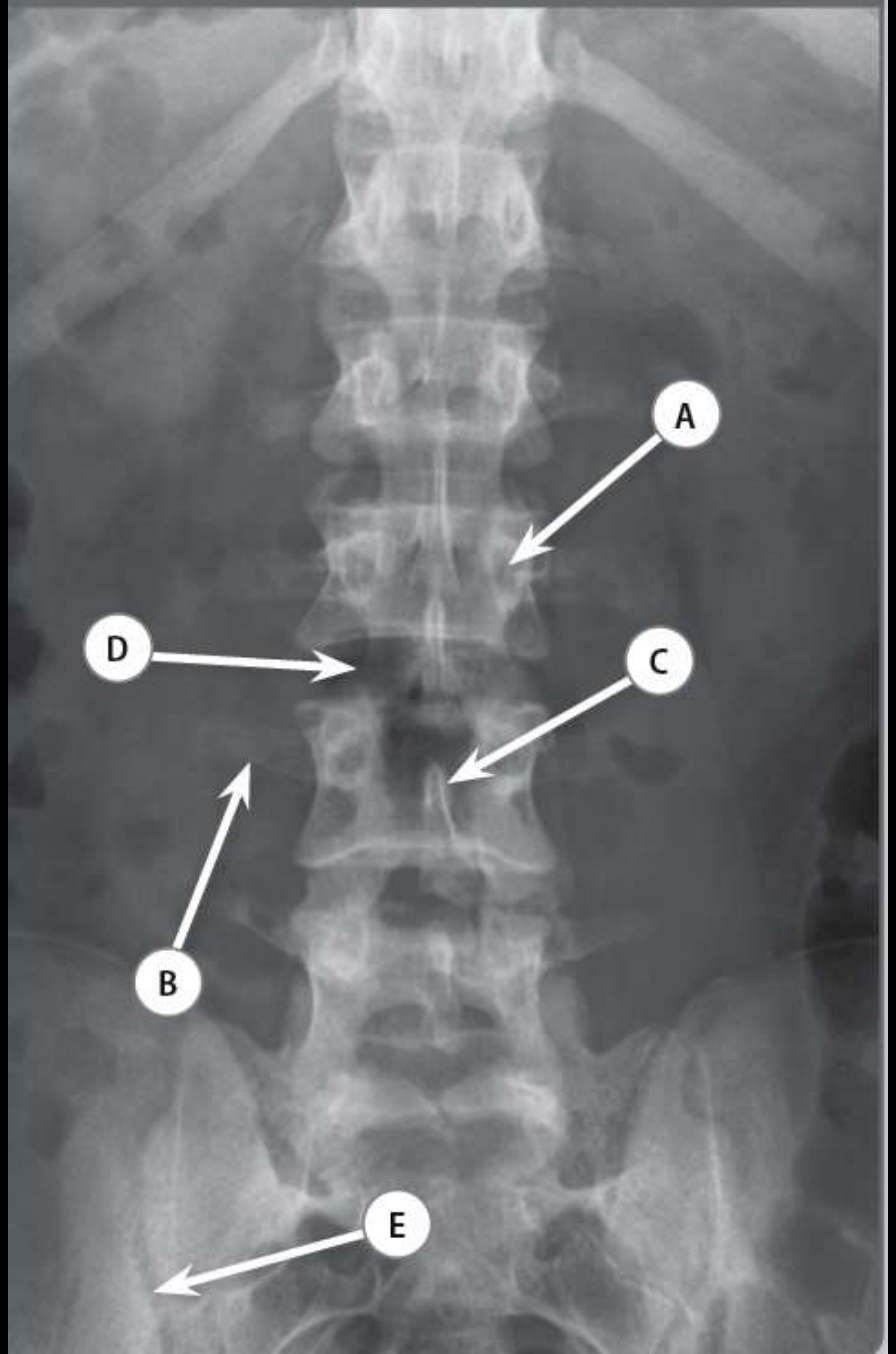
The fifth lumbar vertebra is atypical. It has a wedge-shaped body which is taller anteriorly. The junction between L5 and S1 is inclined to the horizon at an angle between 25° and 55° in the supine position and between 8° and 12° in the erect position.

Identification of the labelled lumbar vertebral body is done on the assumption that segmentation is normal with five free lumbar vertebrae. Another assumption would be that the first vertebral body that does not articulate with a rib is L1. An image of a spine which has abnormal segmentation is unlikely to feature in an exam so it would be safe to number the vertebrae based on these assumptions. In fact the only way to be certain which vertebra is labelled is to count from the top when imaging of the whole spine is available.

Note how the height of the intervertebral discs increases progressively from superior to inferior. The lumbosacral disc however is smaller than the other lumbar discs (usually less than 10 mm in height).

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 59.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 318–320.

Case 4.22



Case 4.22

A Left pedicle of L3

B Right transverse process of L4

C Spinous process of L4

D L3–L4 intervertebral disc space

E Right sacroiliac joint

Anteroposterior lumbar radiograph.

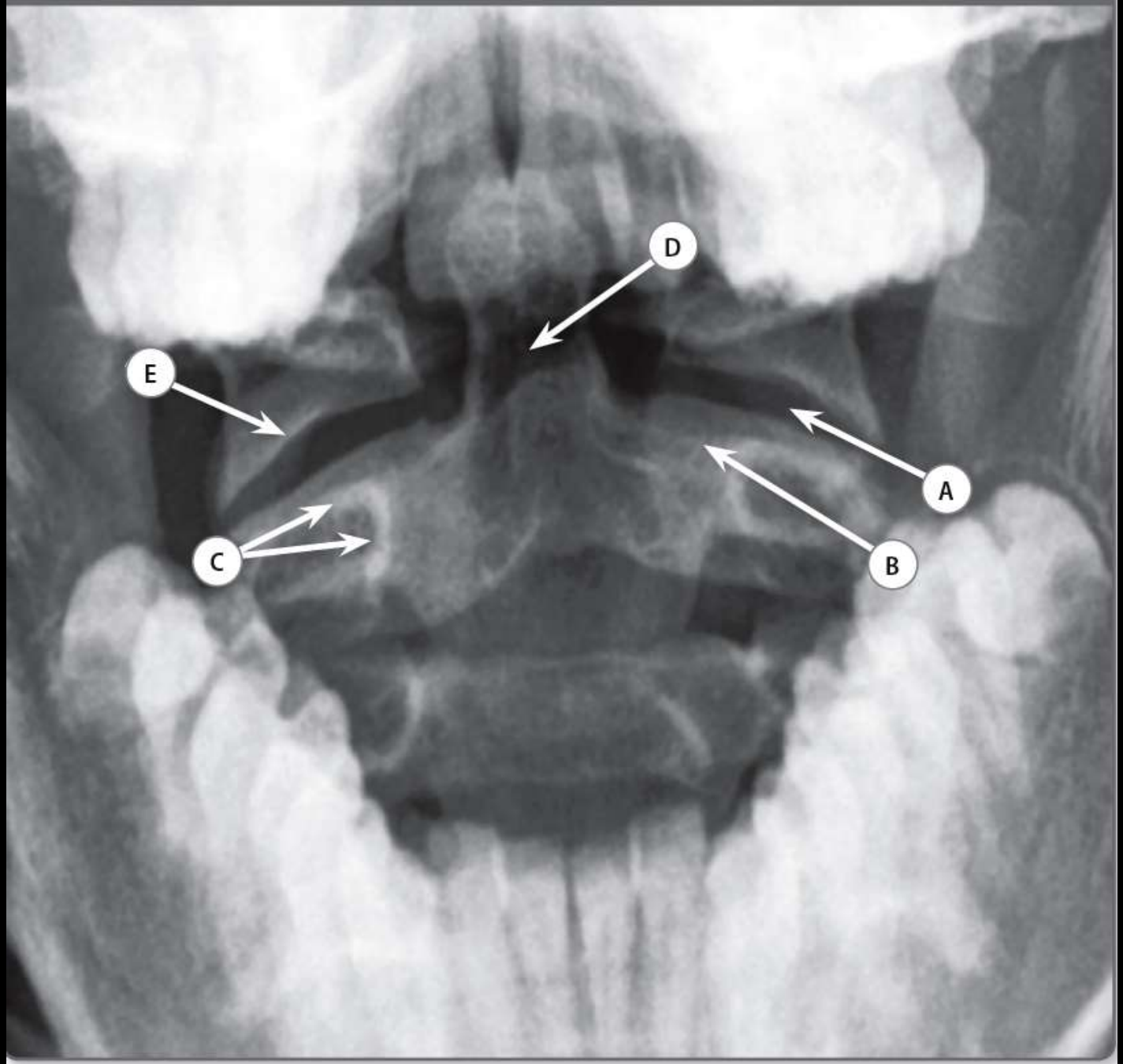
There are normally five free lumbar vertebrae. The L3 is the largest.

Projecting posteriorly are the pedicles which connect to the laminae to form the spinal canal.

The articular processes arise from the junction of the pedicles and the laminae. The superior facets are concave. They face backwards and medially. They articulate with the inferior process of the vertebra above. The inferior articular facets are convex and face forwards and laterally.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 59.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 318–320.

Case 4.23



Case 4.23

A Left atlantoaxial joint

B Left lateral mass of the axis (C2)

C Right pedicle of the axis (C2)

D Odontoid peg

E Right lateral mass of the atlas (C1)

Dens views (open mouth).

This radiograph is performed through an open mouth. It shows an anteroposterior projection of the atlantoaxial joint. The lateral masses of the atlas have a superior and inferior articular facet each. The superior articular facets articulate with the occipital condyles to form the atlanto-occipital joints. The inferior articular facets articulate with the axis in the atlantoaxial joint.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 57.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 312.

Question 4.10

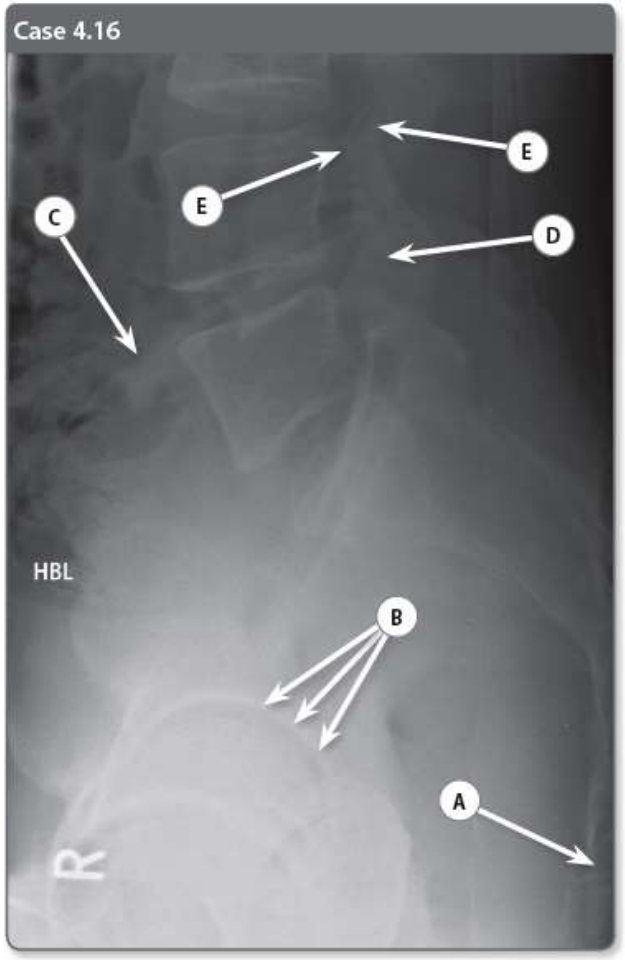
Name the structures labelled **A** to **E**.

4.10 Lateral X-ray of the lumbar spine

A Spinous process of L3.
B Inferior articular facet of L2.
C Pedicle of L2.
D Superior endplate of L2.
E Rectum.

There are five lumbar vertebrae. The superior and inferior margins of the vertebral bodies are termed the superior and inferior endplates. The intervertebral discs lie between the endplates of adjacent vertebrae and are not usually seen on X-rays. The lumbar spine (as demonstrated in this image) and cervical spine have a natural lordosis (or anterior curvature). The thoracic spine has a natural kyphosis (or posterior curvature).

Each thoracic vertebra has paired pedicles that arise from the lateral surface of the vertebral body. These are difficult to separate on the lateral X-ray as the structures overlap. There are paired superior and inferior facets that allow articulation with the adjacent vertebra and are best visualized on the lateral projection. The spinous processes of the lumbar vertebrae are bigger, thicker and broader than their cervical and thoracic counterparts. They are also more square-shaped and angled horizontally, rather than the caudal angulation of the thoracic spinous processes. The transverse processes are not visualized owing to their horizontal orientation.



Case 4.16

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 articulation labelled E.	

Case 4.16

A Coccyx

B Acetabulum

C Iliac crest

D Superior articular process of L5

E Facet joint between L3 and L4

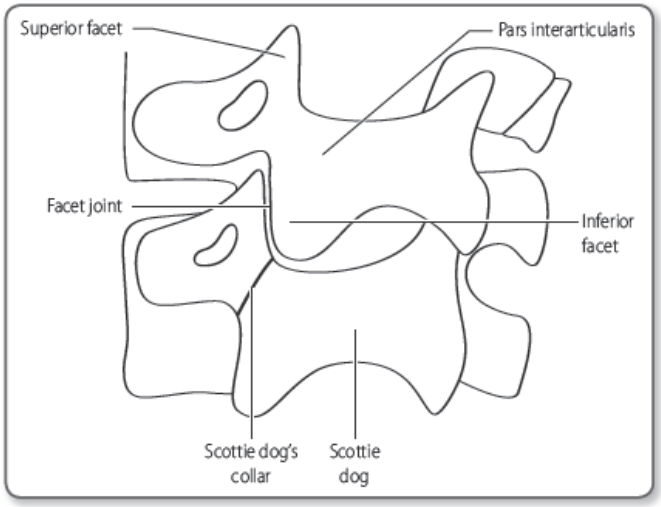
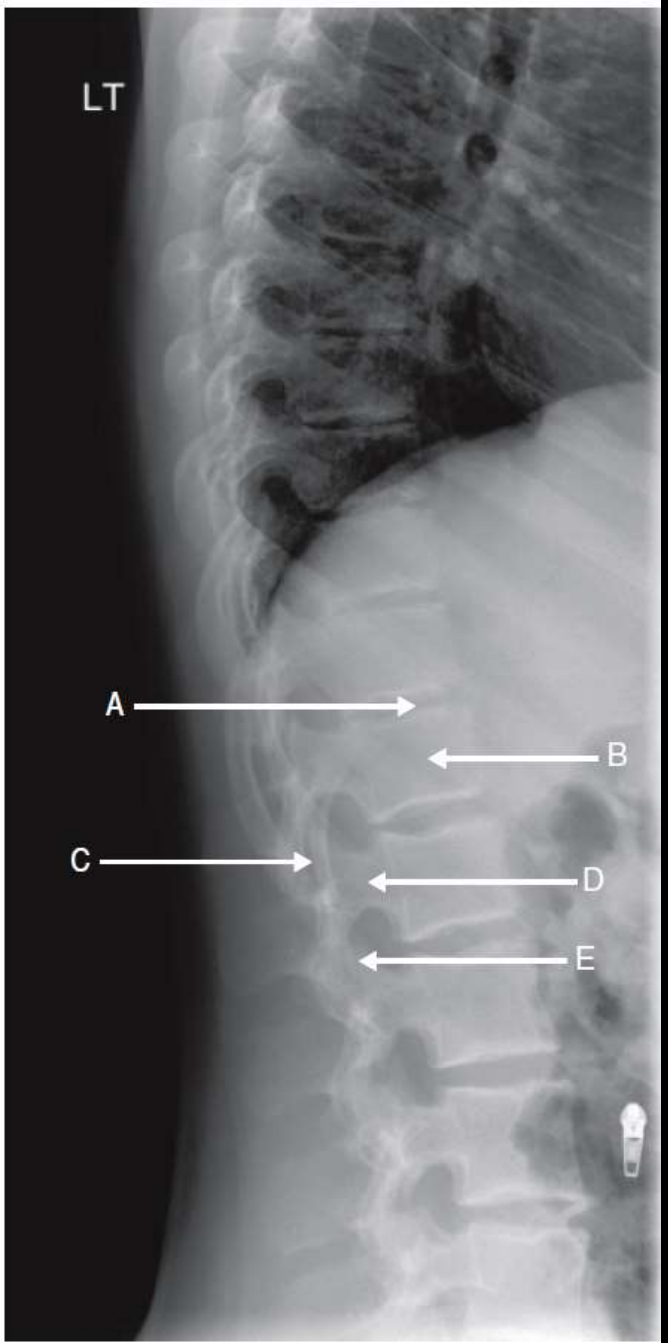


Figure 4.3 Scottie dog's collar is the appearance of a defect in the pars interarticularis.

Coned lateral radiographs of the lumbosacral junction are commonly obtained to assess for spondylolysis and spondylolisthesis. Spondylolysis involves a fracture of the pars interarticularis – the part of a vertebra that lies between its superior and inferior articular facets. On an oblique view, this can be seen as a 'collar' through the neck of a 'Scottie dog' as shown in **Figure 4.3**. Spondylolisthesis describes the vertebral displacement that may occur as a result of spondylolysis.

Case 7.2



7.2 Lateral radiograph thoracolumbar spine

(a) T11/T12 disc space.
(b) T12 vertebral body.
(c) Twelfth rib.
(d) L1 pedicle.
(e) L1/L2 facet joint.

The interpedicular distance should increase to a maximum at the L5 level.

Pedicular destruction is most common in metastatic disease.

Irregularity of the endplates with loss of disc height is often seen in discitis.

Less than 10 degrees of scoliosis is within normal limits.

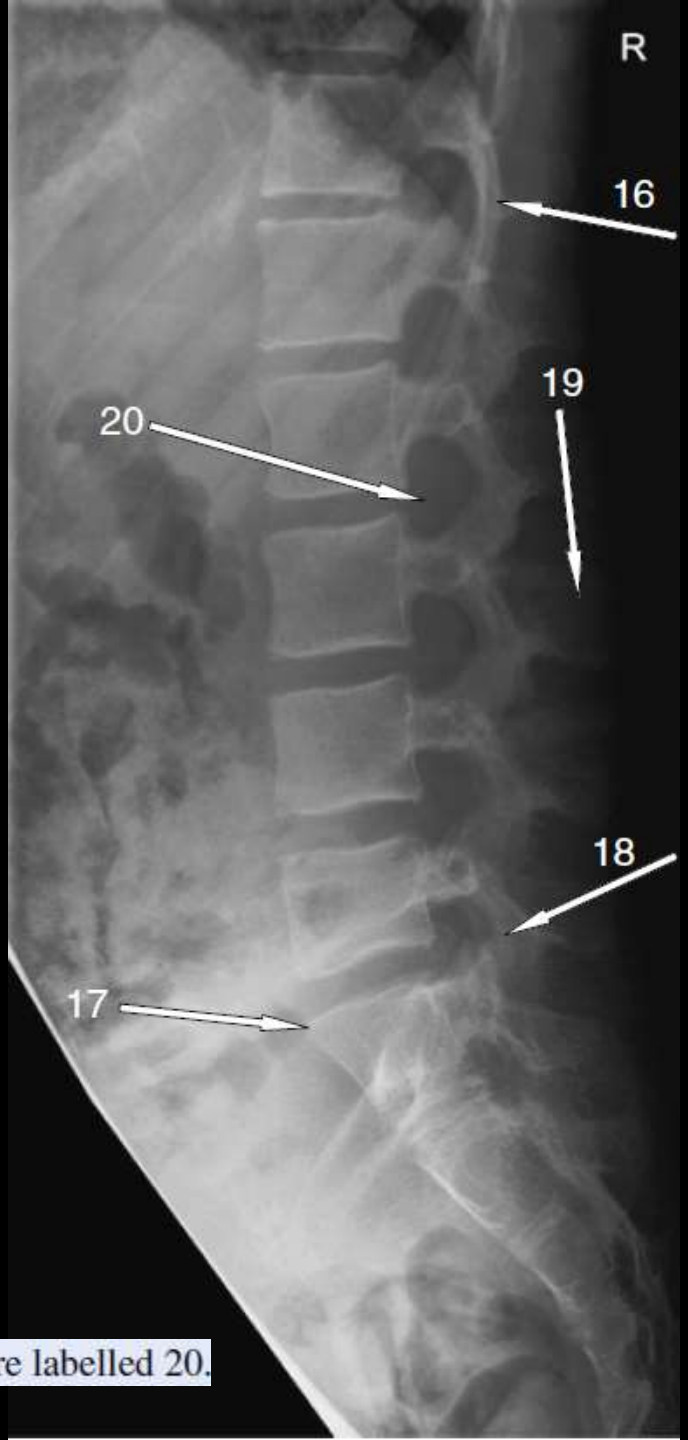
The lateral film demonstrates the depth of the posterior costophrenic angle with the lungs reaching the T12 level.


77
79
78
80
76

Lumbar Spine Radiograph

76. Sacral promontory
77. Transverse process of L3 vertebra
78. Superior articular process of L4 vertebra
79. Inferior articular process (facet) of L2 vertebra
80. Iliac crest

Use the L5 vertebral body as a landmark for identifying the correct level of the lumbar vertebra and hence its respective parts. Oblique views of the lumbar spine are used to see the intervertebral foramina and the pars interarticularis (Scotty dog sign).

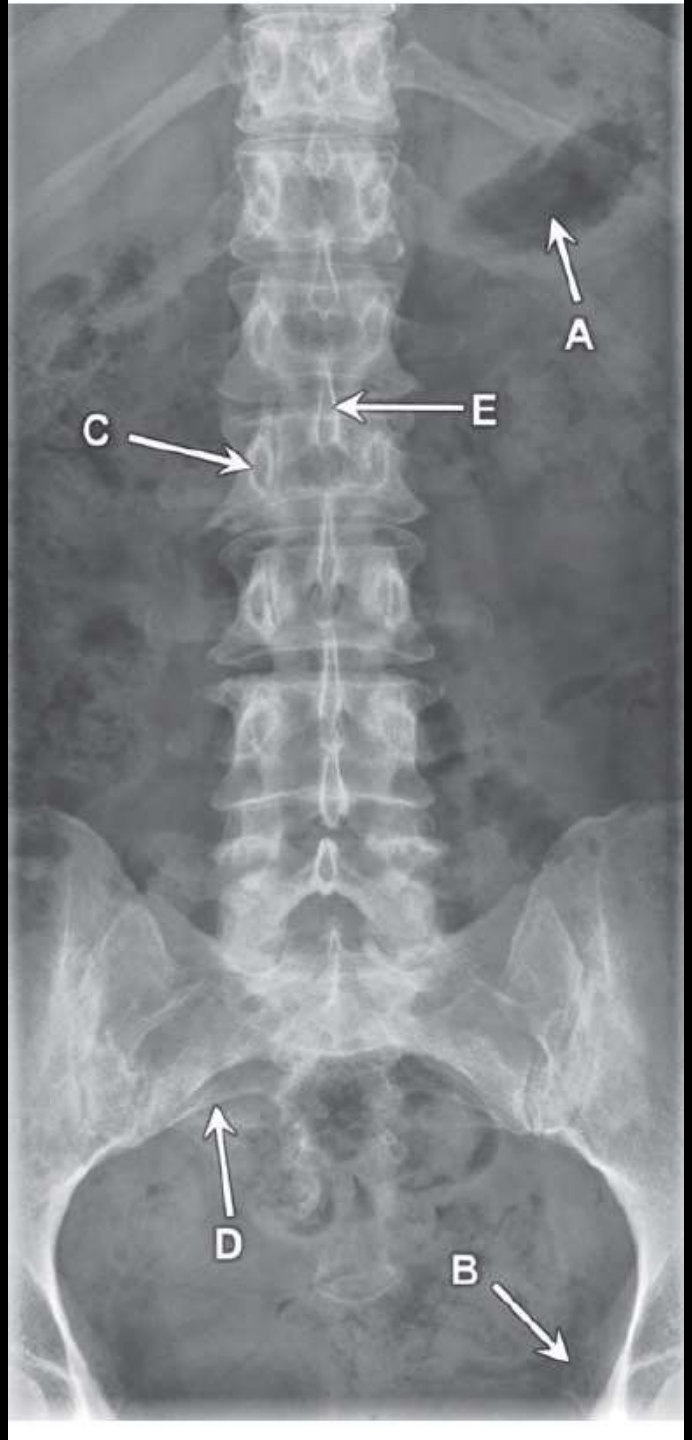


Which nerve passes through the structure labelled 20.

Lumbar Spine Radiograph

16. Twelfth rib
17. Sacral promontory
18. Inferior articular facet of L5 vertebra
19. Spinous process of L3 vertebra
20. L2 nerve root

In the lumbar spine, the nerves exit beneath the pedicle of their respective vertebra. Vertically oriented superior and inferior articular facets give good vertebral stability such that vertebral malalignment should raise the possibility of a defect in the pars interarticularis, best seen on plain films in the oblique projection (Scotty dog view) or optimally demonstrated by CT.

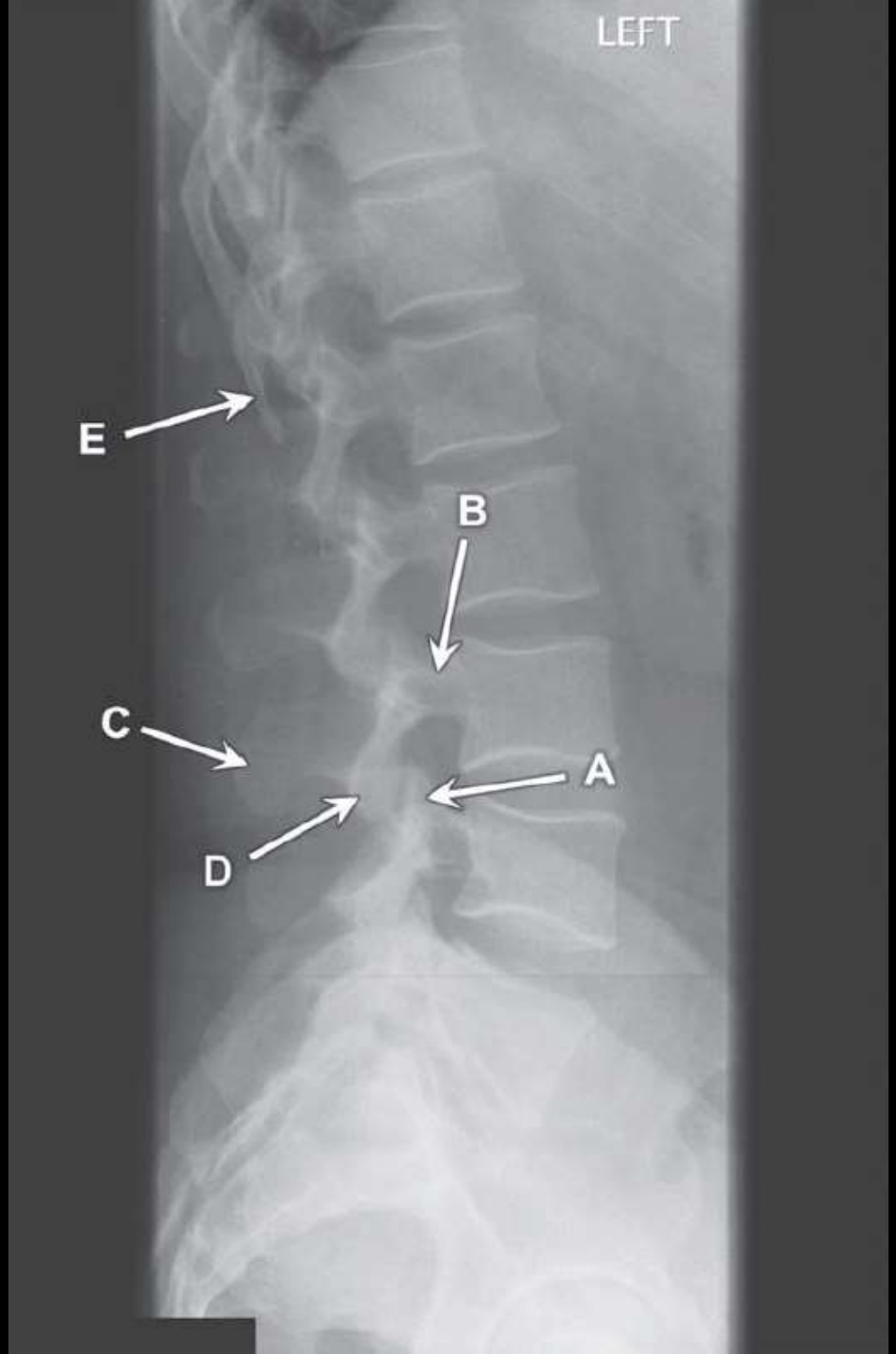

A
E
C
D
B

Case 20

AP radiograph. Lumbar spine.

1. Stomach
2. Left ischial spine
3. Right pedicle of L2 vertebra
4. Right sacral ala
5. Spinous process of L1 vertebra

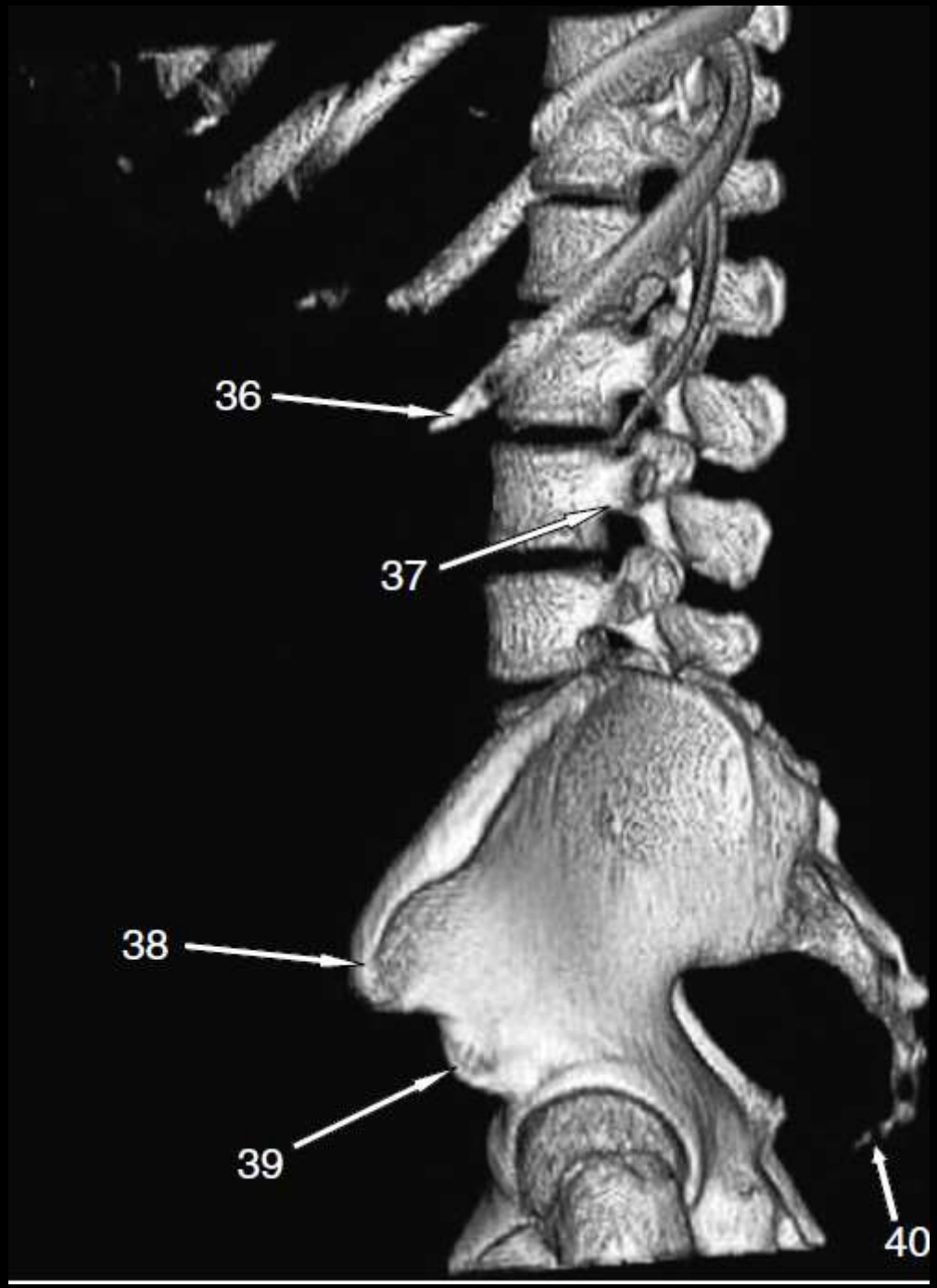
Remember that the spinous processes are angled caudally so usually are projected over the vertebral body below.


LEFT
E
B
C
A
D

Case 19

Plain radiograph. Lateral lumbar spine.

1. Superior articular process of L4
2. Pedicle of L3
3. Spinous process of L3
4. Inferior articular process of L3
5. Twelfth rib

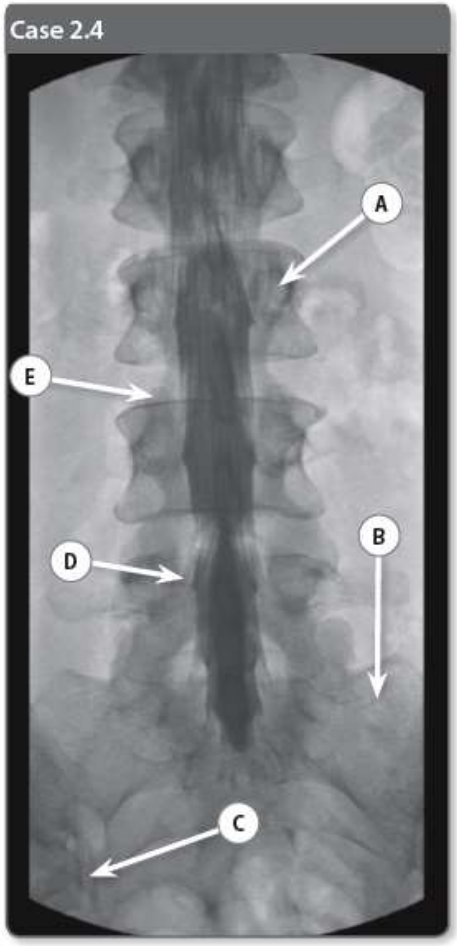

36
37
38
39
40

CT Lumbar Spine (3D Reconstruction)

36. Left 11th rib (tip of)
37. Left pedicle of L3 vertebra
38. Left anterior superior iliac spine
39. Left anterior inferior iliac spine
40. Coccyx

To identify the level of a vertebra, count down from T12 (origin of 12th rib).
The coccyx is formed from four fused vertebrae.

Case 2.4



Case 2.4

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

Case 2.4

A Left pedicle of L3

B Left sacral alum

C Right sacro-iliac joint

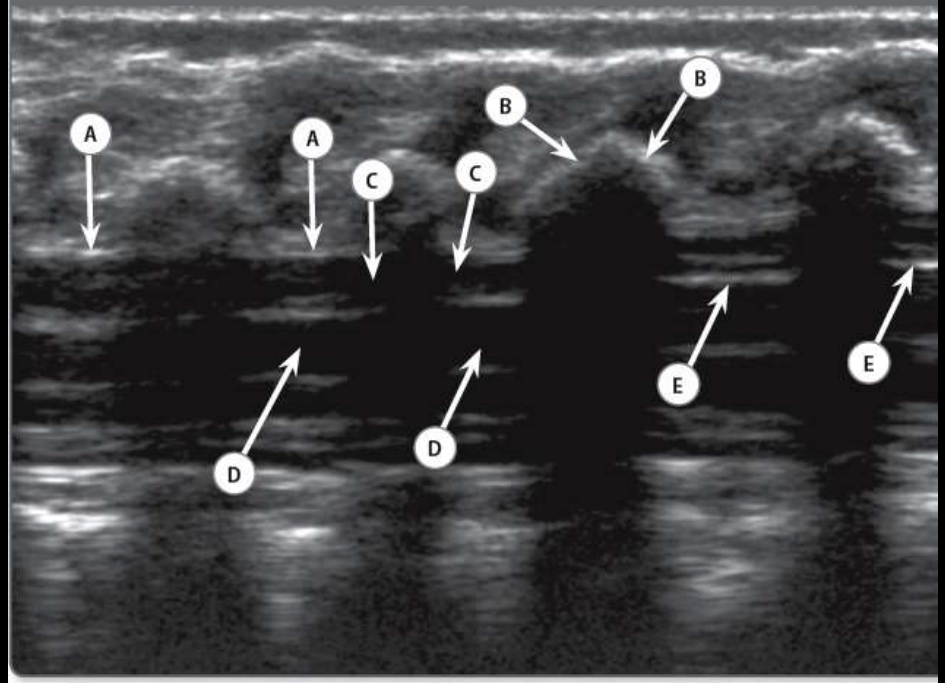
D Right L5 nerve root

E Right superior articular process of L4

Fluoroscopic lumbar myelography is performed as the initial stage of CT myelography and can also provide useful information as to the presence of intervertebral disc disease and nerve root involvement. Nerve roots are evident as filling defects which exit the spinal cord anterolaterally and course inferolaterally on each side. The conus medullaris can be visualised extending down to the level of L1/2, and the filum terminale may also be identified in the midline. The highest level of the iliac crest (L4) is used as a guide for lumbar puncture, which is usually performed using the interspace of the level above or below.

ULTRASOUND

Case 14.16



Case 14.16 Ultrasound of the thoracic cord of a neonate

	QUESTION	WRITE YOUR ANSWER HERE
A	Name the meningeal layer(s) labelled A.	
B	Name the structure labelled B.	
C	Name the structure labelled C.	
D	Name the structure labelled D.	
E	Name the meningeal layer(s) labelled E.	

Case 14.16

A Dura mater

B Spinous process

C Subarachnoid space

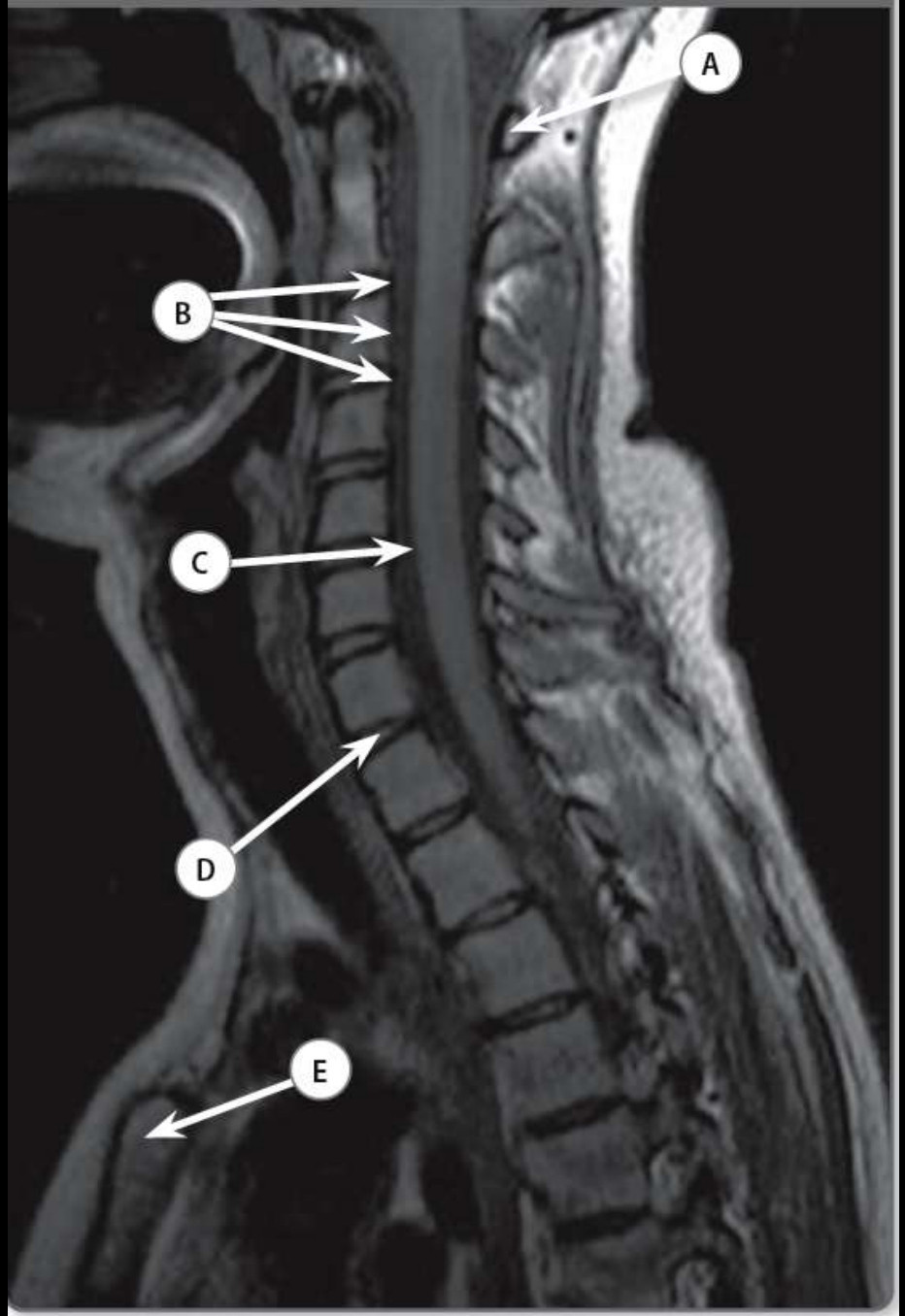
D Spinal cord

E Pia and arachnoid mater

It is possible to visualise the spinal cord using ultrasound in the first few months of life, whilst posterior spinal arches are incompletely ossified. The spinal cord itself is seen on longitudinal ultrasound as a hypoechoic tubular structure with a central echogenic stripe corresponding to the central canal. The echogenic line on either side of the cord represents the pia and arachnoid mater, which lie very close to each other and cannot be distinguished separately on ultrasound. The hypoechoic cerebrospinal fluid-filled subarachnoid space lies between the arachnoid mater and the dura mater (also seen as an echogenic stripe). Dense acoustic shadowing is seen from the spinous processes.

CROSS-SECTIONAL

Case 4.30



Case 4.30

A Posterior arch of the atlas

B Posterior longitudinal ligament

C Spinal cord in the spinal canal

D Intervertebral disc C7–T1

E Manubrium

Sagittal T1-weighted image MRI of the spine.

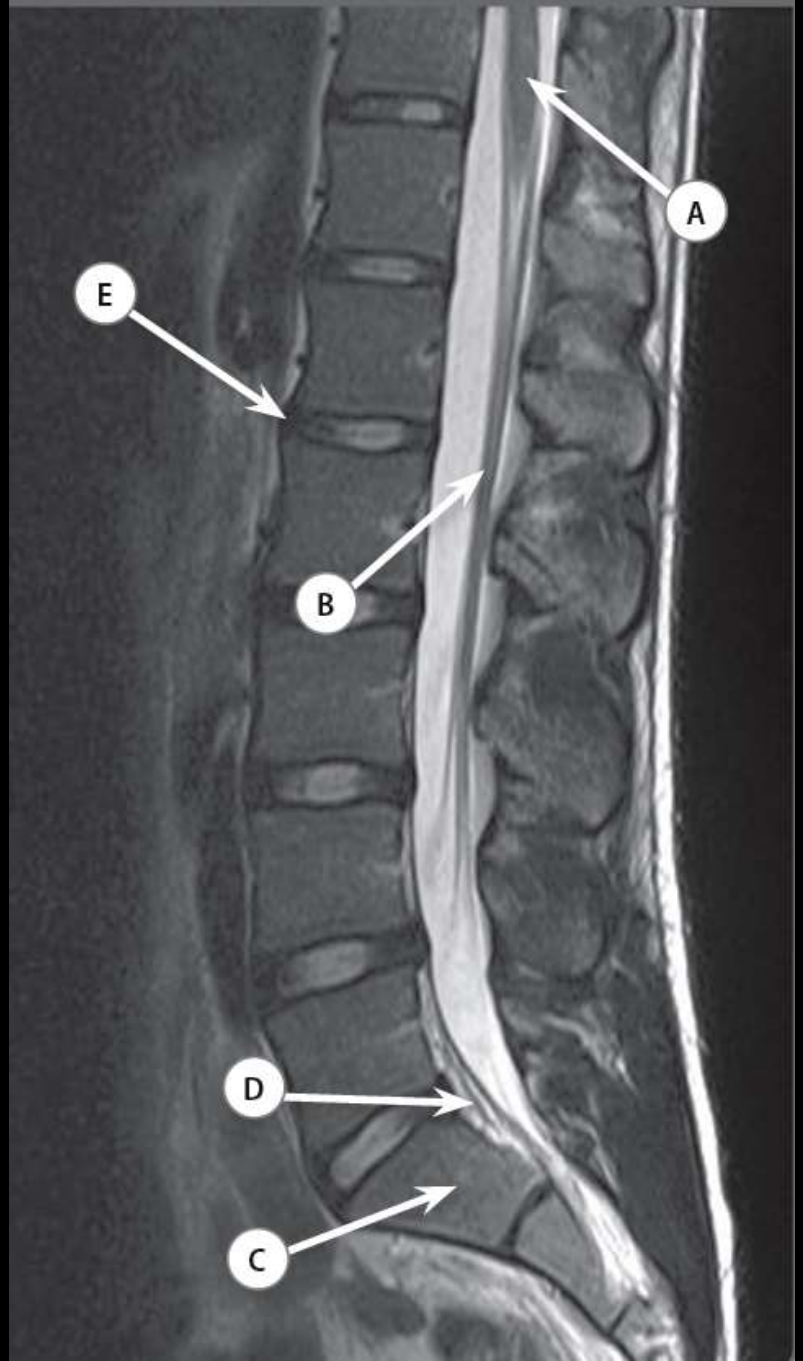
The spinal cord extends from the foramen magnum to the conus medullaris which usually lies at the level of L1/L2. It lies in the spinal canal surrounded by cerebrospinal fluid.

Intervertebral discs lie between vertebral bodies. They are composed of a nucleus pulposus (a gelatinous core) and an outer ring of concentric fibres of fibrous tissues called annulus fibrosus.

The vertebral canal is lined anteriorly by the posterior longitudinal ligament which covers the posterior surface of vertebral bodies and intervertebral discs. Posteriorly, the spinal canal is lined by the ligamentum flavum which joins adjacent laminae.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 62.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 99.

Case 4.31



Case 4.31

A Conus medullaris

B Cauda equina

C Sacral promontory

D Anterior epidural fat pad

E Anterior longitudinal ligament

Sagittal T2-weighted MRI of the lumbar spine.

The lower end of the spinal cord tapers to form the conus medullaris. Below the conus medullaris, the nerve roots pass vertically down to form the cauda equina.

The anterior longitudinal ligament is a strong fibrous band that covers the anterior surface of the vertebral bodies and intervertebral discs. It runs from the anterior tubercle of C1 to the sacrum. It prevents hyperextension of the vertebral column.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 63.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 103.

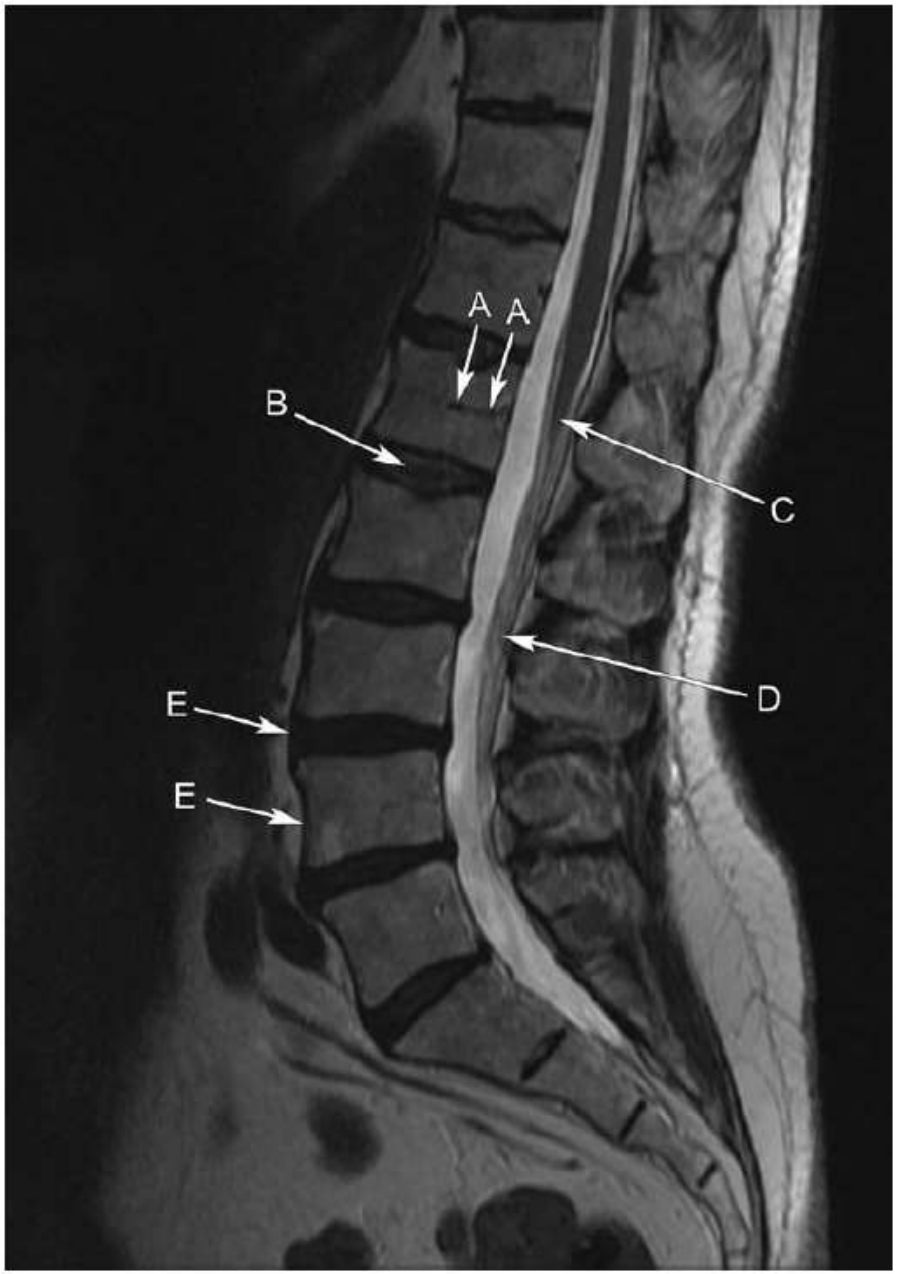
- **Question 23:**

Question 23: T2-weighted sagittal MRI of the spine

Answer: L3/4 intervertebral disc

- Intervertebral discs form fibrocartilaginous joints between successive vertebral bodies.
- They are amphiarthrodial joints (meaning that limited movement is possible) and, in effect, act as a ligament to maintain vertebral alignment.
- The intervertebral discs constitute one fifth of the vertebral column height.
- Intervertebral discs are wedge-shaped in the cervical and lumbar regions, contributing to spine lordosis. The thoracic intervertebral discs are rectangular in shape.
- Each intervertebral disc is composed of an outer annulus fibrosus, a central nucleus pulposus, and cartilaginous endplates.

Question 2.18



Name the structures labelled A to E.

2.18 Sagittal T2 MRI of the lumbar spine

A Nutrient vessel of L1.
B Nucleus pulposus of the L1/L2 disc.
C Conus medullaris.
D Cauda equina.
E Anterior longitudinal ligament.

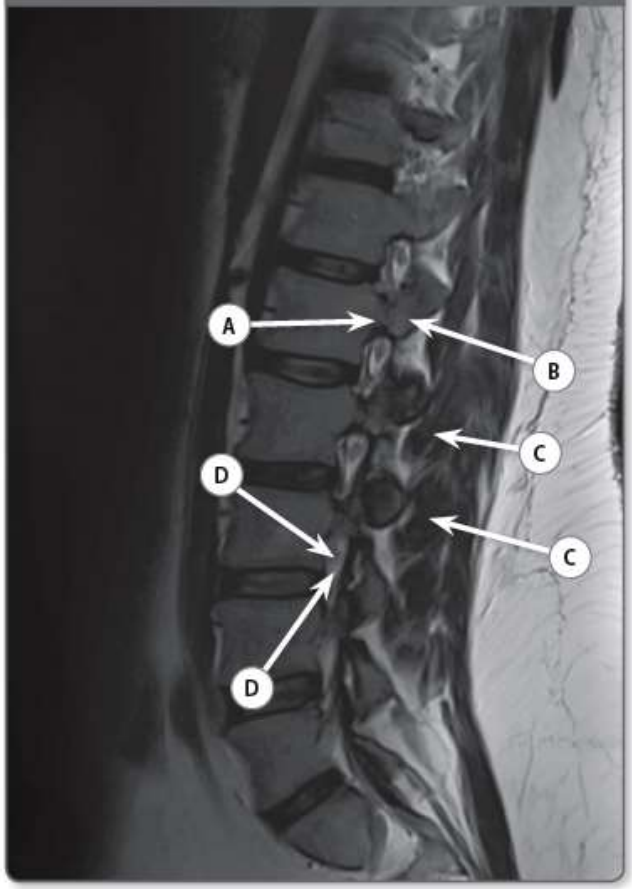
T2 sequences of the lumbar spine can be recognized by the high signal intensity of the cerebrospinal fluid. There are seven cervical, twelve thoracic, five lumbar and five sacral vertebrae. The spinal cord termination is called the conus medullaris and is normally located at the level of L1 or L2. The spinal roots that descend from the lower end of the cord are called the cauda equina, which is Latin for 'the horse's tail'.

The spinal ligaments from anterior to posterior are:

Anterior longitudinal ligament	Extends along the anterior vertebral bodies
Posterior longitudinal ligament	Extends along the posterior vertebral bodies
Ligamentum flavum	Connects the laminae of the adjacent vertebrae
Interspinous ligament	Connect the adjoining spinous processes
Supraspinous ligament	Connects the tips of the spinous processes

The intervertebral discs consist of the central nucleus pulposus and the outer fibrous annulus fibrosus.

Case 3.16



Case 3.16

	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	What nerve root exits below the left L4 pedicle?	

Case 3.16

- **A** Left pedicle of L1
- **B** Left pars interarticularis of L1
- **C** Left erector spinae muscle
- **D** L3 neural exit foramen
- **E** Left L4 nerve root

In the cervical spine, nerve roots exit above their correspondingly numbered pedicles. The C8 nerve root has no corresponding vertebra and accordingly exits below the C7 pedicle. In the thoracolumbar spine, nerve roots exit below their correspondingly numbered pedicles. Accordingly, the left L4 nerve root will exit below the left pedicle of L4, in the neural exit foramen formed between the L4 and L5 vertebrae. See the schematic representation of a parasagittal view of the neural exit foramen in **Figure 3.3.**

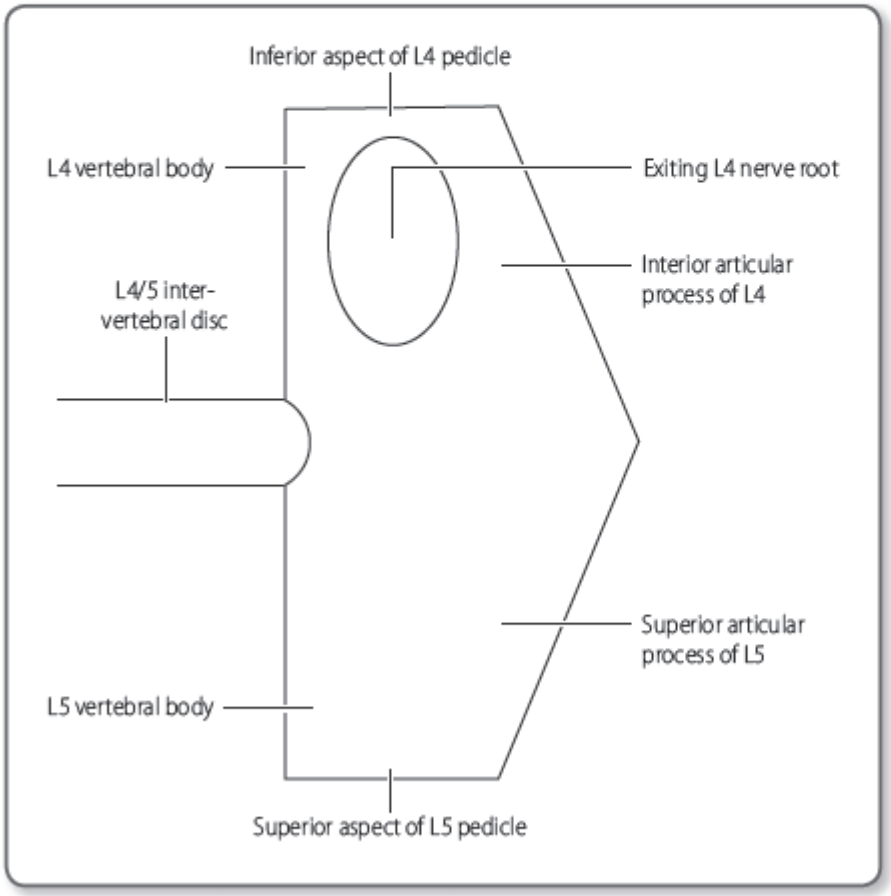
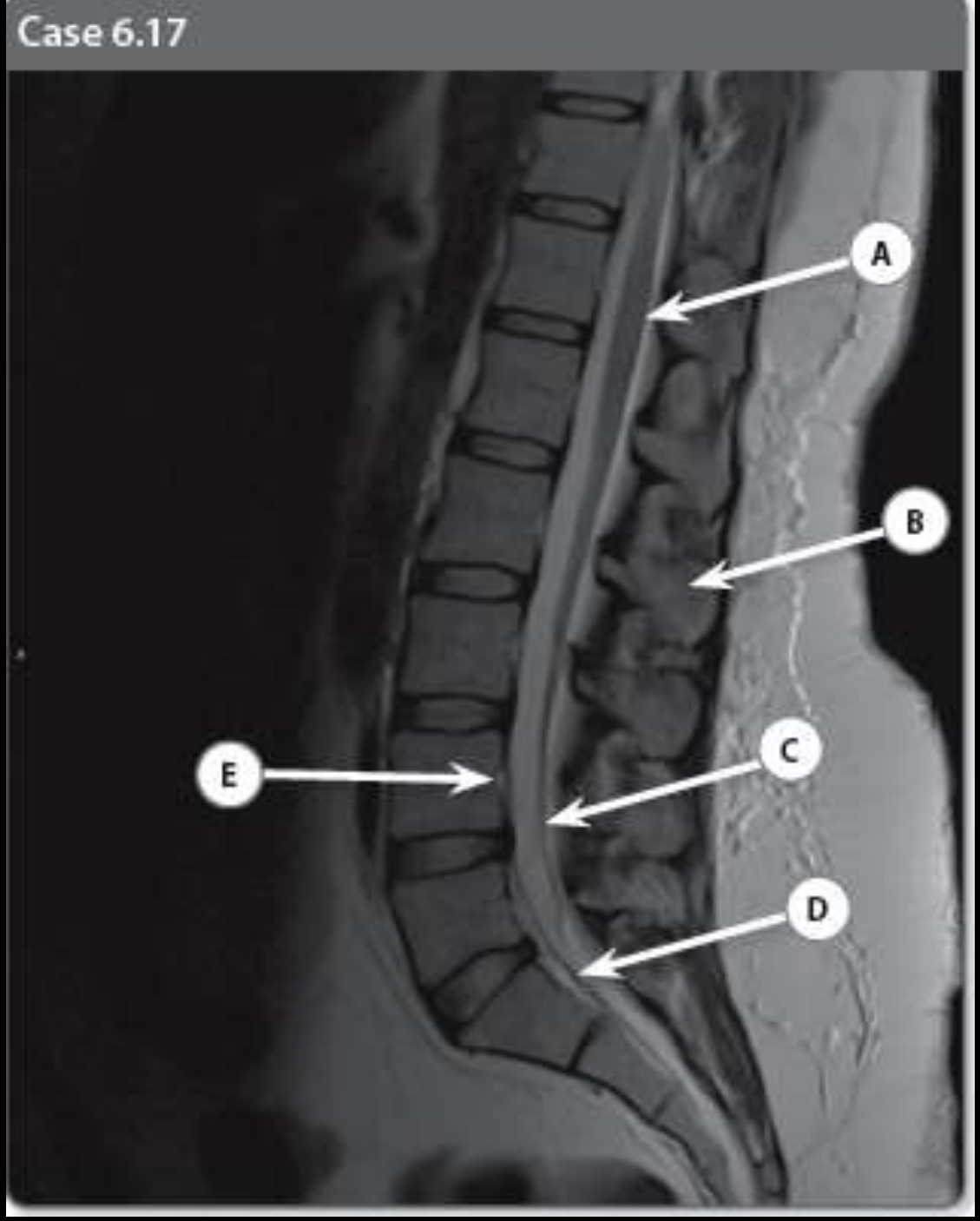


Figure 3.3 Schematic illustration of neural exit foramen.

Case 6.17



Case 6.17

A Conus medullaris

B Spinous process of L2

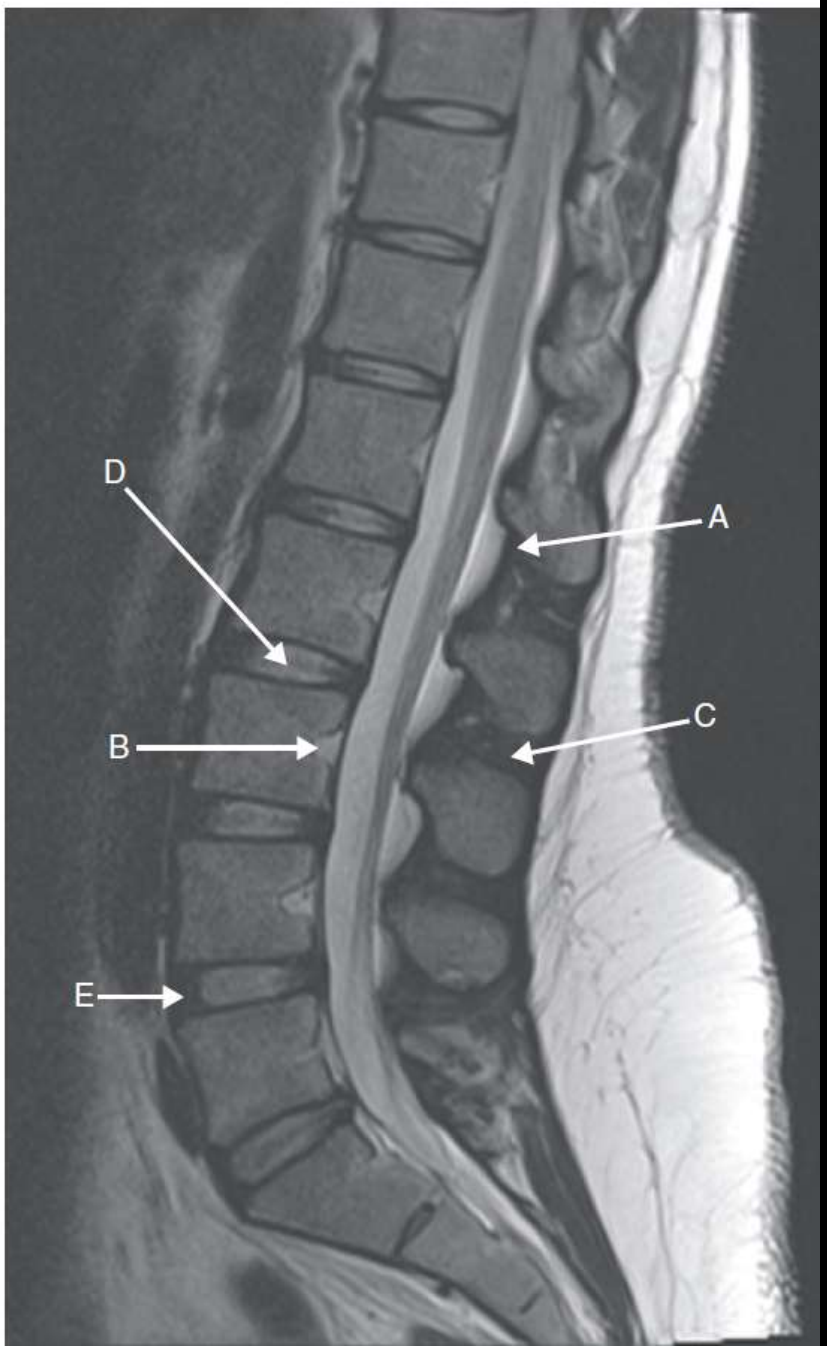
C Filum terminale

D Posterior longitudinal ligament

E Channel for basivertebral veins

The conus medullaris is the most inferior portion of the spinal cord, which in adults usually terminates at the L1–2 level. The filum terminale – a condensation of pia mater – continues inferiorly from the apex of the conus medullaris as a single fibrous strand which inserts into the posterior coccyx. A low-lying conus medullaris and thickening of the filum terminale (it should be less than 3 mm thick) are indicators of spinal dysraphism.

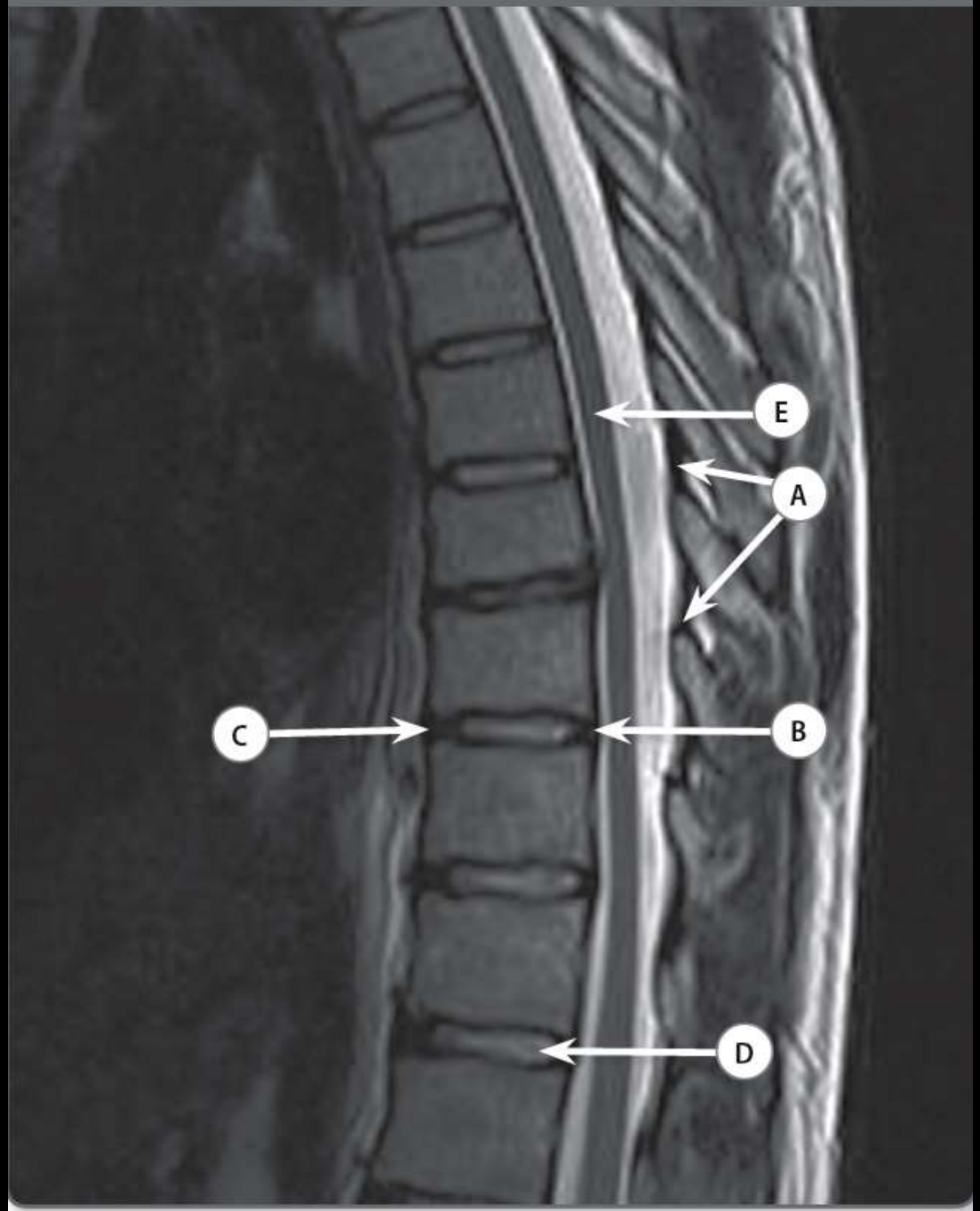
Case 7.18



7.18 Sagittal T2-weighted MR lumbar spine

(a) Ligamentum flavum.
(b) Basivertebral vein.
(c) Interspinous ligament.
(d) Nucleus pulposus of L2/L3 disc
(e) Annulus fibrosis of L4/L5 disc.

Case 6.6



Case 6.6

A Ligamentum flavum

B Posterior longitudinal ligament

C Anterior longitudinal ligament

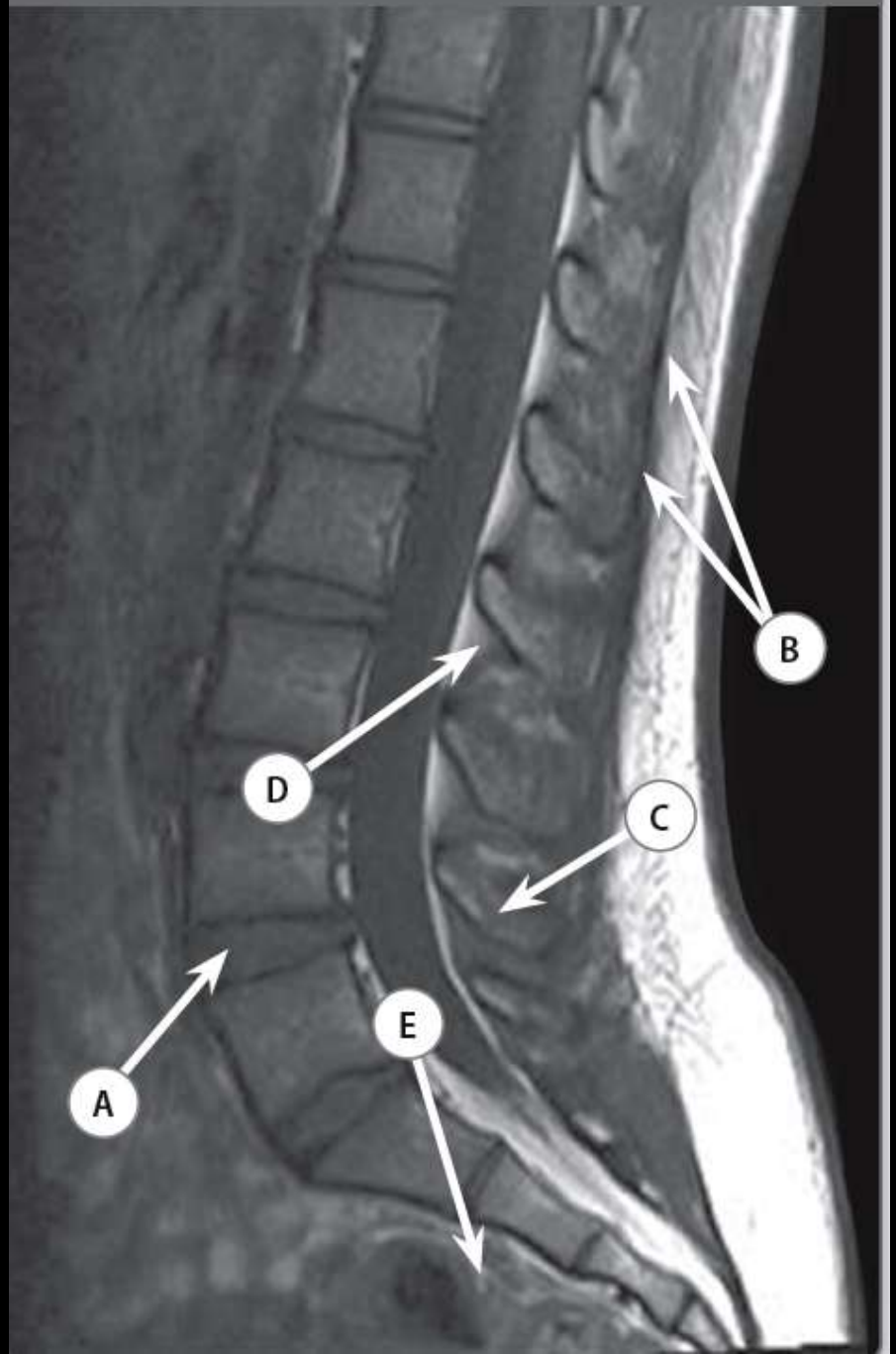
D Intervertebral disc

E Thoracic spinal cord

Sagittal MRI of the spine.

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

Case 6.8



Case 6.8

A L4–L5 Intervertebral disc

B Interspinous ligament

C Spinous process of L4

D Posterior epidural space

E Presacral space

Sagittal MRI of the lumbar spine.

The interspinous ligament is an accessory ligament uniting the spinous processes. The supraspinous ligament joins the tips of the spinous processes.

The epidural space contains epidural veins, fat and nerve roots. The posterior epidural space is most extensive at L3–L4 and L4–L5 interspaces. This is important clinically as it is the site used for epidural injections.

The presacral space is located between the rectum and the sacrococcygeal part of the spine. Knowing the upper limit of the normal width of this space is important as clinically relevant measurements may be asked. If the width exceeds 15 mm, pelvic pathology should be suspected.

Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 103.


60
56
59
57
58

MRI Spine

56. L3/L4 intervertebral disc
57. Sacral promontory
58. Presacral space
59. Filum terminale
60. Abdominal aorta

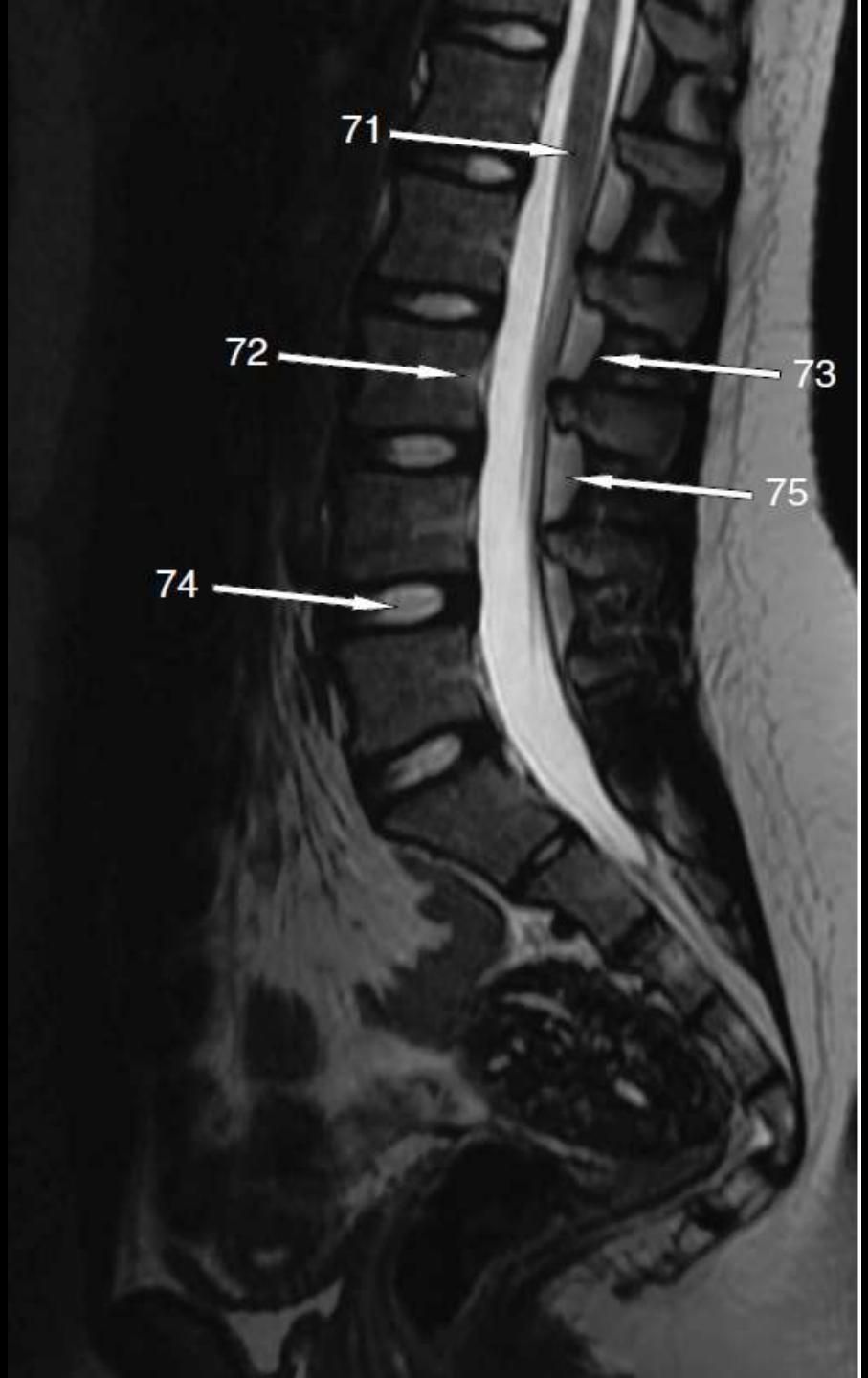
Remember to name the different parts of the aorta (it may seem obvious but you will lose marks unnecessarily).


35
31
32
33
34

MRI Spine

31. Conus medullaris
32. Superior mesenteric artery
33. Posterior longitudinal ligament
34. Presacral fat
35. T11/12 intervertebral disc

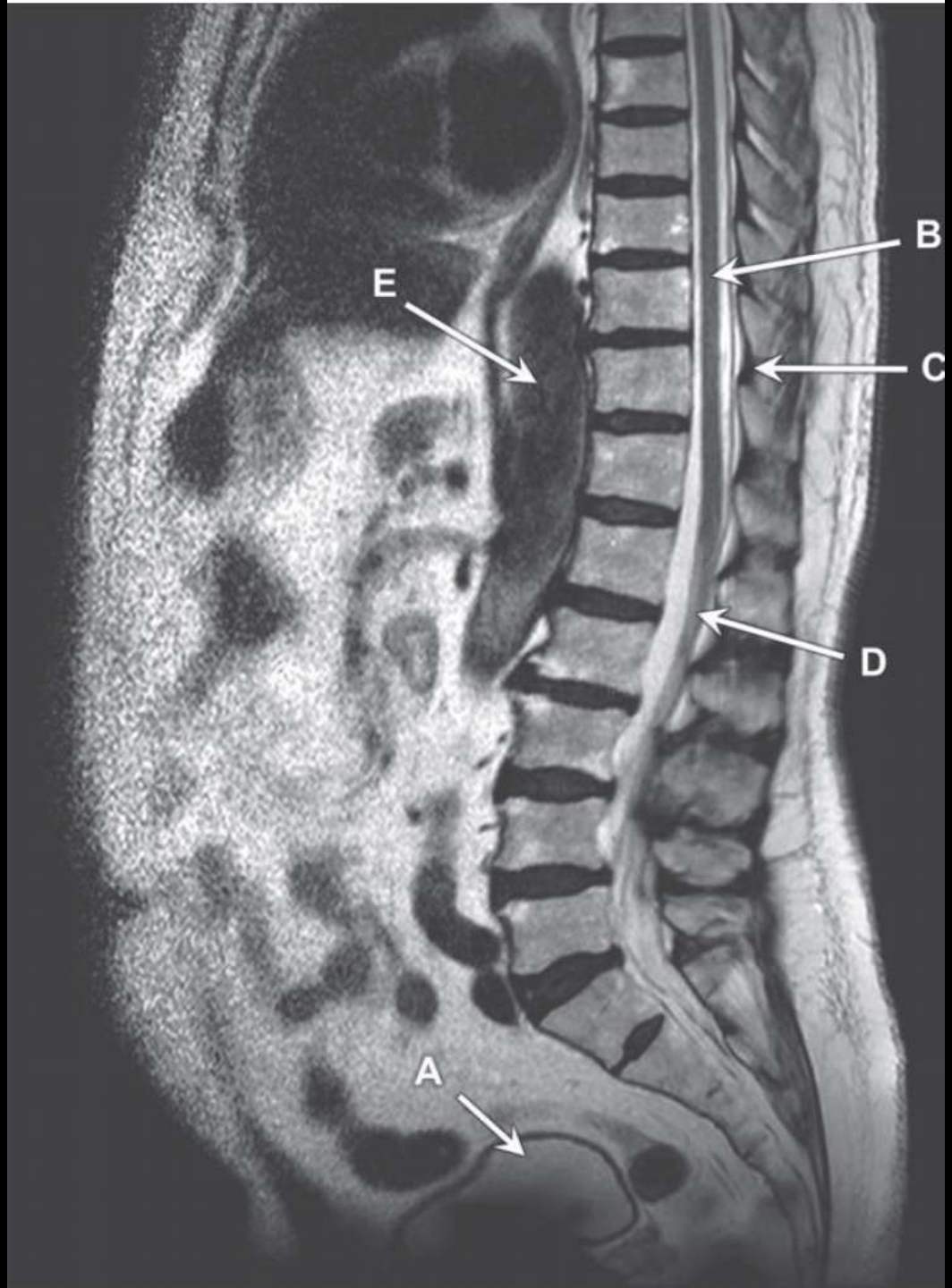
The conus medullaris terminates at L1/L2 level. The presacral fat is high signal on T2-weighted image and blood vessels are of low signal intensity representing flow void. This image shows major blood vessel traversing the length of the abdomen, which can only be either abdominal aorta or IVC. Only the aorta gives off anterior branches. The coeliac artery and SMA are the two major anterior branches of abdominal aorta; hence 32 is a superior mesenteric artery.


71
72
73
75
74

MRI Spine

71. Conus medullaris
72. Basivertebral vein of L3
73. Ligamentum flavum
74. Nucleus pulposus L4/5 intervertebral disc
75. Epidural fat

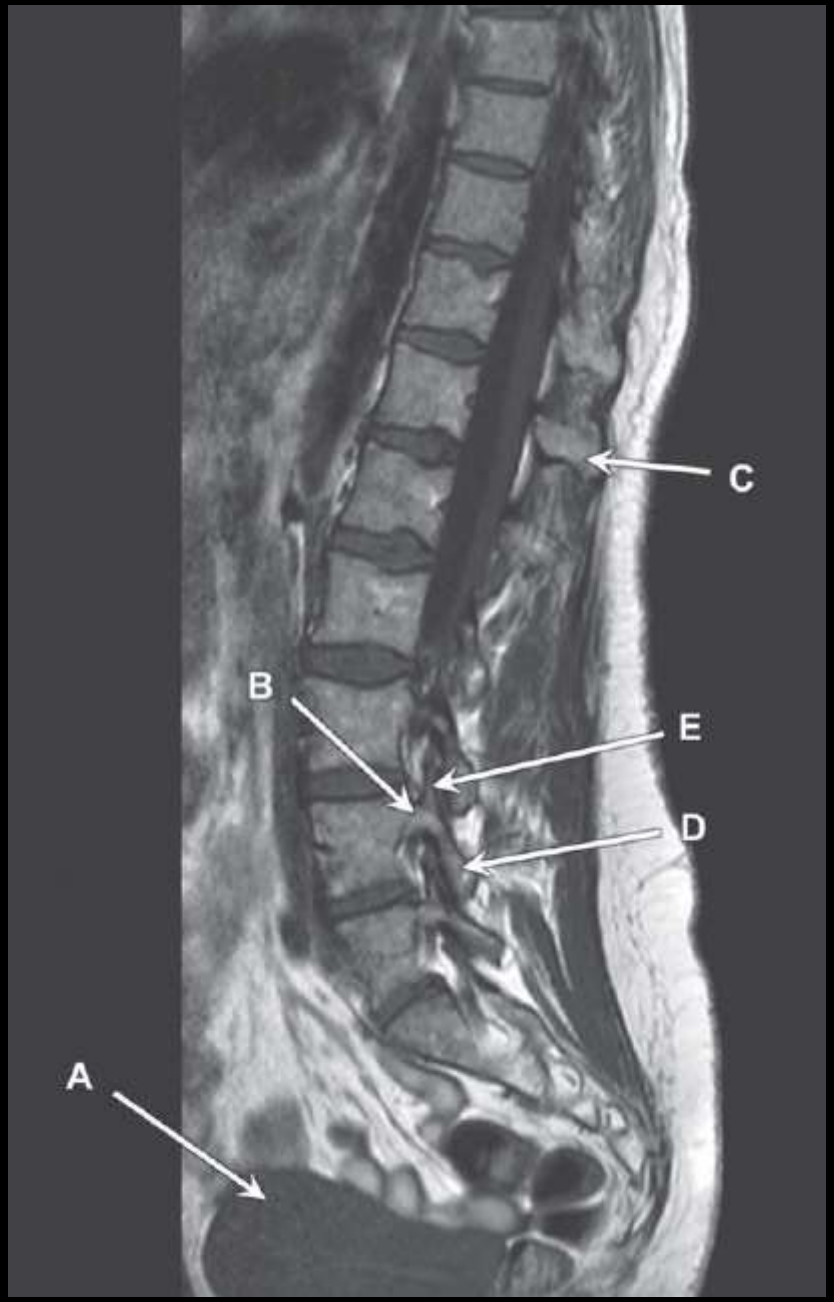
Intervertebral discs have a peripheral annulus fibrosus (dark on all MR sequences) and a central nucleus pulposus (intermediate signal). Normal basivertebral veins may enhance quite prominently following injection of gadolinium-based contrast material.


B
E
C
D
A

Case 18

MRI lumbar spine. T2W sagittal section.

1. Urinary bladder
2. Spinal cord
3. Ligamentum flavum
4. Cauda equina
5. Abdominal aorta

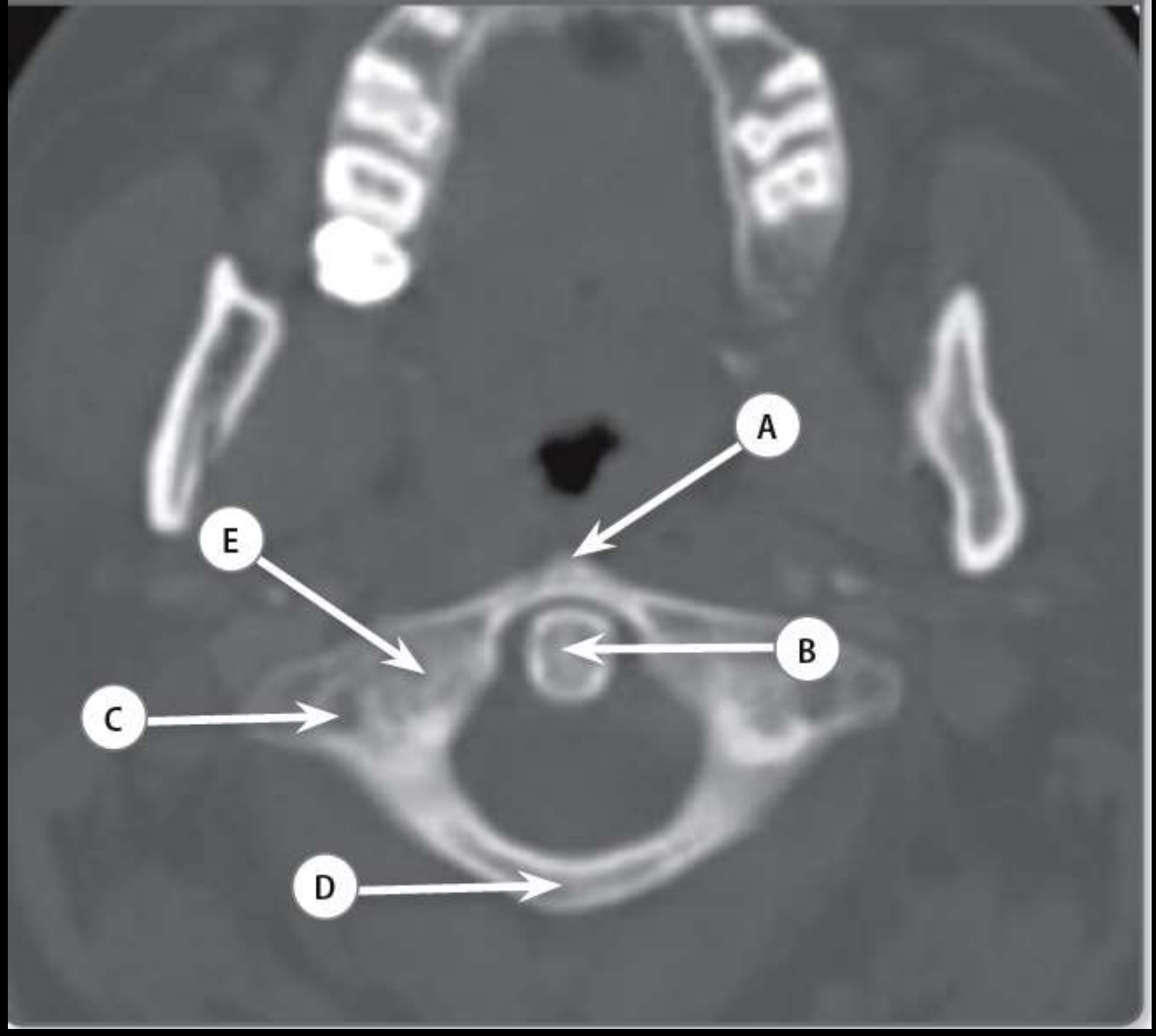

A
B
C
D
E

Case 19

MRI lumbar spine. T1W sagittal section.

1. Uterus
2. Pedicle of L4 vertebra
3. Spinous process of T12 vertebra
4. Inferior articular process of L4 vertebra
5. Superior articular process of L4 vertebra

Case 4.24



Case 4.24

A Anterior tubercle of the atlas

B Odontoid peg

C Right foramen transversarium of the axis

D Posterior arch of the atlas

E Right lateral mass of the atlas

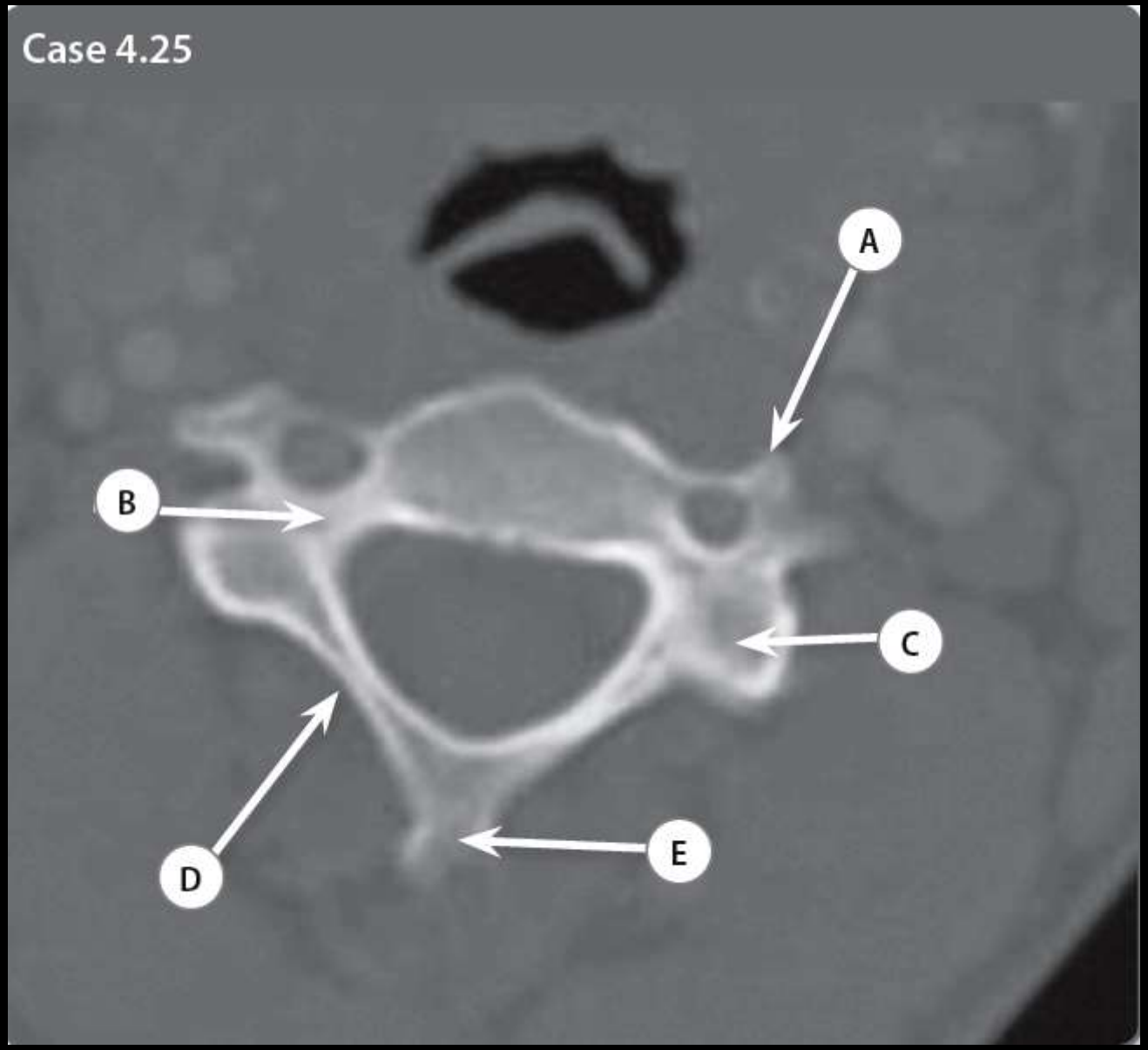
Axial CT image of the atlantoaxial joint.

We have already seen the atlas and the axis in the lateral CT spine radiograph and the open mouth dens views. Here we see the odontoid peg and its relation to the anterior arch of the atlas. This relationship is maintained by the transverse ligament which attaches to the lateral masses of C1.

In this axial view, we see the tubercles on the arches of the atlas. The anterior tubercle projects from the anterior surface of the anterior arch. It is a blunt midline projection. The posterior tubercle is a midline projection on the posterior surface of the posterior arch. It represents the spinous process of the atlas and is an attachment of the ligamentum nuchae.

The atlas has transverse processes that arise from two roots. The anterior root projects from the lateral mass and the posterior route from the posterior arch. The tips of these transverse processes are square and have no tubercles.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 61.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 93.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 312.


Case 4.25
A
B
C
D
E

Case 4.25

A Anterior tubercle of the left transverse process

B Right pedicle

C Left articular pillar

D Right lamina

E Bifid spinous process

Axial CT image of the fifth cervical vertebra.

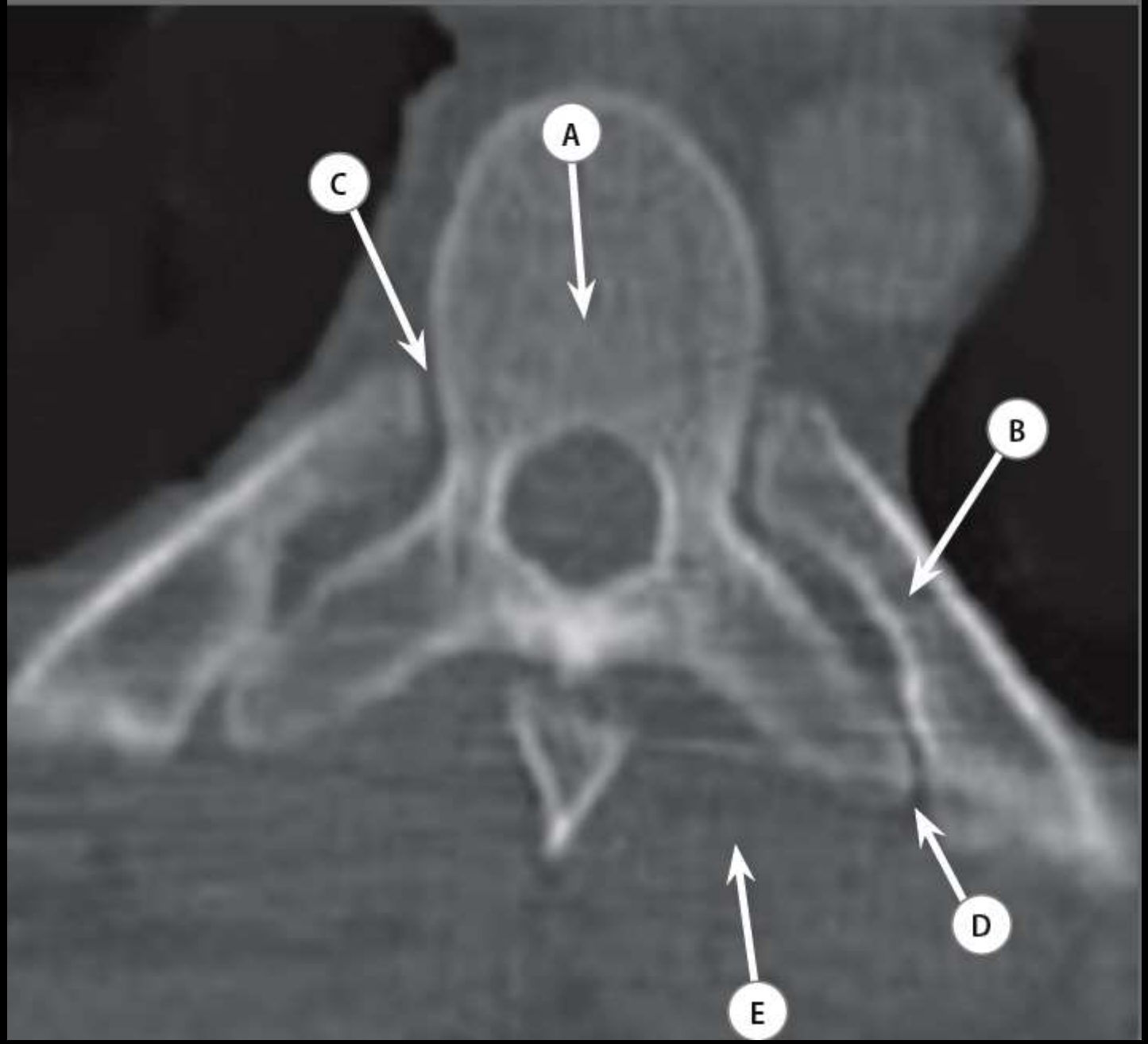
From C3 to C7 the vertebrae are broadly similar. They have small, oval bodies. The transverse processes are short and end laterally with an anterior and posterior tubercle. The tubercles are connected by the intertubercular lamellae. The transverse processes enclose the foramen transversarium which transmits the vertebral artery from C6 and above.

The pillars (or articular masses) are dense, rhomboid-shaped structures bounded by the anterior and posterior facets. The laminae are posteromedial extensions of the articular masses and form the posteromedial aspects of the spinal canal.

The spinous processes in the cervical spine are small and bifid with the exception of the C7.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 61.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 92.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 315.

Case 4.26



Case 4.26

A Thoracic vertebral body

B Neck of the rib (left)

C Right costovertebral joint

D Left costotransverse joint

E Left erector spinae

Axial CT image at the level of a thoracic vertebral body.

The thoracic vertebrae have roughly heart-shaped bodies. Their pedicles project directly backwards. The laminae are wide, flat bars of bone. Their superior margins overlap the inferior margins of the laminae of the vertebrae above. That means that the posterior margin of the vertebral canal at the lumbar spine is closed. The transverse processes project backwards and laterally from the junction of body and pedicles.

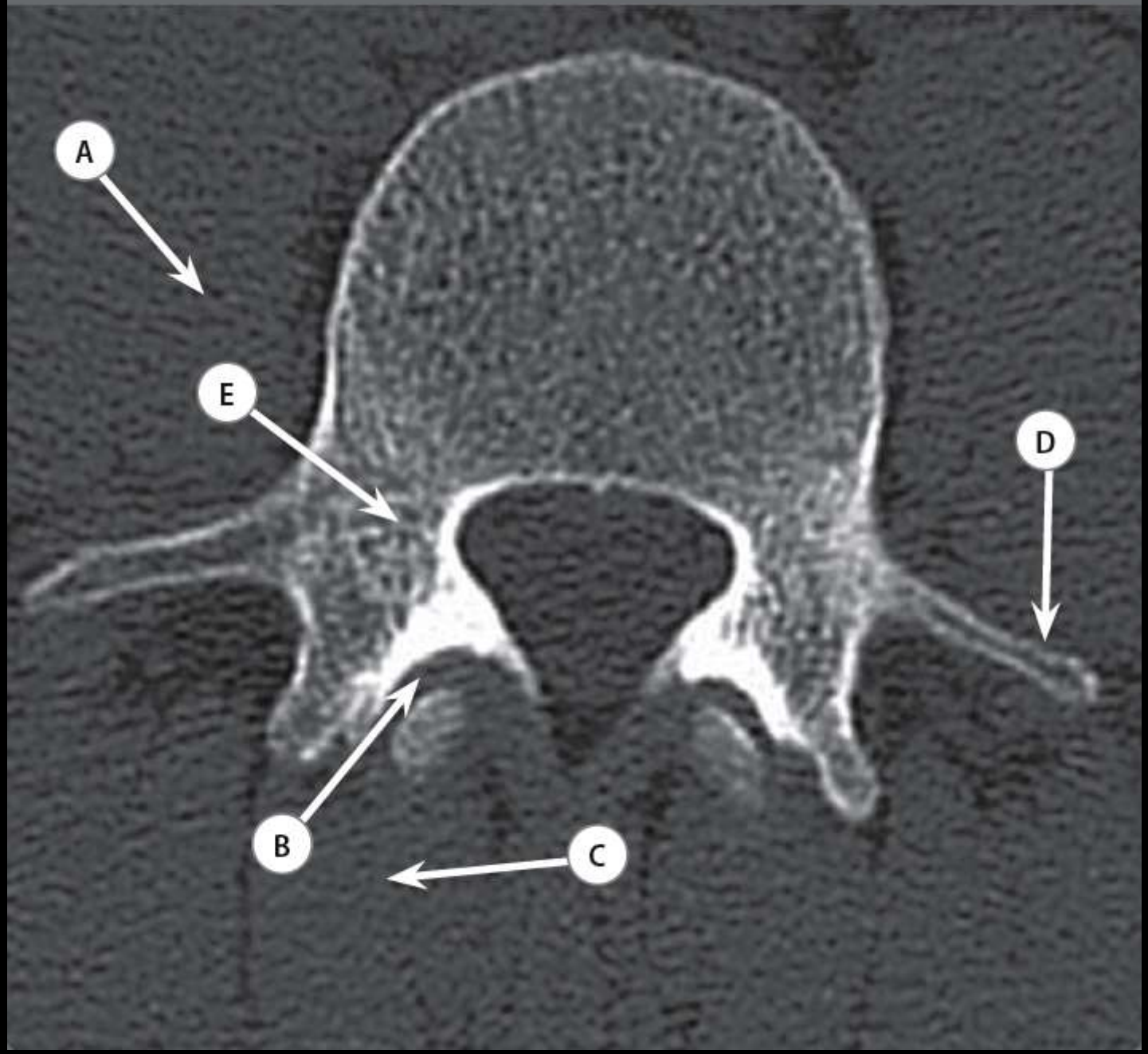
Close to the tip of the transverse process, on the anterior surface, there is an oval articular facet that articulates with a facet on the tubercle of the corresponding rib. This is the costotransverse joint.

From T2 to T10 the vertebrae have a superior and inferior demifacet for articulation with the head of the corresponding rib on each side. T1 has a complete facet superiorly and a demifacet inferiorly. T11 and T12 have a single, complete facet on each side.

Note that the spinous process pictured in this image belongs to the vertebra above. If the question asks which vertebral body is shown, this fact must be taken into account.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 55–63.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 113–114.
Butler P, Mitchell AM, Ellis H. Applied Radiological Anatomy. Cambridge: Cambridge University Press, 1999: 315.

Case 4.27



Case 4.27

A Left psoas

B Right facet joint

C Right erector spinae

D Left transverse process of the lumbar vertebra

E Right pedicle of the lumbar vertebra

Axial CT image of the lumbar spine through a vertebral body.

There are three main groups of back muscles:

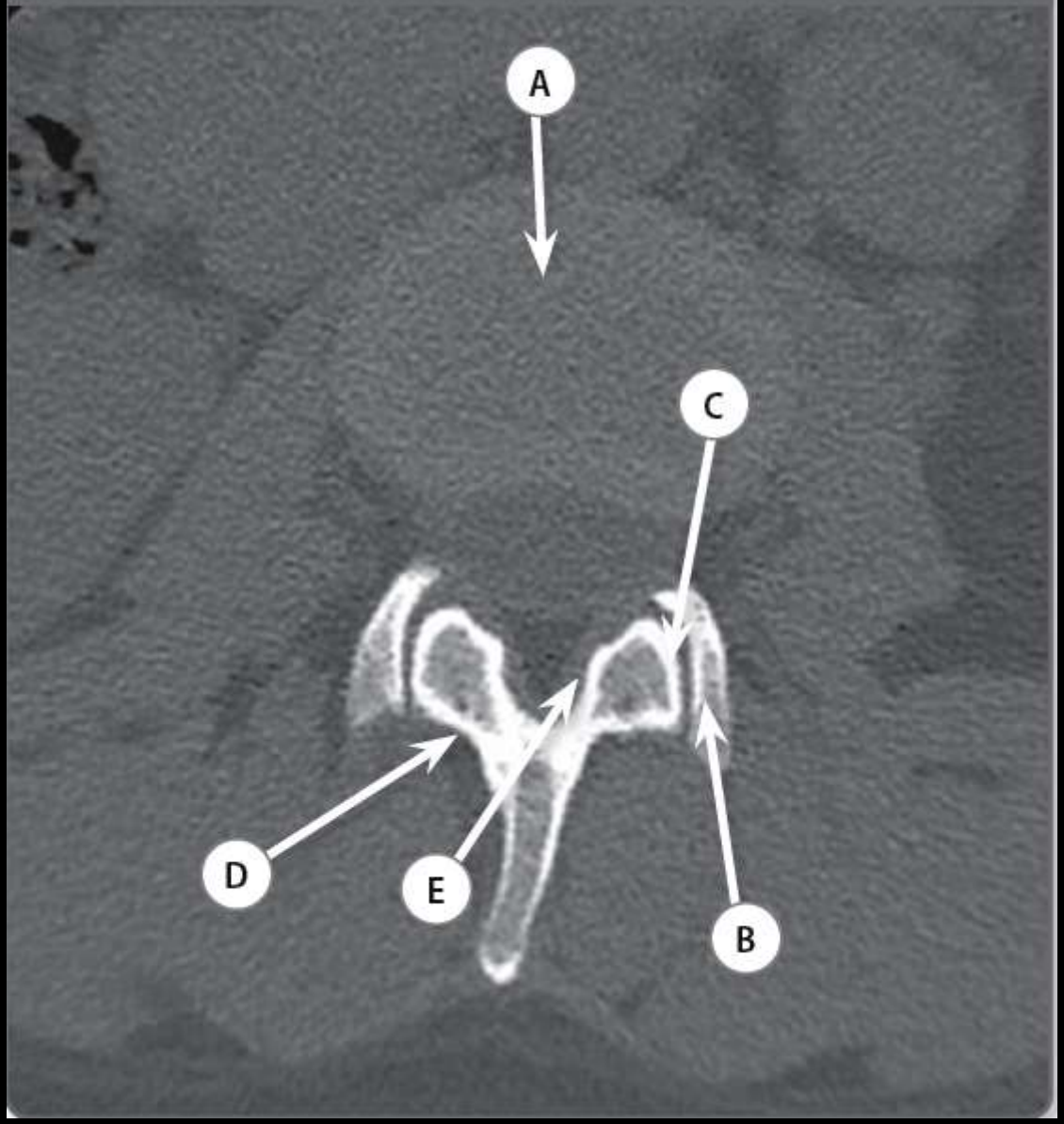
- superficial extrinsic muscles
- intermediate extrinsic muscles
- deep intrinsic muscles

The superficial extrinsic muscles are associated with the upper limb and include the trapezius and the latissimus dorsi. The intermediate extrinsic muscles provide accessory respiratory movements and include the serratus anterior.

The deep intrinsic muscles are further divided into three groups:

- deep layer (interspinalis, intertransversii)
- intermediate layer (collectively known as transversospinalis)
- superficial layer (collectively known as erector spinae)

Case 4.28



Case 4.28

A Lumbar Intervertebral disc

B Left inferior articular process of the vertebral body above (L3)

C Left superior articular process of the vertebral body below (L4)

D Right lamina

E Ligamentum flavum

CT image of the lumbar spine through the L4/L5 intervertebral disc space.

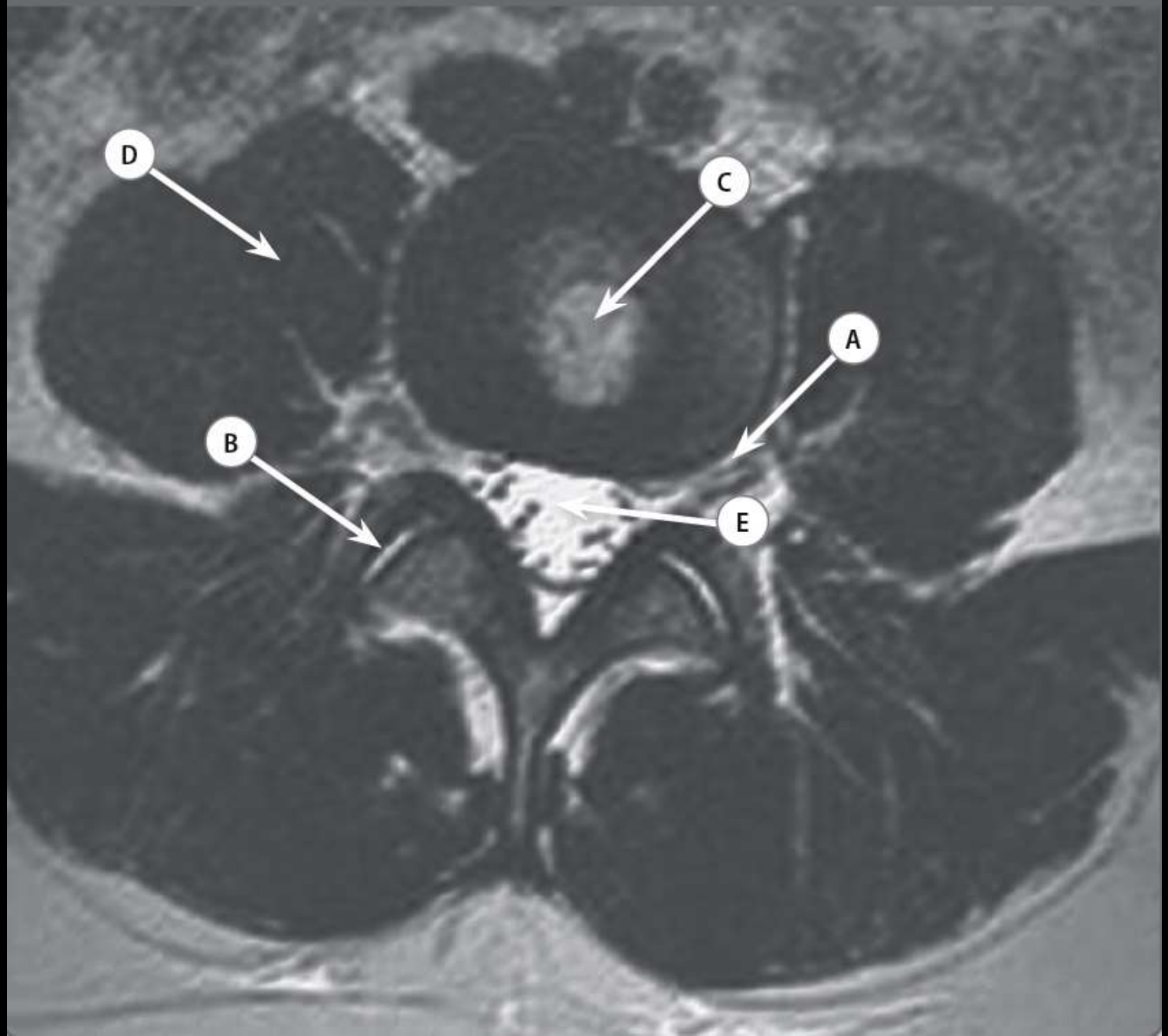
This axial image passes through the intervertebral foramen of L4/L5. The foramen is seen as a gap between the body and the posterior vertebral elements. Note that the anterior border of the vertebral canal at this slice is the intervertebral disc and not the vertebral body.

At this level we see the facet joint which is an articulation between the inferior articular process of L4 and the superior articular process of L5. Note that the inferior articular facet of L4 lies anteriorly and faces posteriorly.

In this image we can identify the ligamentum flavum. The ligamentum flavum unites the laminae of adjacent vertebra by passing from the anterior surface of the lamina above to the posterior surface of the lamina below. It is very elastic.

Weir J, Abrahams P. Imaging Atlas of Human Anatomy, 4th edn. Edinburgh: Mosby, 2010: 62.
Ryan S, McNicholas M, Eustace SJ. Anatomy for Diagnostic Imaging, 3rd edn. Edinburgh: Saunders, 2010: 98.

Case 4.29



Case 4.29

A Spinal nerve root (left)

B Right facet joint (zygapophysial)

C Intervertebral disc (nucleus pulposus)

D Right psoas

E Cauda equina in the thecal sac

Axial T2-weighted MRI of the lumbar spine.

Below the termination of the spinal cord, the nerve roots in the lumbar region pass almost vertically down to form the cauda equina. There are five lumbar spinal nerves. Each spinal nerve is formed by the dorsal (sensory) root and the ventral (motor) root. The ganglia are usually found in the exit foramina.

Remember that in the lumbar spine, each nerve root leaves the spinal canal under the pedicle of the corresponding vertebra.

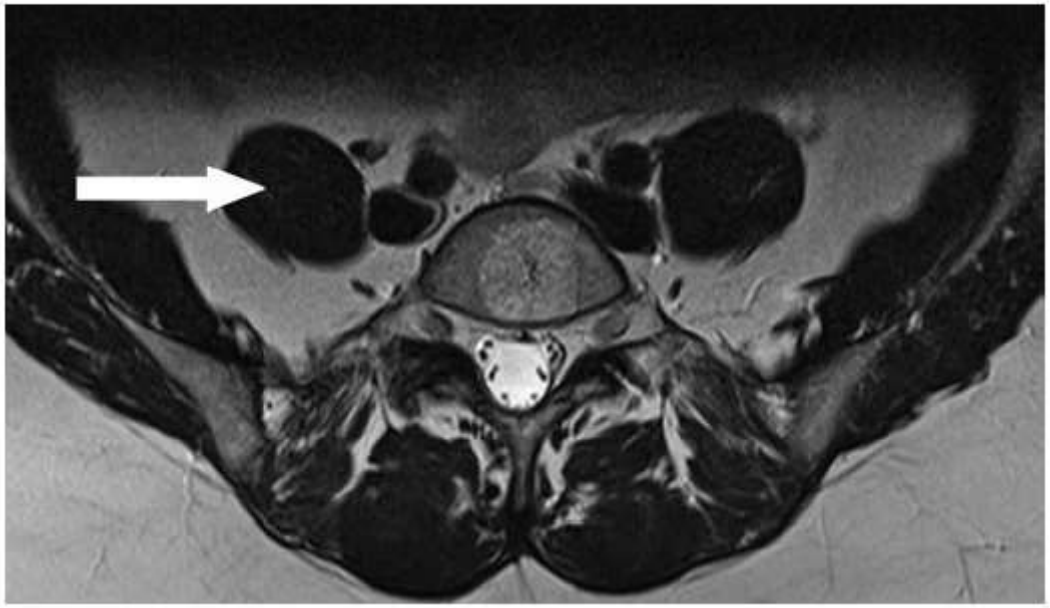
- **Question 24:**

Question 24: Axial MRI of the lumbar spine

Answer: Left spinal nerve root (exiting nerve root)

- There are 31 segmental nerve roots that arise from each side of the spinal cord: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal.
- Each spinal nerve root is formed by the union of a dorsal root (sensory) and a ventral root (motor and autonomic). It passes anterolaterally through the neural/intervertebral foramen before dividing into ventral and dorsal rami.
- Spinal nerve roots of C1-C7 exit above the pedicles of their respective vertebrae. Because there is no C8 vertebra, subsequent nerve roots exit below the pedicles of their respective vertebrae.

- **Question 34:**

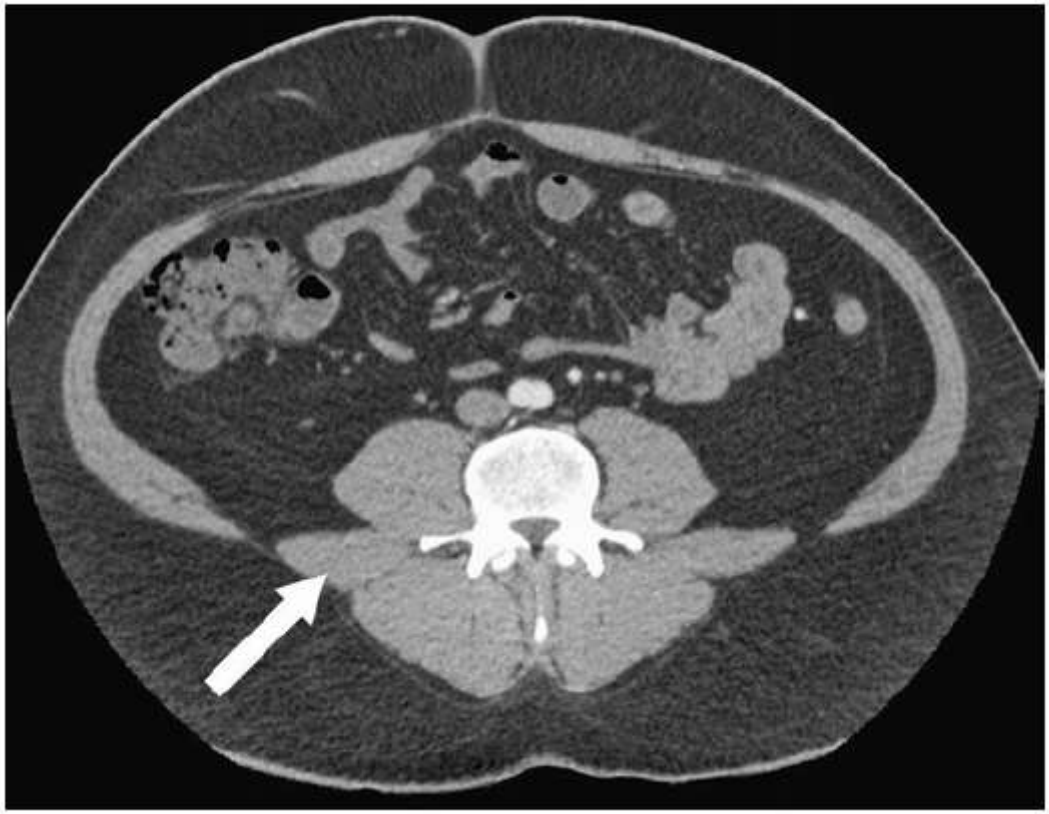


Question 34: T2-weighted axial MRI of the pelvis

Answer: Right psoas major muscle

- The paired psoas major muscles run laterally from the lumbar vertebrae.
- They attach superiorly to the transverse processes of T12-L5 and the lumbar vertebral bodies.
- Psoas major joins the iliacus muscle to form the iliopsoas, which inserts onto the lesser trochanter of the femur.
- *Psoas* is Greek for 'loin'. A beef tenderloin or fillet is actually the psoas muscle.

- **Question 41:**

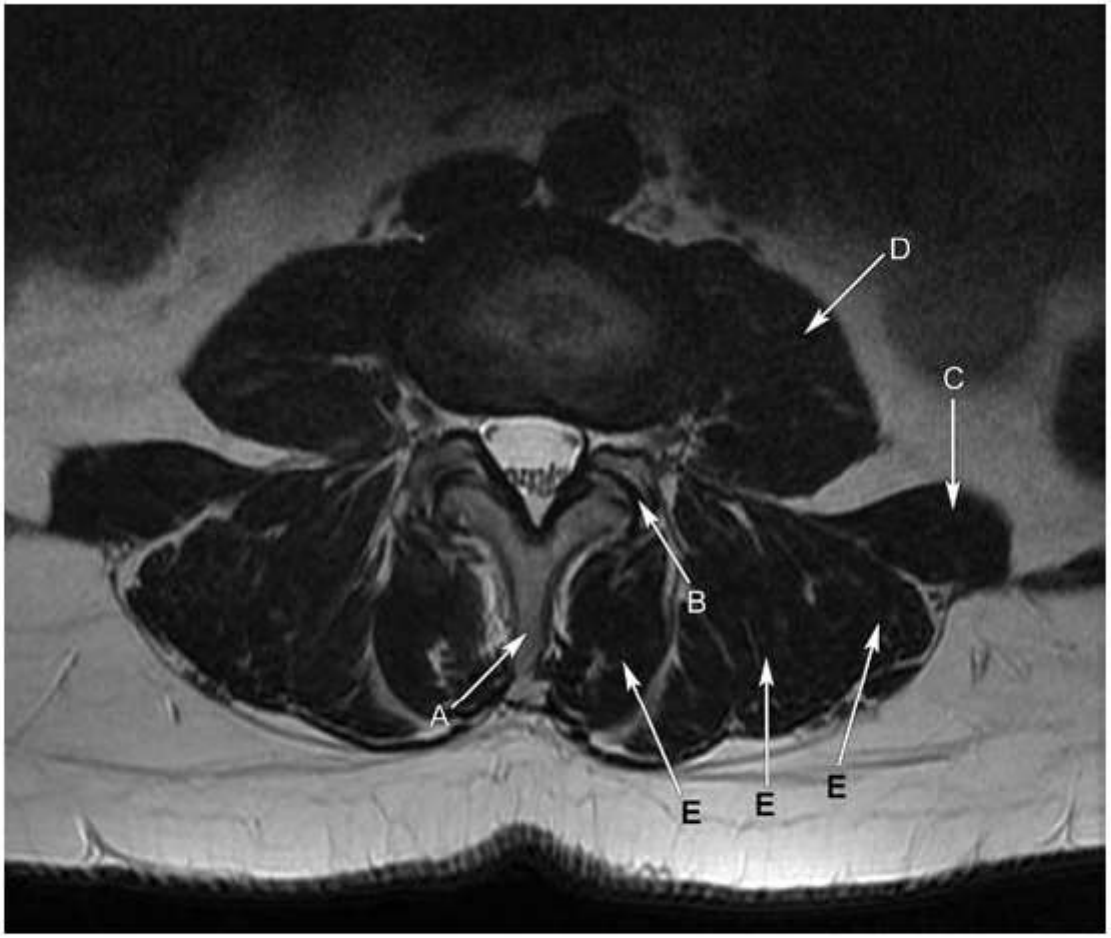


Question 41: Axial contrast-enhanced CT of the abdomen

Answer: Right quadratus lumborum muscle

- The quadratus lumborum muscle is one of the muscles of the posterior abdominal wall. The others are psoas major, iliacus, external oblique, internal oblique, and transversus abdominis.
- It is quadrilateral in shape.
- It lies lateral to the lumbar transverse processes, posterior to the psoas major, and anterior to erector spinae.
- Lateral to quadratus lumborum is the lumbar triangle, a potential site of abdominal herniation.

Question 4.20



This is an axial MRI of the lumbar spine at the level of the L3/4 intervertebral disc. Name the structures labelled A to E.

4.20 Axial T2 MRI of the lumbar spine

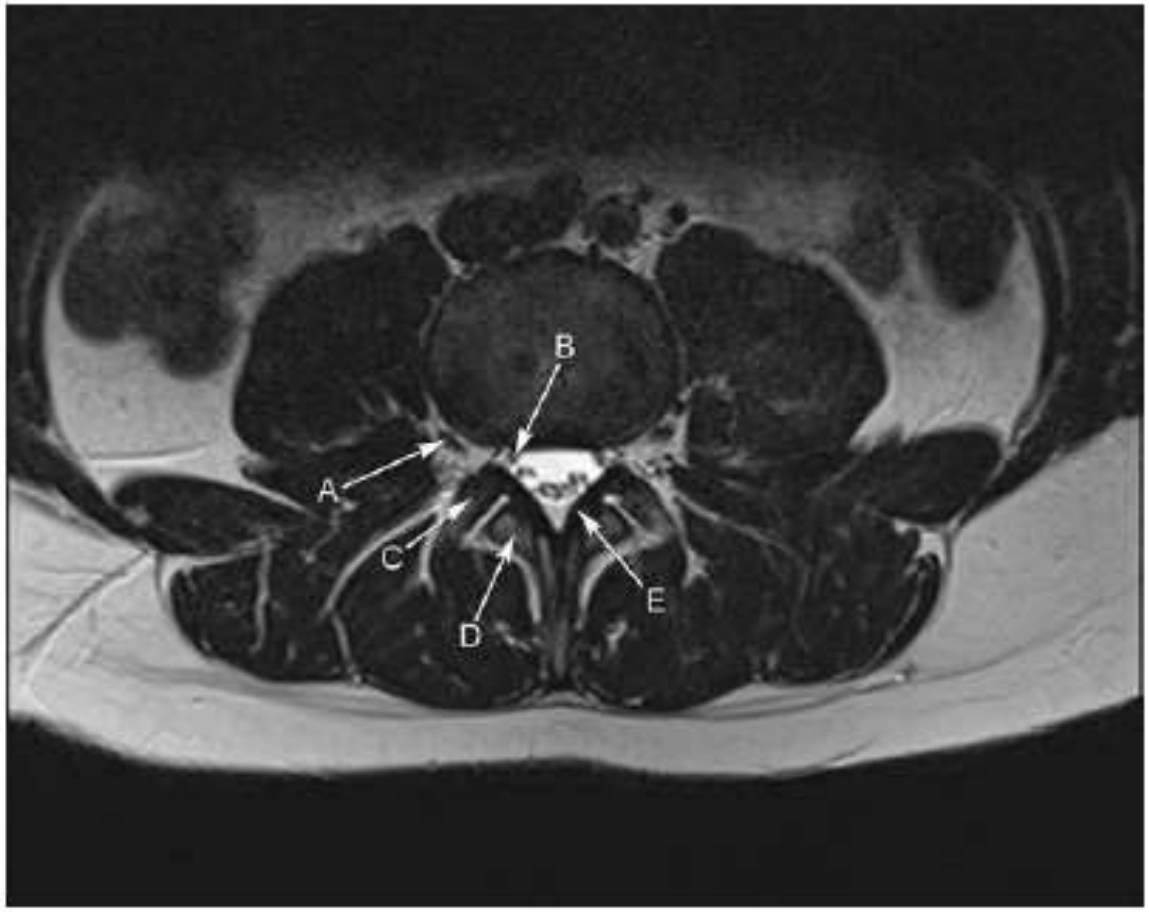
A Spinous process of L3.
B Left L3/4 facet joint.
C Left quadratus lumborum muscle.
D Left psoas major muscle.
E Left erector spinae muscle.

The ligamentum flavum is a ligament that connects the laminae of the vertebrae and extends from C2 to S1. Hypertrophy of the ligamentum flavum is a factor that contributes to spinal stenosis, along with facet joint hypertrophy, osteophyte formation and bulging discs. The quadratus lumborum can be recognized as it lies laterally and posteriorly to the psoas and adjacent to the transverse processes. As the name suggests, it is quadrilateral in shape. It extends from the inferior surface of the 12th rib and inserts into the iliac crest.

The erector spinae is located either side of the spinous process of the vertebral column and is composed of three muscles, which can be remembered by the mnemonic 'I love spinach' (lateral to medial):

- Iliocostalis.
- Longissimus.
- Spinalis.

Question 10.1



This is an MRI of the lumbar spine at the level of the L4/5 intervertebral disc. Name the structures labelled **A** to **E**.

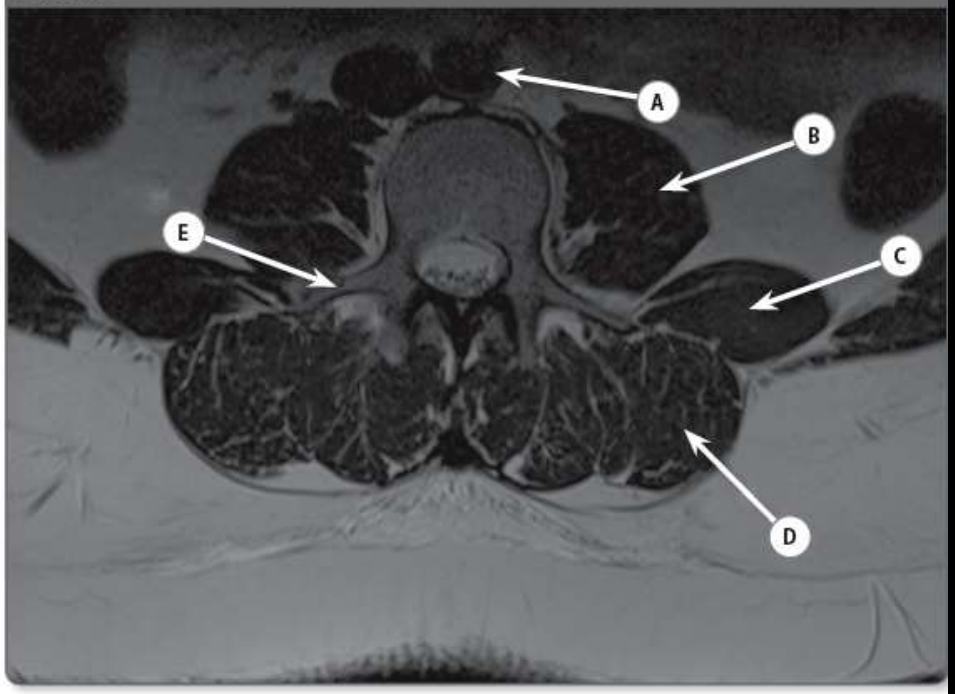
10.1 Axial T2 MRI of the lumbar spine

A Right L4 exiting nerve root.
B Right L5 nerve root.
C Right superior articular facet of L5.
D Right inferior articular facet of L4.
E Ligamentum flavum.

The nerves of the cauda equina are well demonstrated on T2-weighted axial imaging of the lumbar spine. They appear as low signal intensity punctate structures within the bright signal intensity of the surrounding cerebrospinal fluid. The cauda equina are the continuing nerve roots from the cord, which gradually decrease in number as the root pairs exit the spinal column. Within the thoracolumbar spine the nerve roots exit at the exit foramen below the root. For example, the L4 nerve root exits at L4/L5, and is the traversing nerve root at L3/L4.

The ligamentum flavum is a collection of ligaments attached to the vertebral laminae running all the way from C2 to S1. They are seen posteriorly on the interior of the vertebral canal. Hypertrophy of these ligaments can lead to canal stenosis. The facet joints are well demonstrated on this image, with the inferior facets of the vertebra above (L4) lying posterior to the superior facets of the vertebra below (L5).

Case 2.8



Case 2.8 Axial MRI at the level of L3

	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 2.8

A Abdominal aorta

B Left psoas major muscle

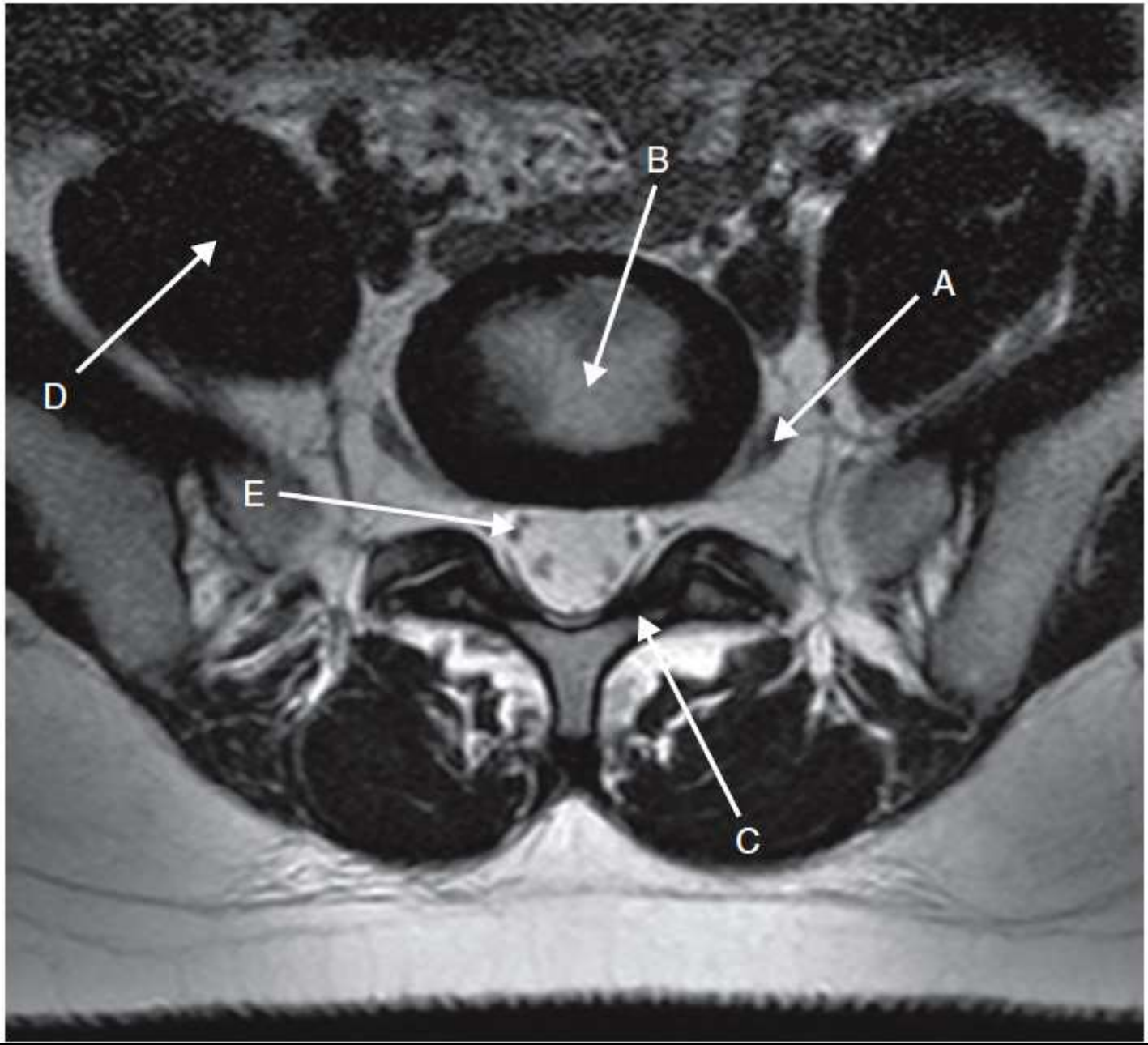
C Left quadratus lumborum muscle

D Left erector spinae muscle

E Right transverse process of L3

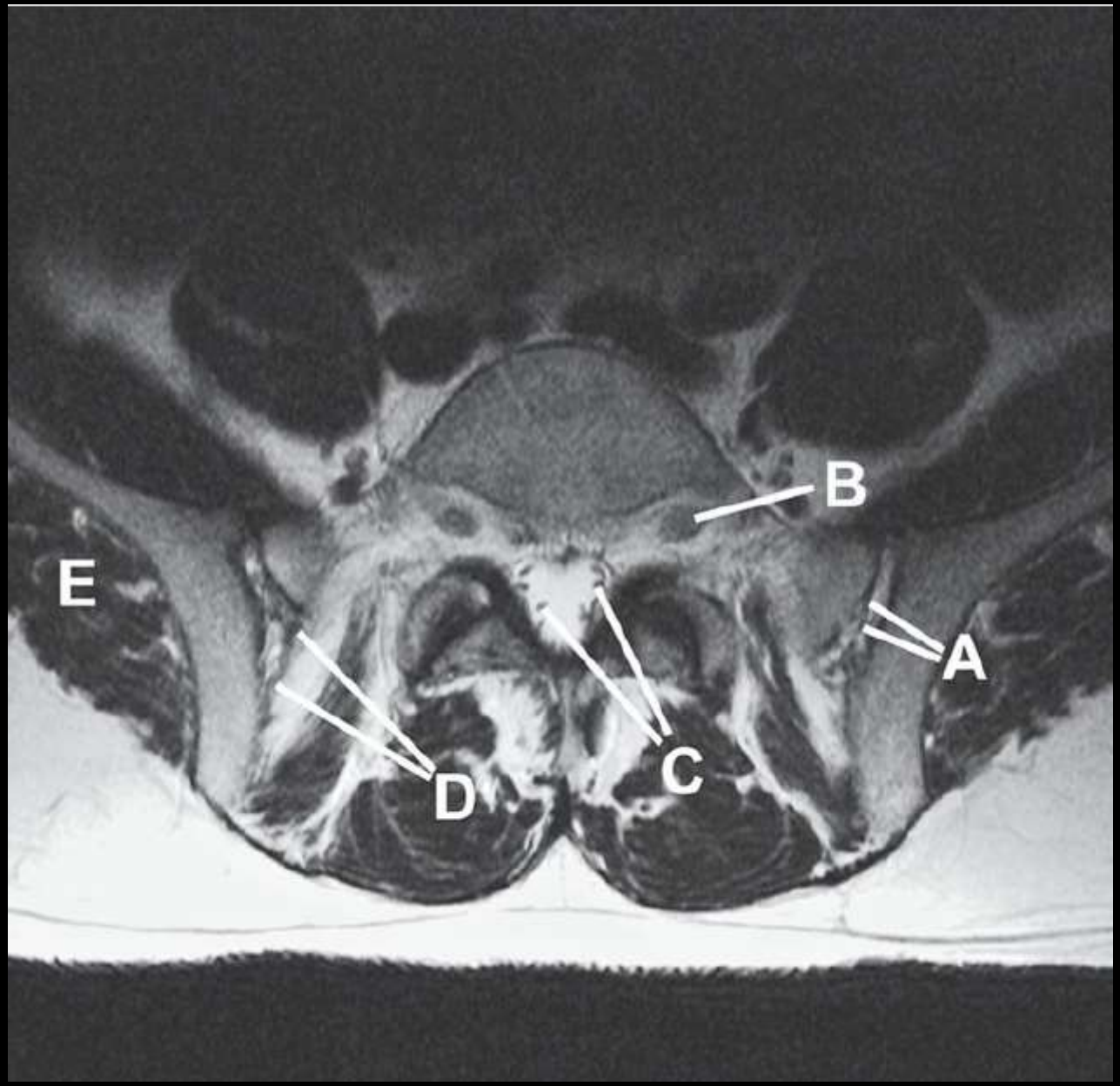
The approximate level of lumbar vertebra can be estimated by observing the blood vessels anterior to the vertebral column. The aorta typically bifurcates at the level of L4, with the IVC usually forming at L5 – hence visualisation of both vessels implies a vertebral level of L3 or above. Exam questions commonly enquire as to the exiting nerve root levels. In the lumbar spine, as with thoracic, nerve roots exit under the pedicle of the corresponding vertebra, i.e. the left L3 nerve root exits under the left pedicle of the L3 vertebra, through the neural exit foramen. This is an important concept to understand when assessing nerve root compression in intervertebral disc disease.

Case 3.2



3.2 Axial T2-weighted lumbar spine through L5

(a) Left L5 nerve. At the level of the L5/S1 disc, the L5 nerve has already left the neural exit foramen. It may become compromised by a far lateral L5 disc herniation in this position.
(b) Nucleus pulposus of L5/S1 disc. This soft central component of the disc is surrounded by the tough outer annulus fibrosus. Annular defects result in herniation of the nucleus pulposus referred to as protrusions or extrusions, based upon their morphology. On T2-weighted images the nucleus pulposus is of high signal and the annulus fibrosus is of low signal intensity.
(c) Left lamina of L5 vertebra. Each lamina fuses in the midline to form the spinous process. The lamina is partly or completely resected (laminectomy) during lumbar disc surgery to facilitate access to the disc.
(d) Right psoas major muscle. This is a powerful hip flexor. In the clinical setting of lumbar discitis it is common to see infection tracking from the disc space into the psoas muscle to form a psoas abscess.
(e) Right S1 nerve.


B
E
A
D
C

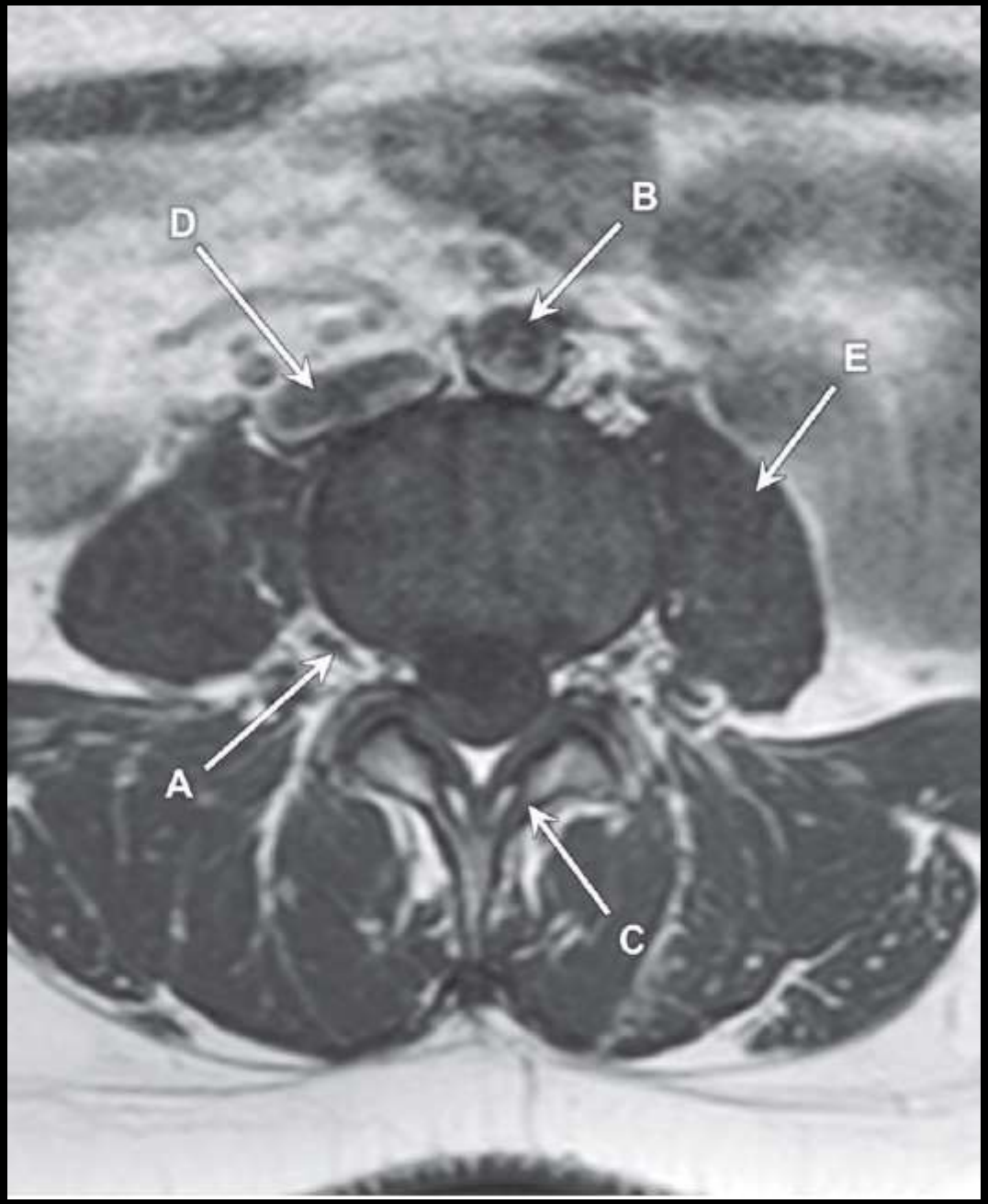
Q17 Answers

a Interosseous sacroiliac ligament
b Dorsal nerve root
c Nerve roots of the cauda equina
d Dorsal sacroiliac ligament
e Gluteus medius

T2W MRI of lower lumbar spine, axial section

Each sacro-iliac joint has to withstand significant forces as they support the axial load of the trunk through their connection to the pelvis and lower limb. The adjacent joint surfaces are irregular but reciprocal in outline which adds to this strength. Additional support is provided by dorsal and ventral sacroiliac ligaments and a deeper interosseous sacroiliac ligament. A small amount of movement is permitted in the joint, predominantly in a rotatory axis.

Nerve roots exit the dura mater to pass obliquely and inferiorly through the intervertebral foramina.


D
B
E
A
C

Case 18

MRI lumbar spine. T1W axial section.

1. Exiting nerve root (right)
2. Abdominal aorta
3. Left vertebral lamina
4. Inferior vena cava
5. Left psoas muscle