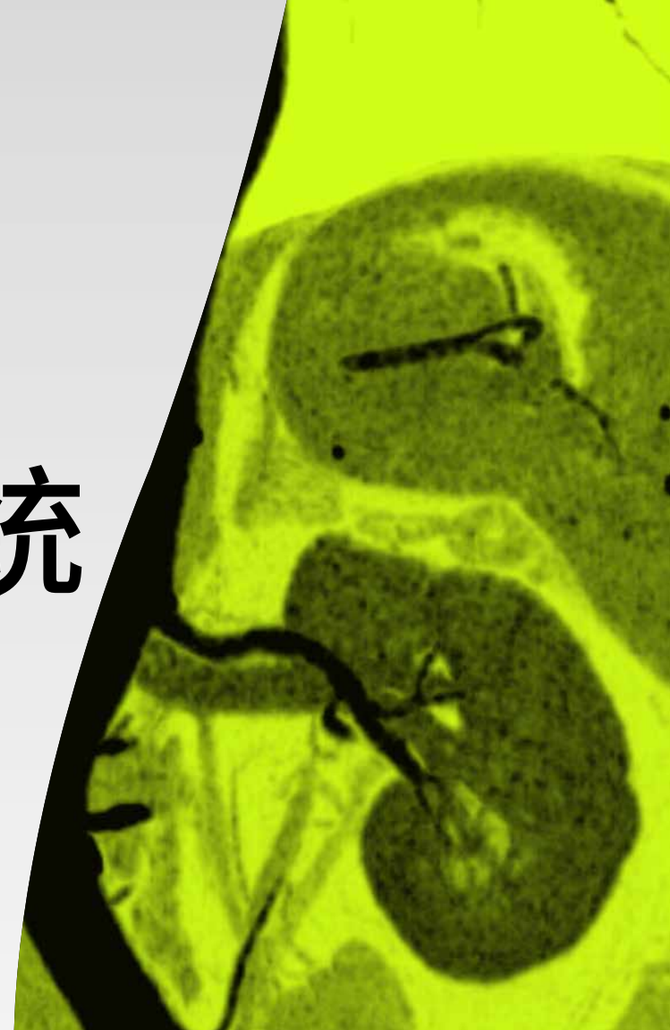
MODERN RADIOLOGY eBook

Urogenital Radiology

泌尿生殖系统放射学



ESR 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

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

前言

章节大纲：

解剖学和解剖结构变异

影像诊断技术

泌尿生殖系统疾病

介入治疗

核心要点

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知识测试

《*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
瑞士日内瓦大学放射学教授

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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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Urogenital Radiology

CHAPTER OUTLINE:

翻译致谢

泌尿生殖系统放射学

章节大纲：

本章节为《现代放射学电子书》的部分译文。

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泌尿生殖系统放射学

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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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/ Signage

<▪> CORE KNOWLEDGE

<!> ATTENTION

<↑> HYPERLINKS

>▪< FURTHER KNOWLEDGE

>|< COMPARE

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/ Urogenital Radiology

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章节大纲：

<▪> 核心知识

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>▪< 进阶知识

>|< 比较

<∞> 参考文献

<?> 问题

MODERN RADIOLOGY eBook

Based on the ESR Curriculum for Radiological Education

Urogenital Radiology

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Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

基于 ESR 课程的放射学教育

章节大纲：

泌尿生殖放射学

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Chapter Outline

- Anatomy and Anatomical Variants
- Diagnostic Imaging Techniques
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  - Computed Tomography
  - Magnetic Resonance Imaging
- Urogenital Diseases
  - Renal Diseases
    - Urolithiasis
    - Acute Pyelonephritis
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章节大纲

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  - 超声
  - 计算机断层扫描
  - 磁共振成像
- 泌尿生殖系统疾病
  - 肾脏疾病
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Anatomy and Anatomical Variants

解剖学和解剖学变异

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章节大纲：

/ Anatomy

The urogenital system can be functionally divided into two different units: the urinary system that filters the blood, removes, and excretes the wastes in the urine, and the genital system, which has a reproductive function.

The urinary system consists of the kidneys, ureters, urinary bladder, and urethra.

Kidneys

The kidneys are paired, and symmetrical organs located behind the parietal peritoneum. The kidney is encased in a fibrous connective tissue layer known as the renal capsule, which closely adheres to its surface. Surrounding the kidney is a layer of perirenal fat, providing cushioning and protection. The entire structure is secured in place by an additional connective tissue layer called the renal fascia.

Each kidney can be divided into three portions: **upper pole**, **middle third** and **lower pole**.

A newly developed kidney segmentation system divides the kidney into 12 distinct segments. Specifically, each section of the upper pole, middle third, and lower pole, is further subdivided into four parts: anterior, posterior, lateral, and medial (1), as illustrated in Fig. 1.

This system improves the diagnostic segmentation of the kidneys, playing a crucial role in treatment planning of renal

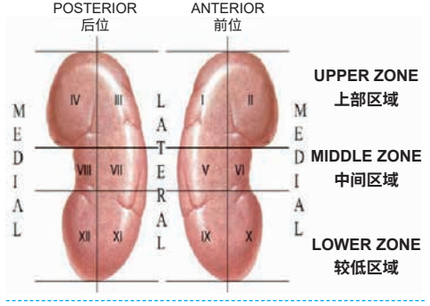

FIGURE 1

Renal segments.

/ Urogenital Radiology

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/ 泌尿生殖系统放射学 / 解剖结构

章节大纲：

泌尿生殖系统在功能上可分为两个不同的单元：泌尿系统，负责过滤血液、清除并以尿液形式排出废物；生殖系统，具有生殖功能。

泌尿系统由肾脏、输尿管、膀胱和尿道组成。

肾脏

肾脏左右成对，是位于腹膜壁层后方的对称器官。肾脏被一层纤维结缔组织包裹，这层组织称为肾包膜，它紧紧贴附于肾脏表面。肾脏周围有一层起到缓冲和保护作用的肾周脂肪。整个结构由另一层称为肾筋膜的结缔组织固定在原位。

每个肾脏可分为三部分：**上极、中部和下极。**

一种新开发的肾脏分段系统将肾脏分为 12 个节段。具体而言，它将上极、中部和下极又进一步细分为四个部分，即前部、后部、外侧部和内侧部 (1)，如图 1 所示。

该系统完善了肾脏的诊断性分段，在肾肿瘤的治疗方案规划，特别是在保留肾单位手术方面，发挥着至关重要的作用。

图 1

肾脏分段。

From an anatomical and functional perspective, the kidney consists of two main regions: the outer cortex and the inner medulla. Describing the corticomedullary ratio in imaging is crucial, as it serves as an important index of renal function.

The renal medulla consists of a series of renal pyramids. Their pointed ends, known as renal papillae, project into the minor calyces, which merge to form the major calyces and ultimately converge to create the renal pelvis.

<!> ATTENTION

For differences between the adult and the paediatric kidneys > see chapter on Paediatric Radiology.

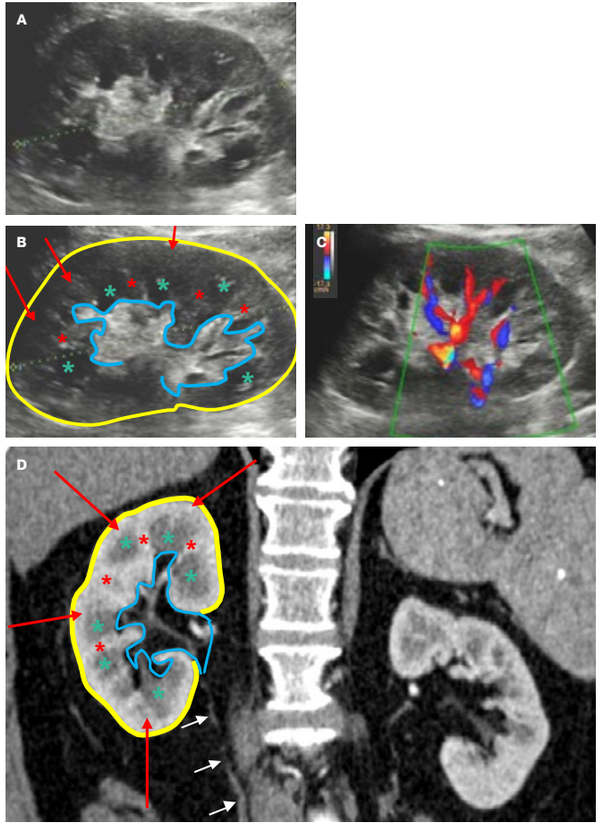

FIGURE 2

Normal renal anatomy. Sagittal ultrasonography (US) image of the left kidney (**A**) and corresponding annotated image (**B**), colour Doppler US (**C**) and coronal contrast enhanced arterial phase CT (**D**).

The renal cortex (indicated by **red arrows**) is located at the periphery, just beneath the renal capsule (highlighted by the **yellow line**). The medulla is composed of renal pyramids (marked with **green asterisks**), which are separated by renal columns (denoted by **red asterisks**). The renal sinus (**blue line**) is the connection between the calices and the ureter (**white arrows** in d). The renal sinus contains calices, renal vessels and nerves, fat and the renal pelvis. In c, arteries are shown in red (blood flow towards the transducer) and veins in blue (blood flow away from the transducer). Figure courtesy: Minerva Becker, MD, Geneva University Hospitals, Switzerland.

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从解剖学和功能角度来看，肾脏主要由两个区域组成：外层的肾皮质和内层的肾髓质。“皮髓质比”是影像学中提示肾功能的一项重要指标。

章节大纲：

肾髓质由一系列肾锥体构成。肾锥体的尖端，即肾乳头，突入肾小盏，肾小盏汇合形成肾大盏，最终汇聚形成肾盂。

<!> 注意

关于成人肾脏与小儿肾脏的差异 > 参阅《儿科放射学》章节。

图 2

正常肾脏解剖结构。左肾矢状位超声 (US) 图像 (**A**) 及相应标注图像 (**B**)、彩色多普勒超声 (**C**) 以及冠状位增强 CT 动脉期图像 (**D**)。

肾皮质（**红色箭头**）位于外周，紧贴肾包膜（**黄线**）。髓质由肾锥体（**绿色星号**）构成，肾锥体之间由肾柱（**红色星号**）分隔。肾窦（**蓝线**）是肾盏与输尿管（图 d 中**白色箭头**）之间的连接部分。肾窦内包含肾盏、肾血管、神经、脂肪以及肾盂。在图 c 中，动脉显示为红色（血流朝向探头），静脉显示为蓝色（血流背离探头）。图片来源：瑞士日内瓦大学医院 Minerva Becker，MD。

The renal pelvis is a funnel-shaped reservoir that collects the urine produced by the kidneys, directing its flow into the ureter for excretion (Fig. 3).

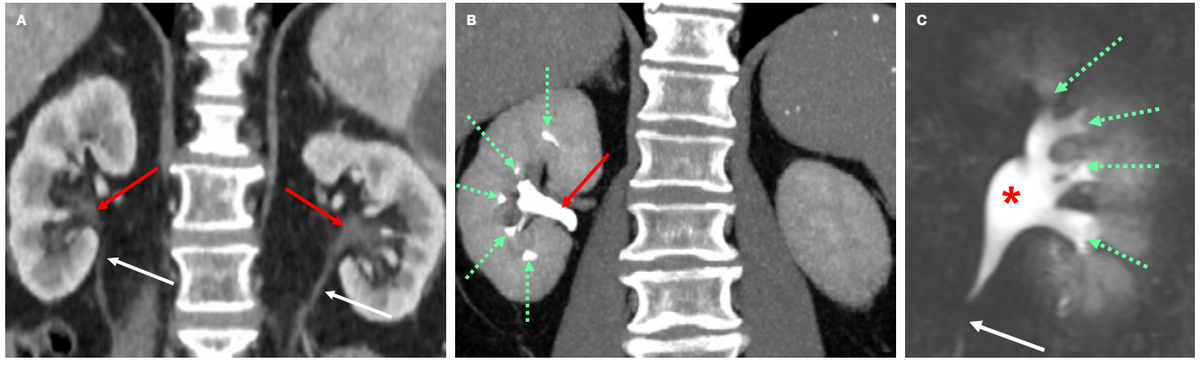

FIGURE 3

The normal renal pelvis (indicated by **red arrows**) is visualised on coronal reconstructions during the early arterial phase (**A**) and the late excretory phase (**B**) of contrast-enhanced CT. For a description of contrast-enhanced CT phases, see Figs. 6 and 15. MR urography image (**C**) of a normal left renal pelvis (**asterisk**). Normal proximal ureters (**white arrows** in a and c) and normal calices (**dashed arrows**). MR urography applies the same physical principle as MR cholangiography (heavily T2 weighted sequences to depict stationary fluids, no contrast material required), see also eBook chapter on biliary tracts. Figure courtesy: Minerva Becker, MD, University Hospitals Geneva, Switzerland

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肾盂是一个漏斗状的储液部位，负责收集肾脏产生的尿液，并将尿液引流入输尿管以排出体外（图 3）。

章节大纲：

图 3

在增强 CT 动脉早期 (**A**) 和排泄晚期 (**B**) 的冠状位重建图像上可见正常的肾盂（**红色箭头**）。有关增强 CT 各期的描述，见图 6 和图 15。正常左肾盂（**星号**）的 MR 尿路造影图像 (**C**)。正常的近端输尿管（图 a 和 c 中的**白色箭头**）和正常肾盏（**虚线箭头**）。MR 尿路造影的物理原理与 MR 胆管造影相同（采用重 T2 加权序列显示静态液体，无需使用对比剂），参阅《胆道系统》电子书章节。图片来源：瑞士日内瓦大学医院 Minerva Becker，MD。

The hilum is another essential renal region to be assed in imaging. It represents the anatomical site where the renal artery enters and the renal vein and ureter exit (Fig. 4).

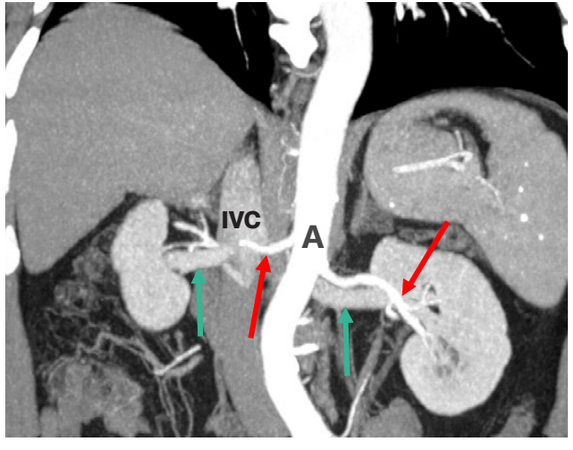

FIGURE 4

Normal renal vascular anatomy as seen on a thick slab coronal multiplanar reconstruction of an angio-CT. Renal arteries (**red arrows**), renal veins (**green arrows**), aorta (**A**), inferior vena cava (IVC). Note that the renal veins are located anteriorly to the renal arteries.

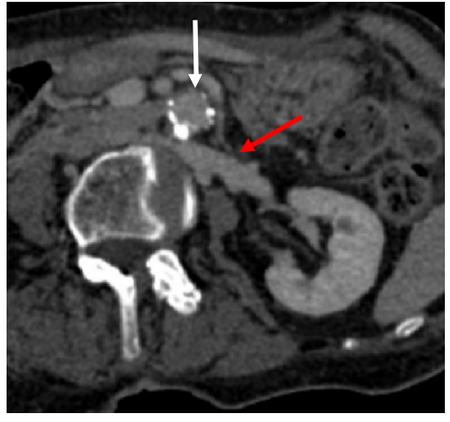

FIGURE 5

Retro-aortic left renal vein course (**red arrow**). Aorta (**white arrow**). Note that the aorta has calcified atheromatous plaques.

<!> ATTENTION

The radiological report should detail the precise number of renal arteries and veins, along with any variations in their course (e.g., a retro-aortic left renal vein) or morphology, as well as the presence of atheromatous changes (Fig. 5).

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肾门是影像学检查需要评估的另一个重要肾脏区域。它是肾动脉进入以及肾静脉和输尿管穿出的解剖部位（图 4 ）。

章节大纲：

图 4

CT 血管造影（angio-CT）厚层冠状位多平面重建图像所示正常肾血管解剖结构。肾动脉（**红色箭头**）、肾静脉（**绿色箭头**）、主动脉 (**A**)、下腔静脉（inferior vena cava，IVC）。注意肾静脉位于肾动脉前方。

图 5

左肾静脉走行在主动脉后（**红色箭头**）。主动脉（**白色箭头**）。注意主动脉的钙化粥样斑块。

<!> 注意

放射学报告应详细说明肾动脉和肾静脉的准确数量，及其走行（如主动脉后左肾静脉）或形态的任何变异，以及是否存在动脉粥样硬化改变（图 5）。

<!> ATTENTION

After intravenous administration of contrast media, CT imaging enables visualisation of the arterial, nephrographic, and excretory phases (Fig. 6). Notably, the corticomedullary renal ratio is most distinctly defined during the arterial phase.

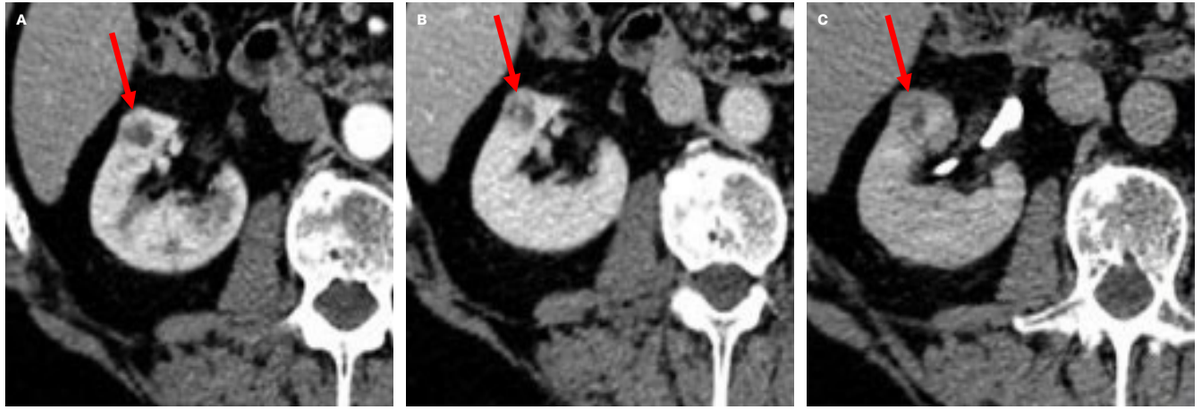

FIGURE 6

Arterial (**A**), nephrographic (**B**) and secretory phase (**C**) as seen after iv. Injection of contrast material on axial CT images. Arrows point at a renal mass.

<!> 注意

静脉注射对比剂后，CT 成像能够显示动脉期、肾实质期和排泄期（图 6）。应注意，皮髓质比在动脉期显示最为清晰。

图 6

静脉注射 (iv) 对比剂后所示的动脉期 (**A**)、肾实质期 (**B**) 及排泄期 (**C**)。静注对比剂后轴位 CT 图像。箭头所示为肾肿物。

Ureters

The ureters (Fig. 7) are bilateral tubular structures that transport urine from the renal pelvis into the bladder. Each ureter consists of three parts:

1. **abdominal ureter**: from the renal pelvis to the beginning of the anatomical pelvis, approximately at the level of the iliac crest
2. **pelvic ureter:** up to the bladder
3. **intravesical or intramural ureter**: within the bladder wall

In a normal ureter, three physiological constrictions are typically observed: the first located approximately 7-8 cm from the renal hilum, the iliac constriction, and the intramural constriction.

The **ureteral wall** and the bladder wall show comparable anatomical layers, with the muscular layer transitioning seamlessly into the bladder wall at the level of the ureteral orifice.

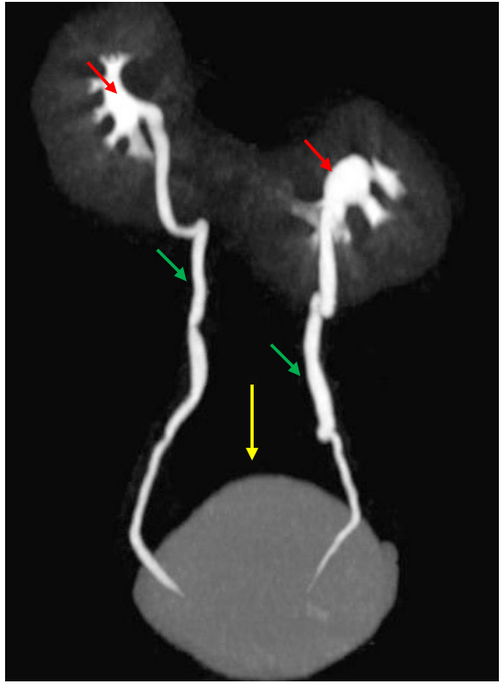

FIGURE 7

CT-Urography showing the excretory system: renal pelvis (**red arrows**), ureters (**green arrows** – please note the different anatomical parts) and the bladder (**yellow arrow**).

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

输尿管

章节大纲：

输尿管（图 7）是双侧的管状结构，负责将尿液从肾盂输送至膀胱。每侧输尿管分为三段：

1. **腹段输尿管**：从肾盂至盆腔的解剖学起点，大致在髂嵴水平
2. **盆段输尿管**：直至膀胱；
3. **膀胱内段或壁内段输尿管**：位于膀胱壁内

正常输尿管通常可见典型的三个生理性狭窄：第一个狭窄在距肾门约 7~8 cm 处，另两个狭窄是髂部狭窄和壁内狭窄。

输尿管壁与膀胱壁的解剖层次相似，其肌肉层在输尿管口水平与膀胱壁平滑过渡。

图 7

CT 尿路造影显示的排泄系统：肾盂（**红色箭头**）、输尿管（**绿色箭头** - 请注意不同的解剖部分）以及膀胱（**黄色箭头**）。

Anatomical variants of the kidneys and ureters are common and can occur in different forms (2):

Location anomalies:

- Pelvic kidney or renal ptosis, that can be a confounding factor during clinical evaluation: "renal colic" pain may be confused with appendicitis, pelvic inflammatory disease (PID), or ovarian torsion.
- Between the 5th and 9th week of gestation, the kidneys undergo a 90° rotation during their ascent. Incomplete rotation can result in the renal pelvis being directed anteriorly at an angle of less than 45°, while hyper-rotation may cause the pelvis to be directed posteriorly, or in reverse rotation, the renal pelvis may be directed laterally.

Shape anomalies:

- Persistent fetal lobulation (Fig. 8)
- Dromedary humps: prominent focal bulges on the lateral border of the left kidney, resulting from the splenic impression on the superolateral border of the kidney.
- Hypertrophied column of Bertin: the column of Bertin represents an extension of renal cortical tissue that separates the renal pyramids. When enlarged, it may be mistaken for a renal mass.

FIGURE 8

Persistent fetal lobulation. Case courtesy of Dr. Chris O'Donnell, Radiopaedia.org, rID: 41364

Urogenital Radiology

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泌尿生殖系统放射学

肾脏和输尿管的解剖变异常见且形式多样 (2):

位置异常：

- 盆腔肾或肾下垂，在临床评估中可能混淆：“肾绞痛”可能会与阑尾炎、盆腔炎症（pelvic inflammatory disease，PID）或卵巢扭转混淆。
- 妊娠第 5 至 9 周期间，肾脏在上升过程中会发生 90° 旋转。旋转不完全可导致肾盂向前角度小于 45°，而过度旋转可能致使肾盂朝后，若发生反向旋转，肾盂则可能朝向外侧。

形状异常：

- 永存胚胎期分叶状肾（图 8）
- 单峰驼峰肾：左肾外侧缘明显局灶性隆起，由脾脏对肾外上缘的压迹所致。
- Bertin 肥大肾柱（Bertin 柱）：Bertin 肾柱是分隔肾锥体的肾皮质组织的延伸部分。当其增大时，可能会被误诊为肾肿物。

图 8

永存胚胎期分叶状肾。病例由 Dr. Chris O'Donnell 提供。Radiopaedia.org. rID：41364

Number Anomalies:

- Renal agenesis
- Supernumerary kidney

Fusion Anomalies:

- Horseshoe kidney (Fig. 9): the most common form of renal fusion, occurring between the lower poles.
- Pancake kidney: both the upper and lower poles are fused.

Urinary Collecting System Anomalies:

- The duplicated collecting system is characterised by a complete or incomplete duplication of the collecting system. In incomplete ureteral duplication, two ureters originate from the same renal pelvis and share a common ostium. In complete ureteral duplication, each ureter opens separately into the bladder. Usually, the ureter draining the upper pole of the kidney opens lower and medially compared to the one draining the lower pole, which has a longer intramural portion, with a lower risk of reflux.

FIGURE 9

Horseshoe kidney (**arrows**) as seen on a CT image. Renal cyst (**asterisk**).

<!> ATTENTION

For anatomical variants > see chapter on Paediatric Radiology.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

章节大纲：

数量异常：

- 肾缺如
- 额外脏

融合异常：

- 马蹄肾（图 9）：最常见的肾脏融合形式，发生于两侧的肾下极之间。
- 饼状肾：肾上极与下极均发生融合。

泌尿集合系统异常：

- 重复集合系统的特征为集合系统完全或不完全重复。不完全性输尿管重复畸形时，两条输尿管发自同一肾盂，并共用一个开口。完全性输尿管重复畸形时，每条输尿管分别开口于膀胱。通常，相较于引流肾下极的输尿管，引流肾上极的输尿管开口位置更低且更靠内侧。引流肾下极的输尿管壁内段更长，发生反流的风险较低。

图 9

CT 图像示马蹄肾（箭头所示）。肾脏囊肿（星号）。

<!> 注意

有关解剖结构变异的内容，参见《儿科放射学》章节。

Bladder

The bladder is an expandable organ located in the pelvis. It is covered by peritoneum on its superior surface and partially on its posterior surface. The shape and position of the bladder change depending on the volume of urine it contains, expanding into the abdominal cavity as it fills.

Anatomically, the bladder is divided into four parts:

1. base (also known as a fundus) located posteroinferiorly
2. the anterior-superior portion, also referred to as the dome
3. body
4. the neck, which is continuous with the urethra (3).

The trigone is a triangular region within the bladder, defined by three key structures: the bilateral ureteric orifices located at the superolateral corners and the internal urethral orifice at the apex, where the urethra begins its role in transporting urine outside the bladder.

The bladder wall is composed of three layers: mucosa and submucosa, muscularis propria (which represents the detrusor muscle), and serosa. The mucosa consists of the urothelium, a specialised stratified epithelium with characteristic cells called umbrella cells, which form an impermeable barrier and can change shape according to the bladder's filling.

<!> ATTENTION

The muscular layer is crucial in the evaluation of bladder cancer, as staging and treatment depend on detrusor muscle invasion.

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膀胱

章节大纲：

膀胱是一个位于盆腔内的可扩张器官。其上面及部分后面被腹膜覆盖。膀胱的形状和位置会随含尿量而改变，充盈时会向腹腔扩展。

从解剖学角度，膀胱分为四个部分：

1. 位于后下部的底部（也称为膀胱底）
2. 前上部，也称作顶部
3. 体部
4. 颈部，与尿道相连 (3)。

膀胱三角区是膀胱内的一个三角形区域，由三个关键结构界定：位于外上角的双侧输尿管开口和位于顶部的尿道内口（尿道由此将尿液排出膀胱）。

膀胱壁由三层组成：黏膜层和黏膜下层、固有肌层（即逼尿肌）以及浆膜层。黏膜层由尿路上皮构成，这是一种特殊的复层上皮，含有被称为“伞细胞”的特征性细胞。这些细胞形成一个不透水的屏障，并能根据膀胱的充盈程度改变形状。

<!> 注意

肌肉层是膀胱癌评估中的关键，因为分期和治疗方案取决于是否侵犯逼尿肌。

Anatomical Variants of the Bladder

- **Septation:** a septum may divide the bladder internally into two or more compartments (Fig. 10).
- **Persistent urachus:** The urachus is a remnant of a foetal channel that originally connected the bladder to the umbilicus, through which urine drained during fetal development. Normally, the urachus regresses after birth, transforming into a fibrous cord known as the middle umbilical ligament.
- **Congenital bladder diverticulum** (it occurs in the absence of obstructive factors such as posterior urethral valves and neurogenic bladder; it is related to a deficient detrusor layer).

FIGURE 10

Bladder septation (**arrows**) as seen on an axial CT image during the excretory phase.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学　膀胱的解剖变异

章节大纲：

- **分隔：**隔膜将膀胱内部划分为两个或更多腔室（图 10）。
- **脐尿管未闭：**脐尿管是胎儿期连接膀胱与脐部的通道遗迹，在胎儿发育过程中通过它排出尿液。正常情况下，脐尿管在出生后退化，变为一条纤维索，即脐正中韧带。
- **先天性膀胱憩室**（其发生在尿道瓣膜缺如及神经性膀胱等梗阻因素的情况下；与逼尿肌层发育不良有关）。

图 10

排泄期轴位 CT 图像可见膀胱分隔（**箭头所示**）。

Genital System

The male genital system consists of the gonads (testicles), the spermatic ducts (epididymis, vas deferens and ejaculatory ducts), the accessory glands (seminal vesicles, prostate and bulbo-urethral glands) and the external genital organs (scrotal bursa and penis).

>▪< FURTHER KNOWLEDGE

The most important anatomical anomaly involving the testicles is crytptorchism, a condition characterised by undescended testicles, which are located in the abdomen rather than the scrotum, due to an abnormality during their migration toward the inguinal canal, through which the testicles normally descend into the scrotum.

Testicles

The testicles are the male gonads responsible for producing spermatozoa and testosterone, which is essential for male growth. Each testicle is surrounded by a fibrous capsule known as the tunica albuginea, which extends inward to form septa that divide the testis into several lobes. Within these lobes lie the seminiferous tubules, where spermatogenesis—the process of sperm production—occurs. The testicles contain also supporting cells called Sertoli cells, and testosterone-producing cells called Leydig interstitial cells.

The testicles are located within the scrotum, external to the body, to maintain a lower temperature, which is essential for the protection and proper development spermatozoa. Ultrasonography represents the first-line imaging modality for the evaluation of testis and scrotum (Fig. 11).

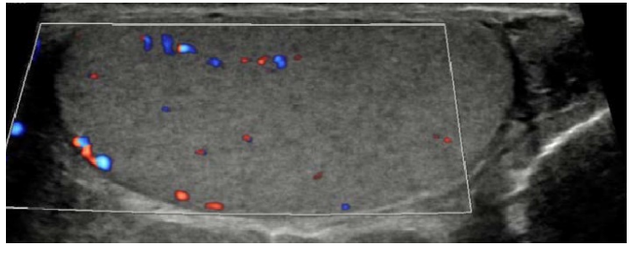

FIGURE 11

Sagittal testicle US image with colour Doppler. Note homogeneous mildly coarse texture.

Urogenital Radiology

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泌尿生殖系统放射学

章节大纲：

生殖系统

男性生殖系统由性腺（睾丸）、输精管道（附睾、输精管和射精管）、附属腺体（精囊、前列腺和尿道球腺）以及外生殖器（阴囊和阴茎）组成。

睾丸

睾丸是男性的性腺，负责生成精子以及分泌睾酮，睾酮对于男性生长发育至关重要。每个睾丸都被一层纤维包膜所包裹，这层包膜称为白膜。白膜向内延伸形成隔膜，将睾丸分隔为若干个小叶。在这些小叶内有生精小管，精子发生（即精子生成的过程）就在此处进行。睾丸内还含有起支持作用的 Sertoli 细胞，以及分泌睾酮的 Leydig 间质细胞。

睾丸位于体外的阴囊内，以保持较低温度，这对精子的保护和正常发育至关重要。超声检查是评估睾丸和阴囊的一线影像学检查方法（图 11）。

>▪< 进阶知识

睾丸最重要的解剖异常是隐睾症，其特征为睾丸未降。正常情况下，睾丸经腹股沟管下降至阴囊，如该过程发生异常，睾丸就会停留在腹部，不能正常降至阴囊内。

图 11

睾丸矢状位彩色多普勒超声图像。注意其质地均匀，略显粗糙。

Prostate

The prostate gland (Fig. 12) is located inferior to the bladder and surrounds the prostatic portion of the urethra. It is the largest male accessory gland, and its primary function is to produce the seminal fluid that nourishes and transports spermatozoa within the sperm. The prostate has an inverted pyramidal shape and is anatomically structured from superior to inferior as follows:

- The base (located inferior to the urinary bladder)
- the mid-gland
- the apex

It is divided into four histologic zones (fig. 12):

1. The **anterior fibromuscular stroma**, which does not contain glandular tissue
2. the **transition zone (tz)**, surrounding the urethra proximal to the verumontanum, contains 5% of the glandular tissue
3. the **central zone (cz)**, surrounding the ejaculatory ducts, contains about 20% of the glandular tissue
4. the outer **peripheral zone (pz)**, which contains 70%-80% of the glandular tissue (4)

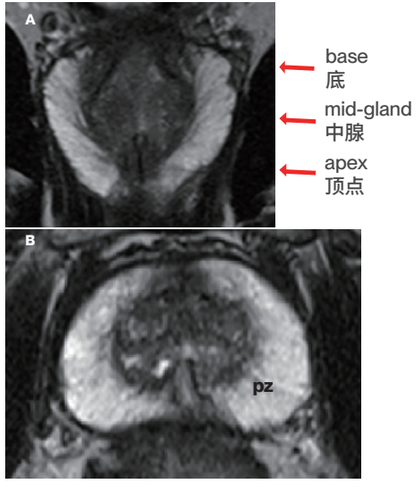

FIGURE 12

Prostate MRI. T2- weighted coronal (**A**) and axial (**B**) planes.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

前列腺

章节大纲：

前列腺（图 12）位于膀胱下方，环绕尿道的前列腺段。它是男性最大的附属腺体，主要功能是产生滋养和输送精子的精液。前列腺呈倒金字塔形，由上至下的解剖结构为：

- 基底部（位于膀胱下方）
- 中部
- 尖部

它在组织学上分为四个区域（图 12）：

1. **前纤维肌性基质**，此区域不含腺体组织
2. **移行带 (tz)**，围绕着精阜近端的尿道，含有 5% 的腺体组织
3. **中央带 (cz)**，围绕着射精管，约含 20% 的腺体组织
4. **外周带 (pz)**，含有 70%~80% 的腺体组织 (4)

图 12

前列腺 MRI。T2 加权冠状位 (**A**) 和轴位 (**B**) 图像。

Penis

The penis is the external organ of male genital system. Its two main functions are sexual intercourse and urination, as the urethra connects to the bladder and passes through the entire length of the penis.

It is divided into:

- **Root:** the most proximal part, which is not externally visible
- **Body:** the external and mobile portion of the penis
- **Glands:** the terminal part of the penis which contains the urinary meatus, the external opening of the urethra, serving as the passage for the expulsion of urine and sperm.

The **tunica albuginea** is a connective, elastic tissue that envelopes the penis and is surrounded by Buck's fascia, which is covered by the fascia of Colles.

The **erectile tissues** (Fig. 13) are structures that become filled with blood during the erection.

In the root, the erectile tissue starts with the left and right crura and the bulb of the penis.

The left and right crura extend into the body of the penis, forming the two **corpora cavernosa**.

The bulb extends into the body of the penis, giving rise to the **corpus spongiosum**, which then enlarges to form the glans.

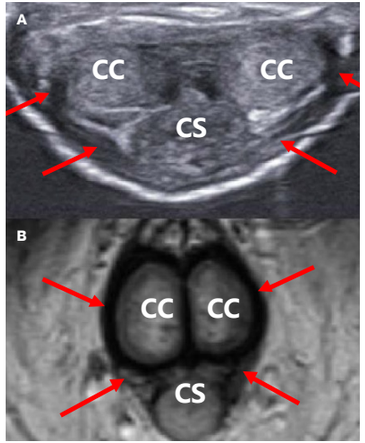

FIGURE 13

Penile ultrasound (**A**) and MRI (**B**) images. CC = corpus cavernosum. CS = corpus spongiosum. Deep fascia (**red arrows**).

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

章节大纲：

阴茎

阴茎是男性生殖系统的外生殖器官。它有两大主要功能，即性交和排尿，因为尿道连接膀胱并贯穿阴茎全长。

它分为以下几部分：

- **根部：**最靠近近端的部分，不露出体表
- **体部：**阴茎的外露且可活动部分
- **龟头：**有尿道口（尿道的外口）的阴茎末端部分，排出尿液和精子的通道。

鞘膜是一层包绕着阴茎的弹性结缔组织，它的外层是 Buck 筋膜，再外面是 Colle 筋膜。

勃起组织（图 13）是勃起过程的充血结构。

勃起组织起自阴茎根部，由两侧海绵体脚和尿道球构成。

两侧海绵体脚延伸入阴茎体，形成两个**阴茎海绵体**。

尿道球延伸入阴茎体，形成**尿道海绵体**，尿道海绵体膨大形成龟头。

图 13

阴茎超声 (**A**) 和 MRI (**B**) 图像。CC＝阴茎海绵体。CS＝尿道海绵体。深筋膜（**红色箭头**）。

Diagnostic Imaging Techniques

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

章节大纲：

影像诊断技术

/ Ultrasound

<!> ATTENTION

Ultrasonography (US) is the first-line imaging modality for patients with suspected urogenital pathology (Fig. 14); Second-level imaging techniques are required for a more detailed characterisation of lesions and for loco-regional staging of disease.

ADVANTAGES:

+ Low cost and easily available
+ Does not utilise ionising radiation
+ High accuracy in detecting hydronephrosis, intraluminal bladder masses and renal masses

DISADVANTAGES:

– Limited visualisation of upper urinary tract, particularly the ureter
– Operator-dependent imaging modality
– Inaccurate when patient preparation is not optimal (i.e., gas)

<!> ATTENTION

Additional imaging may be required!

/ Urogenital Radiology

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/ 泌尿生殖系统放射学

章节大纲：

/ 超声

<!> 注意

超声检查（Ultrasonography，US）是怀疑存在泌尿生殖系统病变患者的一线成像方式（图 14）；如需更详细显示病变特征，以及对疾病进行局部区域分期，则需要使用二级成像技术。

优点：

+ 成本低且易于获取
+ 无电离辐射
+ 在检测肾盂积水、膀胱腔内肿物及肾脏肿物方面准确性高

缺点：

– 上尿路，尤其是输尿管的显像有限
– 操作人员依赖性成像模式
– 若患者准备不充分（如肠道气体影响），结果不准确

<!> 注意

可能需要额外的影像学检查！

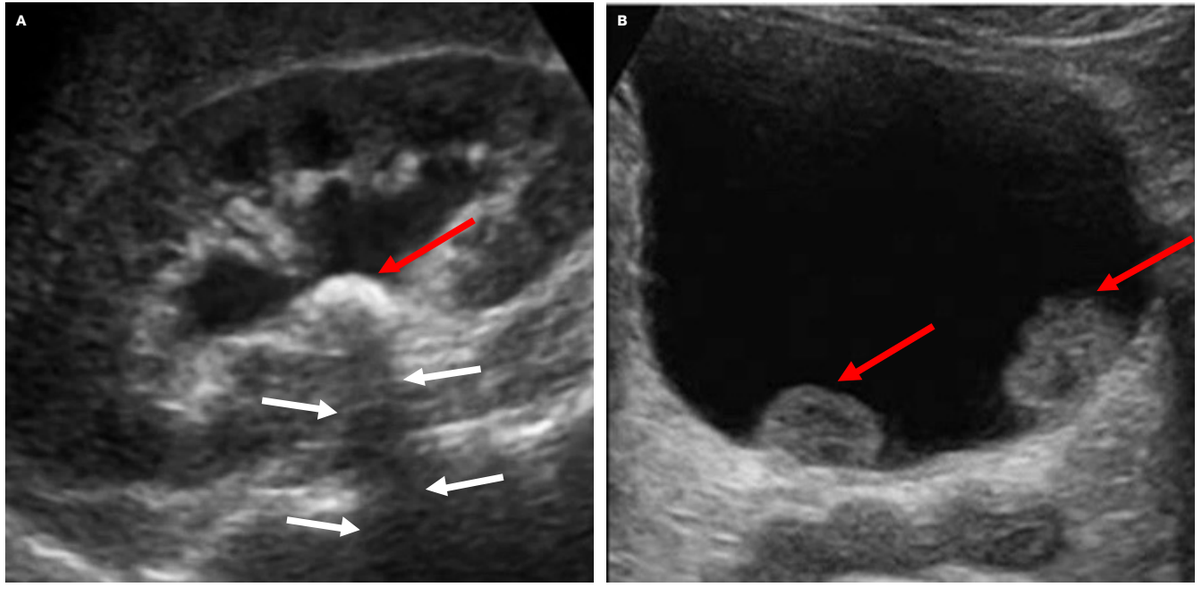

FIGURE 14

Kidney and bladder US. Characteristic features of lithiasis in the renal pelvis (**A**): red arrow points at the hyperechoic stone and **white arrows** indicate the acoustic shadow caused by the stone. (**B**) Two exophytic lesions of the bladder (**red arrows**). The differential diagnosis encompasses blood clots and bladder cancer. If exophytic lesions demonstrate central vascularisation on colour Doppler imaging and remain stationary when the patient changes position, a diagnosis of bladder tumour should be considered.

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

章节大纲：

图 14

肾脏与膀胱超声检查 (US)。肾盂结石的特征表现 (**A**)：红色箭头示高回声结石，**白色箭头**示结石所致声影。(**B**) 膀胱内两处外生性病变（**红色箭头**）。鉴别诊断包括血块与膀胱癌。如果外生性病变在彩色多普勒成像中显示中央血管化，且患者改变体位时病变位置不变，则应考虑诊断为膀胱肿瘤。

/ Computed Tomography

<‑!> ATTENTION

To comprehensively evaluate the entire urinary tract, **CT urography** should be performed, including acquisitions in the **non-contrast**, **corticomedullary**, **nephrographic** and **excretory phases**.

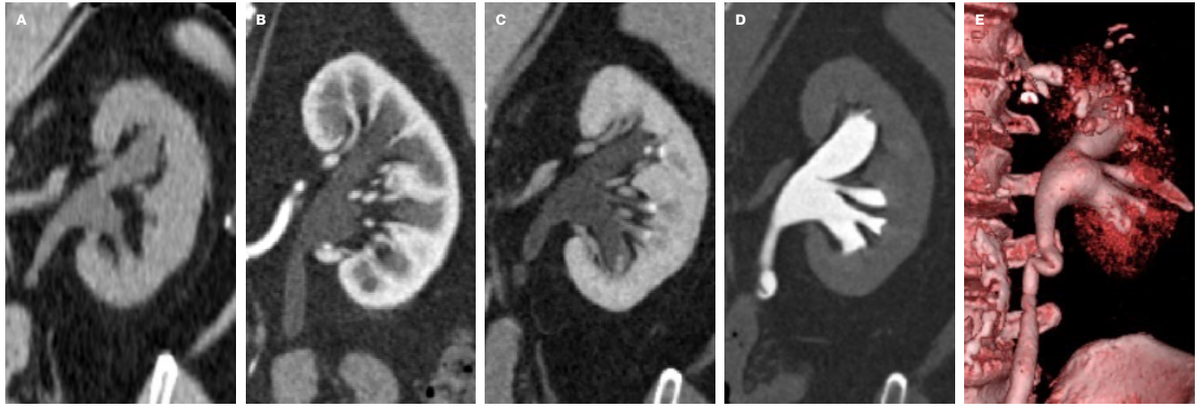

FIGURE 15

Normal CT urography (coronal reconstructions). Non-contrast (**A**), cortico-medullary (**B**), nephrographic (**C**), excretory (**D**) phase and 3D reconstruction of the excretory system (**E**).

/ Urogenital Radiology

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/ 泌尿生殖系统放射学

/ 计算机断层扫描

<‑!> 注意

章节大纲：

需全面检查整个尿路时，应进行 **CT 尿路造影**，包括平扫期、皮质髓质期、肾实质期和排泄期扫描。

图 15

正常 CT 尿路造影（冠状位重建图像）：平扫期 (**A**)、皮质髓质期 (**B**)、肾实质期 (**C**)、排泄期 (**D**) 及排泄系统的 3D 重建 (**E**)。

Low dose and ultra low dose non contrast enhanced CT of the kidneys, ureters and bladder (CT KUB) represents a fast and noninvasive technique that enables the diagnosis of urinary tract stones in the emergency settings. Low dose CT equally allows the evaluation of stone size and location, as well as the presence of renal tract obstruction (Fig. 16).

<!> ATTENTION

FIGURE 16

Axial (**A**) and coronal multiplanar reconstruction (**B**) of a low-dose CT acquisition depicting a calcified ureter stone (**arrows**). Figure courtesy: Alexandra Platon, MD, University Hospitals Geneva, Switzerland.

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CHAPTER OUTLINE:

泌尿生殖系统放射学

低剂量和超低剂量的肾脏、输尿管和膀胱平扫 CT (CT KUB) 是一种快速、无创的技术，可用于急诊诊断尿路结石。低剂量 CT 同样能够评估结石大小与位置，以及是否存在尿路梗阻（图 16）。

<!> 注意

章节大纲：

图 16

低剂量 CT 采集的轴位 (**A**) 及冠状位多平面重建 (**B**) 图像，显示一处钙化的输尿管结石（箭头所示）。图片来源：瑞士日内瓦大学医院 Alexandra Platon，MD。

/ Magnetic Resonance Imaging (MRI)

<‑> ATTENTION

Another highly advanced and powerful imaging technique is **multiparametric (mp) Magnetic Resonance Imaging (MRI)**, as illustrated in Fig. 17, which involves the administration of iv gadolinium-based contrast medium to acquire sequences that provide both morphological and functional information. This technique offers remarkable potential for the precise diagnosis and characterisation of urogenital lesions, particularly of bladder and prostate cancer.

FIGURE 17

MR urography. T2 WI (**A**), fat-saturated non-enhanced T1WI (**B**), post-contrast sequences (**C-G**). Please note the urographic phase in the axial (**D**) and coronal plane (**G**) (**red arrows** point at the renal pelvis).

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

/ 磁共振成像 (MRI)

<‑> 注意

章节大纲：

另一种非常先进且功能强大的成像技术是**多参数磁共振成像**，如图 17 所示。该技术需静脉注射含钆对比剂，以获取能同时提供形态学和功性能信息的序列。这项技术在泌尿生殖系统病变，尤其是膀胱癌和前列腺癌的精确诊断和特征描述方面具有巨大潜力。

图 17

磁共振 (MR) 尿路造影。T2WI (**A**)、脂肪抑制非增强 T1WI (**B**)、增强后序列 (**C-G**)。注意轴位 (**D**) 和冠状位 (**G**) 的尿路造影期（**红色箭头示肾盂**）。

Urogenital Diseases

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

章节大纲：

泌尿生殖系统疾病

/ Urolithiasis

= calculi anywhere along the urinary tracts (i.e., caliceal, pelvic, pyeloureteral junction, ureteric, vesico-ureteric junction, bladder).

Approximately 12% of men and 5% of women are affected by urolithiasis. The most common renal stones are composed of calcium oxalate and they are often mixed with calcium phosphate. As stones pass from the kidneys into the ureters, they can lead to renal colic.

Calcium containing stones are radiopaque (Figs. 16 and 18). Non-contrast CT has the highest sensitivity for renal calculi detection (99%), whereas ultrasound (US) has a sensitivity of approximately 25%. The majority of calculi missed on US are less than 3 mm in size. Examples of renal stones are shown in Figs. 14, 16 and 18.

Complications of urolithiasis include:

- / renal pelvis rupture
- / urinary tract infection
- / hydronephrosis and hydroureter
- / parenchymal damage due to chronic obstruction

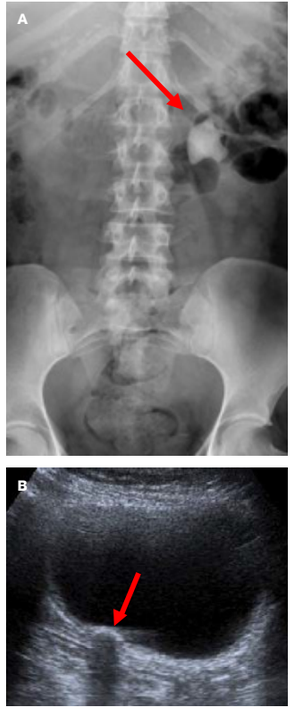

FIGURE 18

Two different patients with urolithiasis. Large left pelvic stone on plain radiograph (**arrow** in **A**).

Bladder stone on US (**arrow** in **B**). Figure courtesy: Alexandra Platon, MD, Geneva University Hospitals, Switzerland.

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

/ 尿石症

章节大纲：

＝尿路任何部位（肾盏、肾盂、肾盂输尿管连接处、输尿管、膀胱输尿管连接处、膀胱）的结石。

约 12% 的男性和 5% 的女性会患有尿石症。最常见的肾结石由草酸钙组成，且常与磷酸钙混合。当结石从肾脏进入输尿管时，可引发肾绞痛。

含钙结石不透射线（图16 和 18）。CT 平扫对肾结石检测的敏感性最高 (99%)，而超声检查 (US) 的敏感性约为 25%。超声检查 (US) 漏诊的大多数结石不足 3 mm。肾结石的示例见图 14、图 16 和图 18。

尿石症的并发症包括：

- / 肾盂破裂
- / 尿路感染
- / 肾盂积水和输尿管积水
- / 因慢性梗阻导致的肾实质损伤

图 18

两例不同的尿石症患者。腹部 X 线平片示左肾盂大结石（图 **A** 中箭头所示）。

超声检查 (US) 示膀胱结石（图 **B** 中箭头所示）。图片来源：瑞士日内瓦大学医院 Alexandra Platon，MD。

/ Hydronephrosis & Hydroureteronephrosis

Hydronephrosis = dilatation of the calices, infundibula and renal pelvis.

/ Common causes include: urolithiasis, obstruction of the pelviureteric junction, cervical or prostate cancer.

/ The role of imaging is to establish the underlying cause.

/ On US, hydronephrosis is characterised by the dilation of the pelvicalyceal system. In cases of chronic hydronephrosis, the renal cortex may become thinned.

/ CT not only facilitates the diagnosis of hydronephrosis but also helps identify its underlying cause.

Hydroureteronephrosis = hydronephrosis accompanied by ureter dilatation.

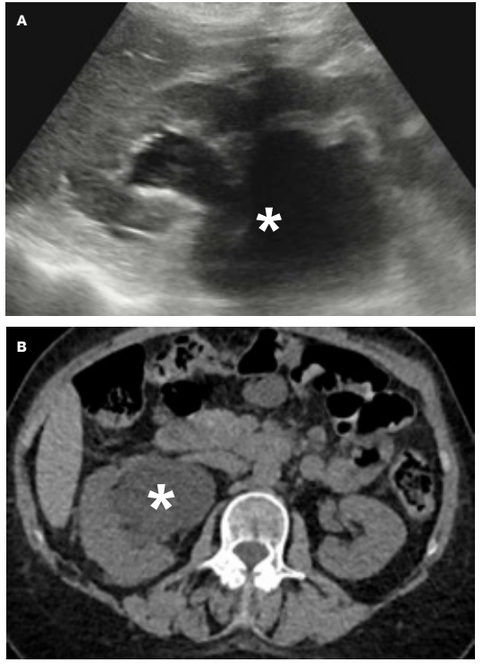

FIGURE 19

US image of the right kidney (**A**) showing characteristic features of hydronephrosis (**asterisk**). CT appearance of hydronephrosis (**asterisk** in **B**). Figure courtesy: Minerva Becker, MD, Geneva University Hospitals, Switzerland.

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

/ 肾盂积水和输尿管肾盂积水

章节大纲：

肾盂积水 = 肾盏、肾盏漏斗部及肾盂的扩张。

/ 常见病因包括：尿石症、肾盂输尿管连接处梗阻、宫颈癌或前列腺癌。

/ 影像学检查的作用是明确潜在病因。

/ 肾盂积水的超声检查 (US) 特征表现为肾盂肾盏系统扩张。慢性肾盂积水病例的肾皮质可能会变薄。

/ CT 不仅有助于诊断肾盂积水，还能帮助查明其潜在病因。

输尿管肾盂积水 = 肾盂积水伴输尿管扩张。

图 19

右肾超声 (US) 图像（图 **A**）示肾盂积水的特征表现（星号所示）。肾盂积水的 CT 所见（图 **B** 中星号所示）。图片来源：瑞士日内瓦大学医院 Minerva Becker，MD。

/ Acute Pyelonephritis

= infection of the upper urinary tract (i.e., renal pelvis, calyces and renal parenchyma).

Acute pyelonephritis is a bacterial infection typically caused by organisms from the gastrointestinal tract. It is most often seen in young women. Although the diagnosis is primarily based on clinical evaluation and laboratory findings, imaging is indicated to exclude the cause of renal obstruction, as well as in immunocompromised patients and those with underlying renal diseases (Fig. 20). Complications of acute pyelonephritis include abscess formation, urosepsis, renal vein thrombosis, renal infarction and chronic renal impairment.

Emphysematous pyelonephritis is a bacterial kidney infection with gas formation. It is seen more often in immunocompromised patients. It has a high mortality if it is not promptly treated.

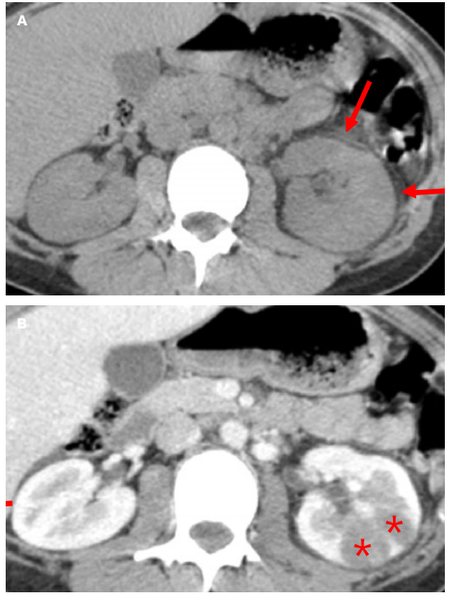

FIGURE 20

Acute pyelonephritis in a diabetic patient. Non- contrast enhanced CT shows swollen left kidney and perinephric fat stranding appearance (**arrows**). On post-contrast CT image, a swollen, wedge-shaped region involving the peripheral cortex is observed (**asterisks**).

Figure courtesy: Minerva Becker, MD, Geneva University Hospitals, Switzerland.

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

/ 急性肾盂肾炎

章节大纲：

= 上尿路（即肾盂、肾盏和肾实质）感染。

急性肾盂肾炎是一种细菌感染，通常由胃肠道细菌引起。多见于年轻女性。虽然诊断主要基于临床评估和实验室检查结果，但仍需进行影像学检查，排除肾梗阻病因，同时也适用于免疫力受损患者以及患有潜在肾脏疾病的患者（图 20）。急性肾盂肾炎的并发症包括脓肿形成、尿脓毒症、肾静脉血栓形成、肾脏梗死以及慢性肾脏功能损害。

气肿性肾盂肾炎是一种伴有气体生成的细菌性肾脏感染。多见于免疫力受损的患者。若不及时治疗，死亡率较高。

图 20

一例糖尿病患者的急性肾盂肾炎。CT 平扫示左肾肿大及肾周脂肪条索影（箭头所示）。增强 CT 图像可见一个累及外周皮质的肿胀楔形区（星号）。

图片来源：瑞士日内瓦大学医院 Minerva Becker，MD。

/ Renal Masses

<!> ATTENTION

Renal masses are common and are usually identified incidentally during ultrasound, CT, or MR exams performed for unrelated reasons.

Renal masses can be divided into two groups:

1. CYSTIC LESIONS: (FIGS. 21 AND 22)

- Simple renal cysts are a very common collateral finding during imaging examination.
- However, they may exhibit specific alarm features. In this scenario, the Bosniak classification (see next page, Fig. 21) plays a crucial role in assessing the risk of malignancy in cystic renal masses. It categorises them into five groups, helping to determine the appropriate follow-up (Bosniak IIF) or the need for surgical intervention (Bosniak III and IV).

2. SOLID MASSES (FIG. 23):

- Approximately 80% of kidney masses are malignant, with renal cell carcinoma (RCC) comprising around 80% of all malignant kidney cancers. RCCs arise from the tubular epithelium and encompass several distinct histological subtypes.
  - Clear cell (70- 80%)
  - Papillary (10-15%)
  - Chromophobe (5%)
  - Other (< 1%, collecting duct carcinoma and medullary carcinoma).

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学 / 肾脏肿物

章节大纲：

<!> 注意

肾脏肿物很常见，通常是在因其他无关原因进行超声、CT 或 MR 检查时偶然发现的。

肾脏肿物可分为两类：

1. 囊性病变：（图21 和 22）

- 单纯性肾囊肿是影像学检查中十分常见的附带发现。
- 然而，它们可能会呈现出特定的警示特征。在这种情况下，Bosniak 分型（见下页，图 21）对评估肾囊性肿物的恶性风险起着至关重要的作用。它将其分为五型，可帮助医生确定是进行适当的随诊（Bosniak IIF 型），还是必须手术干预（Bosniak III 和 IV 型）。

2. 实性肿块（图 23）：

- 约 80% 的肾脏肿物为恶性，其中肾细胞癌（renal cell carcinoma，RCC）约占所有肾脏恶性肿瘤的 80%。肾细胞癌 (RCC) 起源于肾小管上皮，包含几种不同的组织学亚型。
  - 透明细胞型（70%-80%）
  - 乳头状型（10%-15%）
  - 嫌色细胞型（5%）
  - 其他型（< 1%，肾集合管癌和髓样癌）。

1. Cystic Lesions

CLASS	CURRENT BOSNIAK CLASSIFICATION
I	Hairline-thin wall; water attenuation; no septa, calcifications, or solid components; nonenhancing
II	Two types: 1. Few thin septa with or without perceived (not measurable) enhancement; fine calcification or a short segment of slightly thickened calcification in the wall or septa 2. Homogeneously high-attenuating masses ≤ 3 cm that are sharply marginated and do not enhance
IIF	Two types: 1. Minimally thickened or more than a few thin septa with or without perceived (not measurable) enhancement that may have thick or nodular calcification 2. Intrarenal nonenhancing hyperattenuating renal masses > 3 cm
III	Thickened or irregular walls or septa with measurable enhancement
IV	Soft-tissue components (ie, nodule[s]) with measurable enhancement

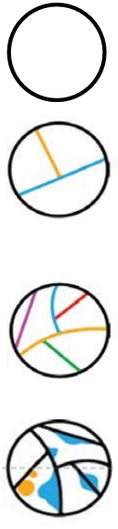

FIGURE 21

Determination of wall and septa thickness/irregularity by using the Bosniak classification of cystic renal masses, version 2019.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

1. 囊性病变

章节框架：

分型	现行的 BOSNIAK 分型
I	发线样薄壁；均匀水样密度；囊内无分隔、钙化或实性成分；无强化
II	两种类型： 1. 囊内有少量纤细分隔，伴或不伴可察觉但不可测量的强化；囊壁或分隔上有细线样钙化或短段轻微增厚钙化 2. 边界光滑、无强化、均匀高密度的肿物，直径 ⩽ 3 cm
IIF	两种类型： 1. 囊壁或分隔轻度增厚，囊内多发薄分隔，伴或不伴可察觉但不可测量的强化，可有粗大或结节样钙化 2. 肾内无强化高密度肿物，直径 > 3 cm
III	囊壁或分隔增厚或不规则，伴可测量的强化
IV	出现软组织成分（如结节），伴可测量的强化

图 21

依据 2019 版肾囊性肿物 Bosniak 分类法判定囊壁及分隔的厚度和不规则性。

1. Cystic Lesions

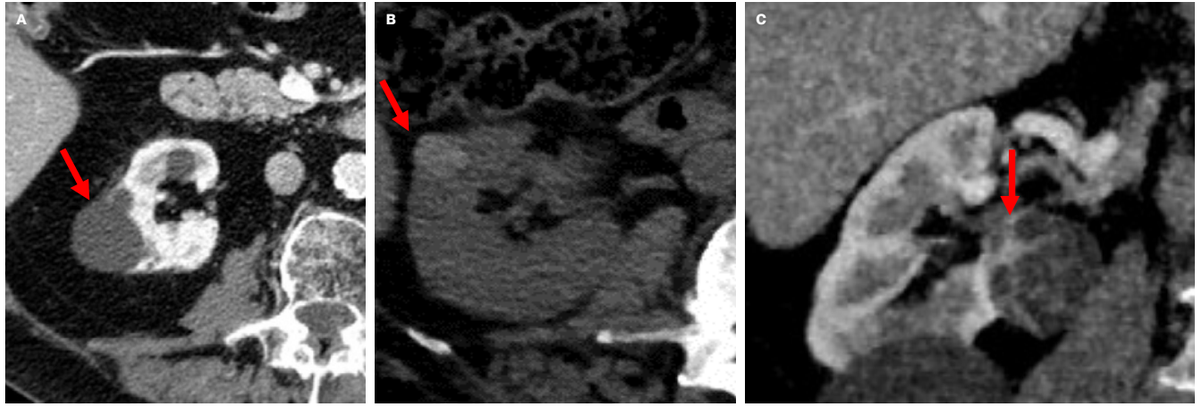

FIGURE 22

Spectrum of complex cystic lesions as categorised by the Bosniak classification. Cystic lesion with homogeneous simple fluid (**red arrow**), Bosniak type I (**A**); hyperdense cystic lesion (**red arrow**) in non-contrast phase, Bosniak type II (**B**); enhancing nodule (**red arrow**) and multiple septa, Bosnkia type IV (**C**).

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

1. 囊性病变

章节大纲：

图 22

按照 Bosniak 分型系统分类的各种复杂性囊性病变。含均质单纯液体的囊性病变（**红色箭头**），Bosniak I 级 (**A**)；平扫高密度囊性病变（**红色箭头**），Bosniak II 级 (**B**)；强化的结节（**红色箭头**）及多发分隔，Bosniak IV 级 (**C**)。

2. Solid Masses

Benign Lesions:

- Angiomyolipoma
- Oncocytoma
- Pseudotumour

Malignant Lesions:

- Renal Cell Carcinoma
- Urothelial Carcinoma
- Lymphoma

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

2. 实性肿块

章节框架：

良性病变：

- 血管平滑肌脂肪瘤
- 肾嗜酸细胞腺瘤
- 假性肿瘤

恶性病变：

- 肾细胞癌
- 尿路上皮癌
- 淋巴瘤

/ 2. Solid Masses

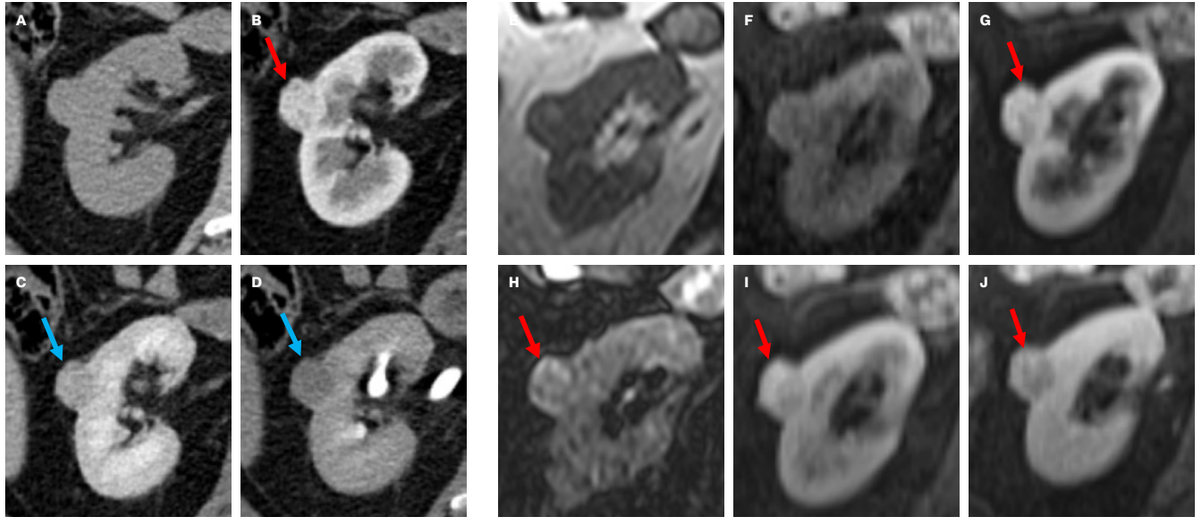

FIGURE 23

CT (**A-D**) and MRI (**E-J**) images showing imaging features corresponding to renal cell carcinoma. More specifically, the CT image on arterial phase (**B**) shows a hypervascular solid mass (**red arrows**), with «wash out» on nephrographic and delayed phases (**C** and **D**, respectively, **blue arrows**). T1WI (**E**), fat saturated T1 WI (**F**), arterial phase fat saturated T1WI (**G**), nephrogenic phase fat saturated T1WI (**I**), excretory phase saturated T1WI (**J**).

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

/ 2. 实性肿块

章节框架：

图 23

CT（**A - D**）及 MRI（**E - J**）图像示与肾细胞癌对应的影像学特征。具体而言，动脉期 CT 图像（**B**）显示富血供实性肿物（**红色箭头**），肾实质期及延迟期出现“廓清”（分别见图 **C** 和图 **D**，**蓝色箭头**）。T1WI (**E**)，脂肪抑制 T1WI (**F**)，动脉期脂肪抑制 T1WI (**G**)，肾实质期脂肪抑制 T1WI (**I**)，排泄期脂肪抑制 T1WI (**J**)。

<!> ATTENTION

Several anatomical characteristics of renal tumours are routinely evaluated in preoperative imaging to classify renal masses into low, intermediate, and high complexity, aiding in surgical planning.

These include:

- Tumour size
- Exophytic / endophytic tumour **growth pattern** and **exophytic rate**
- **Proximity to the renal collecting system** or renal parenchyma.
- Precise localisation (using **renal segmentation**)
- Presence of **feeding artery**

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

章节大纲：

<!> 注意

术前成像通常会评估肾肿瘤的一些解剖特征，将肾脏肿物的复杂程度分为低、中、高三等，以便进行手术规划。

包括：

- 肿瘤大小
- 外生性 / 内生性肿瘤生长模式及外生率
- 与肾集合系统或肾实质的距离
- 精确定位（采用肾脏分段法）
- 供血动脉的存在情况

/ Bladder Cancer

Bladder cancer (BCa) is one of the most frequently diagnosed cancers, with approximately 550,000 new cases reported annually. Urothelial cell carcinoma is the most common histologic type of BCa, representing more than 90% of all cases.

Staging and therapy depend on the **invasion of the muscularis propria**; in fact, **non muscle invasive BCa (NMIBC)** (stage T1) is managed with trans urethral resection of bladder tumour (TURBT), whereas **muscle invasive BCa (MIBC)** (stage T2 or higher) requires radical cystectomy or radiotherapy or, in selected cases neoadjuvant chemotherapy (6).

The detrusor invasion represents the most important predictive and prognostic factor: MIBC is associated with a significantly poorer prognosis compared to NMIBC. This highlights the crucial role of pathological and radiological assessment of muscle invasion, which has a significant impact on treatment strategies (3).

<!> ATTENTION

MRI is considered the best imaging modality for regional staging of bladder cancer (BCa) due to its superior contrast resolution of soft tissues and its ability to assess the muscularis propria, tumour infiltration grade and perivesical extension.

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

/ 膀胱癌

章节大纲：

膀胱癌（Bladder cancer，BCa）是最常确诊的癌症之一，每年约有 55 万新发病例。尿路上皮细胞癌是膀胱癌 (BCa) 最常见的组织学类型，占所有病例的 90% 以上。

分期与治疗方案取决于是否侵及固有肌层。事实上，**非肌层浸润性膀胱癌（non muscle invasive BCa，NMIBC，**T1 期）采用经尿道膀胱肿瘤切除术（trans urethral resection of bladder tumour，TURBT）治疗，**而肌层浸润性膀胱癌（muscle invasive BCa，MIBC，**T2 期或更高分期）则需行根治性膀胱切除术或放疗，部分病例还需接受新辅助化疗 (6)。

逼尿肌浸润是最重要的预测与预后因素：与非肌层浸润性膀胱癌 (NMIBC) 相比，肌层浸润性膀胱癌 (MIBC) 的预后明显更差。这强调了对肌层浸润进行病理和放射学评估的重要意义，它显著影响着治疗策略 (3)。

<!> 注意

由于 MRI 具有更好的软组织对比分辨率，且能够评估固有肌层、肿瘤浸润分级和膀胱周围扩散情况，因此被视为膀胱癌 (BCa) 区域分期的最佳成像方式。

Multiparametric MRI (mpMRI) of the bladder is a crucial diagnostic tool for bladder cancer management since it combines anatomical and functional sequences, improving the local tumour staging compared to conventional imaging alone (Fig. 24).

On T2-weighted imaging (T2WI), the muscularis propria (detrusor muscle) appears as a low-signal intensity (SI) line, which is continuous in case of non-muscle-invasive bladder cancer (NMIBC). On the other hand, in case of muscle-invasive bladder cancer (MIBC), this low-signal intensity line is interrupted, indicating possible muscle infiltration.

<!> ATTENTION

Bladder cancer has a high signal intensity on DWI and a low signal intensity on ADC map. After contrast injection tumours show early enhancement on dynamic contrast-enhanced (DCE) MRI. (7).

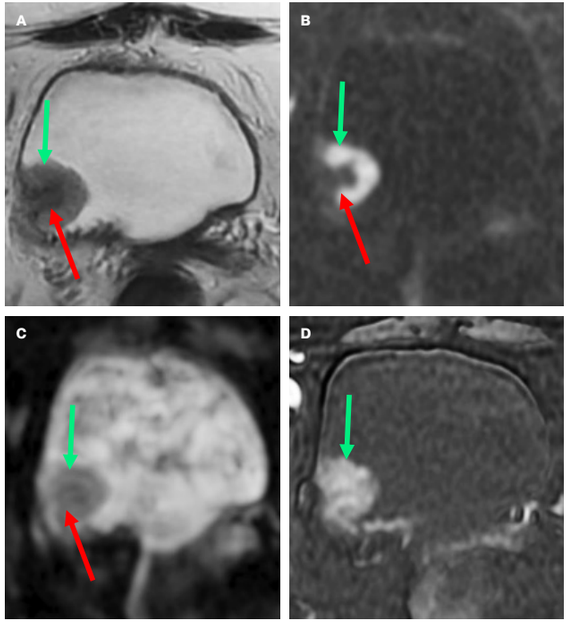

FIGURE 24

Bladder MRI (axial images) showing an exophytic and pedunculated lesion (**green arrows**), with a stalk (**red arrows**). T2 weighted image (**A**), DWI at b1000 image (**B**), ADC map (**C**), subtraction image T1 + Gd – T1 (**D**). Note restricted diffusion and strong contrast enhancement. Histology revealed non-muscle-invasive bladder cancer (NMIBC).

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

章节框架：

膀胱多参数磁共振成像（Multiparametric MRI，mpMRI）是膀胱癌诊疗中的一项关键诊断工具，因为它结合了解剖学和功能序列，与单纯的传统成像相比，能更好地进行局部肿瘤分期（图 24）。

在 T2 加权成像（T2-weighted imaging，T2WI）上，固有肌层（逼尿肌）表现为一条低信号强度（signal intensity，SI）线，在非肌层浸润性膀胱癌 (NMIBC) 中，这条线是连续的。但在肌层浸润性膀胱癌 (MIBC) 中，这条低信号线中断，提示可能存在肌层浸润。

<!> 注意

膀胱癌在弥散加权成像 (DWI) 上呈高信号，在表观扩散系数（apparent diffusion coefficient，ADC）图上呈低信号。注射对比剂后，肿瘤在动态对比增强（dynamic contrast-enhanced，DCE）MRI 上表现为早期强化。(7).

图 24

膀胱 MRI（轴位像）显示一外生性带蒂病灶（**绿色箭头**），带有蒂（**红色箭头**）。T2 加权像 (**A**)，b 值为 1000 的 DWI 像 (**B**)，表观扩散系数 (ADC) 图 (**C**)，T1 + Gd - T1 减影像 (**D**)。注意到弥散受限及明显的对比增强。组织学检查结果为非肌层浸润性膀胱癌 (NMIBC)。

<!> ATTENTION

A new scoring system, the **VI-RADS (Vesical Imaging Reporting and Data System) score**, has been developed to define a standardised approach for image acquisition, interpretation and reporting of mpMRI of the bladder, defining the risk of BCa muscle invasion (7) as shown in **Fig. 25**.

The score is based on T2WI, DCE-MRI and DWI findings. Therefore, three categories can be identified: structural categories (SC) for T2WI, contrast-enhanced (CE) categories for DCE sequences, and diffusion weighted (DW) categories for DWI and ADC map. The final score is based on these categories on a 5-point scale, reflecting the likelihood of **muscle invasion**.

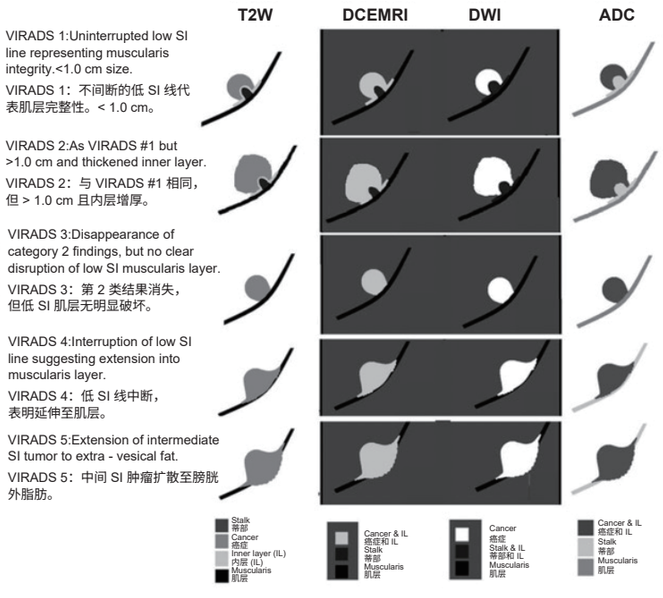

FIGURE 25

Schematic illustration of appearances of VI-RADS scores 1–5 on T2W, DCE, DWI and ADC sequences. ADC =apparent diffusion coefficient; DCE = dynamic contrast enhancement; DWI =diffusion-weighted imaging; SI =signal intensity. Image reproduced from : Panebianco V, Narumi Y, Altun E, et al. Multiparametric Magnetic Resonance Imaging for Bladder Cancer: Development of VI-RADS (Vesical Imaging-Reporting And Data System). Eur Urol. 2018 Sep;74(3):294-306. doi: 10.1016/j.eururo.2018.04.029. Free PMC article. Review.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

章节框架：

<!> 注意

目前，已开发出一种新的评分系统 **- 膀胱影像报告和数据系统（Vesical Imaging Reporting and Data System，VI - RADS），旨在为膀胱多参数磁共振成像 (mpMRI) 的图像采集、解读及报告制定标准化方法，以评定膀胱癌 (BCa) 肌层浸润风险 (7)，如图 25** 所示。

该评分基于 T2 加权成像 (T2WI)、动态对比增强磁共振成像 (DCE - MRI) 和弥散加权成像 (DWI) 的检查结果。由此可确定三种分类：T2WI 的结构分类 (SC)、DCE 序列的对比增强 (CE) 分类、DWI 和表观扩散系数 (ADC) 图的弥散加权 (DW) 分类。根据这些分类得出的最终评分（5 分制）反映了肌层浸润的可能性。

图 25

VI - RADS 评分（1 - 5 分）在 T2W、DCE、DWI 和 ADC 序列像上表现的示意图。ADC = 表观扩散系数；DCE = 动态对比增强；DWI = 弥散加权成像；SI = 信号强度。图片来自：Panebianco V, Narumi Y, Altun E, et al. Multiparametric Magnetic Resonance Imaging for Bladder Cancer: Development of VI-RADS (Vesical Imaging-Reporting And Data System). Eur Urol. 2018 Sep;74(3):294-306. doi: 10.1016/j.eururo.2018.04.029. 可免费获取的 PubMed 中心（PubMed Central，PMC）文章。综述。

/ Prostate Diseases

The two most common prostate diseases are:

- **Benign Prostate Hyperplasia (BPH)**, a non-cancerous enlargement of the prostate gland associated with urinary symptoms, including slow urinary stream, urinary frequency (especially nocturia), urgency and urinary retention with incomplete bladder emptying.
- **Prostate cancer**, the second most frequent cancer in men. Prostate cancer is usually suspected on the basis of PSA levels. Definitive diagnosis depends on histopathological verification of adenocarcinoma in prostate core biopsies.

<!> ATTENTION

As benign prostatic hyperplasia (BPH) progresses, the Transition Zone becomes a larger proportion of the prostate's total volume. On the other hand, prostate cancer typically originates in the Peripheral Zone (5).

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

/ 前列腺疾病

章节框架：

两种最常见的前列腺疾病为：

- **良性前列腺增生（Benign Prostate Hyperplasia，BPH）**。一种前列腺的良性增大，常伴有泌尿系统症状，包括尿流缓慢、尿频（尤其是夜尿增多）、尿急以及膀胱排空不全导致的尿潴留。
- **前列腺癌**，男性中第二常见的癌症。通常根据 PSA 水平来筛查前列腺癌。最终确诊依赖于前列腺活检的腺癌的组织病理学证实。

<!> 注意

随着良性前列腺增生 (BPH) 的进展，移行带占前列腺总体积的比例不断增大。另一方面，前列腺癌通常起源于外周带 (5)。

US Role in the Prostate

- To measure prostate enlargement due to BPH in the pre-treatment setting
- To detect inflammatory conditions
- To guide procedures such as needle biopsies

<!> ATTENTION

Standard transrectal ultrasound (TRUS) is not considered reliable for detecting prostate cancer.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学 超声检查 (US) 在前列腺疾病诊断中的作用

章节大纲：

- 测量治疗前因良性前列腺增生 (BPH) 导致的前列腺增大
- 发现炎症性疾病
- 引导诸如穿刺活检等操作

<!> 注意

标准的经直肠超声（transrectal ultrasound，TRUS）在检测前列腺癌方面被认为并不可靠。

MRI Role for Prostate Cancer

Multiparametric MRI (mpMRI) combines anatomic T2W imaging with functional assessment, including DWI and ADC maps and dynamic contrast-enhanced (DCE) sequences.

MRI demonstrates high sensitivity and specificity for detecting and localising prostate cancer (Fig. 26). Additionally, the clinical applications of prostate MRI have expanded to include surveillance, assessment of suspected recurrence, and image guidance for biopsy, surgery, focal therapy and radiation therapy.

<!> ATTENTION

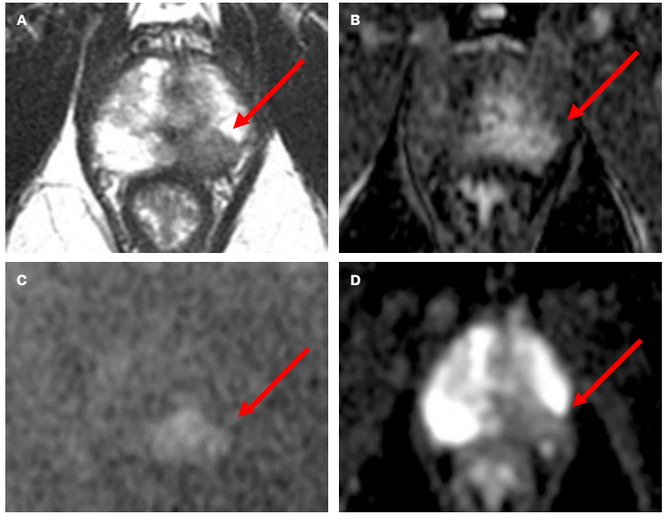

FIGURE 26

Prostate mpMRI (axial images) demonstrating the characteristic features of prostate cancer (**arrows**). T2 WI (**A**), DCE MRI image (**B**), DWI with a b value of 2000 (**C**) and ADC map (**D**). Figure part **A** shows a hypointense lesion in T2 WI localised in the peripheral zone (5 o'clock), with an early and focal enhancement (**B**) after administration of contrast medium (for the detection of neoangiogenesis). On (**C**), the lesion has a high signal intensity and on the ADC map (**D**), a very low signal because of restricted diffusivity. Restricted diffusivity reflects increased cellularity and high cell proliferation.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

MRI 在前列腺癌诊断中的作用

<!> 注意

章节框架：

多参数 MRI (mpMRI) 将解剖学 T2 加权成像与功能评估相结合，包括扩散加权成像 (DWI)、表观扩散系数 (ADC) 图和动态对比增强 (DCE) 序列。

MRI 对前列腺癌的检测和定位具有较高的敏感性和特异性（图 26）。此外，前列腺 MRI 的临床应用已扩展至包括监测、评估疑似复发，以及为活检、手术、局部治疗和放射治疗提供影像引导。

图 26

前列腺 mpMRI（轴位像）显示前列腺癌的特征表现（**箭头所示**）。T2 加权成像 (**A**)，DCE MRI 图像 (**B**)，b 值为 2000 的 DWI (**C**) 以及 ADC 图 (**D**)。图 **A** 示 T2WI 外周带（5 点钟方向）可见一个低信号病灶，注射对比剂（用于检测新生血管生成）后出现早期局灶性强化 (**B**)。图 **C** 中该病灶呈高信号，ADC 图 (**D**) 上，由于扩散受限呈极低信号。扩散受限反映了细胞密度增加和细胞增殖活跃。

<!> ATTENTION

The Prostate Imaging-Reporting and Data System (PI-RADS, Fig. 27) was developed, to provide a systematic and standardised approach for the acquisition, interpretation, and reporting of prostate mpMRI (5).

Each lesion is assigned a PI-RADS Assessment Category on a 5-point scale, based on the likelihood that findings from T2WI, DWI, and DCE imaging are associated with clinically significant prostate cancer.

Lesions classified as PI-RADS score of 4 or higher are referred for a targeted biopsy. PI-RADS 3 lesions' management is stil highly debated.

>=< FURTHER KNOWLEDGE

PIRADS 1 – Very low (clinically significant cancer is highly unlikely to be present)

PIRADS 2 – Low (clinically significant cancer is unlikely to be present)

PIRADS 3 – Intermediate (the presence of clinically significant cancer is equivocal)

PIRADS 4 – High (clinically significant cancer is likely to be present)

PIRADS 5 – Very high (clinically significant cancer is highly likely to be present)

FIGURE 27

Risk assessment using PI-RADS score version 2.1

<!> 注意

目前已开发的前列腺影像报告和数据系统 (PI - RADS，图 27），为前列腺 mpMRI 的采集、解读和报告提供一种系统、标准化的方法 (5)。

根据 T2 加权成像 (T2WI)、扩散加权成像 (DWI) 和动态对比增强 (DCE) 成像结果与临床显著前列腺癌的关联可能性，每个病灶会获得一个前列腺影像报告和数据系统 (PI - RADS) 评分（5 分制）。

PI-RADS 评分≥ 4 分的病变需进行靶向活检。对 PI - RADS 为 3 分病变的管理方式，目前仍存在很大争议。

>=< 进阶知识

图 27

使用 2.1 版 PI - RADS 评分进行风险评估

/ Testicular Diseases

The two most common types of testicular disease are:

1. Testicular torsion

Occurs when a testicle twists on the spermatic cord, cutting off its blood supply. The most common symptom is sudden and intense pain.

The diagnosis is initially suspected based on clinical findings but must be confirmed with colour Doppler ultrasound (10), as illustrated in Fig. 28. Early diagnosis is crucial, as testicular infarction can be avoided with a 100% salvage rate if treated within 6 hours.

<!> ATTENTION

US represents the imaging modality of choice for the assessment of suspected testicular torsion.

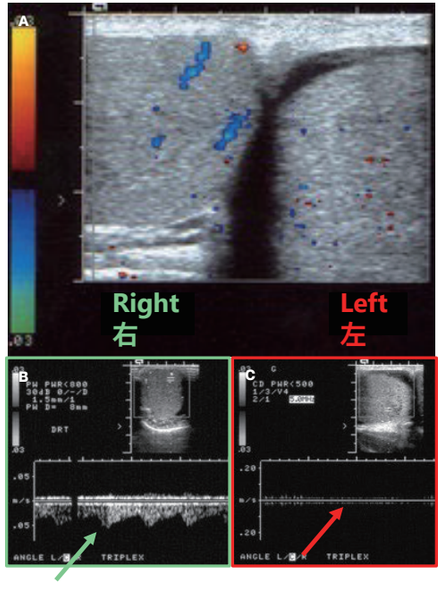

FIGURE 28

Testicular torsion as seen on colour Doppler US. The patient presented with severe pain in the left testis. Colour Doppler images (**A**, **B** and **C**) of the left and right testis showed massively altered blood flow on the left side with increased resistive index. Note normal arterial flow curve on the right (**B**) and absent arterial flow curve on the left (**C**). Figure courtesy: Alexandra Platon, MD, Geneva University Hospitals, Switzerland.

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学 / 睾丸疾病

章节大纲：

两种最常见的睾丸疾病为：

1. 睾丸扭转

当睾丸围绕精索发生扭转，切断其血液供应。最常见症状是突发剧痛。

可根据临床症状初步诊断睾丸扭转，但必须通过彩色多普勒超声检查 (10) 确诊，如图 28 所示。早期诊断至关重要，如果在 6 小时内进行治疗，可避免睾丸梗死，且抢救率为 100%。

<!> 注意

US 是评估疑似睾丸扭转的首选成像手段。

图 28

彩色多普勒超声显示睾丸扭转。患者主诉左侧睾丸剧痛。双侧睾丸彩色多普勒图像（**A**、**B** 和 **C**）示左侧睾丸血流显著改变，伴阻力指数升高。右图为正常动脉血流曲线 (**B**)，左侧无动脉血流曲线 (**C**)。图片来源：瑞士日内瓦大学医院 Alexandra Platon，MD。

2. Testicular Cancer

Testicular cancer accounts for 1% of all male cancers and is the most common type in men during their 3rd and 4th decades of life. Over 90% of testicular cancers are primary germ cell tumours. In men over the age of 70, lymphoma is the most common type of testicular cancer.

EAU (European Association of Urology) recommends to perform:

- Bilateral testicular US in patients with suspicion of testicular cancer (Fig. 29)
- Contrast enhanced CT of the chest, abdomen and pelvis for staging

<!> ATTENTION

MRI of the scrotum provides higher sensitivity and specificity compared to ultrasound in the diagnosing testicular cancer, but its higher cost limits its routine use.

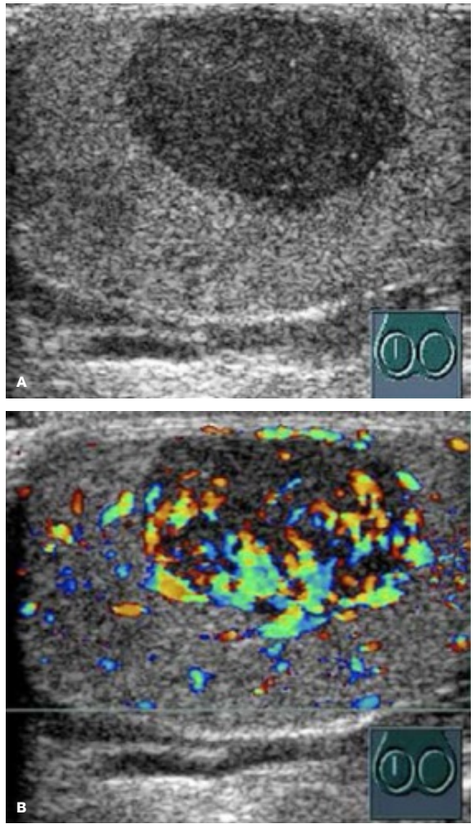

FIGURE 29

Example of a sagittal testicular US image showing a right, nodular, hypoechoic testicular tumour (**A**) with increased vascularity on the colour Doppler image (**B**). Image courtesy: Thomas de Perrot, MD, Geneva University Hospitals.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

2. 睾丸癌

睾丸癌占所有男性癌症的 1%，是 30 至 40 岁男性中最常见的癌症类型。90% 以上的睾丸癌是原发性生殖细胞瘤。在 70 岁以上男性中，淋巴瘤是最常见的睾丸癌类型。

欧洲泌尿外科学会（European Association of Urology，EAU）建议采取以下检查：

- 对怀疑睾丸癌的患者进行双侧睾丸超声 (US) 检查（图 29）
- 行胸部、腹部和盆腔增强 CT 扫描进行分期

<!> 注意

与超声相比，阴囊 MRI 在诊断睾丸癌方面具有更高的灵敏度和特异性，但其较高的费用限制了其常规应用。

图 29

矢状位睾丸超声图像 (US) 示例，右侧睾丸可见结节状低回声肿瘤 (**A**)，彩色多普勒图像显示其血流增加 (**B**)。图片来源：日内瓦大学医院 Thomas de Perrot，MD。

/ Penile Diseases

Penile cancer is a very rare tumour.

Although penile fractures (Fig. 30) are rare, they require immediate diagnosis and treatment as they constitute a medical emergency. These injuries involve rupture of the penile tunica albuginea of the corpora cavernosa or spongiosum, typically caused by trauma to an erect penis, most often during sexual intercourse.

/ **Emergency ultrasound with Doppler** is usually the initial imaging modality, to verify the presence of fracture and haematoma (a common complication).

/ **MRI** of the penis (Fig. 30) is the most valuable imaging technique for assessing the extent of the injury, determining its precise location and depth, and identifying potential complications. These are crucial points to be addressed, to guarantee the most appropriate therapeutic approach (surgery vs conservative approach).

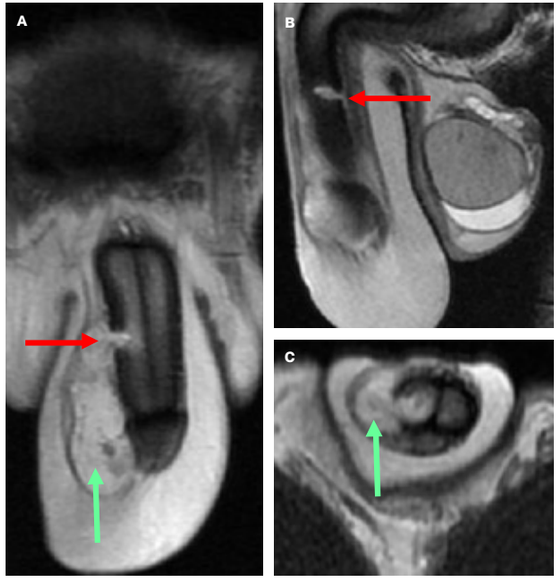

FIGURE 30

Penile fracture on MRI. Coronal (**A**), sagittal (**B**) and axial (**C**) T2 weighted images. Note the breach as red arrow in the band of fibrous tissue (tunica albuginea) and the haematoma alongside the breach (**green arrow**).

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

/ 阴茎疾病

章节大纲：

阴茎癌是一种非常罕见的肿瘤。

尽管阴茎断裂（图 30）罕见，但仍属于医疗急症，需要立即诊断和治疗。这种损伤包括阴茎海绵体或尿道海绵体的阴茎白膜破裂，通常由勃起的阴茎受到外伤引起，最常见于性交过程中。

/ **急诊多普勒超声**通常是验证阴茎是否存在断裂和血肿（常见并发症）的初步影像学检查手段。

/ 阴茎 **MRI 图像**（图 30）是评估损伤程度、确定准确位置和深度，以及发现可能并发症的最有价值的成像技术。这些是需要解决的关键点，以确保采取最合适的治疗方案（手术与保守治疗）。

图 30

MRI 显示阴茎断裂。冠状位 (**A**)、矢状位 (**B**) 和轴位 (**C**) T2 加权像。注意红色箭头所示纤维组织带（白膜）的撕裂，以及**绿色箭头**所示裂口旁血肿。

Interventional Procedures

Urogenital Radiology

CHAPTER OUTLINE:

介入治疗

泌尿生殖系统放射学

章节大纲：

/ Renal Procedures

Even if radical and partial nephrectomy remain the gold standard treatments for renal cancer, interventional procedures such as tumour ablation serve as viable alternatives for patients with small renal masses (< 3 cm).
Tumour ablation (TA) includes two main techniques:

CRYOABLATION (CA)

RADIOFREQUENCY ABLATION (RFA)

> See also eBook chapter on Interventional Radiology

<!> ATTENTION

A RENAL MASS BIOPSY prior to tumour ablation is mandatory, according to European Association of Urology guidelines!

These focal therapies have advantages for

- / Kidney function preservation
- / Minimising bleeding
- / Reducing operative time
- / Reduction in the duration of hospitalisation

/ 泌尿生殖系统放射学 / 肾脏相关操作

尽管根治性肾切除术和部分肾切除术仍然是肾癌的金标准治疗方法，但对于小肾脏肿物（<3 cm）的患者，肿瘤消融术等介入手术是可行的替代方案。

肿瘤消融术（Tumour ablation，TA）主要包括两种技术：

冷冻消融（CRYOABLATION，CA）

射频消融（RFA）

> 请参阅《介入放射学》电子书章节

<!> 注意

根据欧洲泌尿外科学会（European Association of Urology）指南，在进行肿瘤消融之前，必须对肾肿块进行穿刺活检！

局部治疗具有以下优势：

- / 保留肾功能
- / 尽量减少出血
- / 缩短手术时间
- / 缩短住院时间

/ MRI Targeted – Transrectal Ultrasound (TRUS) Biopsy “Fusion Biopsy”

MRI targeted biopsy, which differs from traditional systematic biopsy, involves targeted procedures that focus on specific lesions identified on MRI images and includes:

1. “Fusion biopsy”

Pre-biopsy MRI images are “fused” with “real time” transrectal ultrasound (TRUS) images as shown in Fig. 31 to guide biopsy sampling (11) (12).

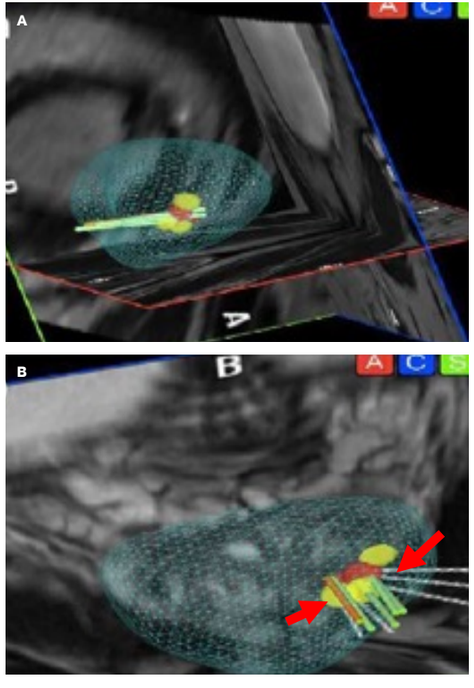

FIGURE 31

Virtual representation of a TRUS-biopsy. In particular, the figures show the co- registration of MRI and US images of the prostate, with the reconstruction of the biopsy targets and cores (**red arrows**).

<!> ATTENTION

- Enhanced accuracy and precision in tumour tissue detection
- Reduced number of tissue samples required
- Minimised pain and lower risk of complications
- Faster post-procedure recovery

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

章节大纲：

/ MRI 靶向 - 经直肠超声 (TRUS) 穿刺活检 “融合穿刺活检”

MRI 靶向穿刺活检与传统系统穿刺活检不同，它是对 MRI 图像上发现的特定病灶的靶向操作，包括:

1. “融合穿刺活检”

如图 31 所示，活检前的 MRI 图像与 “实时” 经直肠超声 (TRUS) 图像 “融合”，引导活检取样 (11)(12)。

<!> 注意

- 提高肿瘤组织检测的准确性和精确性
- 减少所需组织样本数量
- 尽可能减轻疼痛，降低并发症风险
- 术后恢复更快

FIGURE 32

经直肠超声 (TRUS) 穿刺活检的虚拟图。图片显示了前列腺 MRI 与超声 (US) 图像的配准，以及活检靶点和穿刺针（**红色箭头**）的重建图像。

2. “In-bore” biopsy

This approach allows for prostate tissue sampling under direct MR guidance using a robotic system (Fig. 32), providing precise visualisation of the needle's position within the targeted lesion for improved accuracy and reliability.

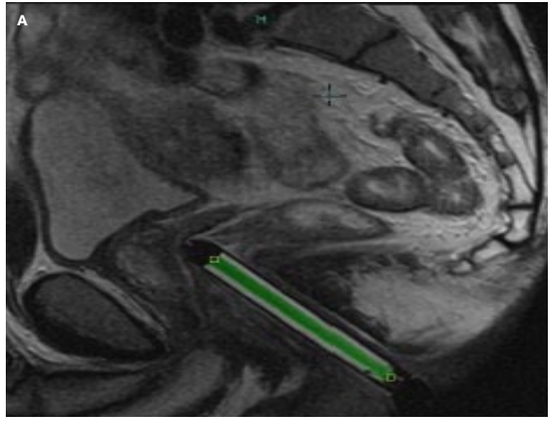

FIGURE 33

In-bore biopsy. Figure (**A**) shows a sagital T2-weighted image obtained before the biopsy to visualise the prostate and to identify the target lesion. Figure (**B**) shows the patient in the prone position and the optimal placement of the device.

The sequences are acquired along the axis of the amagnetic needle to assess the correct position with respect to the target lesion and establish its direction and depth.

Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

章节大纲：

2. “扫描仪内（In-bore）”穿刺活检

这种方法借助机器人系统，可在直接 MR 引导下对前列腺组织进行采样（图 32），能够精确显示活检针在目标病灶内的位置，从而提高准确性和可靠性。

图 33

扫描仪内穿刺活检。图 (**A**) 为活检前采集的矢状位 T2 加权像，显示前列腺并识别目标病灶。图 (**B**) 为俯卧体的患者以及器械的最佳放置。

沿非磁性针轴线采集序列图像，评估其相对于目标病灶的正确位置，并确定其方向和深度。

/ Focal Therapy in Prostate Cancer

Focal therapy is an alternative to surgery or radiation therapy. It uses high doses of various types of energy to selectively target and eliminate malignant cells (13). Two examples:

>|< COMPARE

CRYOTHERAPY:

Rapidly cool the cancerous tissue, inducing extreme hypothermia which kills the cancer cells.

POTENTIAL ADVANTAGES:

Reduction of side effects

HIGH INTENSITY FOCUSED ULTRASOUND (HIFU):

Using sound waves to kill the cancer cells.

REMAINING QUESTIONS:

Cancer control

> See also eBook chapter on Interventional Radiology

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

章节大纲：

/ 前列腺癌的局部治疗

局部治疗是手术或放射治疗的替代方案。它使用各种高剂量的能量，选择性地靶向并消除恶性细胞 (13)。两个示例：

>|< 比较

冷冻疗法：

迅速冷冻癌组织，形成可杀灭癌细胞的极低温度。

潜在优点：

减少副作用

高强度聚焦超声(HIFU)：

利用声波杀死癌细胞。

遗留问题：

癌症控制

> 请参阅《介入放射学》电子书章节

/ Minimally Invasive Surgical Therapies (MISTs) in BPH

Recent advancements in the surgical management of benign prostatic hyperplasia (BPH) have led to significant improvements, thanks to the introduction of minimally invasive surgical techniques (MISTs).

Prostatic artery embolisation (PAE) is one of these endovascular procedures performed under local anaesthesia with access through the femoral or radial arteries. Digital subtraction angiography (DSA) is employed to visualise the arterial anatomy, enabling selective embolisation of the prostatic arteries responsible for the blood supply to the prostate (14).

<!> ATTENTION

Current evidence supporting the safety and efficacy of PAE endorses its use in men with moderate-to-severe lower urinary tract symptoms, although PAE is still under investigation.

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学

章节框架：

/ 良性前列腺增生 (BPH) 的微创手术治疗 (MIST)

由于微创外科技术（minimally invasive surgical techniques，MIST）的引入，良性前列腺增生 (BPH) 的手术治疗目前取得了显著进展。

前列腺动脉栓塞术（Prostatic artery embolisation，PAE）就是一种在局部麻醉下，经股动脉或桡动脉入路施行的血管内手术。数字减影血管成像（Digital subtraction angiography，DSA）用于显示动脉的解剖结构，从而选择性栓塞为前列腺供血的前列腺动脉 (14)。

<!> 注意

尽管前列腺动脉栓塞术 (PAE) 仍在研究中，但目前的安全性和有效性支持证据表明，它可用于具有中至重度下尿路症状的男性患者。

/ Take-Home Messages

Kidney

Imaging is used for:

- Detection and diagnosis of renal masses.
- Therapeutic and surgical planning.
- Establish time 0 for active surveillance.
- Guide for Focal Therapies.

Bladder

- If clinically suspected, perform an ultrasound of the bladder.
- MRI of the bladder is useful for local staging of the disease and for differentiating NMIBC from MIBC, which significantly impacts patient management.

Prostate

- MpMRI of the prostate is a first-line diagnostic tool for detecting prostate cancer, due to its combination of morphological and functional imaging sequences.
- PI-RADS score defines the probability of clinically significant disease.
- When MRI is suspicious, perform a targeted biopsy.

Testicles

- Perform a bilateral testicular ultrasound in patients with clinical suspicion of testicular cancer and CT for staging.
- Perform a Doppler ultrasound to confirm the diagnosis of testicular torsion.

Penis

- In cases of penile cancer or penile fracture, MRI is indicated after US to confirm the diagnosis, assess complications, and guide correct treatment decisions.

CHAPTER OUTLINE:

/ 核心要点

章节大纲：

肾脏

影像学用于：

- 肾脏肿物的检测与诊断。
- 治疗与手术规划。
- 确立主动监测的 0 时间点。
- 引导局部治疗。

膀胱

- 如临床怀疑异常，进行膀胱超声检查。
- 膀胱 MRI 对疾病的局部分期以及区分非肌层浸润性膀胱癌 (NMIBC) 与肌层浸润性膀胱癌 (MIBC) 很有用，这些对患者的治疗管理有重大影响。

前列腺

- 前列腺多参数 MRI(mpMRI)，结合了形态学和功能性成像序列，是检测前列腺癌的一线诊断工具。
- 前列腺影像报告和数据系统（PI - RADS）评分可衡量临床意义疾病的可能性。
- 如 MRI 检查结果可疑，进行靶向穿刺活检。

睾丸

- 对于临床怀疑睾丸癌的患者，进行双侧睾丸超声检查，并通过 CT 进行分期。
- 进行多普勒超声检查，确诊睾丸扭转。

阴茎

- 对于阴茎癌或阴茎断裂病例，超声检查 (US) 后需行 MRI 检查，以确诊、评估并发症和指导做出正确的治疗决策。

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Urogenital Radiology

CHAPTER OUTLINE:

泌尿生殖系统放射学

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Test Your Knowledge

Urogenital Radiology

CHAPTER OUTLINE:

知识测试

泌尿生殖系统放射学

章节大纲：

/ Test Your Knowledge

<?> QUESTION

1 Can cross-sectional imaging distinguish between renal cortex and medulla?

☐ Yes

☐ No

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学 / 知识测试

章节大纲：

<?> 问题

1 横断面成像能够区分肾皮质和肾髓质吗？

☐ 能

☐ 不能

/ Test Your Knowledge

<?> ANSWER

1 Can cross-sectional imaging distinguish between renal cortex and medulla?

- ■ Yes
- ☐ No

/ 泌尿生殖系统放射学 / 知识测试

<?> 回答

1 横断面成像能够区分肾皮质和肾髓质吗？

- ■ 能
- ☐ 不能

/ Test Your Knowledge

<?> QUESTION

2 When can a duplicated collecting system be defined as complete?

(One or more than one answer can be correct.)

- ☐ There are two renal pelvises
- ☐ There are two ureters that open in the same ostium
- ☐ There are two ureters that separately open into the bladder
- ☐ There are two kidneys for side

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

2 完全性重复集合系统具有以下哪些特征？

(一个或多个正确答案。)

- ☐ 存在两个肾盂
- ☐ 有两条输尿管开口于同一开口处
- ☐ 有两条输尿管分别开口于膀胱
- ☐ 每侧有两个肾脏

/ Test Your Knowledge

<?> ANSWER

2 When can a duplicated collecting system be defined as complete?

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- [x] There are two renal pelvises
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CHAPTER OUTLINE:

/ 知识测试

章节大纲：

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- [ ] 每侧有两个肾脏

/ Test Your Knowledge

<?> QUESTION

3 Ureters can be anatomically divided into:

- ☐ Two parts: proximal and distal ureter
- ☐ Two parts: abdominal and pelvic ureter
- ☐ Three parts: abdominal, pelvic and intramural ureter
- ☐ Four parts: abdominal, pelvic, extramural and intramural ureter

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

3 输尿管在解剖学上可分为：

- ☐ 两段：输尿管近段和远段
- ☐ 两段：腹部输尿管和盆腔输尿管
- ☐ 三段：腹部输尿管、盆腔输尿管和壁内段输尿管
- ☐ 四段：腹部输尿管、盆腔输尿管、壁外段输尿管和壁内段输尿管

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CHAPTER OUTLINE:

/ 知识测试

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/ Test Your Knowledge

<?> QUESTION

4 When is a cystic renal lesion classified as Bosniak IV?

- ☐ Irregular septa with measurable contrast enhancement
- ☐ Wall/septa calcifications
- ☐ Hyperattenuating lesion at non-contrast CT
- ☐ Nodular components with measurable contrast enhancement

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

4 Bosniak IV 型肾囊性病变有以下哪些特征？

- ☐ 分隔不规则，有可测量的强化
- ☐ 囊壁 / 分隔钙化
- ☐ 平扫 CT 显示高密度病灶
- ☐ 有可测量强化的结节成分

/ Test Your Knowledge

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CHAPTER OUTLINE:

/ 知识测试

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- ☐ 平扫 CT 显示高密度病灶
- ■ 有可测量强化的结节成分

/ Test Your Knowledge

<?> QUESTION

5 When is surgical therapy indicated for a renal cystic lesion?

(One or more than one answer can be correct.)

- ☐ Bosniak I
- ☐ Bosniak II
- ☐ Bosniak III
- ☐ Bosniak IV

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

5 以下哪型肾囊性病变需要手术治疗？

(一个或多个正确答案。)

- ☐ Bosniak I
- ☐ Bosniak II
- ☐ Bosniak III
- ☐ Bosniak IV

/ Test Your Knowledge

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(One or more than one answer can be correct.)

- ☐ Bosniak I
- ☐ Bosniak II
- ■ Bosniak III
- ■ Bosniak IV

<?> 回答

5 以下哪型肾囊性病变需要手术治疗？

(一个或多个正确答案。)

- ☐ Bosniak I
- ☐ Bosniak II
- ■ Bosniak III
- ■ Bosniak IV

Test Your Knowledge

<?> QUESTION

6 The VI-RADS score suggests the probability of?

(One or more than one answer can be correct.)

- ☐ Presence of bladder cancer
- ☐ Muscle invasiveness of bladder cancer
- ☐ Fat tissue involvement of bladder cancer
- ☐ All the answers

CHAPTER OUTLINE:

知识测试

章节大纲：

<?> 问题

6 膀胱影像报告和数据系统（VI - RADS）评分提示以下哪种情况的可能？

（一个或多个正确答案。）

- ☐ 存在膀胱癌
- ☐ 膀胱癌的肌层浸润
- ☐ 膀胱癌累及脂肪组织
- ☐ 以上全对

/ Test Your Knowledge

<?> ANSWER

6 The VI-RADS score suggests the probability of?

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- ■ Muscle invasiveness of bladder cancer
- ■ Fat tissue involvement of bladder cancer
- ☐ All the answers

/ 知识测试

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- ☐ 存在膀胱癌
- ■ 膀胱癌的肌层浸润
- ■ 膀胱癌累及脂肪组织
- ☐ 以上全对

/ Test Your Knowledge

<?> QUESTION

7

69 years old man undergoing mpMRI of the prostate, which shows on the left peripheral zone a hypointense 10 mm lesion on T2WI, associated with restricted diffusion on DWI/ADC map and post contrast early enhancement. Which PI-RADS score would you assign?

- ☐ PI-RADS 2
- ☐ PI-RADS 3
- ☐ PI-RADS 4
- ☐ PI-RADS 5

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

7

老年男性患者，69 岁。前列腺多参数磁共振成像 (mpMRI) 检查示，T2 加权成像 (T2WI) 左侧外周带可见一 10 mm 低信号病灶，弥散加权成像 (DWI) / 表观扩散系数 (ADC) 图显示弥散受限，增强扫描呈早期强化。患者的前列腺影像报告和数据系统（PI - RADS）评分应为?

- ☐ PI-RADS 2
- ☐ PI-RADS 3
- ☐ PI-RADS 4
- ☐ PI-RADS 5

/ Test Your Knowledge

<?> ANSWER

7 69 years old man undergoing mpMRI of the prostate, which shows on the left peripheral zone a hypointense 10 mm lesion on T2WI, associated with restricted diffusion on DWI/ADC map and post contrast early enhancement. Which PI-RADS score would you assign?

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- ☐ PI-RADS 3
- ■ PI-RADS 4
- ☐ PI-RADS 5

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 回答

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- ☐ PI-RADS 2
- ☐ PI-RADS 3
- ■ PI-RADS 4
- ☐ PI-RADS 5

Test Your Knowledge

<?> QUESTION

8 How can you perform a prostate biopsy?

(One or more than one answer can be correct.)

- ☐ US-guided
- ☐ Fluoroscopy-guided
- ☐ MRI-guided
- ☐ CT-guided

CHAPTER OUTLINE:

知识测试

章节大纲：

<?> 问题

8 如何进行前列腺活检？

(一个或多个正确答案。)

- ☐ 超声 (US) 引导
- ☐ 荧光透视引导
- ☐ MRI 引导
- ☐ CT 引导

/ Test Your Knowledge

<?> ANSWER

8 How can you perform a prostate biopsy?

(One or more than one answer can be correct.)

- ■ US-guided
- ☐ Fluoroscopy-guided
- ■ MRI-guided
- ☐ CT-guided

/ 泌尿生殖系统放射学 / 知识测试

<?> 回答

8 如何进行前列腺活检？

（一个或多个正确答案。）

- ■ 超声 (US) 引导
- ☐ 荧光透视引导
- ■ MRI 引导
- ☐ CT 引导

Test Your Knowledge

<?> QUESTION

9 A 44-year-old male presents with right testicular pain and enlargement of the testis, without a history of trauma. What would be your initial management approach?

- ☐ X-ray
- ☐ US
- ☐ MRI
- ☐ CT with CE

CHAPTER OUTLINE:

知识测试

章节大纲：

<?> 问题

9 44 岁男性患者，右侧睾丸疼痛伴肿大，无外伤史。初步处理方法应该为？

- ☐ X 线
- ☐ US
- ☐ MRI
- ☐ 增强 CT 扫描

/ Test Your Knowledge

<?> ANSWER

9 A 44-year-old male presents with right testicular pain and enlargement of the testis, without a history of trauma. What would be your initial management approach?

- ☐ X-ray
- ■ US
- ☐ MRI
- ☐ CT with CE

/ Urogenital Radiology

CHAPTER OUTLINE:

/ 泌尿生殖系统放射学 / 知识测试

章节大纲：

<?> 回答

9 44 岁男性患者，右侧睾丸疼痛伴肿大，无外伤史。初步处理方法应该为？

- ☐ X 线
- ■ US
- ☐ MRI
- ☐ 增强 CT 扫描

/ Test Your Knowledge

<?> QUESTION

10 US in the patient from question 9 reveals testis enlargement with low signal on colour-Doppler; what do you suspect?

- ☐ Seminoma
- ☐ Testicular torsion
- ☐ Varicocele
- ☐ Acute orchitis

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

10 第 9 题中患者超声检查 (US) 示睾丸增大，彩色多普勒呈低信号，应怀疑什么疾病？

- ☐ 精原细胞瘤
- ☐ 睾丸扭转
- ☐ 精索静脉曲张
- ☐ 急性睾丸炎

/ Test Your Knowledge

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