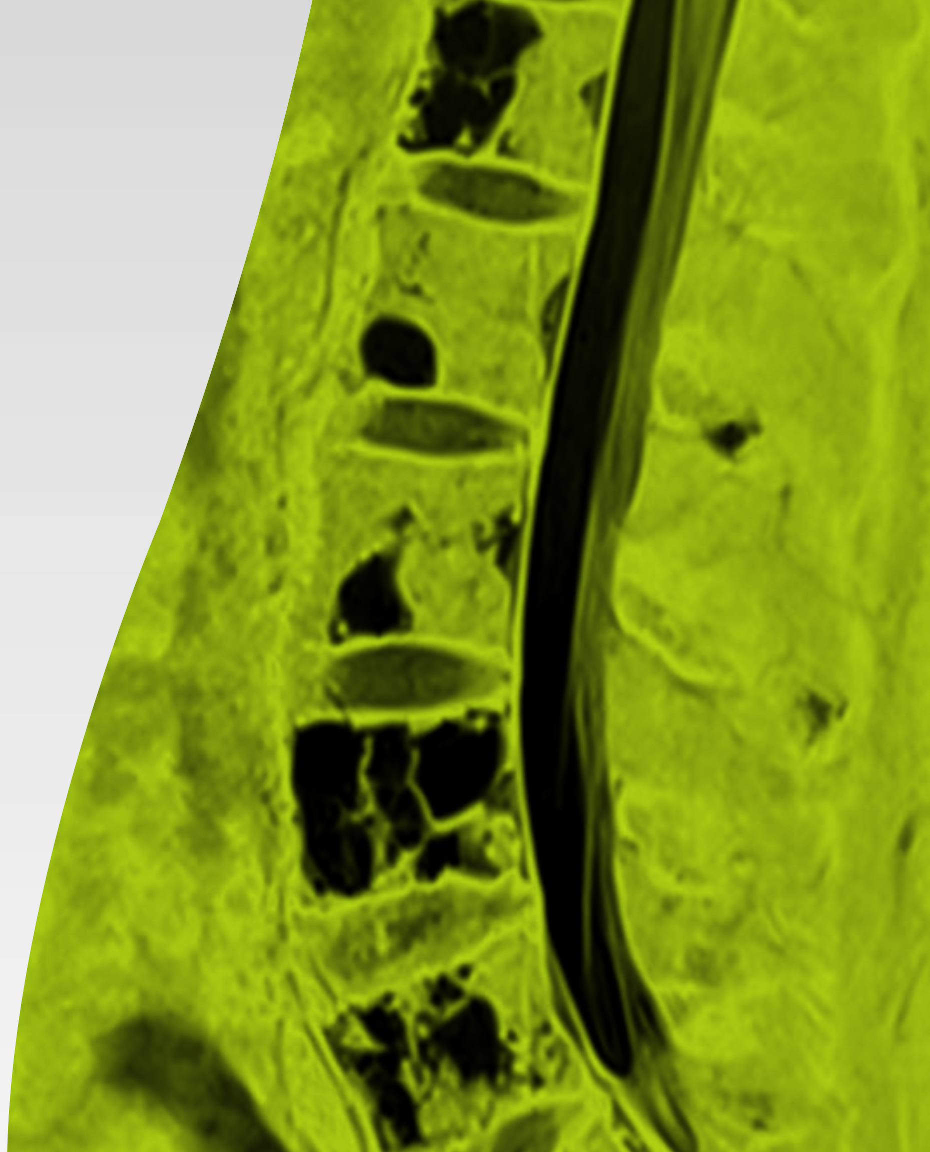
MODERN RADIOLOGY eBook

Spine Imaging



EUROPEAN SOCIETY OF RADIOLOGY

Preface

Modern Radiology is a free educational resource for radiology published online by the European Society of Radiology (ESR). The title of this second, rebranded version reflects the novel didactic concept of the *ESR eBook* with its unique blend of text, images, and schematics in the form of succinct pages, supplemented by clinical imaging cases, Q&A sections and hyperlinks allowing to switch quickly between the different sections of organ-based and more technical chapters, summaries and references.

Its chapters are based on the contributions of over 100 recognised European experts, referring to both general technical and organ-based clinical imaging topics. The new graphical look showing Asklepios with fashionable glasses, symbolises the combination of classical medical teaching with contemporary style education.

Although the initial version of the *ESR eBook* was created to provide basic knowledge for medical students and teachers of undergraduate courses, it has gradually expanded its scope to include more advanced knowledge for readers who wish to 'dig deeper'. As a result, *Modern Radiology* covers also topics of the postgraduate levels of the *European Training Curriculum for Radiology*, thus addressing postgraduate educational needs of residents. In addition, it reflects feedback from medical professionals worldwide who wish to update their knowledge in specific areas of medical imaging and who have already appreciated the depth and clarity of the *ESR eBook* across the basic and more advanced educational levels.

I would like to express my heartfelt thanks to all authors who contributed their time and expertise to this voluntary, non-profit endeavour as well as Carlo Catalano, Andrea Laghi and András Palkó, who had the initial idea to create an *ESR eBook*, and - finally - to the ESR Office for their technical and administrative support.

Modern Radiology embodies a collaborative spirit and unwavering commitment to this fascinating medical discipline which is indispensable for modern patient care. I hope that this *educational* tool may encourage curiosity and critical thinking, contributing to the appreciation of the art and science of radiology across Europe and beyond.

Minerva Becker, Editor
Professor of Radiology, University of Geneva, Switzerland

Spine Imaging

CHAPTER OUTLINE:

/ Copyright and Terms of Use

How to cite this work:

European Society of Radiology, Gennaro D'Anna, Elena Bianchini, Ilaria Salemi, Luigi Manfrè (2025) ESR Modern Radiology eBook:

- Spine Imaging.
  DOI 10.26044/esr-modern-radiology-26

/ Signage

<■> **CORE KNOWLEDGE**

>■< **FURTHER KNOWLEDGE**

<!> **ATTENTION**

>|< **COMPARE**

<?> **QUESTIONS**

<↑> **HYPERLINKS**

<∞> **REFERENCES**

/ Spine Imaging

CHAPTER OUTLINE:

MODERN RADIOLOGY eBook

Based on the ESR Curriculum for Radiological Education

Spine Imaging

AUTHORS

Gennaro D'Anna[1] | Elena Bianchini[1] | Ilaria Salemi[1] | Luigi Manfrè[2]

AFFILIATION

1) Neuroimaging Unit – ASST Ovest Milanese, Legnano (Milan) – Italy

2) Oncologic Institute of the Mediterranean, Catania – Italy

/ Spine Imaging

CHAPTER OUTLINE:

Chapter Outline

Spine: Introduction

CHAPTER OUTLINE:

/ Spine: Introduction

The spine is a complex structure (Fig. 1) with various essential functions:

- allows the whole body to stand and walk
- provides support and protection for the spinal cord
- It's an important place for the haematopoietic apparatus

Understanding the radiological anatomy of the spine and spinal cord is crucial for radiologists, as it aids in the diagnosis and management of various neurological and orthopaedic conditions.

The spine is often underestimated during medical studies although it can be affected by many different pathologic conditions. Nevertheless, knowledge of spine anatomy and pathology is an important part of the core curriculum of future physicians and radiologists. Image-guided interventional procedures play an increasing role for the management of patients with various spine pathologies.

FIGURE 1

T2W sagittal image of the whole spine

/ Spine Imaging

CHAPTER OUTLINE:

/ Anatomy

CHAPTER OUTLINE:

Typical Vertebra

The vertebra is a short bone that has a rough typical shape, with some variations in different segments. The typical vertebra has a body anteriorly and a neural arch posteriorly (Fig. 2).

Vertebral Body: The anterior part of the vertebra is reel-like in shape, and its size increases cranio-caudally.

Neural Arch: Complex bony structure composed of multiple parts, contributing to the creation of the spinal canal. It is composed of:

- **Pedicles:** Two short, bony projections that extend from the posterior edge of the vertebral body
- **Lateral Masses:** Two structures formed by the union of the superior and inferior articular processes. On the superior and the inferior aspects lie the **inferior articular process** and **superior articular process**
- **Laminae:** Two flat, thin plates of bone that join posteriorly at the midline to complete the neural arch
- **Spinous Process:** Prominent, posteriorly-directed projection arising at the junction of the laminae
- **Transverse Processes:** Lateral bony extensions arising from the junction of the pedicles and laminae

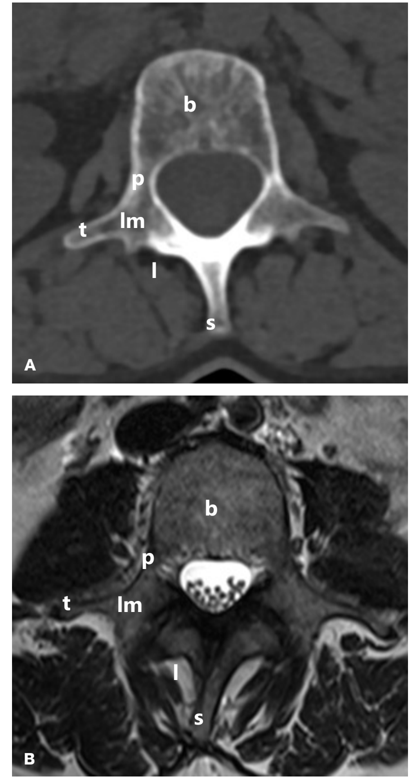


FIGURE 2

Axial CT image (A) and axial T2W sequence (B) of a lumbar vertebra. b: body; p: pedicle; lm: lateral mass; t: transverse process; l: lamina; s: spinous process

Spine Imaging

CHAPTER OUTLINE:

/ Spine Regions

The vertebral column consists of 33 vertebrae grouped into five regions (Fig. 3):

1. **Cervical (C1-C7 [red])**: This region includes the first seven vertebrae, from the base of the skull to the upper thoracic region.
2. **Thoracic (Th1-Th12 [turquoise])**: Located in the upper and mid-back, the thoracic vertebrae are characterized by the presence of ribs attached to each vertebra.
3. **Lumbar (L1-L5 [yellow])**: The lumbar vertebrae are the largest and provide support for much of the body's weight.
4. **Sacrum (S1-S5 [pink])**: These five vertebrae are fused to form a single body.
5. **Coccygeal (Co1-Co4)**: The coccygeal vertebrae are fused to form the coccyx, commonly known as the tailbone.

FIGURE 3

Sagittal T2W sequence of the spine. Vertebral body (vb); intervertebral disc (d). Image reproduced from the ESR e book chapter CNS.
DOI 10.26044/esr-undergraduate-ebook-07

/ Intervertebral Disc

Between each vertebral body, except for the C1 and C2 vertebrae, there is an **intervertebral disc** that provides shock absorption and enables movement between adjacent vertebrae.

Each intervertebral disc is composed of a peripheral annulus fibrosus and a central nucleus pulposus (Fig. 4).

In the thoracic spine, the intervertebral disks have the same height anteriorly and posteriorly, whereas in the cervical and lumbar spine, they are higher anteriorly than posteriorly. Disk height decreases with increasing age.

The nucleus pulposus has no blood supply (nutrition via diffusion), while the annulus fibrosus has a peripheral blood supply both in children and adults.

<!> ATTENTION

The union of an intervertebral disc and the adjacent vertebrae forms the Disco-Somatic Unit, the smallest functional unit of the spine.

FIGURE 4

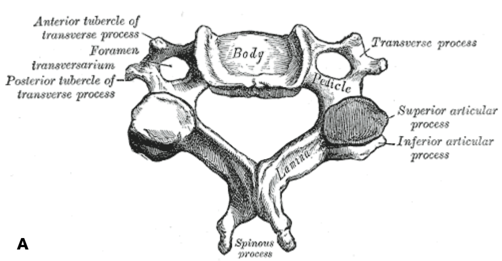
(A) Sagittal T2W MRI sequence of the lumbar spine showing three intervertebral discs (arrows); (B) Simplified drawing of the intervertebral disc with the central nucleus pulposus end peripheral annulus fibrosus.

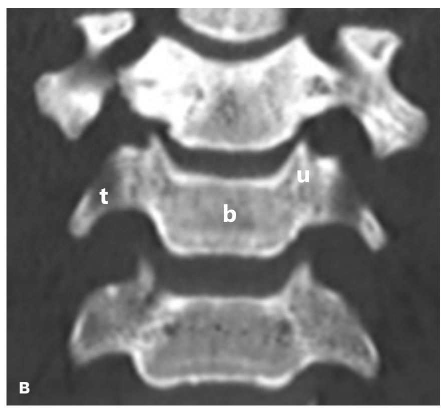
CHAPTER OUTLINE:

/ Cervical Spine

The cervical spine (Fig. 5) is the portion of the vertebral column that extends from the skull base to the thorax and supports the neck. It consists of seven cervical vertebrae, labelled C1 to C7. C1 (atlas), C2 (axis) and C7 (vertebra prominens) have distinct anatomical features whereas C3-C6 display the following typical anatomy:

- a small body, with the presence of a posterolateral lip (uncus, or uncinate process) and the pedicles
- a large vertebral foramen
- a relatively small vertebral canal
- a long bifid spinous process
- bilateral transverse processes with the transverse foramen which allows passage of the vertebral arteries and veins





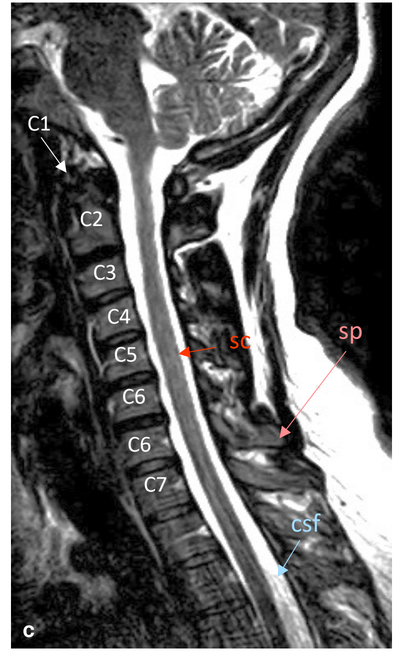


FIGURE 5

(A) Drawing from Gray's Anatomy of a cervical vertebra. (B) CT coronal MPR of the cervical spine showing the body (b), the transverse (t) and the uncinate processes (u); (C) Sagittal T2W sequence of the cervical spine. Spinal cord (sc). Cerebrospinal fluid (csf). Spinous process (sp).

/ Spine Imaging

CHAPTER OUTLINE:

Atlas (C1)

The atlas (Fig. 6) is the first vertebra, with some special features:

It lacks a body and consists of an anterior arch, a posterior arch, and two lateral masses that articulate cranially with the occipital condyles.

Laterally, it has paired transverse processes.

Despite not having a real body, the odontoid process of C2 acts as a functional body.

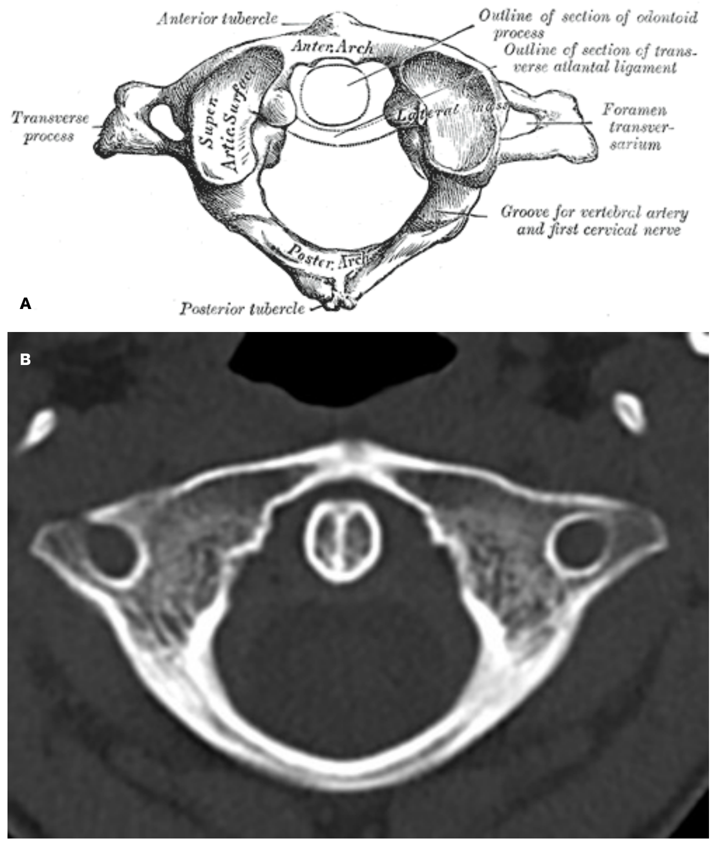


FIGURE 6

(A) Drawing from Gray's Anatomy of a cervical vertebra. (B) CT coronal MPR of the cervical spine showing the body (b), the transverse (t) and the uncinate processes (u); (C) Sagittal T2W sequence of the cervical spine. Spinal cord (sc). Cerebrospinal fluid (csf). Spinous process (sp).

Axis (C2)

The second cervical vertebra (axis) also has dome special features (Fig. 7).

The most important feature is the **odontoid process** (or dens), which acts as the functional body of the atlas (C1).

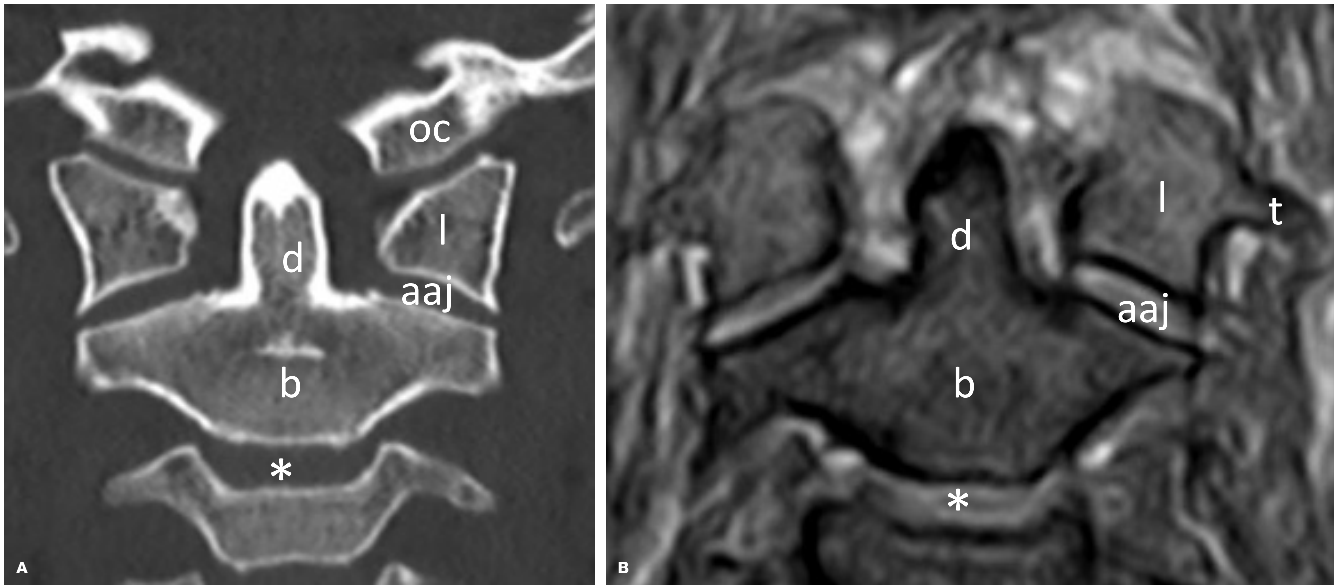


FIGURE 7

(A) CT coronal MPR and (B) T2W sequence of the cervical spine showing C2 and its relationships with C1. Dens axis (d). Body of C2 (b) Transverse process of the atlas (t). Lateral mass of the atlas (l). Atlanto-axial joint (aaj). Intervertebral disk C2-C3 (*). Occipital condyle (oc)

/ Thoracic Spine

The thoracic spine is composed of 12 vertebrae, with a medium size anterior body and a long, downward-pointing spinous process (Fig. 8).

The transverse processes extend laterally and posteriorly. Unlike the cervical vertebrae, the thoracic transverse processes do not have a transverse foramen (Fig. 8). They have facets for supplementary joints with the ribs (costal facets).

The first thoracic vertebra (T1) contains a complete facet for the 1st rib and a demi-facet for the 2nd rib.

T1 also features a more horizontally oriented spinous process compared to the other thoracic vertebrae.

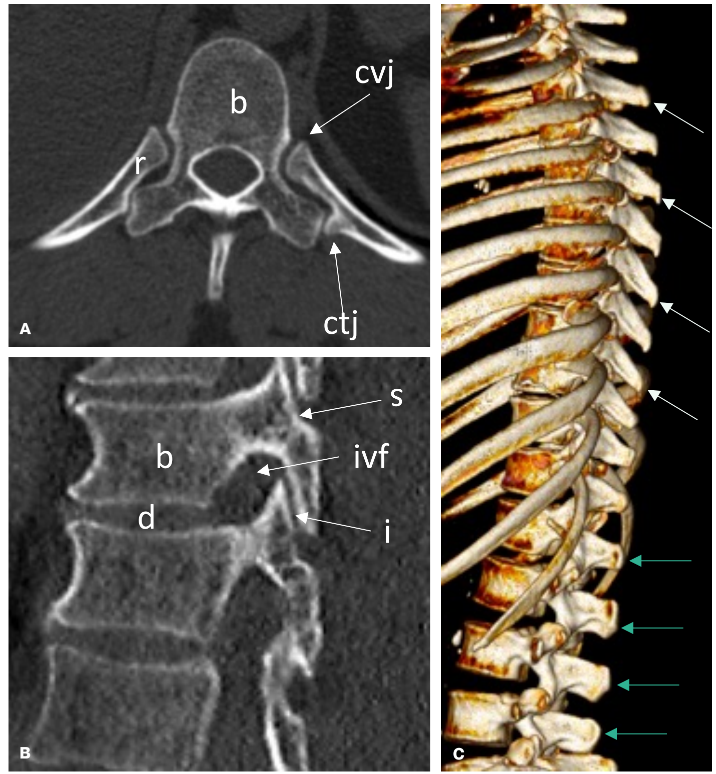


FIGURE 8

(A) Axial CT image, (B) sagittal MPR and 3D volume rendering (C) of the thoracic spine. Vertebral body (b). Costovertebral joint (cvj). Costotransverse joint (ctj). Rib (r). Intervertebral foramen (ivf). Intervertebral disc (d). Superior articular facet (s). Inferior articular facet (i). Note the long downward pointing spinous processes of the thoracic vertebrae (white arrows) on C. The lumbar vertebrae have a thick spinous process pointing posteriorly (green arrows)

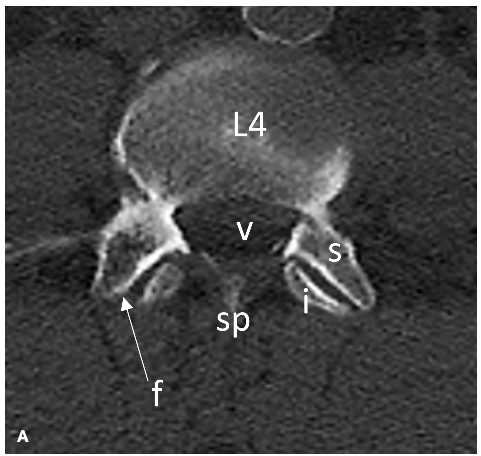
/ Lumbar Spine

The lumbar spine consists of five vertebrae (L1-L5).

Each lumbar vertebra has a robust vertebral body anteriorly and a vertebral arch posteriorly.

They have a short, thick, spinous process that projects posteriorly.

The transverse processes extend laterally and are relatively flat compared to the thoracic vertebrae.



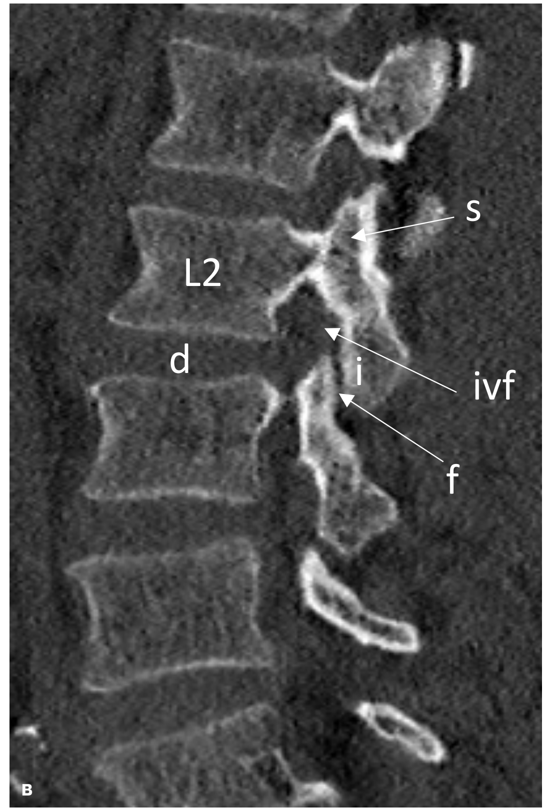


FIGURE 9

Axial CT image through L4 (A) and parasagittal MPR (B) of the lumbar spine. A. Vertebral body of L4. Facet joint L3/L4 (f). Spinous process (sp). Inferior articular process of L3 (i) and superior articular process of L4 (s). Vertebral foramen (v). B. Vertebral body of L2. Intervertebral disc L2/L3. (d). Inferior articular process of L2 (i) and superior articular process (s) of L2. Facet joint L2/L3 (f).

/ Sacrum – Coccyx

The sacrum and coccyx (Fig. 10) are the lowermost portions of the vertebral column, and play essential roles in supporting the pelvis and providing attachment points for various ligaments and muscles.

The sacrum is a triangular-shaped bone located at the base of the vertebral column, between the lumbar spine and the coccyx. It is formed by the fusion of five sacral vertebrae (S1-S5) during late adolescence.

The coccyx, also known as the tailbone, is a small triangular-shaped bone located at the very end of the vertebral column.; it is typically formed by the fusion of four coccygeal vertebrae, although it can vary in the number of fused segments. The number of segments in the coccyx can vary, and in some individuals, it may be partially or completely unfused.

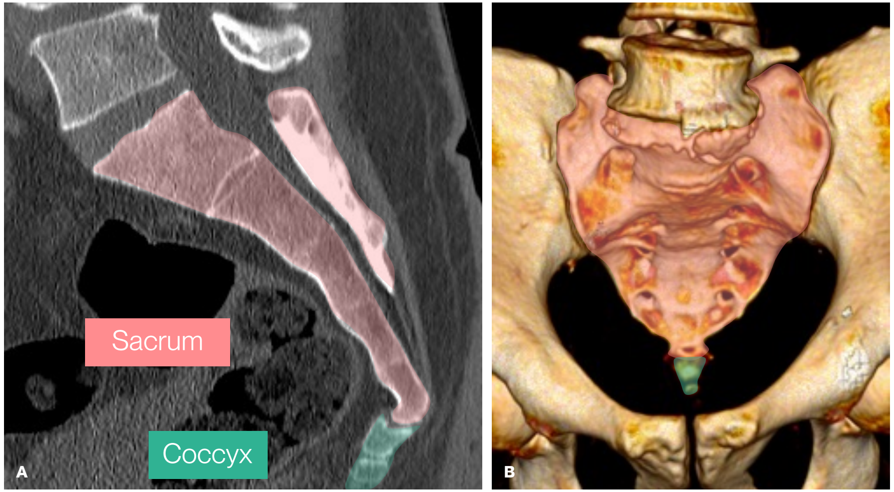


FIGURE 10

(A) CT Sagittal MPR of the sacrum and coccyx. (B) 3D volume rendering from a CT acquisition, anterior view.

/ Spinal Ligaments

The spinal ligaments are shown in Fig. 11.

Anterior Longitudinal Ligament (ALL [orange]): along the anterior (front) surface of the vertebral bodies from the skull to the sacrum.

Posterior Longitudinal Ligament (PLL [blue]): along the posterior (back) surface of the vertebral bodies within the vertebral canal.

Supraspinous Ligament (SSL [green]): along the tips of the spinous processes from the seventh cervical vertebra to the sacrum.

Interspinous Ligament (ISL [pink]): It connects adjacent spinous processes along the posterior aspect of the vertebral column.

Ligamentum Flavum (LF [yellow]): this ligament connects the laminae of adjacent vertebrae within the vertebral canal.

Intertransverse Ligaments: These ligaments connect adjacent transverse processes.

Nuchal Ligament (Ligamentum Nuchae): It's a continuation of the supraspinous ligament in the neck region, extending from the external occipital protuberance to the spinous process of the seventh cervical vertebra.

The PLL, the ISL and the Supraspinosus Ligament along with the facet joint capsule constitute the Posterior Ligament Complex (PLC), which play an important role in fracture evaluation.

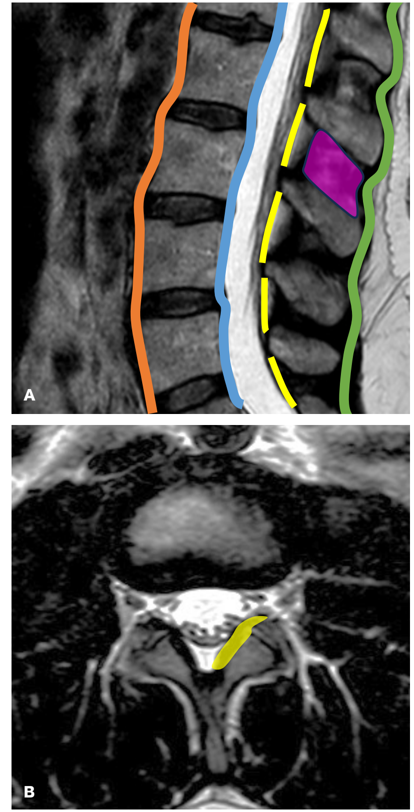


FIGURE 11

Sagittal T2W MRI sequence (A) and axial T2W image (B), with ligaments annotated

/ Spinal Canal and Intervertebral Foramen

The union of the vertebrae forms the **spinal canal**, where lie the spinal cord and the meninges. (Fig. 12) The spinal canal is irregularly oval on axial images.

Laterally, the vertebrae form the **intervertebral** or **neural foramina**, where nerves exit the spinal canal (Fig. 12). On a sagittal image, the neural foramina look like a «comma».

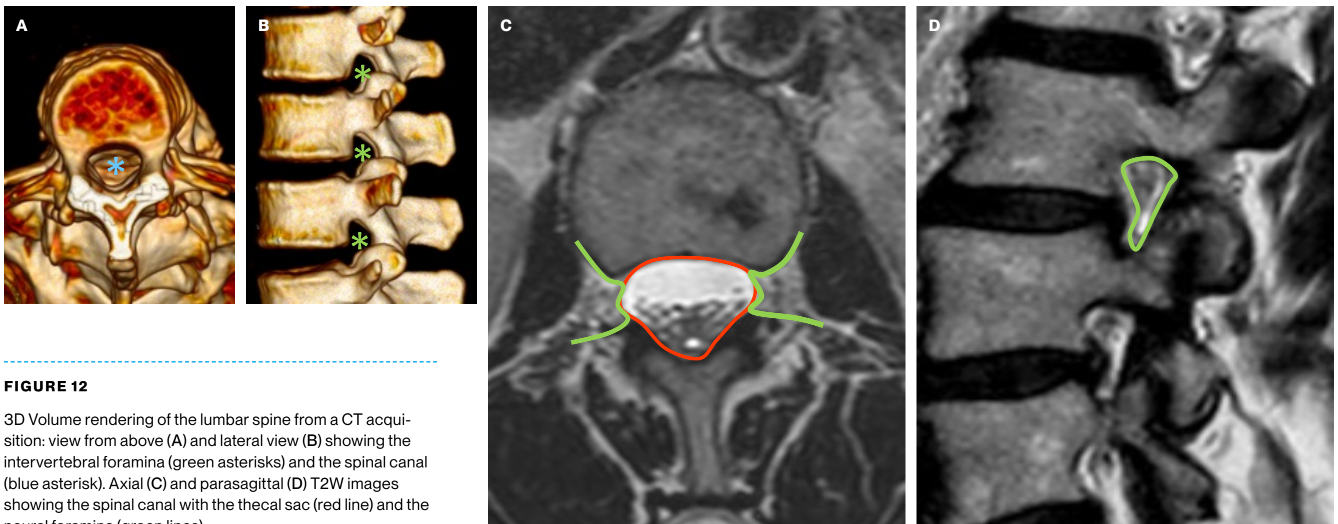


FIGURE 12

3D Volume rendering of the lumbar spine from a CT acquisition: view from above (A) and lateral view (B) showing the intervertebral foramina (green asterisks) and the spinal canal (blue asterisk). Axial (C) and parasagittal (D) T2W images showing the spinal canal with the thecal sac (red line) and the neural foramina (green lines).

/ Variants: Lumbar Transitional Vertebra

Lumbosacral transitional vertebrae (LSTV) are a relatively common variant that can be missed or not well recognised. It is seen in about 9% of the population.

Depending on the total number of vertebrae, the number in a specific segment, or the degree of transition, the vertebrae can be labelled as lumbarised S1 (often associated with lumbar ribs) or sacralised L5.

It is always useful to compare with previous examinations and, if possible, evaluate the entire column.

The most common transitional vertebra is a sacralised L5 (Fig. 13), that can be recognized based on the following findings: only four rib-free lumbar type vertebrae, the wedging of the lowest lumbar (transitional) vertebral body and especially a rudimental intervertebral disc at L5-S1.

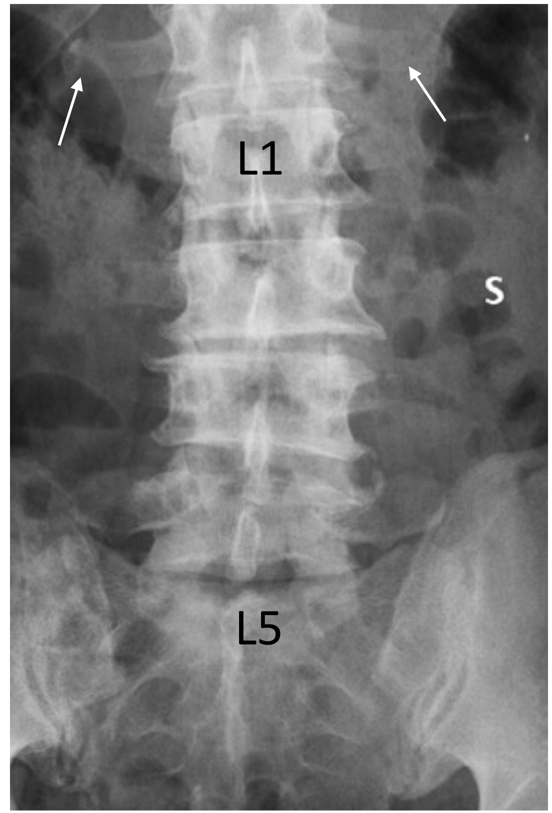


FIGURE 13

PA X-Ray of the lumbar spine showing partial sacralisation of L5. The 12th right and left ribs are indicated by arrows. There were only 4 rib-free lumbar type vertebrae and normal cervical and thoracic spine vertebrae.

/ Castellvi Classification

The **Castellvi classification** (**Fig. 14**) is used for lumbosacral transitional vertebra (LSTV):

- **Type I:** enlarged transverse process (**Ia:** unilateral, **Ib:** bilateral)
- **Type II:** pseudoarticulation of the transverse process and sacrum with incomplete lumbarisation/sacralisation (**IIa:** unilateral, **IIb:** bilateral)
- **Type III:** complete lumbarisation or sacralisation (**IIIa:** unilateral, **IIIb:** bilateral)
- **Type IV:** type **IIa** on one side and type **IIIa** on the other side

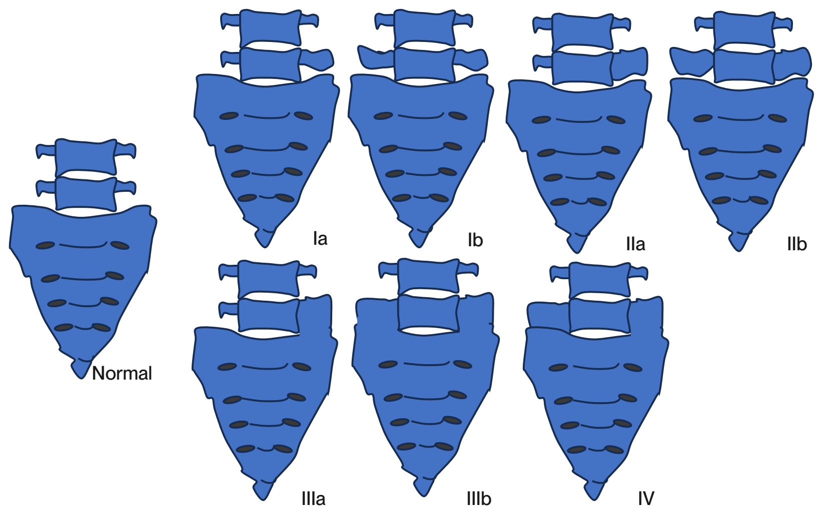


FIGURE 14

Schematic diagram of the Castellvi classification

Degenerative Spine Diseases

CHAPTER OUTLINE:

/ Degenerative Spine Diseases

Low back pain refers to discomfort or pain that occurs in the region of the lower back, below the ribcage and above the hips. It is a common medical complaint and can be caused by a variety of factors. Here are some key concepts related to low back pain:

Low back pain is one of the most common disorders worldwide. It affects people of all ages, but it is particularly prevalent among adults. It can be **Acute** (**Lasts** for a short duration, less than six weeks, and it resolves on its own or with conservative treatment) or chronic (persists for longer than three months).

<∞> REFERENCE

> see also eBook chapter on Central Nervous System and Musculoskeletal Imaging

Causes:

- **Muscle Strain or Sprain:** Often occurs due to sudden or improper lifting, twisting or overexertion
- **Disc extrusion/protrusion:** When part of intervertebral disc protrudes posteriorly (in CNS chapter)
- **Osteoarthritis:** Degeneration of the spine's facet joints
- **Spinal Stenosis:** Narrowing of the spinal canal that can compress the spinal cord or nerve roots
- **Spondylolisthesis:** When one vertebra slips forward over another
- **Trauma or Injury:** Such as from a fall, car accident or sports injury
- **Structural Abnormalities:** Congenital or acquired abnormalities in spine anatomy

CHAPTER OUTLINE:

A seminal paper for understanding this important topic is without any doubt the article by Fardon et al

ELSEVIER

CrossMark

THE SPINE JOURNAL

The Spine Journal 14 (2014) 2525–2545

Review Article

Lumbar disc nomenclature: version 2.0
Recommendations of the combined task forces of the North American Spine Society, the American Society of Spine Radiology and the American Society of Neuroradiology

David F. Fardon, MD[a], Alan L. Williams, MD[b], Edward J. Dohring, MD[c,d,*], F. Reed Murtagh, MD[e], Stephen L. Gabriel Rothman, MD[f], Gordon K. Sze, MD[g]

[a]*Department of Orthopaedics, Midwest Orthopaedics at Rush, Rush University Medical Center, Third Floor, 1611 W. Harrison, Chicago, IL 60612, USA*
[b]*Medical College of Wisconsin, 9200 West Wisconsin Ave., Milwaukee, WI 53226, USA*
[c]*Midwestern University School of Medicine, 19389 N 59th Ave, Glendale, AZ 85308, USA*
[d]*Spine Institute of Arizona, 9735 N. 90th Pl., Scottsdale, AZ 85258, USA*
[e]*Moffitt Cancer Center and Research Institute, University of South Florida College of Medicine, 3301 USF Alumni Dr., Tampa, FL 33612, USA*
[f]*Keck School of Medicine of the University of Southern California, 1975 Zonal Ave., Los Angeles, CA 90089, USA*
[g]*Department of Radiology, Yale University School of Medicine, 20 York St., New Haven, CT 06510, USA*

Received 23 July 2013; revised 17 March 2014; accepted 14 April 2014

REFERENCE

Fardon DF, Williams AL, Dohring EJ, Murtagh FR, Gabriel Rothman SL, Sze GK. Lumbar disc nomenclature: version 2.0: Recommendations of the combined task forces of the North American Spine Society, the American Society of Spine Radiology and the American Society of Neuroradiology. Spine J. 2014 Nov 1;14(11):2525-45. doi: 10.1016/j.spinee.2014.04.022. Epub 2014 Apr 24. PMID: 24768732.

CHAPTER OUTLINE:

/ Spinal Canal Stenosis

Spinal stenosis is the narrowing of the spinal canal to the point at which it can generate compression to the dural sac and the spinal cord/cauda equina. It can be congenital or acquired (degenerative changes).

Several classifications have been proposed: a simple one has been proposed by Lee et al, that reported a four-grade classification based on the morphology of the dural sac on axial T2W images (Fig. 15); it is related to the lumbar spine:

- Grade 0 (no stenosis): the anterior CSF space is not obliterated
- Grade 1 (mild stenosis): the anterior CSF space is mildly obliterated but all cauda equina is still well visible
- Grade 2 (moderate stenosis): the anterior CSF space is moderately obliterated and cauda equina begins to be effaced
- Grade 3 (severe stenosis): the anterior CSF space is severely obliterated and cauda equina can't be visualised

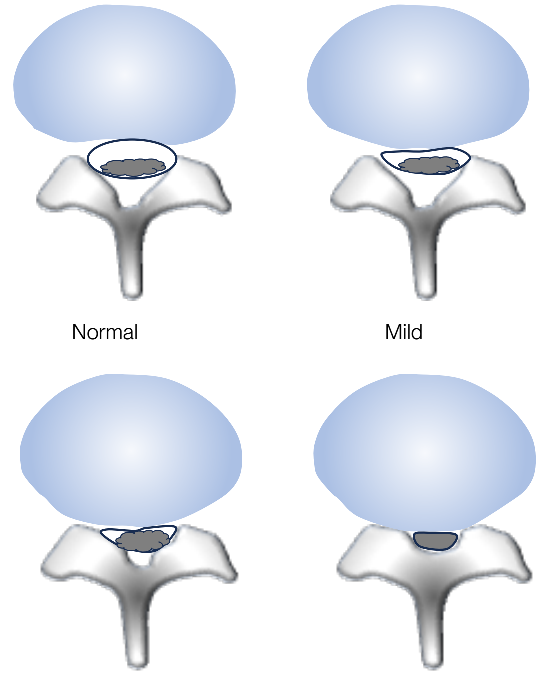


FIGURE 15

Schematic diagram of the spinal canal stenosis classification proposed by Lee et al.

CHAPTER OUTLINE:

/ Foraminal Stenosis

Foraminal stenosis refers to the narrowing of the neural foramina.

It is part of the changes related to the broad chapter of degenerative disease, and can be caused by osteophytes, disc protrusion/extrusion, thickening of ligaments, but especially by the sum of all these conditions.

For the lumbar spine, we can use the classification by Lee et al (Fig. 16) evaluating sagittal T2W images:

- Grade 0: no stenosis, the fat surrounds the nerve root circumferentially
- Grade 1: absence of perineural fat visualization in one dimension
- Grade 2: absence of perineural fat visualization circumferentially but without compression of the nerve root
- Grade 3 (severe): absence of perineural fat visualization with compression of the nerve root

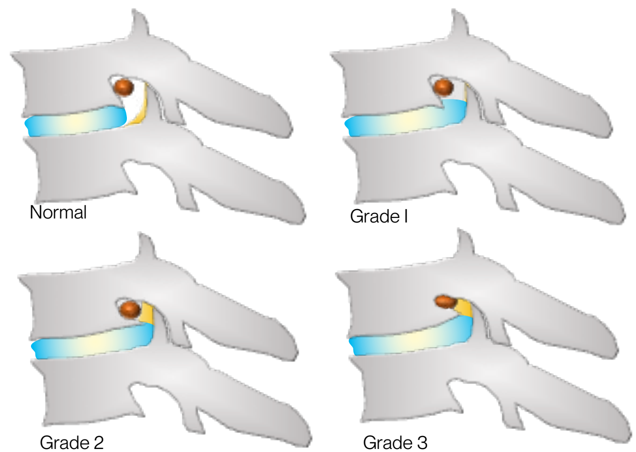


FIGURE 16

Schematic diagram of the Lee classification of lumbar foraminal stenosis

/ Modic Changes

Modic degeneration refers to specific patterns of vertebral bone marrow changes seen on MRI. These changes are named after the Danish radiologist Dr. Michael Modic, who first described them in the 1980s.

The classification has three scores (Fig. 17):

- **Type I:** decreased signal intensity on T1W MR images and increased signal intensity on T2W and STIR images. It refers to oedema and inflammation within the vertebral body.
- **Type II:** increased signal intensity on both T1- and T2W MR images and decreased signal intensity on STIR images. It refers to fatty replacement of the bone marrow.
- **Type III:** decreased signal intensity on T1W, T2W and STIR images. It refers to sclerosis.

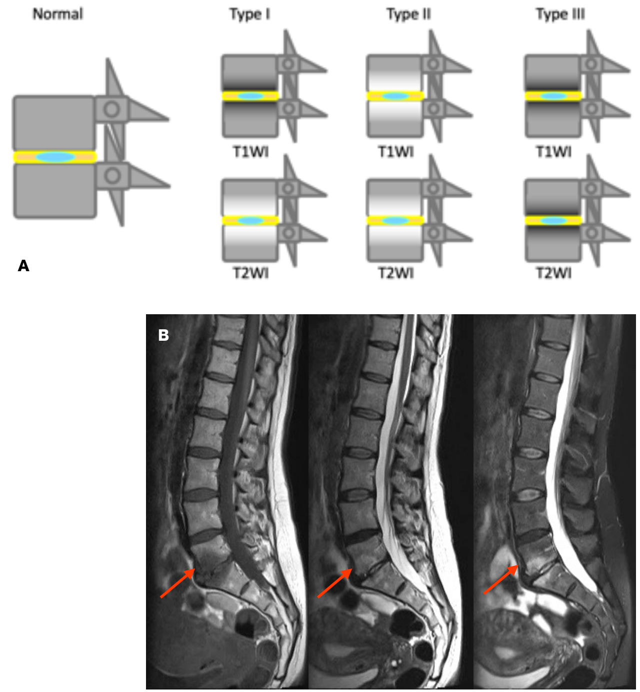


FIGURE 17

(A) Schematic diagram of Modic changes. (B) T1W (left) T2W (center) and STIR images in the sagittal plane, showing Type I Modic changes (arrows) at L5-S1.

Schmorl's Node

Schmorl's node (Fig. 18), also known as an intravertebral disc herniation, is a specific type of disc herniation that occurs within the vertebral body itself.

Schmorl's nodes are thought to be the result of structural weaknesses or defects in the endplate of the vertebra. The endplate is the thin layer of cartilage that covers the top and bottom of each vertebral body, acting as a cushion between the disc and the bone.

On imaging (X-ray, CT or MRI) Schmorl's nodes appear as small, round or oval-shaped lesions within the vertebral body. Schmorl's nodes are often discovered incidentally on imaging studies and may not cause any symptoms.

Schmorl's nodes can be associated with other spinal conditions, such as degenerative disc disease, scoliosis or osteoporosis.

In many cases, Schmorl's nodes are asymptomatic.

FIGURE 18

CT Sagittal MPR of the lumbar spine showing a Schmorl's node in the upper endplate of L4 (arrow).

/ Isthmic Spondylolisthesis

Isthmic spondylolisthesis is a spinal condition that involves the forward displacement of one vertebra over the one below it. This displacement occurs in the pars interarticularis of the neural arch, which is the part of the lateral mass between the superior and inferior articular facets.

Isthmic spondylolisthesis is often caused by a stress fracture in the pars interarticularis, which is usually due to repetitive strain or acute injury. This condition can be congenital (Fig. 19) or acquired later in life. It most commonly occurs at the fifth lumbar vertebra (L5), which slips forward over the sacrum (S1).

It may be completely asymptomatic in many cases and discovered incidentally on imaging studies. However, when symptomatic, common symptoms may include lower back pain, stiffness, muscle tightness and sometimes radiating pain or numbness.

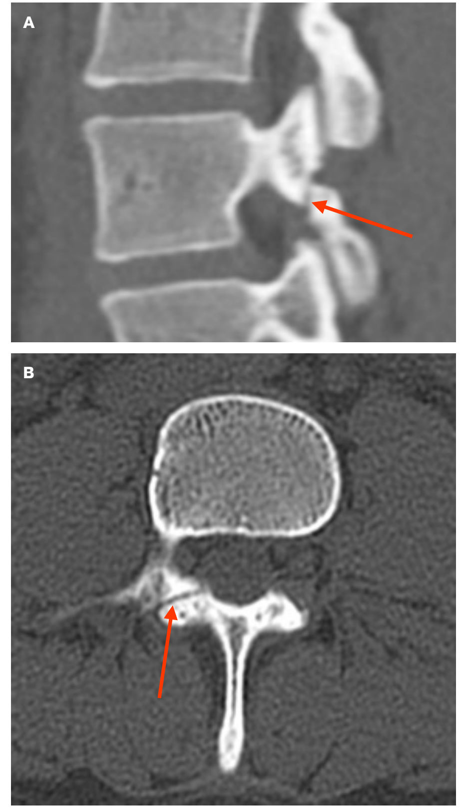


FIGURE 19

CT MPR in the parasagittal (A) and axial (B) plane showing a congenital Isthmic lesion (arrows).

The severity of spondylolisthesis can be classified using the Meyerding grading system (Fig. 20), which divides the superior endplate of the vertebra below into 4 quarters.

The grade depends on the location of the posteroinferior corner of the vertebra above:

- **I:** 0-25%
- **II:** 26-50%
- **III:** 51-75%
- **IV:** 76-100%
- **V:** > 100%

Grade V can also be named spondyloptosis.

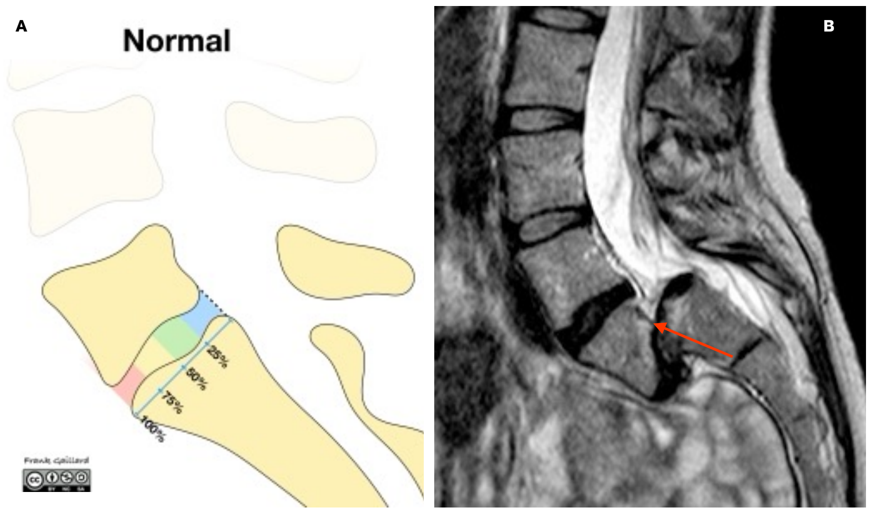


FIGURE 20

(A) Schematic drawing explaining the Meyerding grading system. Case courtesy of Frank Gaillard, Radiopaedia.org, rID: 57603. (B) T2W sagittal MRI sequence of grade IV spondylolisthesis (arrow). Case courtesy of Gennaro D'Anna, Radiopaedia.org, rID: 64335

/ **Spine** Imaging

CHAPTER OUTLINE:

/ Trauma

Vertebral Fractures: Stable versus Unstable Fractures

Vertebral fractures can be a consequence of trauma, osteoporosis and various pathological conditions affecting the spine.

They can occur at any level, and the classification can be done in several ways: morphology, columns, biomechanics. Important is the three-column concept in fracture stability developed by Francis Denis.

Denis divided the vertebral column into 3 vertical columns (Fig. 21):

- **Anterior (red):** anterior longitudinal ligament, anterior two-thirds of vertebral body and the correspondent part of intervertebral disc (especially annulus fibrosus)
- **Middle (green):** posterior one-third of the vertebral body and the correspondent part of intervertebral disc (especially annulus fibrosus), posterior longitudinal ligament
- **Posterior (yellow):** neural arch and ligaments

A fracture is considered stable if only one column is involved, especially the anterior one.

When the anterior and middle columns are involved, the fracture is considered unstable.

When all three columns are involved, the fracture is by definition unstable.

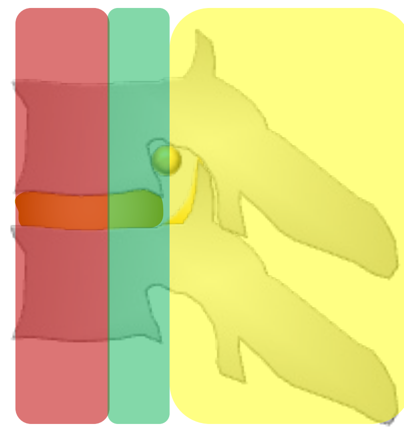


FIGURE 21

Schematic drawing explaining the Denis classification

/ Types of Fractures: Morphology

Fig. 22 and Fig. 23 illustrate different vertebral fracture types.

Compression (wedge) fracture: Loss of vertebral body height, often resulting from osteoporosis or trauma.

Burst Fracture: This involves the vertebral body and posterior elements. They often result from high-energy trauma and can be associated with spinal cord injury.

Flexion-Distraction (Chance) Fractures: Sudden flexion of the spine.

Fracture-Dislocations: These are severe injuries involving both fracture of the vertebral body and dislocation of the facet joints.

<∞> REFERENCE

> see also eBook chapter on Central Nervous System and Musculoskeletal Imaging

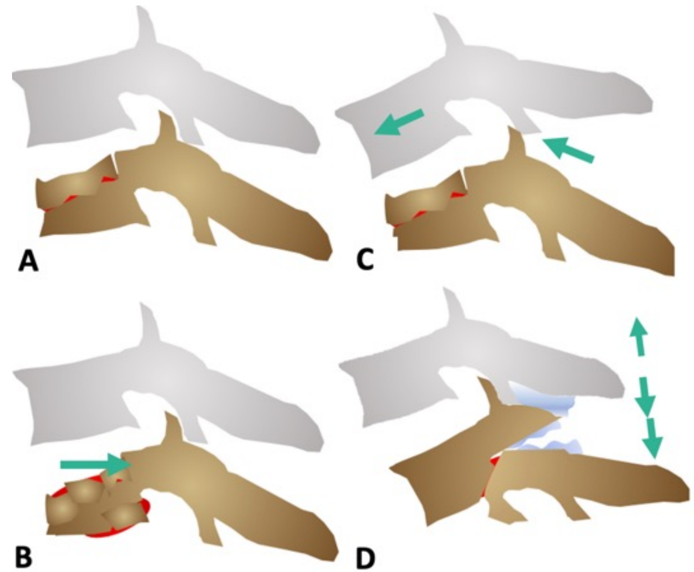


FIGURE 22

Types of vertebral fractures. (A) Simple one point compression fracture (single compression, wedge deformity). (B) Burst two point fracture (compression with superior body fragment displaced posteriorly). (C) Translation/rotation three point fracture (rotatory shearing with anterior/lateral displacement and displacement of facet joint. (D) Distraction four point fracture (horizontal fracture of the posterior elements with their separation).

/ Cervical Fractures

- **Jefferson Fracture (C1 Burst Fracture):** a burst fracture of the first cervical vertebra (the atlas) due to axial loading or hyperextension.
- **Hangman's Fracture (C2 Fracture):** Mechanism: This involves a fracture of the pars interarticularis of the second cervical vertebra (the axis) usually due to hyperextension and axial loading.
- **Odontoid Fractures (C2 Dens Fractures):** These fractures occur at the dens.
- **Extension Teardrop Fracture:** This involves a triangular fragment avulsed from the anteroinferior aspect of a vertebral body.
- **Flexion-Teardrop Fracture:** Mechanism: It is a combination of flexion and axial loading, resulting in both vertebral body compression and avulsion of an anterior-inferior fragment.
- **Clay-Shoveler's Fracture:** this involves an avulsion fracture of the spinous process of a lower cervical or upper thoracic vertebra.

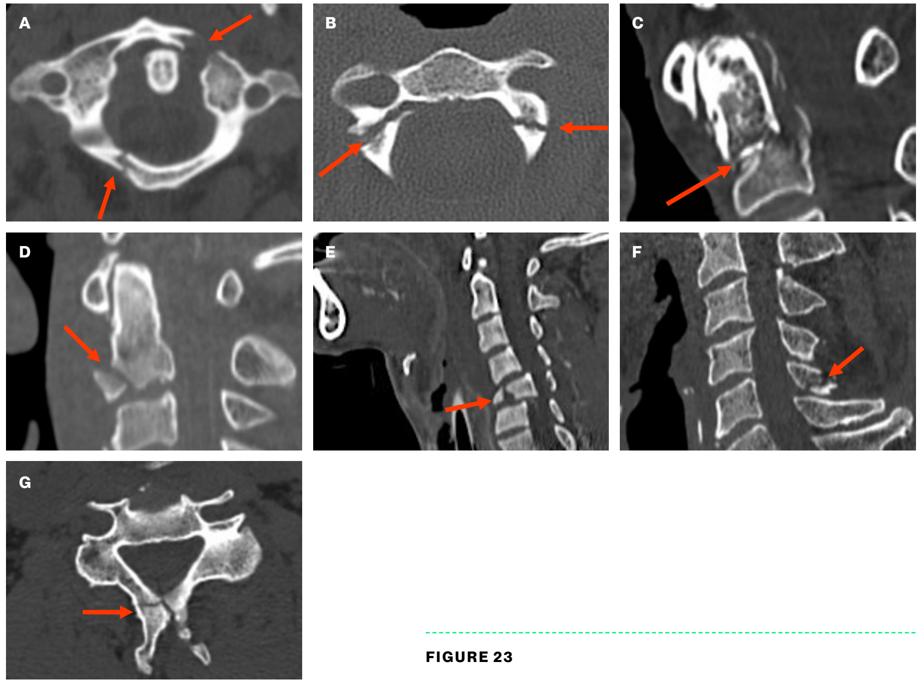


FIGURE 23

(A) Jefferson fracture. Case courtesy of Fakhry Mahmoud Ebouda, Radiopaedia.org, rID: 30679. (B) Hangman fracture Case courtesy of Andrew Dixon, Radiopaedia.org, rID: 10130. (C) Odontoid fracture. (D) Extension teardrop fracture involving C2. (E) Flexion teardrop fracture involving C5. (F and G) Clay-Shoveler's fracture involving C5. Images D-G courtesy Alexandra Platon, MD, Emergency Radiology, Geneva University Hospitals.

/ Thoracolumbar Fractures

The thoracic spine is inherently more rigid than both the cervical and lumbar regions, making it intrinsically more resistant to trauma. Conversely, the lumbar region is more mobile and prone to fractures. It is beneficial to study both regions simultaneously in a trauma setting, particularly because the thoracolumbar junction is the most common site for thoracolumbar fractures, owing to its transitional point of increased mobility (Fig. 24).

When discussing thoracolumbar fractures, two important classifications come into play:

- AO Thoracolumbar Spine Classification
- Thoraco-Lumbar Injury Classification and Severity score (TLICS)

Both classifications are very useful, with some differences:

- AO classification is essentially based on CT assessment and is related to the injury mechanism
- TLICS is more related to MRI and to the clinical condition of the patient. TLICS depicts the features important in predicting spinal stability, future deformity and progressive neurological compromise

>|< COMPARE

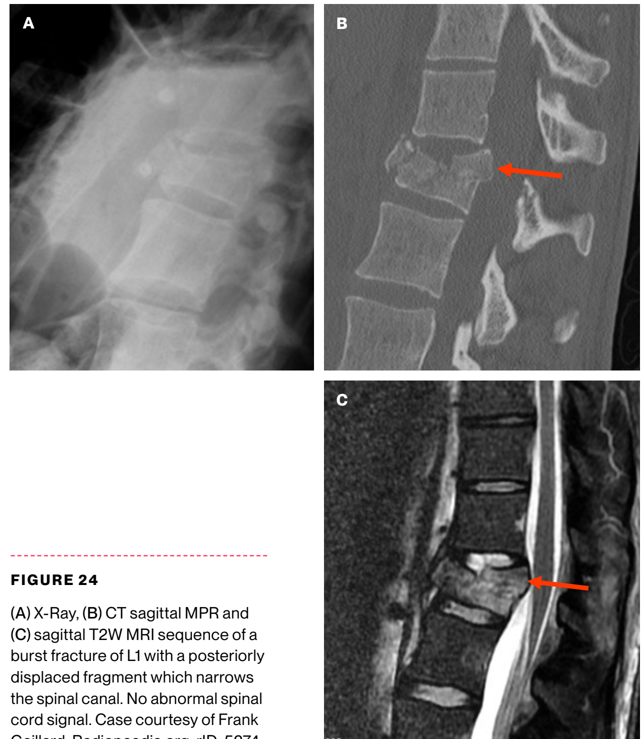


FIGURE 24

(A) X-Ray, (B) CT sagittal MPR and (C) sagittal T2W MRI sequence of a burst fracture of L1 with a posteriorly displaced fragment which narrows the spinal canal. No abnormal spinal cord signal. Case courtesy of Frank Gaillard, Radiopaedia.org, rID: 5274

CHAPTER OUTLINE:

/ Thoracolumbar – AO Classification

The AO classification system (Fig. 25), developed by the AO Foundation, is a widely used method for categorising fractures. It provides a systematic way to describe fractures based on their anatomical location and the degree of displacement or instability.

Type A - Compression Injuries:

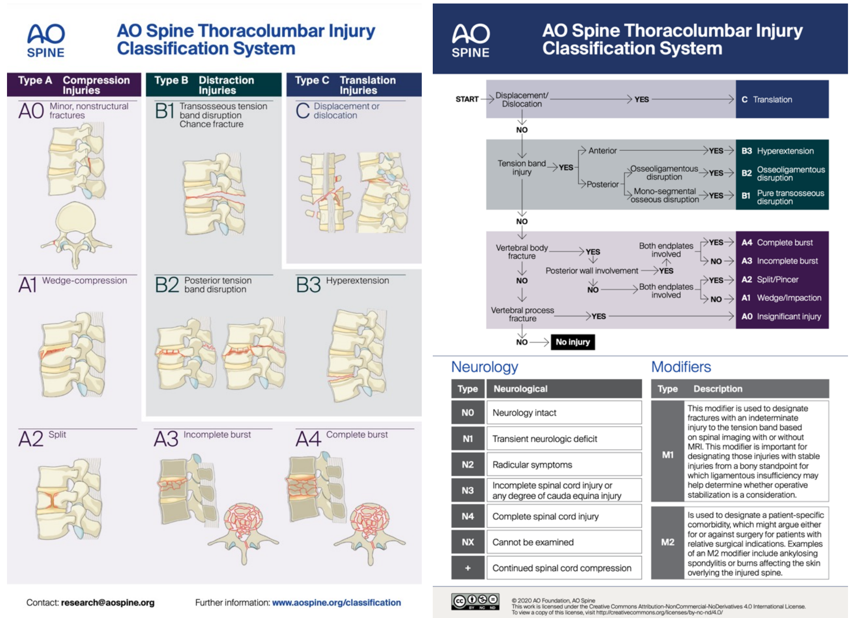
- A1: Impaction
- A2: Split
- A3: Burst

Type B - Distraction Injuries:

- B1: Distraction
- B2: Lateral Flexion
- B3: Flexion-Rotation

Type C - Rotation Injuries:

- C1: Unilateral
- C2: Bilateral
- C3: Dislocation



<∞> REFERENCE

FIGURE 25

The AO classification system (AO stands for Arbeitsgemeinschaft für Osteosynthesefragen, which translates into English as Working Group for Osteosynthesis Questions): https://www.aofoundation.org/spine/clinical-library-and-tools/aospine-classification-systems

CHAPTER OUTLINE:

/ Thoracolumbar – TLICS Classification

The Thoracolumbar Classification for Standards, TLICS (Fig. 26) evaluates three independent parameters:

- Injury morphology
- Integrity of the Posterior Ligamentous Complex (PLC)
- Neurologic status

Each parameter is assigned a score, and the total score provides a prediction of the surgical requirement. It is worth noting that when evaluating the fracture morphology, TLICS also considers the integrity of the Posterior Ligament Complex (PLC) and the neurological status.

Morphology	Compression	1
	Burst	2
	Translation/rotation	3
	Distraction	4
PLC	Intact	0
	Suspected	2
	Injured	3
Neurological status	Intact	0
	Nerve root	2
	Complete cord	2
	Incomplete cord /cauda	3

<∞> REFERENCE

FIGURE 26

The TLICS score. Reproduced from The Radiology Assistant.
https://radiologyassistant.nl/neuroradiology/spine/tlics-classification

CHAPTER OUTLINE:

/ Genant Classification

The Genant Classification is a system used to assess vertebral fractures, specifically in the context of osteoporosis. It provides a standardized way to describe the severity of vertebral fractures based on radiographic imaging based on shape with respect to height loss (Fig. 27).

This classification system considers three key parameters:

- **Grade 0 (normal):** No evidence of any vertebral deformity
- **Grade 1 (mild):** Reduction in anterior, middle, or posterior height of the vertebral body by 20-25%
- **Grade 2 (moderate):** Reduction in anterior, middle, or posterior height of the vertebral body by 26-40%
- **Grade 3 (severe):** Reduction in anterior, middle, or posterior height of the vertebral body by more than 40%

<∞> REFERENCE

> **See Osteoporosis in eBook chapter on Musculoskeletal Imaging**

In addition to assessing vertebral height reduction, the Genant Classification also considers the presence of vertebral wedge deformities and biconcave deformities. These deformities can be additional indicators of vertebral fracture.

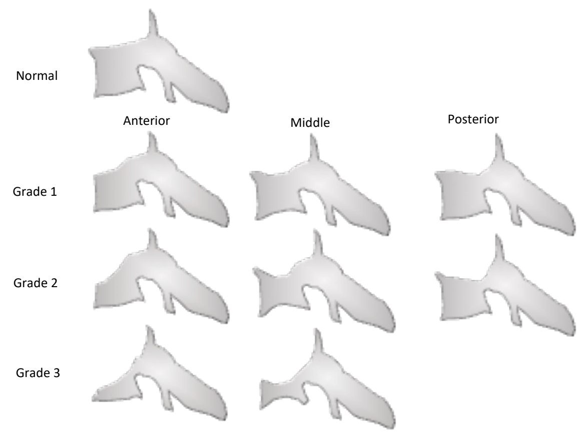


FIGURE 27

Schematic drawing explaining the Genant grading system.

Spinal Infections

CHAPTER OUTLINE:

/ Spinal Infections

>|< COMPARE

Spinal Infections are infections that affect the vertebral column, i.e., the vertebrae, intervertebral discs and surrounding soft tissues. These infections can manifest in various locations, such as:

- **Vertebral Spondylodiscitis:** Infection of the vertebral bones, often resulting from haematogenous spread (via the bloodstream) or direct extension from adjacent infected tissues
- **Septic Arthritis:** Infection of the facet joints
- **Epidural Abscess:** This type of infection develops within the epidural space and can exert pressure on the spinal cord and nerve roots, potentially leading to neurological deficits

Imaging in Spinal Infections:

- **X-Rays:** Initial imaging tool to identify gross bony abnormalities, such as vertebral destruction or deformities. Not able to find early conditions.
- **Magnetic Resonance Imaging (MRI):** The most sensitive and specific imaging modality for detecting spinal infections. It provides detailed images of soft tissues, allowing visualization of purulent collections, bone marrow oedema, and involvement of adjacent structures.
- **Computed Tomography (CT):** Useful for the assessment of bone destruction and often used in conjunction with MRI for better visualization of bony structures and detection of abscesses or areas of bone destruction.

CHAPTER OUTLINE:

/ Spondylodiscitis

Spondylodiscitis is an infection involving the inter-vertebral disc and two adjacent vertebrae (Fig. 28).

The main underlying process in the fully developed spine is an osteomyelitis of the endplate region (isolated discitis can occur in childhood), followed by the involvement of the intervertebral disc.

Aetiology: Staphylococcus aureus is the most common infectious agent.

Location: it can occur anywhere in the spine (prevalence in the lumbar tract), especially with involvement of a single disc-endplates unit; less frequent the involvement of multiple levels.

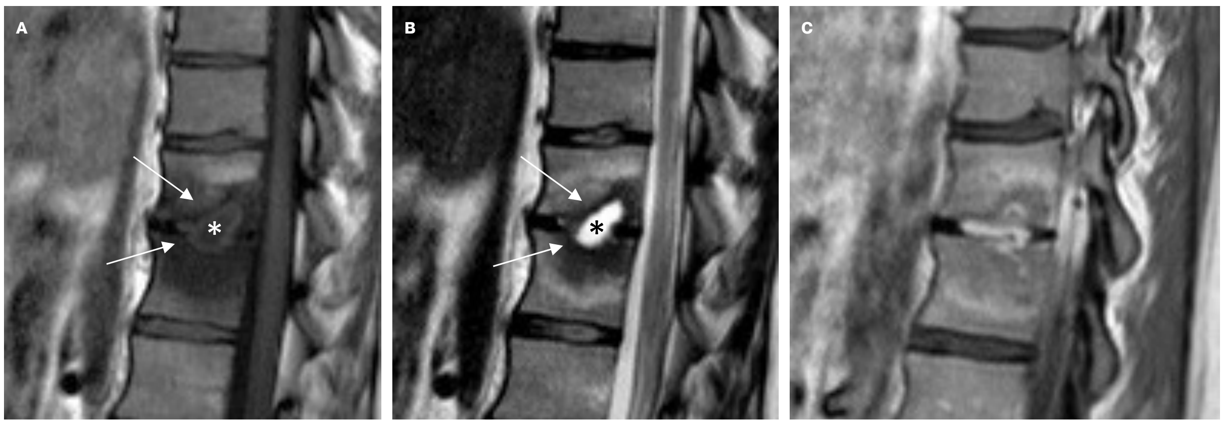


FIGURE 28

(A) T1W, (B) T2W and (C) contrast enhanced sagittal T1W images showing the typical features of pyogenic spondylodiscitis. There is fluid accumulation in the disk space (low signal on T1 and high signal on T2, asterisk) and the adjacent endplates show marrow oedema and loss of low signal of the cortex (arrows). Contrast enhancement of the disc and around the endplates.

/ Tuberculous Spondylitis (Pott's Disease)

One of the most common site of infections by tuberculosis (TB) is the spine. TB spondylitis or Pott's disease is most often the consequence of haematogenous spread via arteries and veins. The differential diagnosis with other pathogens can be challenging in countries where TB is not prevalent.

Some useful points for the diagnosis of TB spondylitis (Fig. 29) include multiple localizations in different spine segments (skip lesions), predominant involvement of vertebrae rather than intervertebral discs and more severe bone destruction, especially if there is thoracic involvement. Due to anterior vertebral body involvement, a **gibbus deformity** can result very rapidly. In addition, large paraspinal collections with fluid and enhancing margins are quite characteristic.

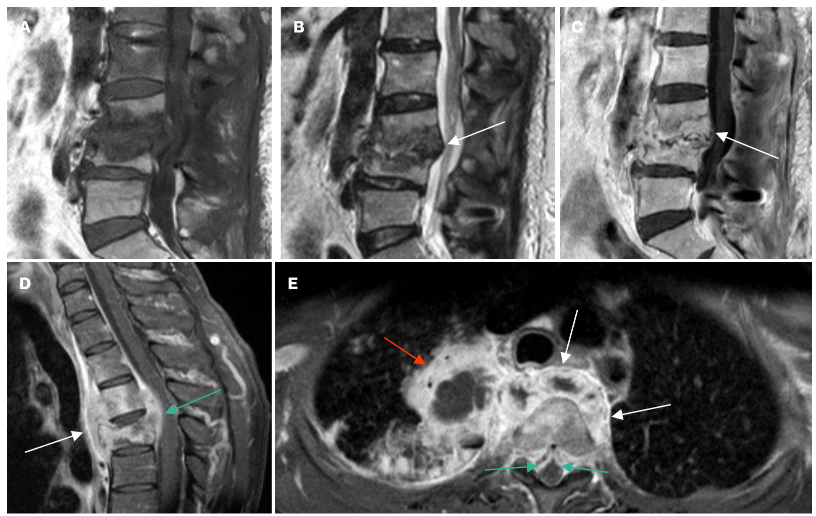


FIGURE 29

Two different patients with TB spondylitis. Lumbar spine TB spondylitis in patient 1 (A-C). (A) T1W, (B) T2W and (C) contrast-enhanced T1W sequences show involvement of L3 and L4 and of the intervertebral disc L3/L4. Vertebral body collapse and mass effect on the thecal sac due to epidural granulation tissue (arrows). Different patient with upper thoracic involvement (D and E). Sagittal (D) and axial (E) contrast enhanced fat saturated T1W images show massive involvement of T3 and T4 with pre-vertebral abscesses (white arrows), large pulmonary collection (red arrow) and epidural collection with spinal cord compression (green arrows). Note thoracic gibbus deformity. Images D and E courtesy Minerva Becker. MD, Geneva University Hospitals.

/ Spinal Epidural Abscess

<!> ATTENTION

Infection of the epidural space (located between the spinal dura mater and the vertebral periosteum) is an uncommon condition, and its aetiology is typically bacterial. As it can rapidly lead to spinal cord compression, it often requires emergency surgery.

The most common location is in the thoracic canal, posteriorly.

It can develop as a complication of extradural hematoma and/or trauma, as a complication of spondylodiscitis, septic facet joint arthritis or via haematogenous spread from a remote infection.

The epidural phlegmon must be distinguished from the epidural liquid abscess, which requires surgical drainage. MRI is the imaging modality of choice to distinguish between the two patterns (Fig. 30).

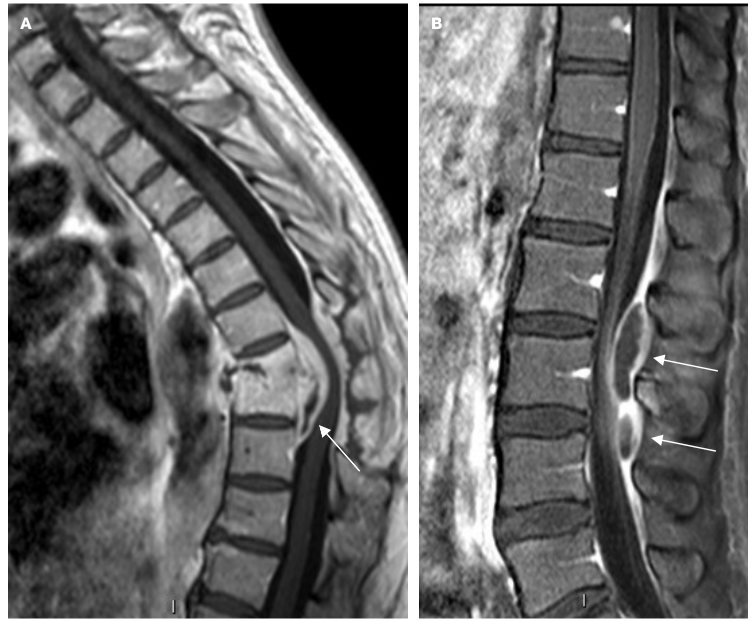


FIGURE 30

Sagittal T1W contrast enhanced image (A) shows spondylodiscitis with an anterior epidural abscess (arrow) and spinal cord compression. Different patient (B). Fat saturated contrast-enhanced T1W image showing a posterior epidural abscess (arrows)

CHAPTER OUTLINE:

Vertebral Tumours and Tumour-Like Lesions

CHAPTER OUTLINE:

/ Vertebral Tumours

The spine can host various types of neoplastic lesions, with metastases from neoplasms originating from elsewhere being particularly common (Fig. 31). The most common primary malignancies involving the vertebrae include breast cancer, lung cancer and prostate cancer.

Additionally, primary lesions, both solitary and diffuse, can affect the vertebral column, and they can be either benign or malignant.

It is crucial for physicians and radiologists to accurately identify the location of the lesion(s), assess their morphology and understand their relationships with surrounding structures.

FIGURE 31

Sagittal T1W sequence showing multiple spinal metastases (arrows)

CHAPTER OUTLINE:

Vertebral tumours comprise an extremely heterogeneous group of lesions, ranging from simple 'do not touch' lesions to highly aggressive ones.

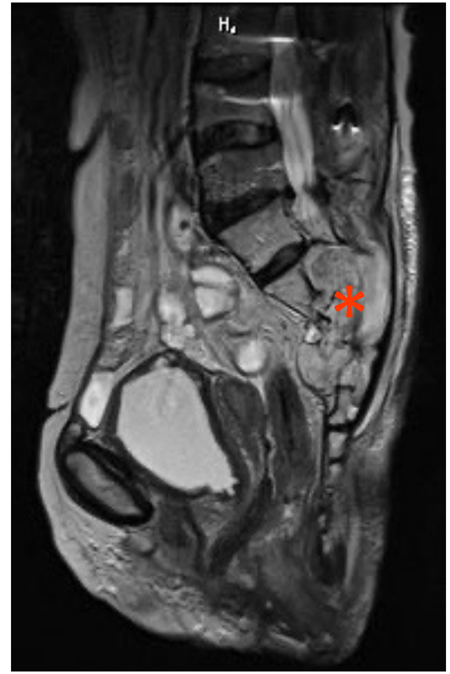
Non-neoplastic lesions

- Vertebral venous malformation (vertebral haemangioma)
- Aneurysmal bone cyst
- Bone island

Primary bone tumours

- Multiple Myeloma
- Chordoma (Fig. 32)
- Osteoid osteoma
- Chondrosarcoma
- Ewing sarcoma
- Lymphoma
- Osteosarcoma
- Giant cell tumour
- Osteoblastoma

Metastases



REFERENCE

FIGURE 32

Sagittal T2W sequence showing a sacral chordoma (asterisk). Case courtesy of Mohammadtaghi Niknejad, Radiopaedia.org, rID: 85458

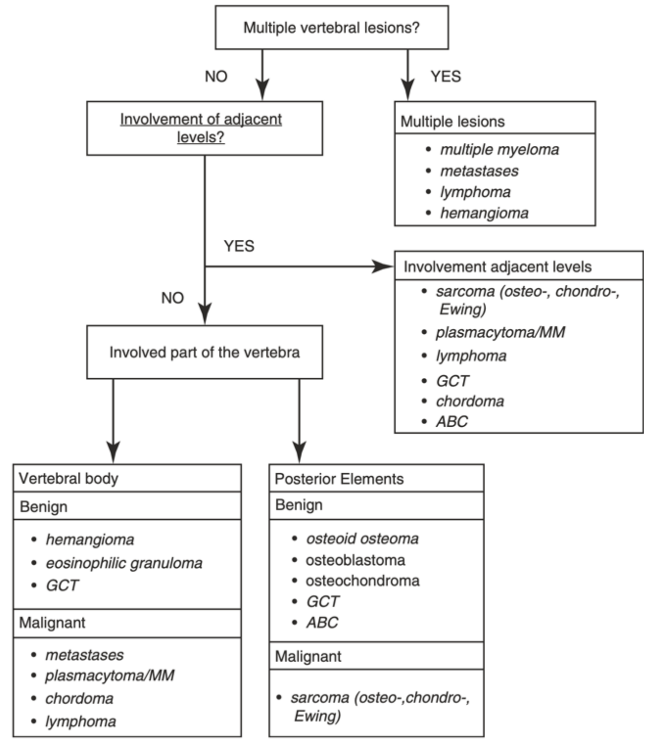
https://radiopaedia.org/articles/vertebral-body-mass?lang=us

CHAPTER OUTLINE:

/ Vertebral Lesions: Differential Diagnostic Approach

For the differential diagnosis of vertebral lesions at imaging, the stepwise approach proposed by Manfrè (Fig. 33) includes answering the following questions:

- / Is there a single lesion or are there multiple lesions?
- / Is there involvement of adjacent levels?
- / Which part of the vertebra is involved (body versus posterior elements)?



<∞> REFERENCE

FIGURE 33

Flowchart of the approach to vertebral lesions. Modified from Luigi Manfrè – Vertebral Lesions, Springer 2017

/ Spine Imaging

CHAPTER OUTLINE:

/ Vertebral Venous Malformation

<!> ATTENTION

Vertebral Venous Malformation (VVM), better known as Vertebral Haemangioma (VH), is the most common incidentaloma in the spine. It is not considered a true neoplasm. Typically, it is asymptomatic and easily detected due to its characteristic features on imaging.

On a CT scan, it may display the classic 'salt and pepper' appearance owing to the specific arrangement of trabeculae.

On MRI, its lipid-rich appearance is evident on all sequences (Fig. 34).

In rare cases, it can exhibit local aggressiveness.

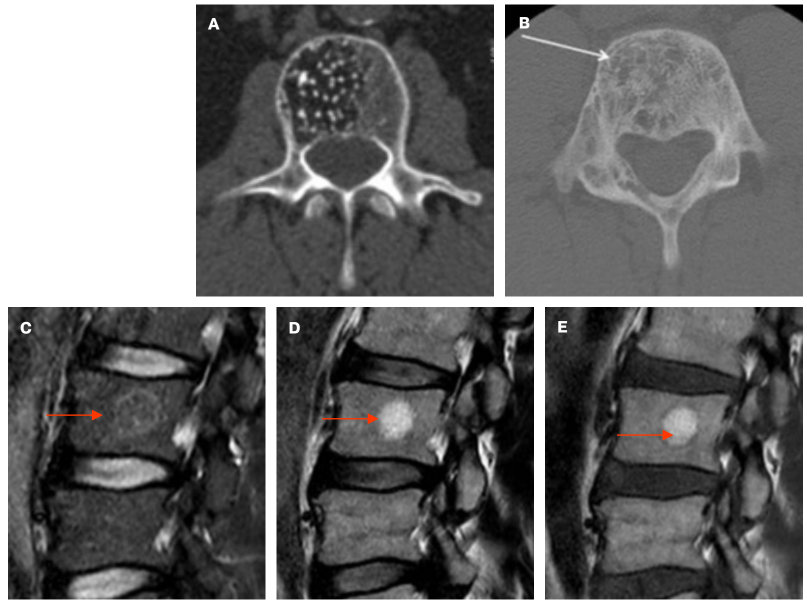


FIGURE 34

Axial CT images showing VVMs in 2 different patients with the characteristic salt and pepper (**A**) or striated appearance (**B**). Image **A**: courtesy of Bruno Di Munzio, Radiopaedia.org. rID: 15248. Image **B**: reproduced from McEvoy SH et al. Insights into Imaging 7, 87-98 (2016). Different patient (**C**-**E**). Sagittal STIR (**C**), T2W (**D**) and T1W (**E**) images of a classical VVM (arrows). As the lesion contains fat, its signal disappears on the STIR sequence.

/ Multiple Myeloma (MM)

<!> ATTENTION

The spine is one of the most common sites for Multiple Myeloma (MM), which is characterised by the proliferation of plasma cells originating in the bone marrow.

In recent years, there have been significant advances in MRI, low-dose Multidetector Computed Tomography (MDCT), and 18F-fluoro-deoxyglucose Positron Emission Tomography (18F-FDG PET)/18F-FDG PET-CT, which are now used to assess lytic bone lesions and early stages of bone marrow infiltration.

Notably, the presence of more than one focal lesion on MRI (> 5 mm) is sufficient to define Multiple Myeloma. For the diagnosis of MM with MRI, T1W, T2W and diffusion weighted imaging (DWI) sequences are used (Fig. 35). MM lesions show restricted diffusivity on DWI.

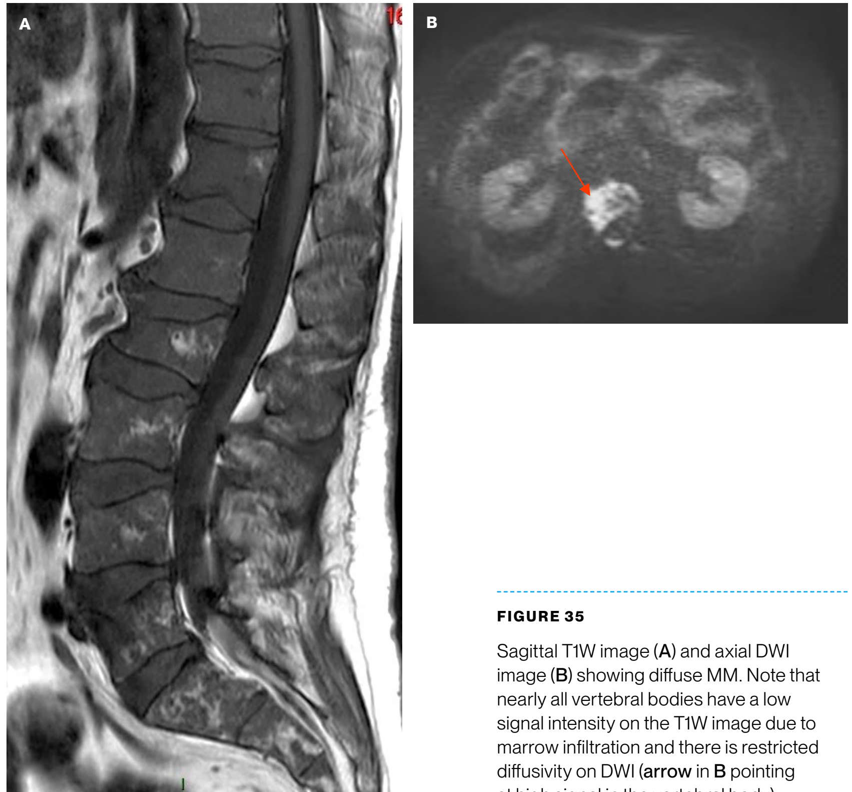


FIGURE 35

Sagittal T1W image (**A**) and axial DWI image (**B**) showing diffuse MM. Note that nearly all vertebral bodies have a low signal intensity on the T1W image due to marrow infiltration and there is restricted diffusivity on DWI (**arrow** in **B** pointing at high signal in the vertebral body).

CHAPTER OUTLINE:

/ Vertebral Metastases

<!> ATTENTION

The spinal column is a common location for metastases from several primary sites (Fig. 36). These metastases can present as osteoblastic or osteolytic, and in some instances, the same tumour can give rise to both osteoblastic and osteolytic lesions.

Tumours with **osteolytic** metastases include:

- lung cancer
- renal cell carcinoma
- melanoma
- multiple myeloma

Tumours with **osteoblastic** metastases include:

- prostate carcinoma
- osteosarcoma
- medullary thyroid carcinoma

Breast cancer typically results in osteolytic lesions, but occasionally, it can also lead to osteoblastic lesions.

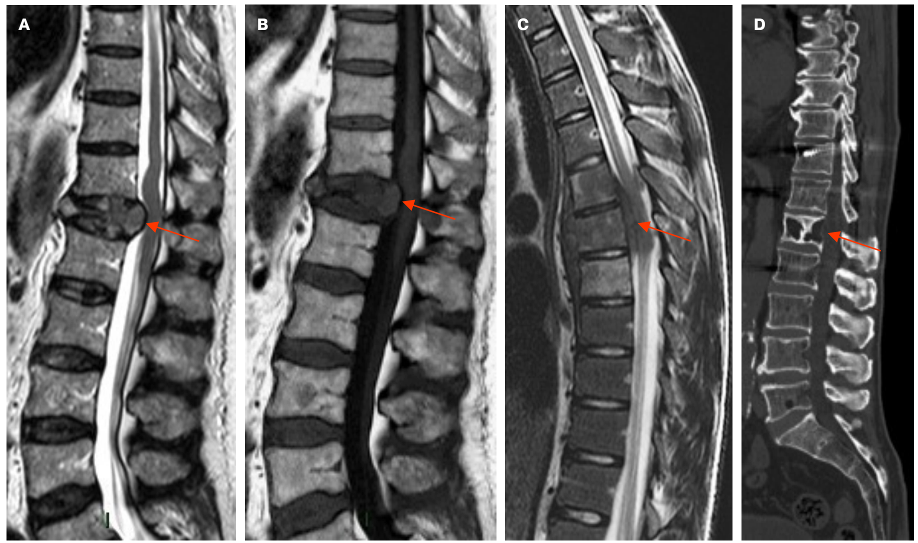


FIGURE 36

Multiple types of metastases with posterior invasion of spinal canal (arrows). Sagittal MRI images (**A**, **B** and **C**). Sagittal CT MPR (**D**).

CHAPTER OUTLINE:

Interventional Procedures

CHAPTER OUTLINE:

/ Vertebroplasty

Vertebroplasty is a **minimally invasive imaging-guided procedure** used to treat vertebral compression fractures, which are often caused by osteoporosis. Furthermore, it can be used to treat some spine tumours to improve stability and for an antalgic effect.

During vertebroplasty, a special bone cement (usually polymethylmethacrylate, or PMMA) is injected directly into the fractured vertebral body using a needle (Fig. 37). The cement hardens quickly, stabilising the bone and providing support.

The skin over the affected area is anaesthetised with a local anaesthetic. The patient is in a prone position or on the side, and the procedure is guided by fluoroscopy (real-time X-ray imaging). A hollow needle is inserted into the fractured vertebra under X-ray guidance. The cement is then injected into the vertebral body. The cement quickly hardens, providing structural support to the fractured bone. The procedure itself usually takes about 30 to 60 minutes per treated vertebra.

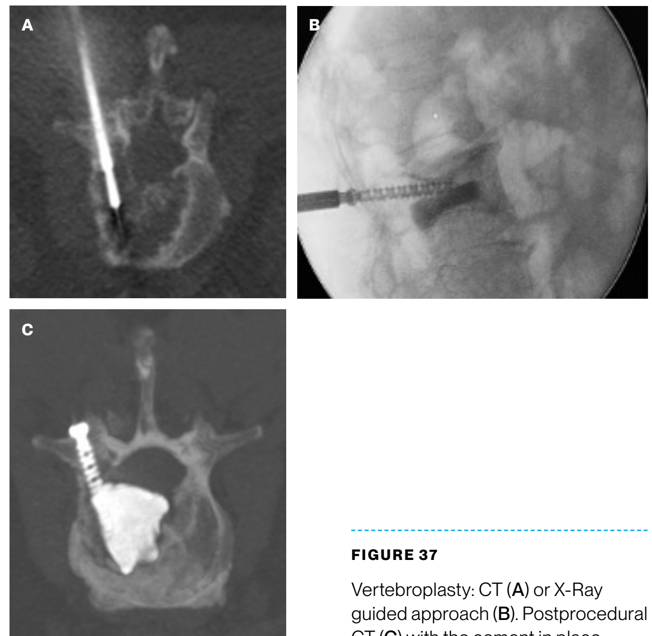


FIGURE 37

Vertebroplasty: CT (**A**) or X-Ray guided approach (**B**). Postprocedural CT (**C**) with the cement in place.

CHAPTER OUTLINE:

/ Posterior Facet Joint Fixation (PFJF)

In case of painful spondylolysis, new percutaneous approaches can be used to perform **posterior facet joint fixation (PFJF)**. The advantage is that PFJF can achieve nearly equivalent immediate stabilization of the lumbar spine as traditional surgical procedures.

The PFJF (Fig. 38) is a fast procedure using local anaesthesia or mild sedation and preserving muscle anatomy and the adjacent facet joint.

Lumbar PFJF can be performed with a simple C-arm, or better under a combination of C-arm and CT control that results in better choice of the correct size, length and orientation of fixation tools, e.g., trans-articular screws or intra-articular implants, avoiding extra-vertebral or extra-articular incorrect fixation placement.

FIGURE 38

PFJF Postprocedural CT MPR images in the axial (**A**) and sagittal (**B**) plane showing the correct position of the trans-articular screws.

/ Take-Home Messages

- The spine is a fascinating complex of anatomy and biomechanics.
- It is also the location of several often under-recognised pathologies.
- Understanding spinal pathology is crucial in the core curriculum for physicians and future radiologists.
- In addition to its diagnostic role, it is important to emphasise the significance of interventional procedures in the treatment of a wide range of spinal conditions.

CHAPTER OUTLINE:

/ References

/ Yokota H, Tali ET. Spinal Infections. Neuroimaging Clinics of North America. 2023;33(1):167-183. doi:10.1016/j.nic.2022.07.015

/ Sundgren PC, Philipp M, Maly PV. Spinal Trauma. Neuroimaging Clinics of North America. 2007;17(1):73-85. doi:10.1016/j.nic.2006.11.006

/ Genant HK, Wu CY, van Kuijk C, Nevitt MC. Vertebral fracture assessment using a semiquantitative technique. J Bone Miner Res. 1993 Sep;8(9):1137-48. doi: 10.1002/jbmr.5650080915. PMID: 8237484.

/ Diehn FE. Imaging of Spine Infection. Radiologic Clinics of North America. 2012;50(4):777-798. doi:10.1016/j.rcl.2012.04.001

/ Manfrè L, Van Goethem J, eds. The Disc and Degenerative Disc Disease: Remove or Regenerate? Springer International Publishing; 2020. doi:10.1007/978-3-030-03715-4

/ Kotsenas AL. Imaging of Posterior Element Axial Pain Generators. Radiologic Clinics of North America. 2012;50(4):705-730. doi:10.1016/j.rcl.2012.04.008

/ Manfrè L, ed. Spinal Canal Stenosis. Springer International Publishing; 2016. doi:10.1007/978-3-319-26270-3

/ Manfrè L, ed. Vertebral Lesions. Springer International Publishing; 2017. doi:10.1007/978-3-319-52634-8

/ Van Goethem JWM, Van den Hauwe L, Parizel PM. Spinal Imaging: Diagnostic Imaging of the Spine and Spinal Cord. Springer; 2007.

/ Manfrè L, ed. Spinal Instability. Springer International Publishing; 2015. doi:10.1007/978-3-319-12901-3

/ AO Spine Classification Systems. Accessed October 25, 2023. https://www.aofoundation.org/spine/clinical-library-and-tools/aospine-classification-systems

/ Raniga SB, Menon V, Al Muzahmi KS, Butt S. MDCT of acute subaxial cervical spine trauma: a mechanism-based approach. Insights Imaging. 2014;5(3):321-338. doi:10.1007/s13244-014-0311-y

/ Dreizin D, Letzing M, Sliker CW, et al. Multidetector CT of Blunt Cervical Spine Trauma in Adults. RadioGraphics. 2014;34(7):1842-1865. doi:10.1148/rg.347130094

/ Shah NG, Keraliya A, Nunez DB, et al. Injuries to the Rigid Spine: What the Spine Surgeon Wants to Know. RadioGraphics. 2019;39(2):449-466. doi:10.1148/rg.2019180125

/ Wáng YXJ, Santiago FR, Deng M, Nogueira-Barbosa MH. Identifying osteoporotic vertebral endplate and cortex fractures. Quant Imaging Med Surg. 2017;7(5):555-591. doi:10.21037/qims.2017.10.05

/ Carli D, Venmans A, Lodder P, et al. Vertebroplasty versus Active Control Intervention for Chronic Osteoporotic Vertebral Compression Fractures: The VERTOS V Randomized Controlled Trial. Radiology. 2023;308(1):e222535. doi:10.1148/radiol.222535

/ Genant HK, Wu CY, van Kuijk C, Nevitt MC. Vertebral fracture assessment using a semiquantitative technique. J Bone Miner Res. 1993;8(9):1137-1148. doi:10.1002/jbmr.5650080915

/ Murphy A. Thoracolumbar spine fracture | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-77431

/ Murphy A. Thoracolumbar spine fracture | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-77431

/ Gaillard F. Cervical spine fractures | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-1089

/ Mous AN. Spinal fractures | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-2069

/ Schubert R. Three column concept of spinal fractures | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-15488

/ Verma R. AO Spine classification of thoracolumbar injuries | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-59124

/ Radswiki T. Thoracolumbar spinal fracture classification systems | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-15493

/ Robertson P. Thoracolumbar injury classification and severity score (TLICS) | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-30250

Test Your Knowledge

/ Test Your Knowledge

<?> QUESTION

1

How many vertebrae are there in the cervical region?

- ☐ 12
- ☐ 7
- ☐ 5
- ☐ 39

/ Test Your Knowledge

<?> ANSWER

1 How many vertebrae are there in the cervical region?

- ☐ 12
- ■ 7
- ☐ 5
- ☐ 39

/ Test Your Knowledge

<?> QUESTION

2 Vertebroplasty is indicated for

- ☐ Spinous process avulsion
- ☐ Disc extrusion
- ☐ Rupture of anterior longitudinal ligament
- ☐ Vertebral fracture

/ Test Your Knowledge

<?> ANSWER

2 Vertebroplasty is indicated for

- ☐ Spinous process avulsion
- ☐ Disc extrusion
- ☐ Rupture of anterior longitudinal ligament
- ■ Vertebral fracture

/ Test Your Knowledge

<?> QUESTION

3 The most common localisation of transitional vertebra

- ☐ L5-S1
- ☐ Th6-Th7
- ☐ Co1-Co2
- ☐ L3-L4

CHAPTER OUTLINE:

/ Test Your Knowledge

<?> ANSWER

3 The most common localisation of transitional vertebra

- ■ L5-S1
- ☐ Th6-Th7
- ☐ Co1-Co2
- ☐ L3-L4

/ Test Your Knowledge

<?> QUESTION

4 What is your diagnosis based on these MRI images?

- ☐ MODIC 1
- ☐ MODIC 2
- ☐ MODIC 3

/ Test Your Knowledge

<?> ANSWER

4 **What is your diagnosis based on these MRI images?**

- ■ MODIC 1
- ☐ MODIC 2
- ☐ MODIC 3

/ Test Your Knowledge

<?> QUESTION

5 Which Thoracolumbar classification takes the Posterior Ligamentous Complex (PLC) into account?

- ☐ AO
- ☐ TLICS
- ☐ Gennant

/ Test Your Knowledge

<?> ANSWER

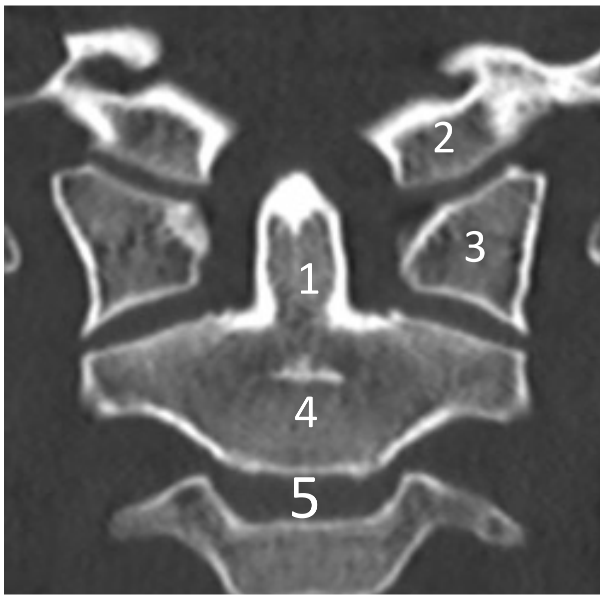
5 Which Thoracolumbar classification takes the Posterior Ligamentous Complex (PLC) into account?

- ☐ AO
- ■ TLICS
- ☐ Gennant

/ Test Your Knowledge

<?> QUESTION

6 Annotate the following image:

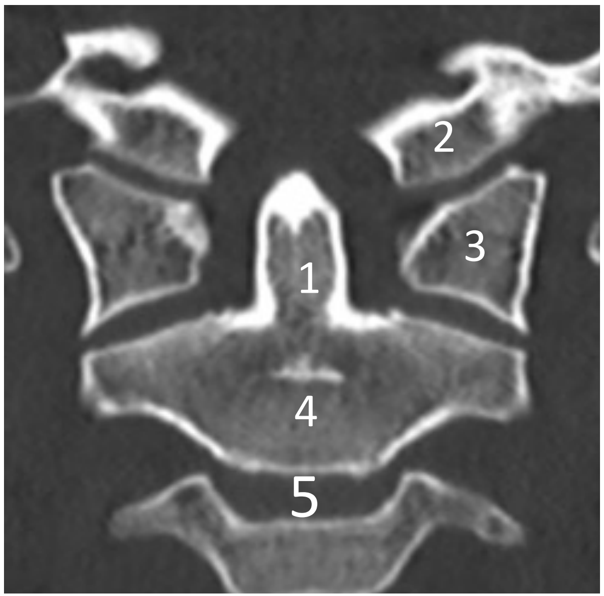


1. ....
2. ....
3. ....
4. ....
5. ....

/ Test Your Knowledge

<?> ANSWER

6 Annotate the following image:



1. Dens axis
2. Occipital condyle
3. Lateral mass of the atlas
4. Body of the axis (C2)
5. Intervertebral disc C2/C3

/ Test Your Knowledge

<?> QUESTION

7 According to Denis concept, a fracture involving the anterior column only is:

- ☐ Unstable
- ☐ Stable

/ Test Your Knowledge

<?> ANSWER

7 According to Denis concept, a fracture involving the anterior column only is:

- ☐ Unstable
- ■ Stable

/ Test Your Knowledge

<?> QUESTION

8 Which of the following statements regarding multiple myeloma (MM) is correct?

- ☐ It rarely affects the spine in adults
- ☐ At least 5 positive lesions should be present at MRI to make the diagnosis
- ☐ One FDG avid lesion should be present at PET/CT to make the diagnosis
- ☐ MM lesions show restricted diffusivity at MRI

/ Test Your Knowledge

<?> ANSWER

8 Which of the following statements regarding multiple myeloma (MM) is correct?

- ☐ It rarely affects the spine in adults
- ☐ At least 5 positive lesions should be present at MRI to make the diagnosis
- ☐ One FDG avid lesion should be present at PET/CT to make the diagnosis
- ■ MM lesions show restricted diffusivity at MRI

/ Test Your Knowledge

<?> QUESTION

9

Modic degeneration type 1 refers to:

- ☐ Sclerotic phase
- ☐ Fatty replacement
- ☐ Oedema phase

CHAPTER OUTLINE:

/ Test Your Knowledge

<?> ANSWER

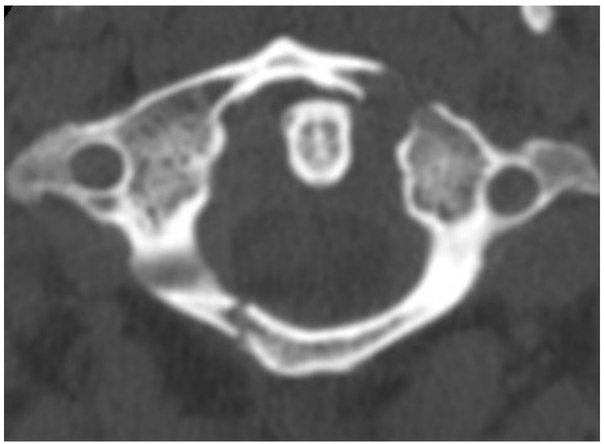
9 Modic degeneration type 1 refers to:

- ☐ Sclerotic phase
- ☐ Fatty replacement
- ■ Oedema phase

/ Test Your Knowledge

<?> QUESTION

10 What kind of fracture is shown on this image?

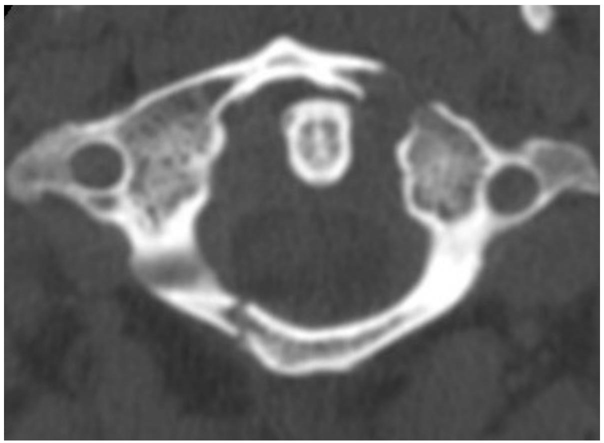


- ☐ Hangman
- ☐ Jefferson
- ☐ Odontoid
- ☐ Extension Teardrop

/ Test Your Knowledge

<?> ANSWER

10 What kind of fracture is shown on this image?



- ☐ Hangman
- ■ Jefferson
- ☐ Odontoid
- ☐ Extension Teardrop

Acknowlegments

We would like to thank **Sana Boudabbous** from the Division of Radiology, Diagnostic Department, University Hospitals of Geneva for kindly providing the cover image of this chapter.