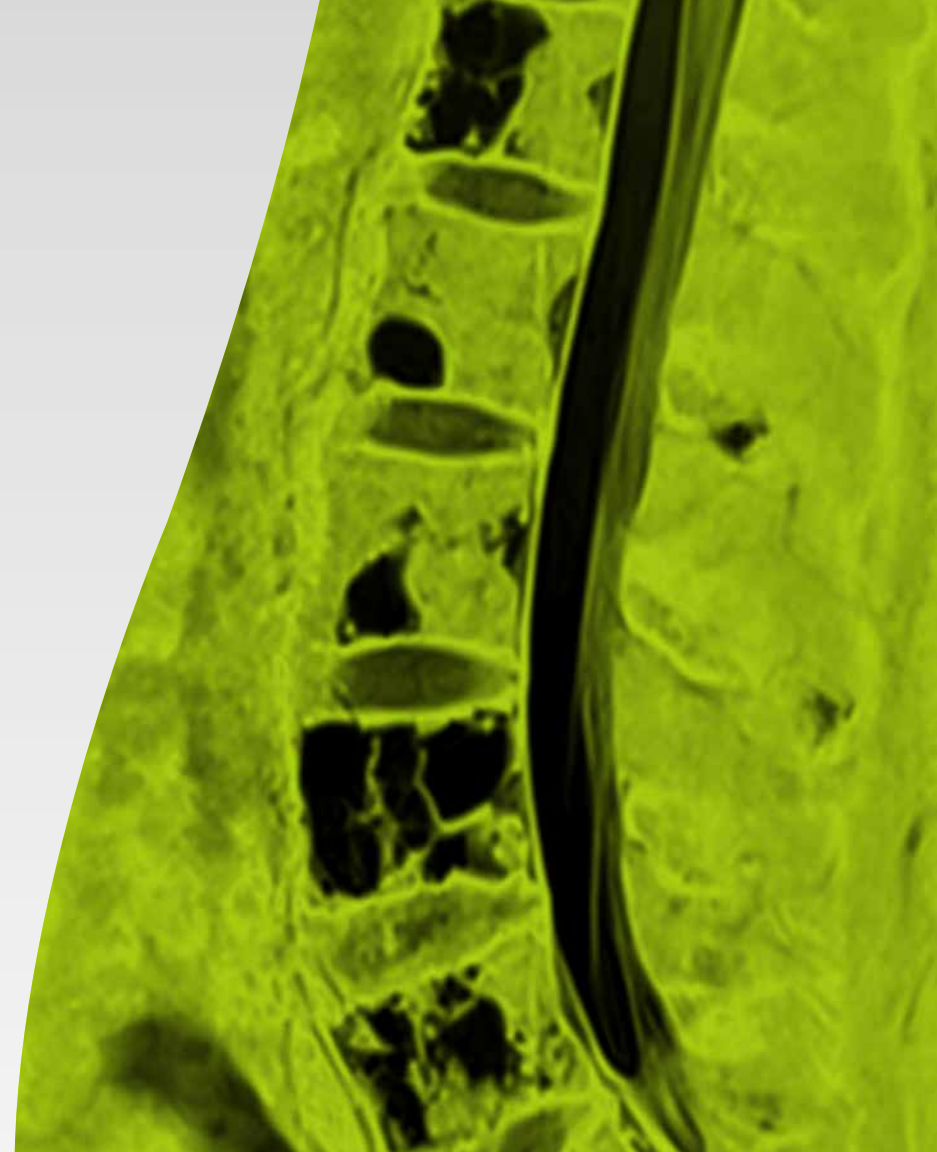


MODERN
RADIOLOGY
eBook

Spine Imaging

ESR EUROPEAN SOCIETY
OF RADIOLOGY

脊柱 影像学



/ 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

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/ 前言

《现代放射学》是由欧洲放射学协会 (European Society of Radiology, ESR) 在线发布的免费放射学教育资源。第二版 (更名版) 标题反映了 *ESR 电子书* 新颖的教学概念, 它以简洁页面的形式巧妙地融合文本、图像和示意图, 并辅以临床影像学案例、问答部分和内容超链接, 使读者能够在各基于器官的部分、更具技术性的章节、摘要以及参考文献之间快速切换浏览。

其章节以 100 多名公认欧洲专家的优秀稿件为根基, 涉及各类一般技术和基于器官的临床影像学主题。同时采用了全新的图形外观, 展示了佩戴时尚眼镜的 Asklepios, 象征着传统医学教学与现代风格教育的结合。

虽然初版 *ESR 电子书* 旨在为医学生和本科生教师提供医学基础知识, 但现已逐渐扩充其知识领域, 为希望“深入挖掘”的读者提供了更多高阶技术知识。因此, 《现代放射学》还涵盖了 *欧洲放射学培训课程* 研究生水平的各类主题, 旨在解决住院医师的研究生教育需求。此外, 书中还囊括了全球医疗专业人士的反馈, 他们希望更新自己在医学影像特定领域的知识, 并对 *ESR 电子书* 在基础和高等教育水平上的深度和清晰度表示高度赞赏。

我要衷心感谢所有为这项非营利活动自愿贡献时间和专业知识的作者, 以及最初提出创作 *ESR 电子书* 的 Carlo Catalano、Andrea Laghi 和 András Palkó, 最后还要感谢 ESR 办公室所提供的技术和行政支持。

《现代放射学》充分体现了医者的协作精神和对这门热门医学学科坚定不移的承诺, 这是现代患者护理必须具备的优秀精神品质。我希望这款 *教育工具* 能够激励各位始终保持好奇心和批判性思维, 从而促进整个欧洲乃至欧洲以外地区对放射学艺术和科学的认识。

Minerva Becker, 编辑
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ENDORSED BY:

Chinese Society of Radiology

NOTE FROM THE COORDINATORS:

Thank you to Chinese radiology experts for bridging languages and open the world-class English resource by ESR to every Mandarin-speaking student, fueling global radiology talent with a single click

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/ 翻译致谢

本章节为《现代放射学电子书》的部分译文。

原文标题:

脊柱影像学

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审定:

中华医学会放射学分会

译者寄语:

感谢中国放射学专家们的倾力奉献! 你们跨越了语言的鸿沟, 将欧洲放射学会 (ESR) 的世界级学术宝库呈献给广大中文学子。如今, 前沿智慧一键即达, 为全球放射学人才的蓬勃发展注入了强劲动力。

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/ 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

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/ 脊柱：简介

- 脊柱是一个具有多种重要功能的复杂结构（图 1）：
- / 支撑全身站立、行走
 - / 为脊髓提供支持和保护
 - / 它是一个重要的造血器官
- 了解脊柱和脊髓的放射解剖学对于放射科医生至关重要，有助于各种神经和骨科疾病的诊断和治疗。
- 尽管脊柱可能受到许多不同病理状况的影响，但其在医学研究中经常被低估。尽管如此，脊柱解剖学和病理学知识，仍是未来医生和放射科医生核心课程的重要组成部分。影像引导下的介入性操作在多种脊柱病变患者的治疗中，发挥着日益重要的作用。

图 1
全脊柱 T2 加权 (T2W) 矢状位图像

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/ 解剖 结构

/ 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

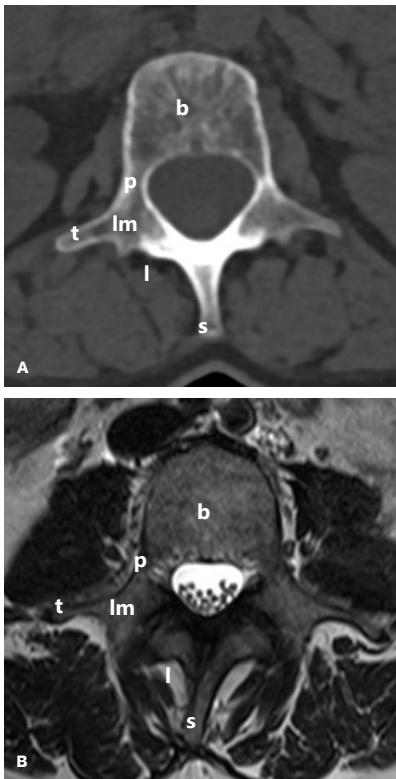


FIGURE 2

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

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/ 椎骨的典型结构

椎骨为短骨，形态大致相似，但不同节段存在一定差异。典型椎骨前部为椎体，后部为椎弓（图 2）。

椎体：椎骨的前部呈圆盘状，从头侧向尾侧体积逐渐增大。

椎弓：由多个部分组成的复杂骨结构，共同形成了椎管。组成部分有：

- / **椎弓根：**从椎体后缘伸出的两个短小的骨性突起
- / **侧块：**由上关节突和下关节突结合形成的两个结构。在其上、下表面分别是下关节突和上关节突。
- / **椎板：**两块扁平的薄骨板，在后方中线处相连，共同构成完整的椎弓
- / **棘突：**椎板连接处向后突出的显著骨性结构
- / **横突：**从椎弓根与椎板连接处向外侧伸出的骨性结构

图 2

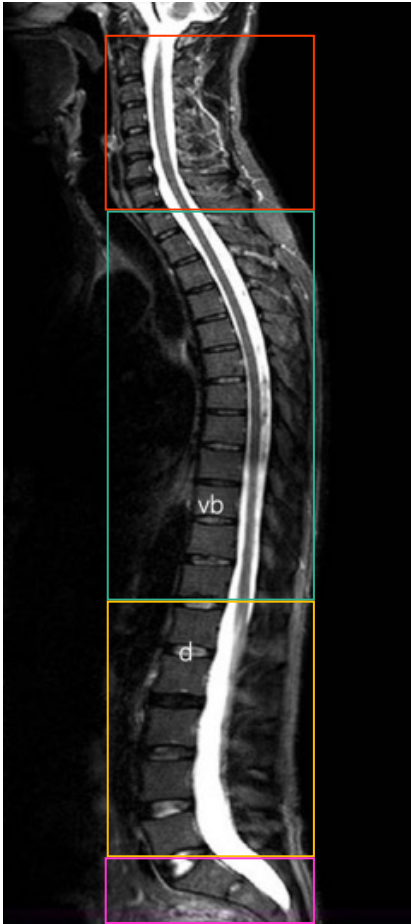
腰椎轴位 CT 图像 (A) 及轴位 T2 加权序列图像 (B)。b: 椎体; p: 椎弓根; lm: 侧块; t: 横突; l: 椎板; s: 棘突

/ 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



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/ 脊柱的分段

脊柱由 33 块椎骨组成，共分为五段（图 3）：

- 1. **颈段（C1-C7 [红色]）：** 该段从颅底至上胸部，由最上面的七块椎骨构成。
- 2. **胸段（Th1-Th12 [绿色]）：** 位于上背部和中背部，胸椎的特点是每块椎骨都有肋骨附着。
- 3. **腰椎（L1-L5 [黄色]）：** 腰椎是最大的椎骨，支撑着身体的大部分重量。
- 4. **骶骨（S1-S5 [粉色]）：** 五块椎骨融合为一个单独的骨体。
- 5. **尾骨（Co1-Co4）：** 尾椎融合形成尾骨，也就是通常所说的尾椎骨 (tailbone)。

图 3
脊柱矢状位 T2W 序列图像。椎体 (vb)；椎间盘 (d)。图片摘自 ESR 电子书 CNS 章节。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 discs 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.

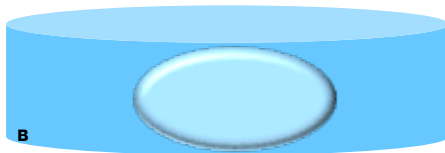


FIGURE 4

(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 and peripheral annulus fibrosus.

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/ 椎间盘

除了第一颈椎 (C1) 和第二颈椎 (C2) 外, 每两个相邻椎体之间都有一个椎间盘。椎间盘起到减震和使相邻椎体能够活动的作用。

每个椎间盘由外周纤维环和中央髓核组成 (图 4)。

胸椎段的椎间盘前后高度一致; 而颈椎和腰椎椎间盘呈前高后低。椎间盘高度会随着年龄增长而降低。

髓核无血液供应 (通过扩散获取营养), 而纤维环在儿童和成人中都有外周血液供应。

<!=> 注意

椎间盘与相邻椎体共同构成了“椎间盘-椎体”单元, 这是脊柱最小的功能单位。

图 4

(A) 腰椎矢状位 T2 加权 MRI 序列图像, 显示三个椎间盘 (箭头所示); (B) 椎间盘的简化示意图, 显示中央的髓核和外周的纤维环。

/ 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 uncinat 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

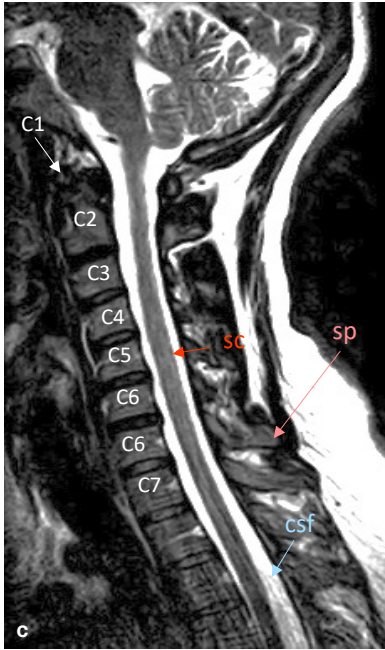
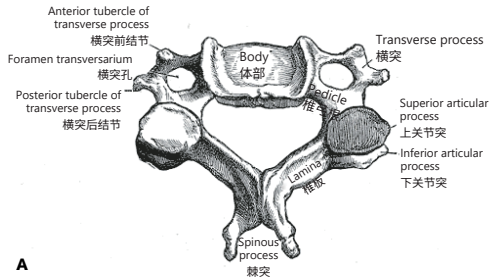


FIGURE 5
(A) Drawing from Gray's Anatomy of a cervical vertebra. (B) CT coronal MPR of the cervical spine showing the body (b), the transverse (t) and the uncinat processes (u); (C) Sagittal T2W sequence of the cervical spine. Spinal cord (sc). Cerebrospinal fluid (csf). Spinous process (sp).

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/ 颈椎

颈椎 (图 5) 是脊柱从颅底延伸至胸廓的部分, 支撑着颈部。它由七块颈椎组成, 标记为 C1 至 C7。C1 (寰椎)、C2 (枢椎) 和 C7 (隆椎) 具有独特的解剖特征, 而 C3 - C6 则有以下典型解剖结构:

- / 椎体较小, 具有后外侧唇状结构 (钩突或钩状突) 和椎弓根
- / 椎孔较大
- / 椎管相对较小
- / 长且分叉的棘突
- / 带有横突孔的双侧横突, 椎动脉和静脉由此通过

图 5
(A) 《格雷氏解剖学》中的颈椎示意图。(B) 颈椎 CT 冠状位多平面重建 (MPR) 图像, 显示椎体 (b)、横突 (t) 和钩突 (u); (C) 颈椎矢状位 T2 加权序列图像。脊髓 (sc)、脑脊液 (csf)、棘突 (sp)。

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.

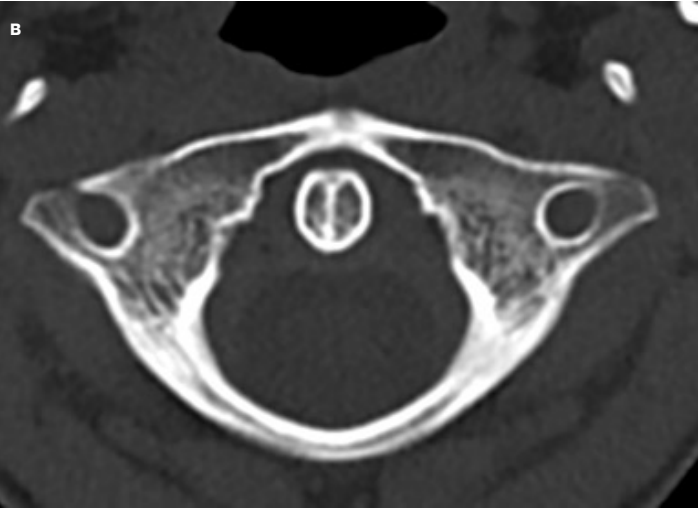
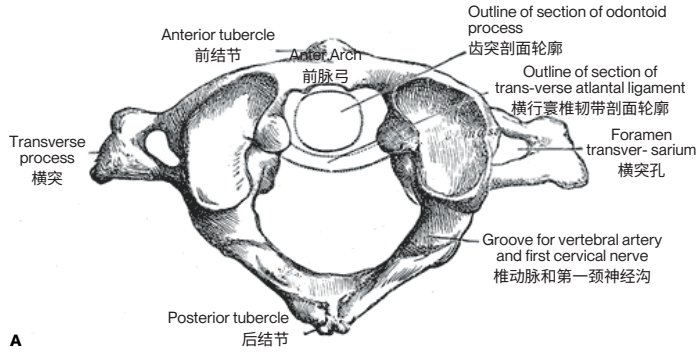


FIGURE 6
(A) Drawing from Gray's Anatomy of a cervical vertebra. (B) CT coronal MPR of the cervical spine showing the body (b), the transverse (t) and the uncinate processes (u); (C) Sagittal T2W sequence of the cervical spine. Spinal cord (sc). Cerebrospinal fluid (csf). Spinous process (sp).

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寰椎 (C1)

寰椎 (图 6) 是第一块椎骨, 具有一些特殊的特征:

它没有椎体, 由前弓、后弓和两个侧块组成, 侧块向上与枕骨髁形成关节。

其两侧有成对的横突。

尽管没有真正意义上的椎体, 但 C2 的齿状突起到了类似椎体的功能。

图 6
(A) 《格雷氏解剖学》中的颈椎示意图。(B) 颈椎 CT 冠状位多平面重建 (MPR) 图像, 显示椎体 (b)、横突 (t) 和钩突 (u); (C) 颈椎矢状位 T2 加权序列图像。 脊髓 (sc)。脑脊液 (csf)。棘突 (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).

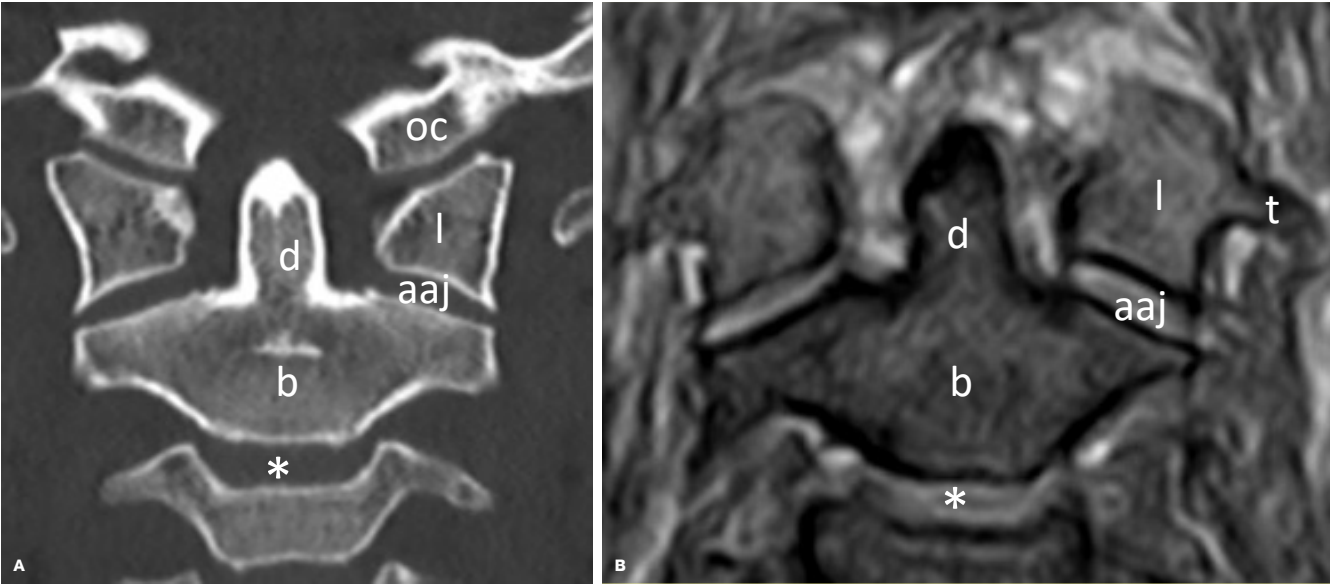


FIGURE 7
(A) CT coronal MPR and (B) T2W sequence of the cervical spine showing C2 and its relationships with C1. Dens axis (d). Body of C2 (b) Transverse process of the atlas (t). Lateral mass of the atlas (l). Atlanto-axial joint (aa). Intervertebral disk C2-C3 (*). Occipital condyle (oc)

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枢椎 (C2)

第二颈椎（枢椎）也有一些独特特征（图 7）。

最重要的特征就是齿状突（或称为齿突），起到了寰椎（C1）功能性椎体的作用。

图 7
(A) 颈椎 CT 冠状位多平面重建 (MPR) 图像和 (B) 颈椎 T2 加权序列图像，显示 C2 及其与 C1 的关系。枢椎齿状突 (d)。C2 椎体 (b) 寰椎横突 (t)。寰椎侧块 (l)。寰枢关节 (aa)。C2-C3 椎间盘 (*)。枕骨髁 (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).

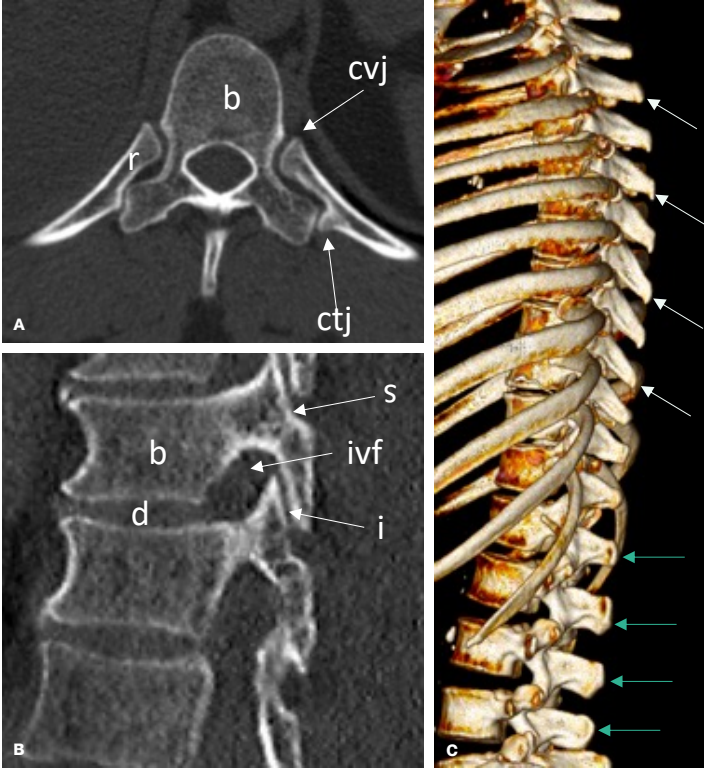
The transverse processes extend laterally and posteriorly. Unlike the cervical vertebrae, the thoracic transverse processes do not have a transverse foramen (Fig. 8). They have facets for supplementary joints with the ribs (costal facets).

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)



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/ 胸椎

胸椎由 12 块椎骨组成，椎体前部大小中等，棘突长且向下倾斜（图 8）。

横突向外侧和后方延伸。与颈椎不同，胸椎横突没有横突孔（图 8）。但有与肋骨相连的辅助关节面（肋凹）。

第一胸椎 (T1) 有一个完整的肋凹用于连接第 1 肋骨，还有一个半肋凹用于连接第 2 肋骨。

与其他胸椎相比，T1 的棘突更接近水平位。

图 8

(A) 胸椎轴位 CT 图像, (B) 矢状位多平面重建 (MPR) 图像, (C) 3D 容积重建图像。椎体 (b)。肋椎关节 (cvj)。肋横突关节 (ctj)。肋骨 (r)。椎间孔 (ivf)。椎间盘 (d)。上关节面 (s)。下关节面 (i)。注意图 C 中, 胸椎的棘突长且向下倾斜 (白色箭头所示)。腰椎的棘突粗短且向后突出 (绿色箭头所示)。

/ Lumbar Spine

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

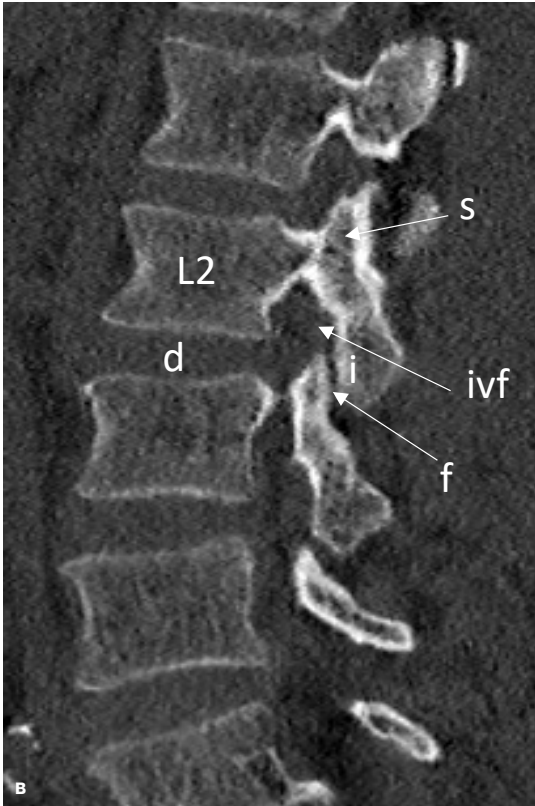
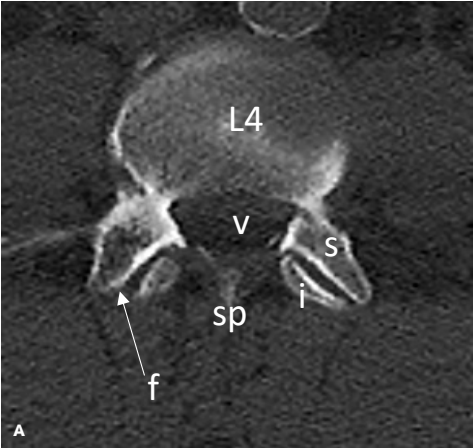
Each lumbar vertebra has a robust vertebral body anteriorly and a vertebral arch posteriorly.

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).



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腰椎由五块椎骨（L1 - L5）组成。

每块腰椎前部都有一个坚固的椎体，后部为椎弓。

它们的棘突短而粗，向后突出。

向两侧延伸的是横突，与胸椎的横突相比较为扁平。

图 9

L4 的轴位 CT 图像 (A) 和腰椎旁矢状位多平面重建 (MPR) 图像 (B)。A. L4 椎体。L3/L4 关节突关节 (f)。棘突 (sp)。L3 下关节突 (i) 和 L4 上关节突 (s)。椎孔 (v)。B. L2 椎体。L2/L3 椎间盘(d)。L2 下关节突 (i) 和 L2 上关节突 (s)。L2/L3 关节突关节 (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.

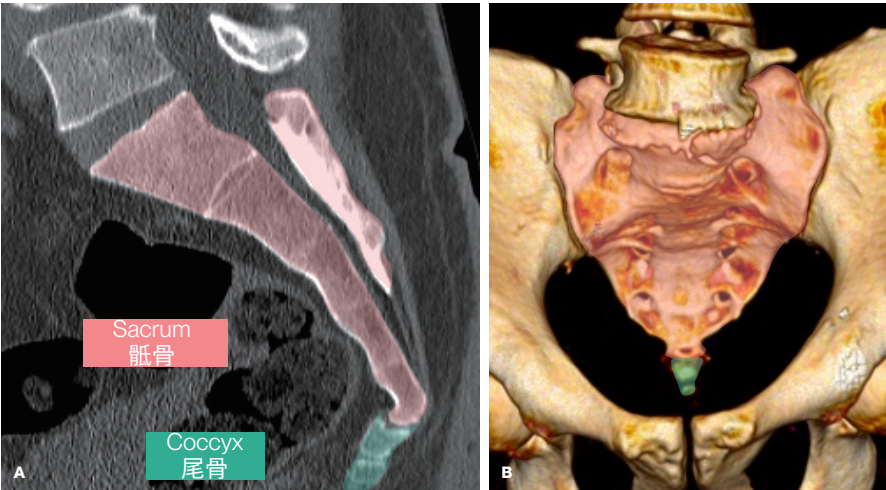


FIGURE 10
(A) CT Sagittal MPR of the sacrum and coccyx. (B) 3D volume rendering from a CT acquisition, anterior view.

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/ 骶骨-尾骨

骶骨和尾骨（图 10）是脊柱的最下端部分，在支撑骨盆以及为各类韧带和肌肉提供附着点方面发挥着重要的作用。

骶骨是介于腰椎和尾骨之间的一块三角形骨。青春期后期，5 块骶椎 (S1-S5) 融合形成骶骨。

尾骨，又称尾椎骨，是一块三角形小骨，位于脊柱的最末端；通常由四块尾椎融合而成，不过融合节段的数量可能存在个体差异。尾骨的块数因人而异，部分人群尾骨可能部分或完全未融合。

图 10
(A) 骶骨与尾骨的 CT 矢状位多平面重建 (MPR) 图像。(B) CT 扫描的 3D 容积重建图像，前视图。

/ 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.

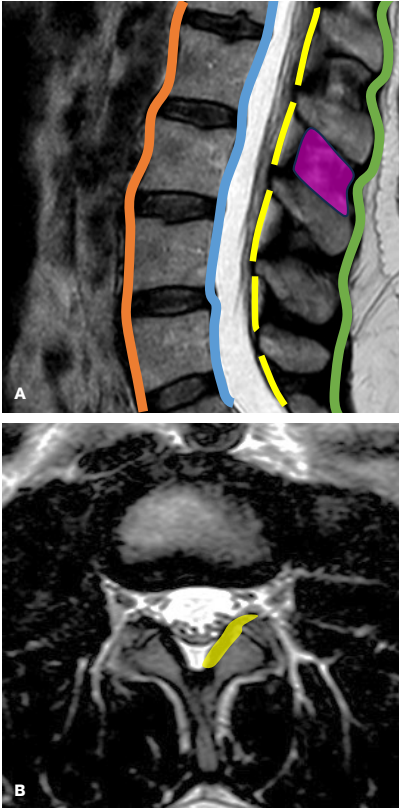


FIGURE 11
Sagittal T2W MRI sequence (A) and axial T2W image (B), with ligaments annotated

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/ 脊柱韧带

脊柱韧带如图 11 所示。

前纵韧带 (Anterior Longitudinal Ligament, ALL [橙色]): 沿椎体前表面行走, 从颅底延伸至骶骨。

后纵韧带 (Posterior Longitudinal Ligament, PLL [蓝色]): 在椎管内沿椎体的背面行走。

棘上韧带 (Supraspinous Ligament, SSL [绿色]): 沿棘突尖端从第七颈椎延伸至骶骨。

棘间韧带 (Interspinous Ligament, ISL [粉红色]): 连接脊柱后部相邻的棘突。

黄韧带 (Ligamentum Flavum, LF [黄色]): 位于椎管内, 连接相邻椎骨的椎板。

横突间韧带: 该韧带连接相邻椎骨的横突。

项韧带 (又称项部韧带): 是棘上韧带在颈部的延续, 自枕外隆凸延伸至第 7 颈椎棘突。

后纵韧带 (PLL)、棘间韧带 (ISL)、棘上韧带与关节突关节囊共同构成后韧带复合体 (Posterior Ligament Complex, PLC), 该复合体在骨折评估中具有重要作用。

图 11

矢状位 T2 加权 MRI / 序列图像 (A) 及轴位 T2 加权图像 (B), 图中标注了各种韧带。

/ 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».

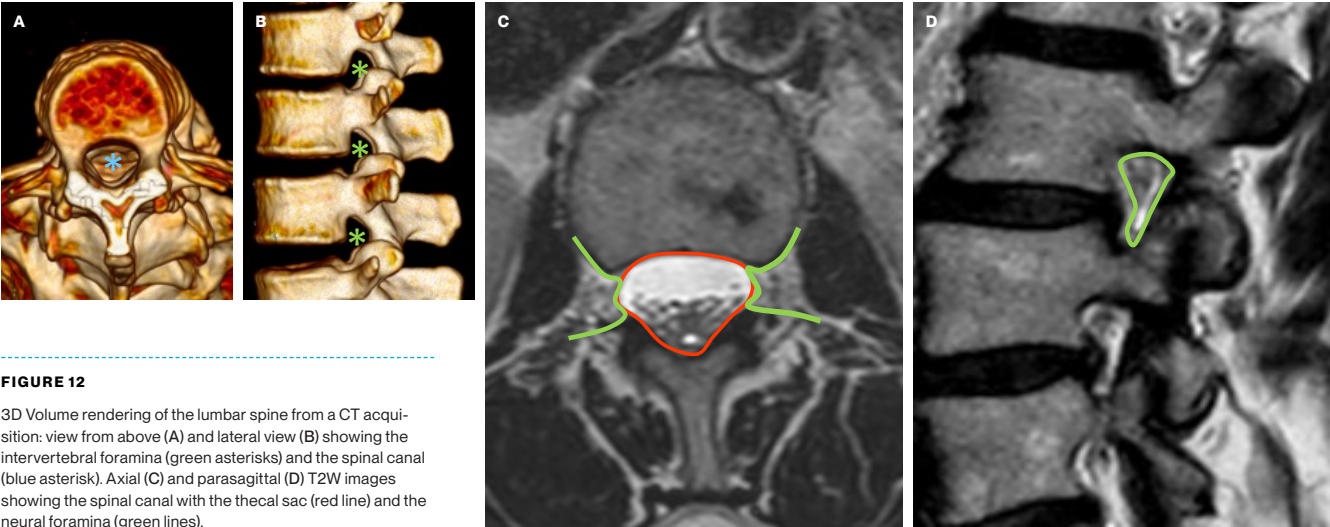


FIGURE 12
3D Volume rendering of the lumbar spine from a CT acquisition: view from above (A) and lateral view (B) showing the intervertebral foramina (green asterisks) and the spinal canal (blue asterisk). Axial (C) and parasagittal (D) T2W images showing the spinal canal with the thecal sac (red line) and the neural foramina (green lines).

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/ 椎管和椎间孔

椎骨相互连接形成椎管，脊髓和脑膜位于椎管内。(图 12) 椎管在轴位图像上呈不规则椭圆形。

在椎体外侧，相邻椎骨形成椎间孔或神经孔，神经由此穿出椎管(图 12)。在矢状位图像上，神经孔呈“逗号”状。

图 12
腰椎 CT 扫描 3D 容积重建图像：俯视图 (A) 和侧位像 (B)，显示椎间孔 (绿色星号) 和椎管 (蓝色星号)。轴位 (C) 和旁矢状位 (D) T2 加权图像，显示椎管内的硬脊膜囊 (红线标注) 和神经孔 (绿线标注)。

/ Variants: Lumbar Transitional Vertebra

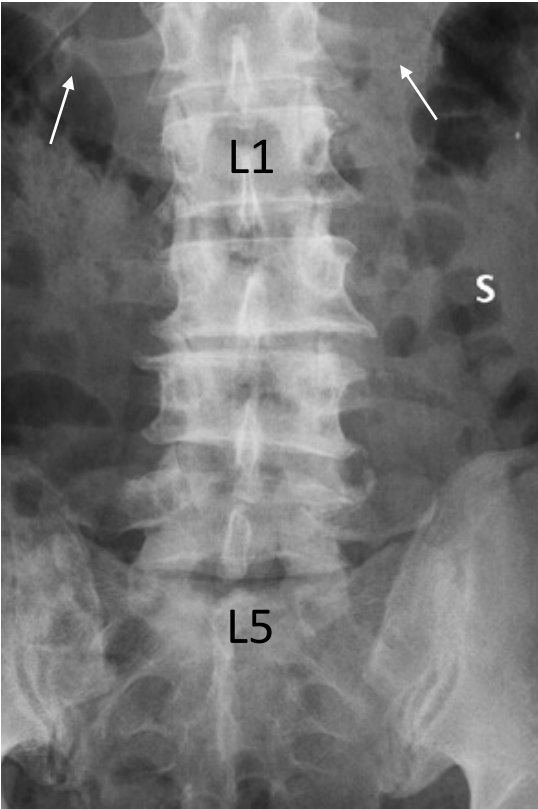
Lumbosacral transitional vertebrae (LSTV) are a relatively common variant that can be missed or not well recognised. It is seen in about 9% of the population.

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.



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/ 解剖结构变异：腰椎移行椎

腰骶移行椎 (Lumbosacral transitional vertebrae, LSTV) 是一种相对常见但易被漏诊或识别不清的变异。约 9% 的人群存在该变异。

根据椎骨总数、特定节段的椎骨数量或移行程度，可将其标记为腰化的 S1 (常伴有腰肋) 或骶化的 L5。

与既往检查结果进行对比会很有帮助，且应在可能的情况下，检查整个脊柱。

最常见的移行椎是 L5 骶化 (图 13)，可依据以下表现识别：仅有 4 块无肋骨附着的腰椎型椎骨、最下方腰椎 (移行椎) 椎体呈楔形，尤其是 L5 - S1 间隙存在残存椎间盘。

图 13
腰椎后前 (PA) 位 X 线片显示 L5 部分骶化。箭头所示为双侧第 12 肋骨。该患者仅可见 4 块无肋骨附着的腰椎型椎骨，颈胸椎的椎体正常。

/ 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 (**Ila:** unilateral, **Ilb:** bilateral)
- / **Type III:** complete lumbarisation or sacralisation (**IIla:** unilateral, **IIlb:** bilateral)
- / **Type IV:** type **Ila** on one side and type **IIla** on the other side

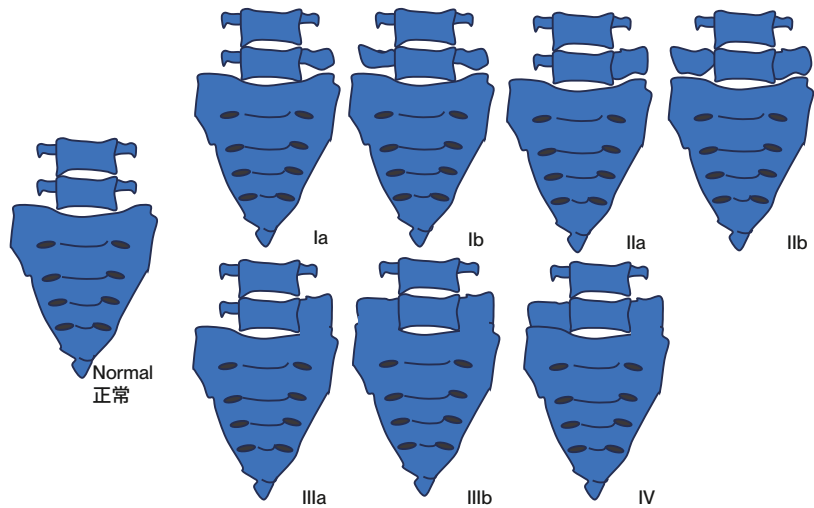


FIGURE 14
Schematic diagram of the Castellvi classification

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/ Castellvi 分型

Castellvi 分型法 (图 14) 对腰骶部移行椎 (LSTV) 的分型:

- / I 型: 横突增大 (Ia 型: 单侧; Ib 型: 双侧)
- / II 型: 横突与骶骨形成假关节, 伴不完全骶椎腰化/腰椎骶化 (IIa 型: 单侧; IIb 型: 双侧)
- / III 型: 完全骶椎腰化或腰椎骶化 (IIla 型: 单侧, IIlb 型: 双侧)
- / IV 型: 一侧为 IIa 型, 另一侧为 IIIa 型

图 14
Castellvi 分型示意图

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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

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/ 脊柱退行性疾病

腰痛是指发生在肋骨以下、臀部以上的下背部区域的不适或疼痛。这是一种常见的就医主诉，可由多种因素引起。以下是一些与腰痛相关的重要概念：

腰痛是全球最常见的疾病之一。它影响各个年龄段的人群，但在成年人中最普遍。可分为急性（持续时间较短，少于六周，可自行缓解或通过保守治疗治愈）或慢性（持续时间超过三个月）。

<∞> 参考文献

> 请参阅《中枢神经系统》和《骨骼肌肉影像学》电子书章节

- 病因:**
- / **肌肉拉伤或扭伤:** 常因突然或不当的提拉、扭转或用力过度导致
 - / **椎间盘突出/膨出:** 部分椎间盘向后突出（见《CNS》章节）
 - / **骨关节炎:** 脊柱关节突关节退行性变
 - / **椎管狭窄:** 椎管变窄，可能压迫脊髓或神经根
 - / **脊椎滑脱:** 一个椎骨向前滑脱超过另一个椎骨
 - / **创伤或损伤:** 比如跌倒、车祸或运动损伤
 - / **结构异常:** 脊柱解剖结构的先天性或后天性异常

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



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

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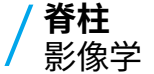
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Received 23 July 2013; revised 17 March 2014; accepted 14 April 2014

<∞> 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.



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毫无疑问，了解这一重要主题的一篇开创性论文是 Fardon 等人的文章。

<∞> 参考文献

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.

/ 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

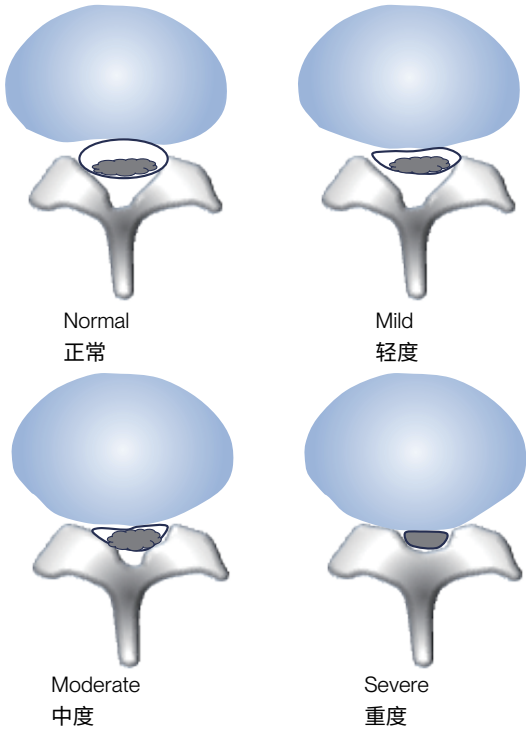


FIGURE 15
Schematic diagram of the spinal canal stenosis classification proposed by Lee et al.

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/ 椎管狭窄

椎管狭窄是指椎管变窄，达到可能对硬膜囊以及脊髓 / 马尾神经产生压迫的程度。它可以是先天性的，也可能因后天因素（退变）引起。

目前已提出多种分级方法：Lee 等人提出了一种简易的分级方法，该方法根据轴位 T2 加权图像上硬膜囊的形态，将腰椎椎管狭窄分为四级（图 15）：

- / 0 级（无狭窄）：前脑脊液 (CSF) 间隙未闭塞
- / 1 级（轻度狭窄）：前 CSF 间隙轻度闭塞，但所有马尾神经仍清晰可见
- / 2 级（中度狭窄）：前 CSF 间隙中度闭塞，马尾神经开始模糊不清
- / 3 级（重度狭窄）：前 CSF 间隙严重闭塞，马尾神经无法显示

图 15
Lee 等人提出的椎管狭窄分级示意图

/ 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

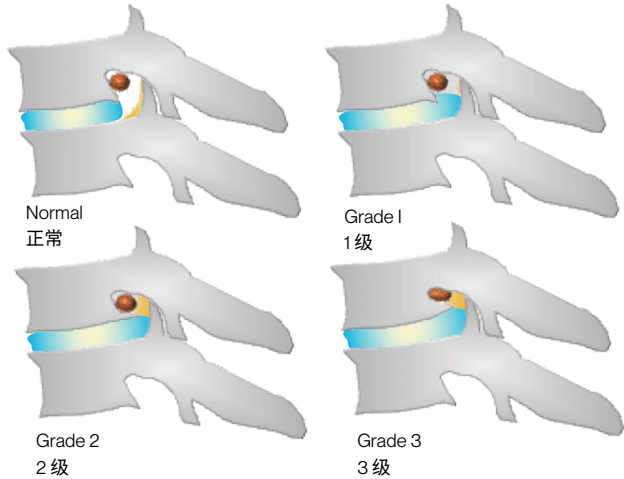


FIGURE 16
Schematic diagram of the Lee classification of lumbar foraminal stenosis

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/ 椎间孔狭窄

椎间孔狭窄是指神经孔变窄。

它是退行性疾病导致的一种改变，可由骨质增生、椎间盘膨出/突出、韧带增厚等原因引起，尤其常见于多种情况并存时。

我们可采用 Lee 等提出的分级法（图 16），通过矢状位 T2 加权图像评估腰椎椎间孔狭窄：

- / 0 级：无狭窄，脂肪环绕神经根
- / 1 级：某一个维度上无法看到神经根周围脂肪
- / 2 级：神经根周围脂肪均不可见，但神经根未受压
- / 3 级（重度）：神经根周围脂肪不可见且神经根受压

图 16

腰椎间孔狭窄的 Lee 分级示意图

/ 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.

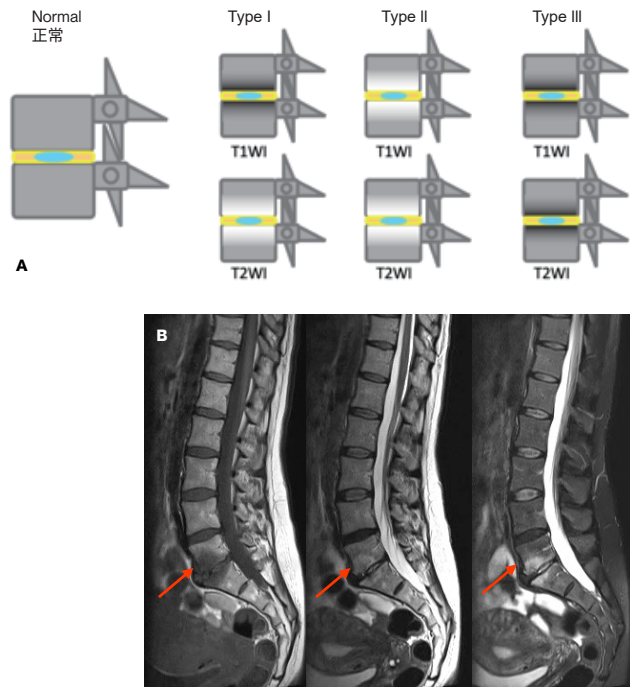


FIGURE 17

(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.

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/ Modic 改变

Modic 退变指 MRI 上可见的椎体内骨髓发生特定模式改变。此类变化以丹麦放射科医生迈克尔·莫迪 (Michael Modic) 博士的名字命名, 他于 20 世纪 80 年代首次对其进行了描述。

此分类有三种类型 (图 17):

- / **I 型:** MR T1WI 上信号降低, T2WI 和短时间反转恢复序列 (STIR) 信号增高。提示了椎体内存在水肿与炎症。
- / **II 型:** MR T1WI 和 T2WI 信号均增高, STIR 图像上信号降低。提示脂肪组织取代骨髓。
- / **III 型:** T1W、T2W 和 STIR 图像上信号强度均降低。提示发生了硬化。

图 17

(A) Modic 改变的示意图。(B) 矢状位 T1WI (左)、T2WI (中) 和 STIR (右) 图像, 显示 L5-S1 的 I 型 Modic 改变 (箭头所示)。

/ 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).

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/ 许莫氏结节

许莫氏结节（图 18），又称椎体间椎间盘突出，是一种发生在椎体自身内部的特殊类型椎间盘突出。

许莫氏结节被认为是椎体终板结构薄弱或存在缺陷所致。终板是覆盖在每个椎体顶部和底部的一层薄软骨，在椎间盘与骨间隙起到缓冲作用。

在影像学检查（X 线、CT 或 MRI）中，许莫氏结节表现为椎体内的小圆形或椭圆形病变。许莫氏结节常在影像学检查中偶然发现，可能不会引发任何症状。

许莫氏结节可能与其他脊柱疾病相关，如椎间盘退行性疾病、脊柱侧凸或骨质疏松症等。

许莫氏结节在大多数情况下无症状。

图 18
腰椎 CT 矢状位多平面重建 (MPR) 图像，显示 L4 上终板的许莫氏结节（箭头所示）。

/ 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.

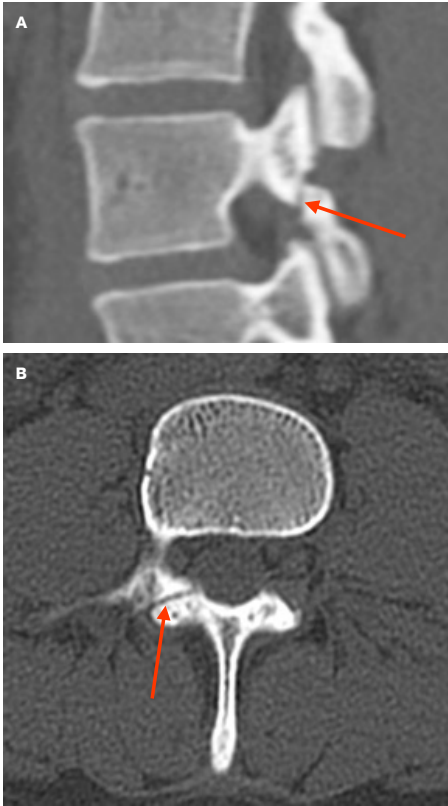


FIGURE 19
CT MPR in the parasagittal (A) and axial (B) plane showing a congenital Isthmic lesion (arrows).

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/ 峡部裂型腰椎滑脱

峡部裂型腰椎滑脱是一种脊柱疾病，表现为一个腰椎椎体相对于其下方椎体向前移位。这种移位发生在椎弓的峡部，即上、下关节突之间的侧块部分。

峡部裂型腰椎滑脱通常由峡部应力性骨折引起，而应力性骨折往往源于重复性劳损或急性损伤。该疾病可以是先天性（图 19），也可能是后天获得的。它最常见于第五腰椎（L5），该椎体向前滑过骶骨（S1）。

许多病例可能完全无症状，在影像学检查时偶然发现。但如出现症状，常见的可能有下背痛、僵硬、肌紧张，有时还会出现放射痛或麻木。

图 19
旁矢状位 CT 多平面重建 (MPR) 图像 (A) 和轴位图像 (B) 显示先天性峡部病变（箭头所示）。

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.

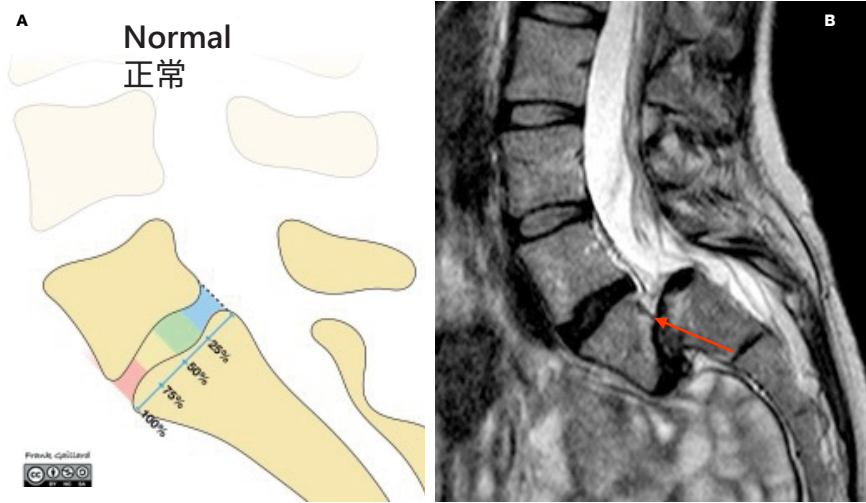


FIGURE 20
(A) Schematic drawing explaining the Meyerding grading system. Case courtesy of Frank Gaillard, Radiopaedia.org, rID: 57603. (B) T2W sagittal MRI sequence of grade IV spondylolisthesis (arrow). Case courtesy of Gennaro D'Anna, Radiopaedia.org, rID: 64335

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脊椎滑脱的严重程度可采用 Meyerding 分级系统进行分级 (图 20)。该系统将下位椎体的上终板四等分。

分度基于上位椎体后下角的位置:

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

V 度也可称为脊椎滑脱症。

图 20
(A) Meyerding 分级系统示意图。病例来源: Frank Gaillard, Radiopaedia.org, rID: 57603. (B) IV 度脊椎滑脱 (箭头所示) 的 MRI T2WI 矢状位图像。病例由 Gennaro D'Anna 提供。Radiopaedia.org, rID: 64335

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/ 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, bio-mechanics. 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.

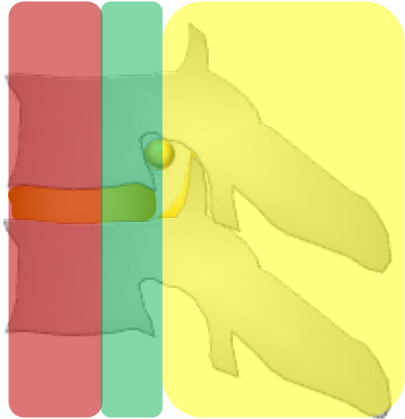


FIGURE 21
Schematic drawing explaining the Denis classification

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/ 椎骨骨折：稳定性骨折与不稳定性骨折

椎骨骨折可能是外伤、骨质疏松以及影响脊柱的各种病理状况所导致的后果。

骨折可发生在任何节段，分类方式也很多：依据形态、脊柱三柱结构、生物力学特性等。其中最重要的是弗朗西斯·丹尼斯（Francis Denis）提出的用于判定骨折稳定性的脊柱三柱概念。

- Denis 将脊柱分为 3 个垂直柱（图 21）：
- / **前柱（红色）：**前纵韧带、椎体前 2/3 以及椎间盘相应部分（尤其是纤维环）
 - / **中柱（绿色）：**椎体后 1/3 以及椎间盘相应部分（尤其是纤维环）、后纵韧带
 - / **后柱（黄色）：**椎弓和韧带

如果骨折仅累及一个柱，特别是前柱，认为是稳定骨折。

若累及前柱和中柱，骨折是不稳定的。

如果三个柱均受累，则属于不稳定骨折。

图 21
Denis 分类法示意图

/ 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

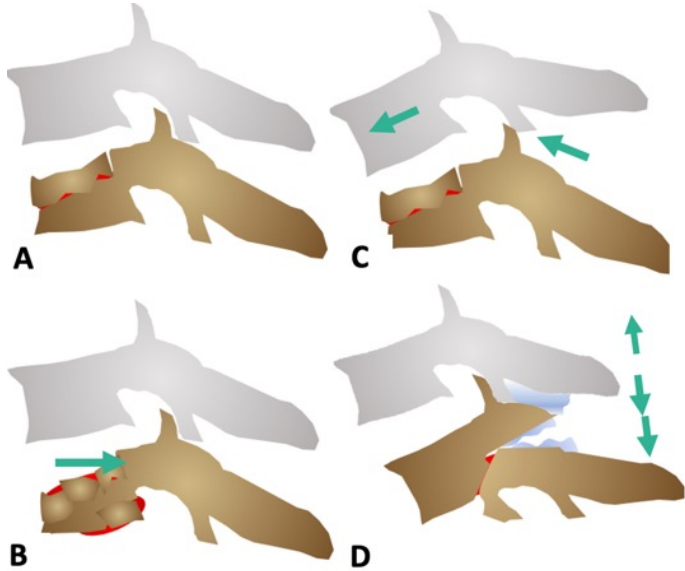


FIGURE 22

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).

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/ 骨折类型：形态

图 22 和图 23 展示了不同类型的椎体骨折。

压缩（楔形）性骨折：椎体高度降低，常由骨质疏松或外伤导致。

爆裂性骨折：这种骨折累及椎体和后部结构。通常由高能量创伤引起，且可能伴有脊髓损伤。

屈曲-牵张 (Chance) 性骨折：脊柱突然屈曲所致。

骨折-脱位：这类损伤很严重，同时涉及椎体骨折和关节突关节脱位。

<=> 参考文献

> 请参阅《中枢神经系统》和《骨骼肌肉影像学》电子书章节

图 22

椎体骨折的类型。(A) 单纯的单点压缩性骨折（单一压缩，楔形变形）。(B) 两点爆裂性骨折（伴有上位椎体碎片向后移位的压缩性骨折）。(C) 平移/旋转三点骨折（伴有前/侧方移位及小关节移位的旋转剪切骨折）。(D) 牵张性四点骨折（后部结构发生水平骨折并伴有分离）。

/ 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.

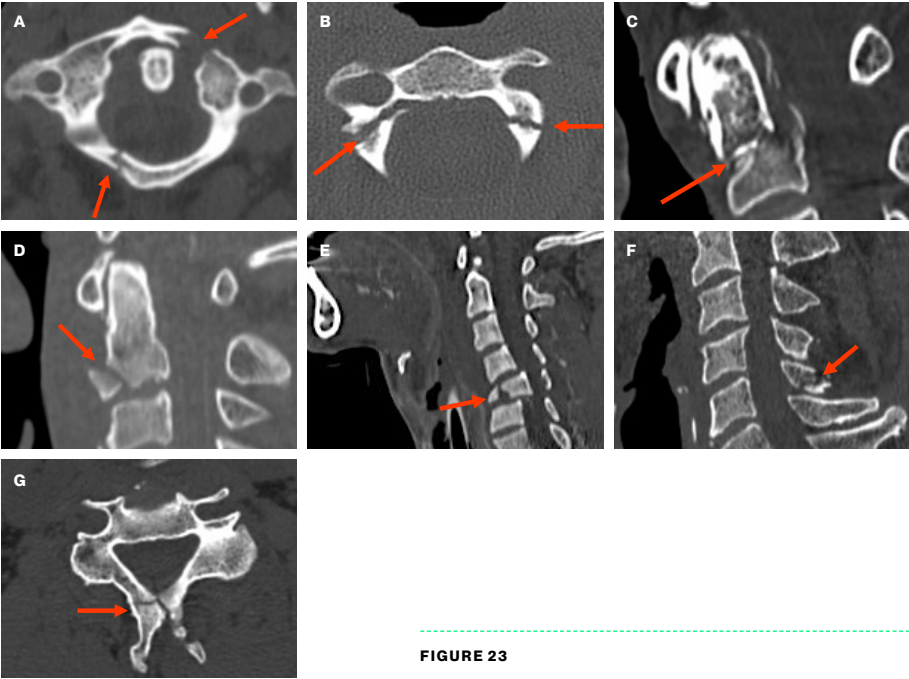


FIGURE 23
(A) Jefferson fracture. Case courtesy of Fakhry Mahmoud Ebouda, Radiopaedia.org, rID: 30679. (B) Hangman fracture Case courtesy of Andrew Dixon, Radiopaedia.org, rID: 10130. (C) Odontoid fracture. (D) Extension teardrop fracture involving C2. (E) Flexion teardrop fracture involving C5. (F and G) Clay-Shoveler's fracture involving C5. Images D-G courtesy Alexandra Platon, MD, Emergency Radiology, Geneva University Hospitals.

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- / **Jefferson 骨折 (C1 爆裂性骨折):** 由于轴向负荷或过度伸展导致的第一颈椎 (寰椎) 爆裂性骨折。
- / **Hangman 骨折 (C2 骨折):** 机制: 涉及到第二颈椎 (枢椎) 椎弓峡部骨折, 通常由过度伸展和轴向负荷引起。
- / **齿状突骨折 (C2 齿状突骨折):** 此类骨折发生在齿状突处。
- / **伸展型泪滴样骨折:** 这种骨折涉及从椎体前下缘撕脱的三角形骨碎片。
- / **屈曲型泪滴样骨折:** 机制: 是屈曲和轴向负荷共同作用的结果, 导致椎体压缩以及前下缘骨块撕脱。
- / **Clay-Shoveler's 骨折:** 这种骨折涉及下颈椎或上胸椎棘突的撕脱骨折。

图 23
(A) Jefferson 骨折。病例来源: Fakhry Mahmoud Ebouda, Radiopaedia.org, rID: 30679。 (B) Hangman 骨折病例来源: Andrew Dixon, Radiopaedia.org, rID: 10130。 (C) 齿状突骨折。 (D) 累及 C2 的伸展型泪滴样骨折。 (E) 累及 C5 的屈曲型泪滴样骨折。 (F 和 G) C5 Clay-Shoveler 骨折。图 D - G 由日内瓦大学医院急诊放射科 Alexandra Platon, MD 提供。

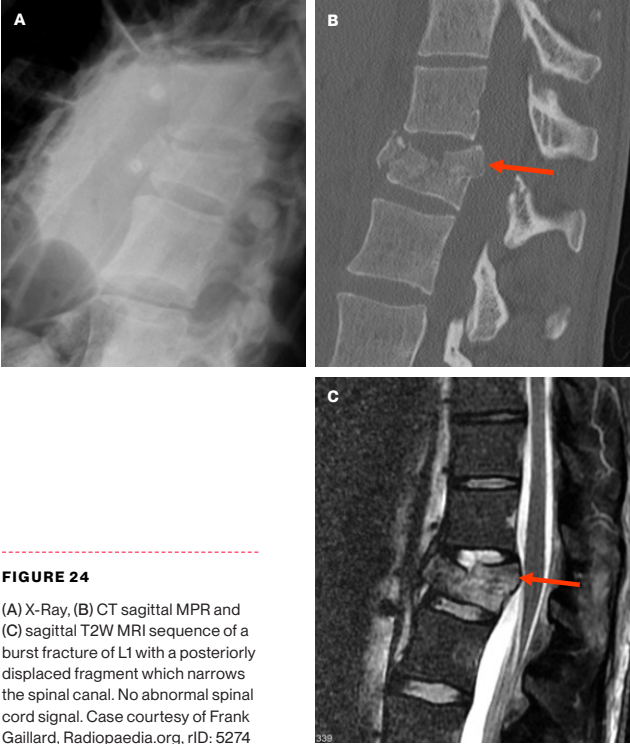
/ Thoracolumbar Fractures

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



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胸椎本质上比颈椎和腰椎更为坚硬，因此抗外伤能力更强。相反，腰椎活动度更大，更容易发生骨折。在外伤情况下，同时检查这两个区域会很有帮助。特别是因为胸腰段交界处是活动度增加的过渡点，所以也是胸腰椎骨折最常见部位（见图 24）。

讨论胸腰椎骨折时，有两种重要的分类方法：

- / AO 胸腰椎骨折分类法
- / 胸腰椎损伤分类及严重程度评分（Thoraco-Lumbar Injury Classification and Severity score, TLICS）

尽管两种分类方法都很实用，但还是有一些差异：

- / AO 分类法主要基于 CT 评估，且与损伤机制相关
- / 胸腰椎损伤分类及严重程度评分（TLICS）则与 MRI 以及患者的临床状况关联更为紧密。TLICS 描述了对预测脊柱稳定性、未来畸形发展以及进行性神经功能损害等方面至关重要的特征

图 24

(A) X 线片，(B) CT 矢状位多平面重建 (MPR) 图像，(C) L1 爆裂性骨折的矢状位 T2W MRI 序列像，可见骨折片向后移位，使椎管变窄。脊髓信号未见异常。病例来源：Frank Gaillard, Radiopaedia.org, rID: 5274

/ 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:

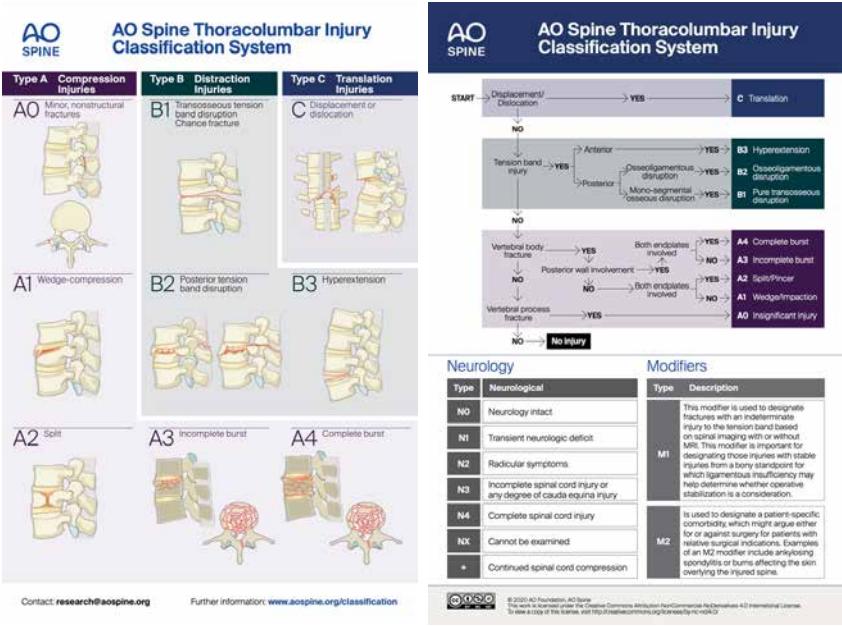
- / A1: Impaction
- / A2: Split
- / A3: Burst

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>

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/ 胸腰椎骨折 - AO 分类法

AO 分类系统 (图 25) 是由国际内固定研究工作组 (Arbeitsgemeinschaft für Osteosynthesefragen, AO) 基金会开发的一种广泛应用的骨折分类方法。它根据骨折的解剖位置、移位或不稳定程度, 提供了一套系统描述骨折的方式。

A 型 - 压缩性损伤:

- / A1: 嵌压骨折
- / A2: 劈裂骨折
- / A3: 爆裂骨折

B 型 - 牵张性损伤:

- / B1: 单纯牵张损伤
- / B2: 侧屈牵张损伤
- / B3: 屈曲 - 旋转牵张损伤

C 型 - 旋转性损伤:

- / C1: 单侧损伤
- / C2: 双侧损伤
- / C3: 脱位

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图 25

AO 分类系统 (AO 代表 Arbeitsgemeinschaft für Osteosynthesefragen, 英文为 Working Group for Osteosynthesis Questions [国际内固定研究工作组]): <https://www.aofoundation.org/spine/clinical-library-and-tools/aospine-classification-systems>

/ 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>

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/ 胸腰椎 – TLICS 分类

胸腰椎损伤标准分类 (Thoracolumbar Classification for Standards, TLICS, 图 26) 评估三个独立参数:

- / 损伤的形态
- / 后韧带复合体 (PLC) 完整性
- / 神经功能状态

为每个参数赋予分值, 总分可预测是否需要手术。值得注意的是, 在评估骨折形态时, 胸腰椎损伤分类及严重程度评分 (TLICS) 同时会考量后韧带复合体 (PLC) 的完整性以及神经功能状态。

形态	压缩骨折	1
	爆裂骨折	2
	平移/旋转	3
	单纯牵张损伤	4
后韧带复合体 (PLC)	完好	0
	可疑损伤	2
	损伤	3
神经功能状态	完好	0
	神经根	2
	完全性脊髓损伤	2
	不完全性脊髓/马尾神经损伤	3

<∞> 参考文献

图 26
胸腰椎损伤分类及严重程度评分 (TLICS)。转载自《放射学助手》。
<https://radiologyassistant.nl/neuroradiology/spine/tlics-classification>

/ 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.

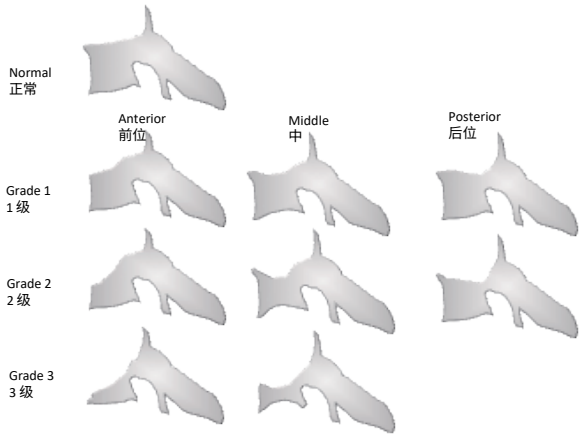


FIGURE 27
Schematic drawing explaining the Genant grading system.

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/ Genant 分类

Genant 分类法是一种用于评估椎体骨折的系统，尤其适用于骨质疏松相关的椎体骨折评估。它基于 X 线影像，依据椎体形态及高度丢失情况，提供了一套标准化描述椎体骨折严重程度的方法（图 27）。

该分类系统考量三个关键参数：

- / **0 级（正常）：**无任何椎体畸形迹象
- / **1 级（轻度）：**椎体前部、中部或后部高度降低 20%~25%
- / **2 级（中度）：**椎体前部、中部或后部高度降低 26%-40%
- / **3 级（重度）：**椎体前部、中部或后部高度降低超过 40%。

除了评估椎体高度降低情况，Genant 分类法还会考虑椎体楔形变和双凹形变的存在情况。这些畸形可作为椎体骨折的额外指征。

<∞> 参考文献

> 请参阅《骨骼肌肉影像学》电子书章节的“骨质疏松”部分

图 27

Genant 分级系统的示意图。

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/ Spinal Infections

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.

>|< COMPARE

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脊柱感染是指侵及到脊柱的感染，即累及椎体、椎间盘以及周围软组织的感染。感染可出现在不同部位，例如：

- / **椎体椎间盘炎：**椎骨感染，常由血行播散（通过血液循环）或邻近感染组织直接蔓延所致
- / **脓毒性关节炎：**关节突关节（小关节）感染
- / **硬膜外脓肿：**此类感染发生于硬膜外间隙，可对脊髓及神经根产生压迫，进而可能造成神经功能障碍

脊柱感染影像学检查：

- / **X 线检查：**它是用于识别明显骨骼异常（如椎体破坏或畸形）的初步影像学手段。但无法发现早期病灶。
- / **磁共振成像（Magnetic Resonance Imaging, MRI）：**用于检测脊柱感染最为灵敏且特异的成像方式。它能提供软组织的清晰图像，可显示脓液积聚、骨髓水肿及邻近结构受累情况。
- / **计算机断层扫描 (CT)：**CT 对评估骨质破坏非常有用，常与 MRI 联用，更清晰地显示骨骼结构，同时发现脓肿或骨质破坏区域。

/ 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.

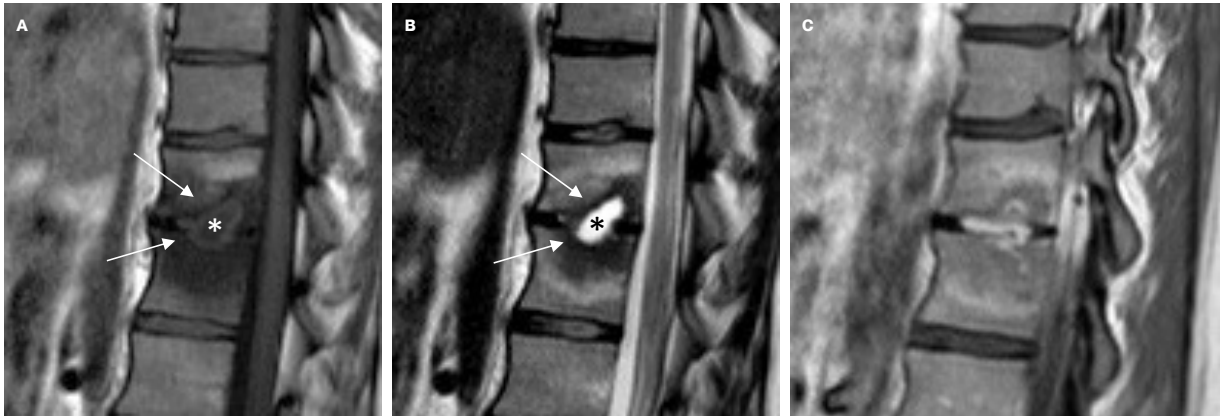


FIGURE 28
(A) T1W, (B) T2W and (C) contrast enhanced sagittal T1W images showing the typical features of pyogenic spondylodiscitis. There is fluid accumulation in the disk space (low signal on T1 and high signal on T2, asterisk) and the adjacent endplates show marrow oedema and loss of low signal of the cortex (arrows). Contrast enhancement of the disc and around the endplates.

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/ 椎间盘炎

椎体椎间盘炎是一种累及椎间盘及其相邻两个椎体的感染性病变 (图 28)。

在发育成熟的脊柱中，主要病理过程起始于终板区骨髓炎（儿童期可仅表现为单纯椎间盘炎），随后累及椎间盘。

病因：金黄色葡萄球菌是最常见的病原体。

发病部位：它可发生于脊柱的任何部位（以腰椎段最为多见），尤其常累及单个椎间盘-终板单元；多节段受累相对少见。

图 28

(A) T1WI、(B) T2WI，以及 (C) 矢状位增强 T1WI，显示了化脓性椎间盘炎的典型特征。椎间盘间隙存在积液 (T1WI 呈低信号影，T2WI 呈高信号影，星号所示)，相邻终板显示骨髓水肿，皮质的低信号影消失 (箭头所示)。椎间盘及终板周围显示强化。

/ 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.

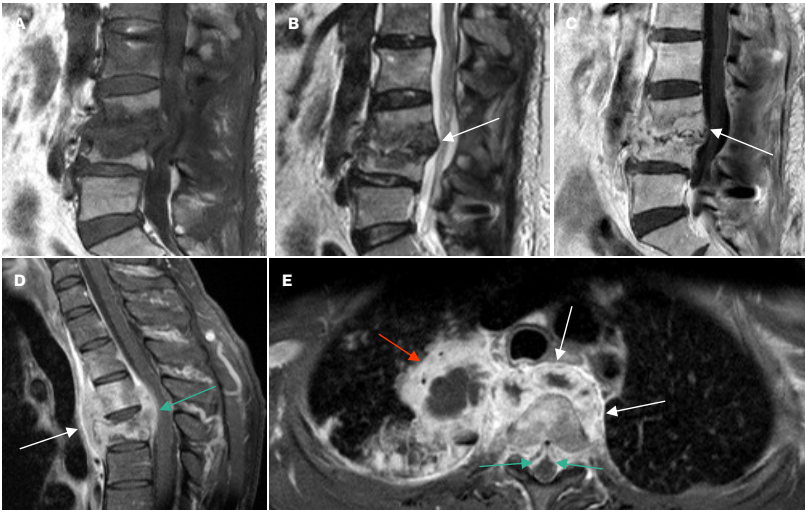


FIGURE 29
Two different patients with TB spondylitis. Lumbar spine TB spondylitis in patient 1 (A-C). (A) T1W, (B) T2W and (C) contrast-enhanced T1W sequences show involvement of L3 and L4 and of the intervertebral disc L3/L4. Vertebral body collapse and mass effect on the thecal sac due to epidural 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.

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/ 结核性脊柱炎 (Pott 病)

脊柱是结核病 (tuberculosis, TB) 最常见的感染部位之一。结核性脊柱炎, 又称 Pott 病, 通常是结核菌经动脉和静脉血行播散的结果。在结核病 (TB) 不流行的国家, 要将其与其他病原体感染进行鉴别诊断颇具挑战性。

诊断结核性脊柱炎 (图 29) 的一些要点包括: 在脊柱不同节段出现多处病灶 (跳跃性病变), 椎体受累多于椎间盘, 且骨质破坏较为严重, 特别是累及胸椎时。由于椎体前部受累, 可能很快就会出现驼背畸形。此外, 伴有液性成分及强化边界的巨大椎旁脓肿亦为其典型表现。

图 29
两例不同的结核性脊柱炎患者。患者 1 患有腰椎结核性脊柱炎 (A-C)。(A) T1WI、(B) T2WI 及 (C) 增强 T1WI 示 L3 和 L4 椎体以及 L3/L4 椎间盘受累。椎体塌陷, 硬膜外肉芽组织对硬脊膜囊产生占位效应 (箭头所示)。另一例累及上胸椎的患者 (D 和 E)。矢状位 (D) 和轴位 (E) 脂肪抑制 T1WI 增强图像显示 T3 和 T4 椎体广泛受累, 伴有椎前脓肿 (白色箭头)、巨大肺部脓腔 (红色箭头) 以及压迫脊髓的硬膜外脓肿 (绿色箭头)。注意胸廓的驼背畸形。图 D 和图 E 由日内瓦大学医院医学博士 Minerva Becker 提供。

/ Spinal Epidural Abscess

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).

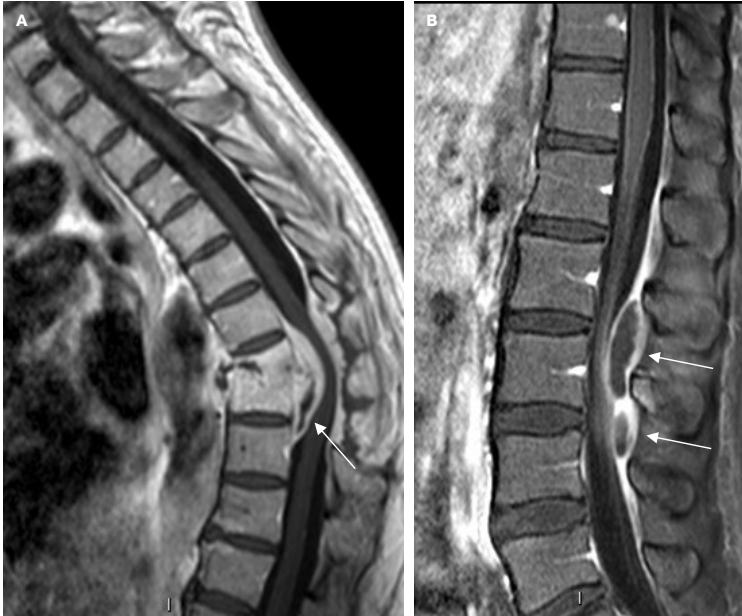


FIGURE 30
Sagittal T1W contrast enhanced image (A) shows spondylodiscitis with an anterior epidural abscess (arrow) and spinal cord compression. Different patient (B). Fat saturated contrast-enhanced T1W image showing a posterior epidural abscess (arrows)

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/ 脊髓硬膜外脓肿

硬膜外间隙（位于硬脊膜与椎骨骨膜之间）的感染较为罕见，其病因通常为细菌感染。由于它可迅速造成脊髓压迫，往往需要进行急诊手术。

最常见的发病部位是胸段椎管后方。

其可继发于硬膜外血肿和/或外伤，也可由椎间盘炎、小关节化脓性关节炎或远处感染经血行播散引发。

硬膜外蜂窝织炎必须与硬膜外脓肿相鉴别，后者需要手术引流。MRI是鉴别这两种疾病的首选影像学检查方法（图 30）。

图 30
矢状位增强 T1WI 图像 (A) 示椎间盘炎伴前方硬膜外脓肿（箭头）和脊髓压迫。另一例患者 (B)。脂肪抑制 T1WI 增强图像显示后方硬膜外脓肿（箭头所示）

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/ 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)



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/ 椎体肿瘤

脊柱可发生各类肿瘤性病变，其中源自其他部位的转移瘤尤为常见（图 31）。最常累及椎体的原发性恶性肿瘤有乳腺癌、肺癌和前列腺癌。

此外，椎体还可出现原发病变，可为局灶性或弥漫性，性质既可为良性，亦可为恶性。

对于临床医生和放射科医生而言，准确识别病变部位、评估病变形态、了解其与周围结构的关系十分重要。

图 31
矢状位 T1WI 图像显示多处脊柱转移瘤（箭头所示）。

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

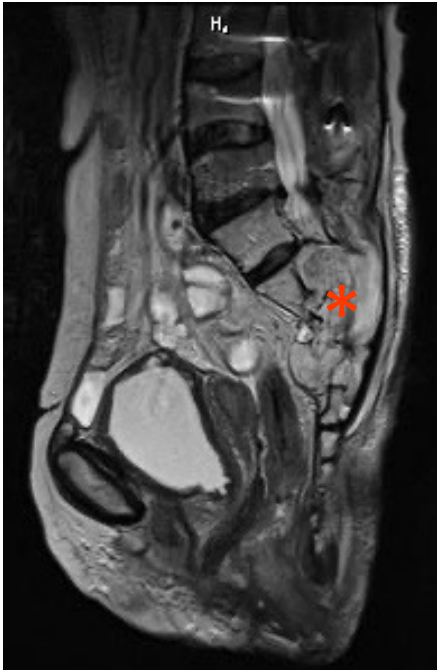
Non-neoplastic lesions

- / 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>

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非肿瘤性病变

- / 椎体静脉畸形（椎体血管瘤）
- / 动脉瘤样骨囊肿
- / 骨岛

原发性骨肿瘤

- / 多发性骨髓瘤
- / 脊索瘤（图 32）
- / 骨样骨瘤
- / 软骨肉瘤
- / 尤因肉瘤
- / 淋巴瘤
- / 骨肉瘤
- / 巨细胞瘤
- / 成骨细胞瘤

转移瘤

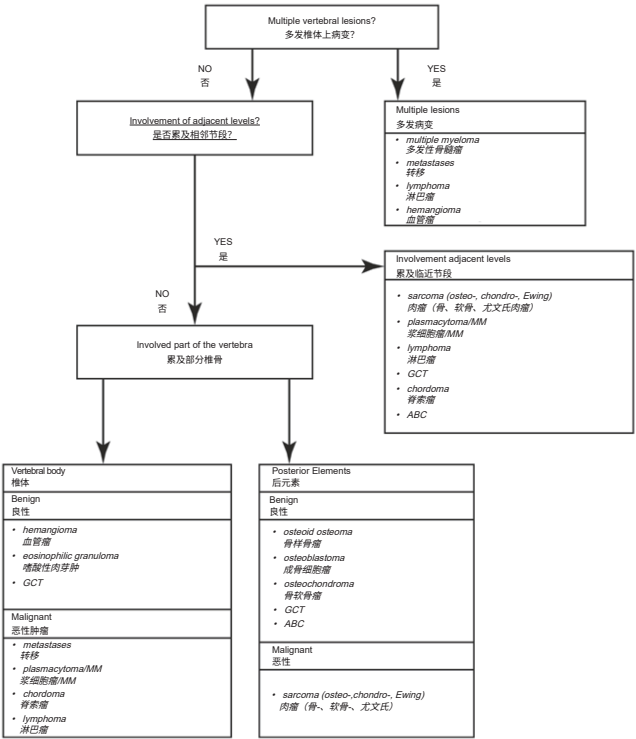
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图 32
矢状位 T2WI 序列图像显示骶骨脊索瘤（星号所示）。病例来源: Mohammadtaghi Niknejad, Radiopaedia.org, rID: 85458
<https://radiopaedia.org/articles/vertebral-body-mass?lang=us>

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

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椎体病变: 鉴别诊断方法

在椎体病变的影像学鉴别诊断方面, 曼弗雷 (Manfrè) 提出了基于以下问题的逐步诊断法 (图 33):

- / 是单发病变还是多发病变?
- / 相邻节段是否受累?
- / 椎体的哪一部分受累 (椎体还是后部结构)?

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图 33

椎体病变诊断流程示意图。改编自 Luigi Manfrè 所著《椎体病变 (Vertebral Lesions)》, 施普林格出版社 (Springer) 2017 年出版

/ 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.

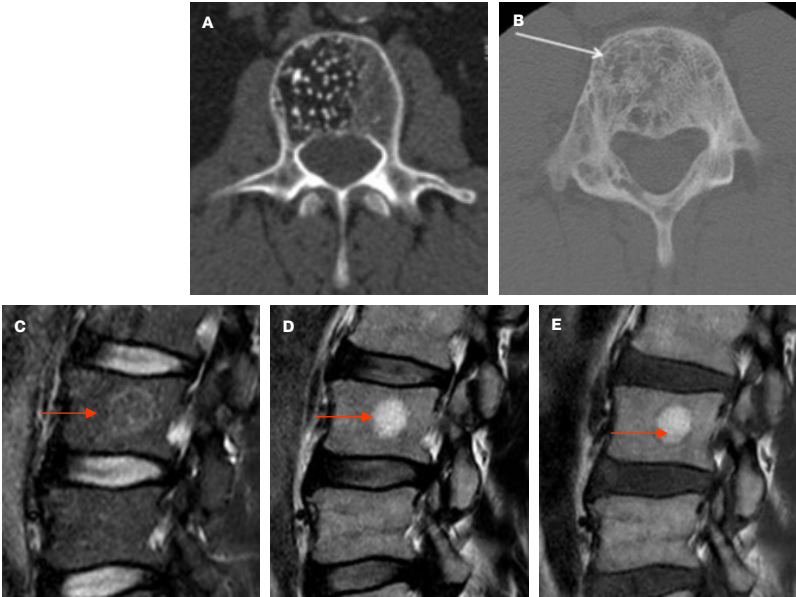


FIGURE 34
Axial CT images showing VVMs in 2 different patients with the characteristic salt and pepper (A) or striated appearance (B). Image A: courtesy of Bruno Di Munzio, Radiopaedia.org. rID: 15248. Image B: reproduced from McEvoy SH et al. Insights into Imaging 7, 87-98 (2016). Different patient (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.

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/ 椎体静脉畸形

<!=> 注意

椎体静脉畸形 (Vertebral Venous Malformation, VVM) 又称为椎体血管瘤 (Vertebral Haemangioma, VH), 是最常见的脊柱偶发瘤。它并不是真正的肿瘤。该病通常无症状, 因其影像学特征明显很容易发现。

在 CT 扫描中因小梁排列很有特点, 可能呈现典型的“椒盐征”。

在 MRI 上, 其富含脂质的特征在所有序列像上都很明显 (图 34)。

在极少数情况下, 它可能表现出局部侵袭性。

图 34
轴位 CT 图像显示两例患者的椎体静脉畸形 (VVM), 分别具有特征性“椒盐征” (A) 或条纹样表现 (B)。图像 A: 由 Bruno Di Munzio 提供, Radiopaedia.org. rID: 15248。图像 B: 转载自 McEvoy SH 等人的文章 Insights into Imaging 7, 87-98 (2016)。另一例患者 (C-E)。一例典型椎体静脉畸形 (VVM) (箭头所示) 患者的矢状位 STIR (C)、T2WI (D) 及 T1WI 图像 (E)。由于该病灶内含脂肪成分, 在 STIR 序列上其信号不可见。

/ 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.

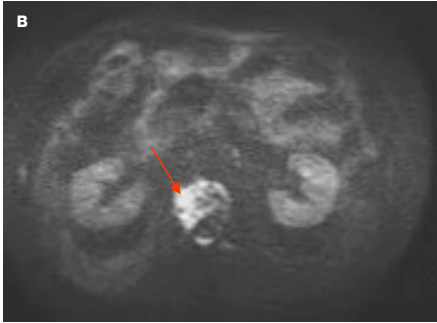


FIGURE 35

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).

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/ 多发性骨髓瘤

<!=> 注意

脊柱是多发性骨髓瘤 (MM) 最常见的发病部位之一，其特征为骨髓内浆细胞的异常增殖。

近年来，MRI、低剂量多排螺旋 CT 扫描 (low-dose Multidetector Computed Tomography, MDCT) 以及 18F-氟代脱氧葡萄糖正电子发射计算机断层显像 (18F-fluoro-deoxyglucose Positron Emission Tomography, 18F - FDG PET) /18F - FDG PET - CT 取得了重大进展，如今这些技术已用于评估溶骨性骨病变和骨髓浸润的早期阶段。

值得注意的是，MRI 上出现一个以上的局灶性病变 (> 5 mm) 就足以确诊多发性骨髓瘤。MRI 诊断多发性骨髓瘤 (MM) 时，通常采用 T1WI、T2WI 和扩散加权成像 (diffusion weighted imaging, DWI) 序列 (图 35)。多发性骨髓瘤 (MM) 病灶在扩散加权成像 (DWI) 上表现为扩散受限。

图 35

矢状位 T1WI (A) 和轴位扩散加权成像 (DWI) (B) 显示弥漫性多发性骨髓瘤 (MM)。请注意，由于骨髓浸润，几乎所有椎体在 T1WI 上均呈低信号，且在扩散加权成像 (DWI) 上存在扩散受限 (图 B 中箭头示椎体内的高信号影)。

/ 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).

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/ 椎体转移瘤

<=> 注意

脊柱是多种原发肿瘤的常见转移部位 (图 36)。这些转移瘤可表现为成骨性或溶骨性, 在某些情况下, 同一肿瘤也可同时导致成骨性和溶骨性改变。

具有溶骨性转移的肿瘤包括:

- / 肺癌
- / 肾细胞癌
- / 黑色素瘤
- / 多发性骨髓瘤

具有成骨性转移的肿瘤包括:

- / 前列腺癌
- / 骨肉瘤
- / 甲状腺髓样癌

乳腺癌骨转移通常造成溶骨性病变, 但偶尔也可导致成骨性病变。

图 36

多种类型转移瘤, 向后侵犯椎管 (箭头所示)。矢状位 MRI 影像 (A, B 和 C)。矢状 CT 多平面重建 (MPR) 图像 (D)。

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/ 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 analgic 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.

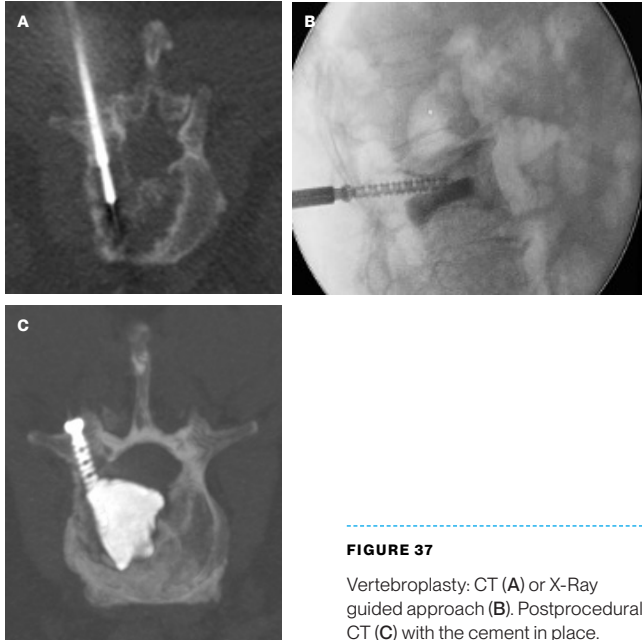


FIGURE 37
Vertebroplasty: CT (A) or X-Ray guided approach (B). Postprocedural CT (C) with the cement in place.

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椎体成形术是一种影像引导下的微创手术，用于治疗常由骨质疏松引起的椎体压缩性骨折。此外，它还可用于治疗某些脊柱肿瘤，以增强稳定性并起到止痛效果。

椎体成形术通过针头将一种特制的骨水泥（通常是聚甲基丙烯酸甲酯，即 PMMA）直接注入骨折的椎体中（图 37）。骨水泥会迅速硬化，稳固骨骼并提供支撑。

在患处经皮注射局部麻醉剂进行麻醉。患者取俯卧位或侧卧位，手术在荧光透视（实时 X 线成像）引导下进行。经 X 线引导，将空心针插入骨折椎体。然后将骨水泥注入椎体中。骨水泥迅速硬化，为骨折的椎骨提供结构支撑。该手术每治疗一个椎体通常需要约 30 到 60 分钟。

图 37
椎体成形术：CT 引导入路 (A) 或 X 线引导入路 (B)。术后 CT 扫描 (C) 显示骨水泥在位。

/ 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.



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对于有疼痛症状的腰椎峡部裂,可采用新型经皮入路施行后关节突关节固定术 (PFJF)。后关节突关节固定术 (PFJF) 的优点是腰椎的快速稳定,效果几乎与传统外科手术相当。

后关节突关节固定术 (PFJF, 图 38) 操作快捷,采用局部麻醉或轻度镇静,可以保留肌肉解剖结构及相邻的关节突关节。

腰椎后关节突关节固定术 (PFJF) 仅用 C 形臂即可完成,若在 C 形臂与 CT 联合引导下进行则效果更佳。后者有助于更好地选择尺寸、长度合适且定位精准的固定器械,如经关节螺钉或关节内植入物,从而避免椎体外或关节外的错误固定位置。

图 38

后关节突关节固定术 (PFJF) 后轴位 (A) 和矢状位 (B) CT 多平面重建 (MPR) 图像,显示经关节螺钉位置正确。

/ 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.

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- / 脊柱是解剖学与生物力学复合的精细结构。
- / 同时，它也是多种常被忽视疾病的发病部位。
- / 不断强化对脊柱疾病的理解对于临床医生和未来的放射科医生而言，是核心课程中的关键内容。
- / 除了诊断外，还需要重视介入手术在治疗各类脊柱疾病中的重要价值。

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<?> QUESTION

1 How many vertebrae are there in the cervical region?

- ☐ 12
- ☐ 7
- ☐ 5
- ☐ 39

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<?> 问题

1 颈椎由多少块椎骨组成?

- ☐ 12
- ☐ 7
- ☐ 5
- ☐ 39

/ Test Your Knowledge

<?> ANSWER

1 How many vertebrae are there in the cervical region?

- ☐ 12
- ☒ 7
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<?> 回答

1 颈椎由多少块椎骨组成?

- ☐ 12
- ☒ 7
- ☐ 5
- ☐ 39

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<?> QUESTION

2 Vertebroplasty is indicated for

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

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<?> 问题

2 椎体成形术适用于

- ☐ 棘突撕脱
- ☐ 椎间盘脱出
- ☐ 前纵韧带断裂
- ☐ 椎骨骨折

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<?> ANSWER

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- ☐ 前纵韧带断裂
- ☒ 椎骨骨折

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<?> QUESTION

3 The most common localisation of transitional vertebra

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

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<?> 问题

3 移行椎最常见的发生部位是

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

/ Test Your Knowledge

<?> ANSWER

3 The most common localisation of transitional vertebra

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

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

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<?> QUESTION

4 What is your diagnosis based on these MRI images?

- ☐ MODIC 1
- ☐ MODIC 2
- ☐ MODIC 3



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<?> 问题

4 根据以下 MRI 图像可诊断为?

- ☐ MODIC 1 型
- ☐ MODIC 2 型
- ☐ MODIC 3 型

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<?> ANSWER

4 What is your diagnosis based on these MRI images?

- ☒ MODIC 1
- ☐ MODIC 2
- ☐ MODIC 3



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<?> 回答

4 根据以下 MRI 图像可诊断为?

- ☒ MODIC 1 型
- ☐ MODIC 2 型
- ☐ MODIC 3 型

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<=> QUESTION

5

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

- ☐ AO
- ☐ TLICS
- ☐ Gennant

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<=> 问题

5

哪种胸腰椎损伤分类法考虑到后纵韧带复合体(PLC)?

- ☐ AO
- ☐ TLICS
- ☐ Gennant

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<=> ANSWER

5

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

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- ☒ TLICS
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<=> 回答

5

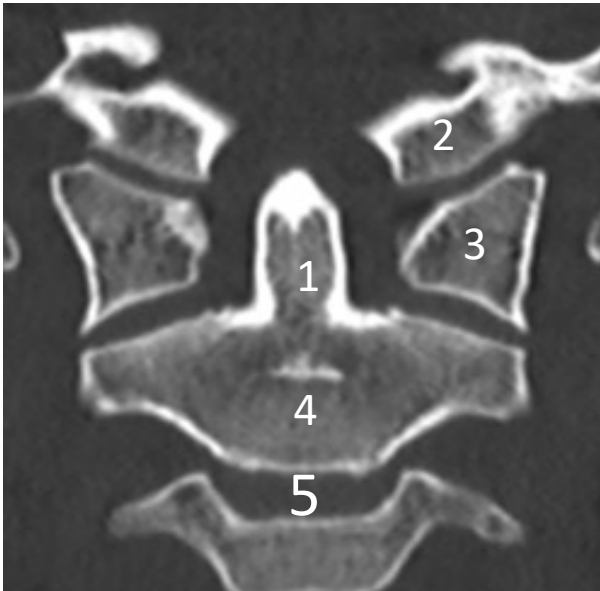
哪种胸腰椎损伤分类法考虑到后纵韧带复合体(PLC)?

- ☐ AO
- ☒ TLICS
- ☐ Gennant

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<=> QUESTION

6 Annotate the following image:



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

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<=> 问题

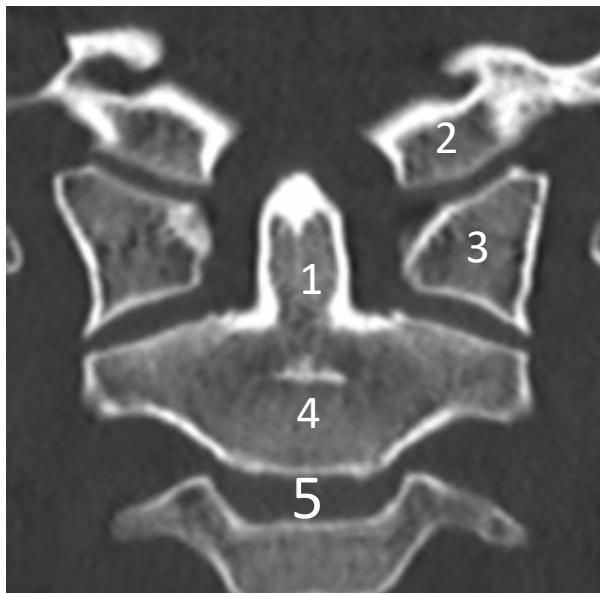
6 写出图像中数字所指代结构的名称:

- 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

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<=> 回答

6 写出图像中数字所指代结构的名称:

1. 枢椎齿突
2. 枕骨髁
3. 寰椎侧块
4. 枢椎 (C2) 椎体
5. C2/C3 椎间盘

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<=> QUESTION

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

- ☐ Unstable
- ☐ Stable

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<=> 问题

7 根据 Denis 理论，仅累及前柱的骨折属于：

- ☐ 不稳定骨折
- ☐ 稳定骨折

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<=> ANSWER

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

- ☐ Unstable
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<=> 回答

7 根据 Denis 理论，仅累及前柱的骨折属于:

- ☐ 不稳定骨折
- ☒ 稳定骨折

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<=> 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

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<=> 问题

8

关于多发性骨髓瘤 (MM)，以下哪项陈述是正确的？

- ☐ 它很少累及成人的脊柱
- ☐ MRI 上应至少存在 5 处阳性病灶，方可做出诊断
- ☐ PET / CT 检查出现 1 处氟代脱氧葡萄糖 (Fludeoxyglucose, FDG) 高摄取病灶即可作出诊断
- ☐ 多发性骨髓瘤 (MM) 病灶在 MRI 中显示扩散受限

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<?> ANSWER

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- ☒ 多发性骨髓瘤 (MM) 病灶在 MRI 中显示扩散受限

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<=> QUESTION

9 Modic degeneration type 1 refers to:

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

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<=> 问题

9 I 型 Modic 改变指的是:

- ☐ 硬化期
- ☐ 脂肪变性
- ☐ 水肿期

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<=> ANSWER

9 Modic degeneration type 1 refers to:

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

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<=> 回答

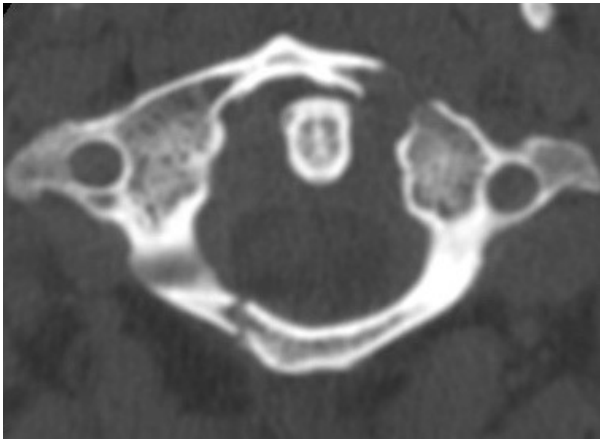
9 I 型 Modic 改变指的是:

- ☐ 硬化期
- ☐ 脂肪变性
- ☒ 水肿期

/ Test Your Knowledge

<?> QUESTION

10 What kind of fracture is shown on this image?



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

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- 退行性疾病
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- 椎体肿瘤和肿瘤样病变
- 介入治疗
- 核心要点
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<?> 问题

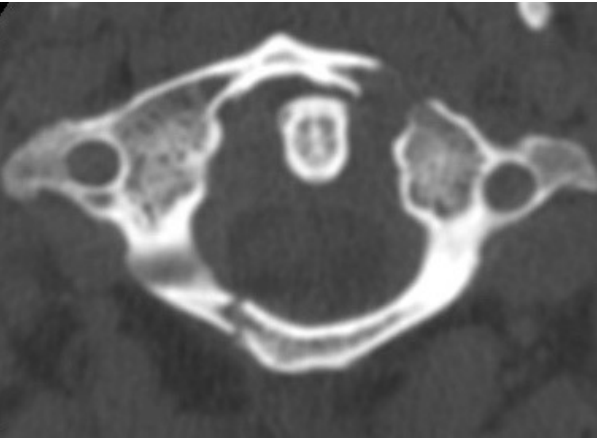
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- ☐ Jefferson 骨折
- ☐ 齿状突骨折
- ☐ 伸展型泪滴样骨折

/ Test Your Knowledge

<?> ANSWER

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/ 致谢

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