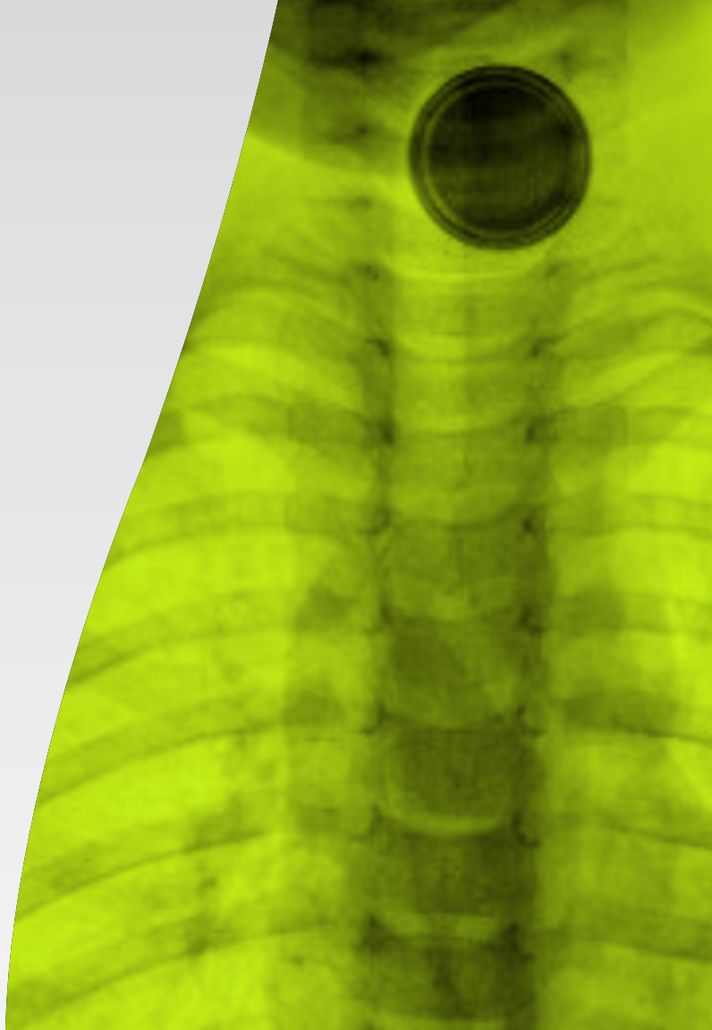
MODERN RADIOLOGY eBook

Paediatric Radiology

儿科放射学



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

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

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
瑞士日内瓦大学放射学教授

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TRANSLATED BY:
Prof. Jing Chen, Tianjin Children's Hospital
Prof. Yumin Zhong, Shanghai Children's Medical Center, Shanghai Jiao Tong University School of Medicine
Prof. Gang Ning, West China Second University Hospital, Sichuan University

COORDINATED BY:
Prof. Shiyuan Liu, Shanghai Changzheng Hospital
Prof. Yi Xiao, Shanghai Changzheng Hospital

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

<↑> HYPERLINK

bbchenjing@126.com
zyumin2002@163.com
ng6611@163.com

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

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：
儿科放射学

翻译：
陈静教授，天津市儿童医院
钟玉敏教授，上海交通大学医学院附属上海儿童医学中心
宁刚教授，四川大学华西第二医院

联合翻译：
刘士远教授，长征医院
萧毅教授，长征医院

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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bbchenjing@126.com
zyumin2002@163.com
ng6611@163.com

/ Signage

<▪> CORE KNOWLEDGE

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<↑> HYPERLINKS

>▪< FURTHER KNOWLEDGE

>|< COMPARE

<∞> REFERENCES

<?> QUESTIONS

/ Paediatric Radiology

CHAPTER OUTLINE:

Definitions

Differences between Children and Adults

Indications, Strengths and Weaknesses of Imaging Techniques

Radiation Protection in Paediatric Imaging

Disorders in Children

Take-Home Messages

References

Test Your Knowledge

/ 儿科放射学

章节大纲：

定义

儿童和成人之间的差异

影像学检查技术的适应证、优势和劣势

儿科影像学检查的辐射防护

儿童疾病

核心要点

参考文献

知识测试

/ 导示

<▪> 核心知识

<!> 注意

<↑> 超链接

>▪< 进阶知识

>|< 比较

<∞> 参考文献

<?> 问题

MODERN RADIOLOGY eBook

Based on the ESR Curriculum for Radiological Education

Paediatric Radiology

AUTHORS

Chair and Editor: Maria Raissaki

Members: Ignasi Barber | Jean-François Chateil | Julian Jürgens | Rutger Nievelstein
Annie Paterson | Michael Paddock | William Ramsden | Andrea Rossi | Aurelio Secinaro
Susan Shelmerdine | Samuel Stafrace | Eilish Twomey

AFFILIATION

European Society of Paediatric Radiology (ESPR) Education Committee

office@espr.org

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

基于 ESR 课程的放射学教育

儿科放射学

作者

主席和编辑：Maria Raissaki

成员：Ignasi Barber | Jean-François Chateil | Julian Jürgens | Rutger Nievelstein | Annie Paterson | Michael Paddock | William Ramsden | Andrea Rossi | Aurelio Secinaro | Susan Shelmerdine | Samuel Stafrace | Eilish Twomey

所属机构

European Society of Paediatric Radiology (ESPR) Education Committee

office@espr.org

Chapter Outline

Definitions

- Paediatric Radiology
- Foetus, Neonate, Infant, Toddler, Child, Adolescent

Differences between Children and Adults

- Normal Paediatric Anatomy
- Effects of Ionising Radiation; Radiosensitivity of Children
- Paediatric-Friendly Environment
- Communication Skills and Attitudes

Indications, Strengths and Weaknesses of Imaging Techniques

- Conventional Radiography
- Ultrasonography (US)
- Fluoroscopy
- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Nuclear Medicine

Radiation Protection in Paediatric Imaging

Disorders in Children

- Brain, Spine & Neck
- Chest
- Abdominal
- Paediatric Tumours
- Musculoskeletal (MSK)
- Multisystem Conditions

Take-Home Messages

References

Test Your Knowledge

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

章节大纲

定义

- 儿科放射学
- 胎儿、新生儿、婴儿、幼儿、儿童和青少年

儿童和成人之间的差异

- 正常儿科解剖学
- 电离辐射的影响；儿童的辐射敏感性
- 儿童友好型环境
- 沟通技巧和态度

影像学检查技术的适应证、优势和劣势

- 常规 X 线摄影
- 超声检查 (US)
- X 线透视检查
- 计算机断层扫描 (CT)
- 磁共振成像 (MRI)
- 核医学

儿科影像学检查的辐射防护

儿童疾病

- 脑、脊柱和颈部
- 胸部
- 腹部
- 儿科肿瘤
- 骨骼肌肉 (MSK)
- 多系统疾病

核心要点

参考文献

知识测试

Definitions

Paediatric Radiology

CHAPTER OUTLINE:

定义

儿科放射学

章节大纲：

/ Paediatric Radiology

Paediatric Radiology is the **art** and the **science** of working with children, imaging children, choosing the most appropriate imaging modality to answer clinical questions depending on the situation, interpreting imaging findings related to growth, congenital or acquired abnormalities and finally, treating children using imaging-guided techniques.

Paediatric Radiologists are specialists who interpret such imaging, discuss with clinical colleagues and recommend the next steps in the child's care.

Paediatric Radiology is a **challenging**, and **exciting** radiological **subspecialty**, due to the wide range of imaging techniques, the different developmental stages of children from foetal life to adolescence, and the diversity and uniqueness of diseases that are encountered at this stage of life.

Paediatric Radiology can be extremely **rewarding** given the significant and appropriate solutions to daily medical inquiries which can be provided efficiently for vulnerable children and their families.

/ **Paediatric** Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 儿科放射学

儿科放射学是一门与儿童打交道、对儿童进行影像学检查、根据具体情况选择最合适的影像学检查方式来解答临床问题、解读与生长、先天性或后天性异常相关的影像学检查结果，并最终利用影像引导技术对儿童进行治疗的综合**艺术**与**科学**。

儿科放射科医生是负责解读影像学检查结果，与临床医生进行讨论，并就患儿的下一步治疗提出建议的专业人员。

儿科放射学是一门极具**挑战性且令人兴奋**的放射学**分支学科**，原因在于其广泛的影像学技术、儿童从胎儿时期到青春期不同的发育阶段，以及在此阶段所发生疾病的多样性和独特性。

儿科放射学可以为患病儿童及其家庭有效提供关于日常医疗问题的切实可行的解决方案，因此是一项极有**价值**的工作。

/ Definitions

FOETUS

- A foetus (related to the Latin 'offspring' or 'bring forth', and the Greek 'to plant') refers to the developing young in the uterus, specifically the unborn offspring in the postembryonic period from the third month (11th week) after fertilisation until birth.
- The 'full term' gestational period in humans ranges from 37 to 42 weeks.

NEONATE

- A neonate (literally from the Latin, 'newborn') is a newly born human in their first 28 days of life.
- A term neonate is one who is born at over 37 weeks of gestation; a premature neonate is one who is born before 37 weeks of gestation; a post-dates or post-term neonate is one who is born after 42 weeks of gestation.

INFANT

- An infant (from the Latin infans, meaning 'unable to speak' or 'speechless') generally refers to a young child from the age of 1 to 12 months.
- Baby, a more informal term meaning very young offspring, may be used by parents/caregivers.

TODDLER

- The term toddler is used for those who are walking unsteadily or 'toddling' from the age of 12 to 36 months, including those who are newly ambulant to those with more developed gross motor skills.

CHILD

- Childhood is the period of life from the developmental stage of infancy to puberty.
- After toddler, the terms young and older child can be used; a 'school-aged child' is usually one from the age of 5 years onwards.
- Legally, child refers to an individual who has not reached the 'age of majority'.

ADOLESCENT

- A young person who has undergone puberty but who has not yet reached full 'adult' maturity (from the Latin, adolescere, meaning 'to grow up').

CHAPTER OUTLINE:

/ 定义

章节大纲：

胎儿

- 胎儿（与拉丁语“offspring [后代]”或“bring forth [生育]”和希腊语“to plant [种植]”有关）是指子宫内正在发育的幼体，具体指从受精后第三个月（第 11 周）到出生为止的胚胎后期这一时间段内，尚未出生的后代。
- 人类的“足月”妊娠期为 37～42 周。

新生儿

- 新生儿（字面意思来自拉丁语“new-born [新生]”）是指出生 28 天内的婴儿。
- 足月新生儿是指妊娠期超过 37 周的新生儿；早产儿是指妊娠期不足 37 周的新生儿；过期产儿是指妊娠期超过 42 周的新生儿。

婴儿

- 婴儿（来自拉丁语 infans，意思是“不能说话”或“说不出话”）通常指年龄在 1～12 个月的幼儿。
- “宝宝”是一个较为通俗的称呼，指的是非常年幼的子女，常由父母或照顾者使用。

幼儿

- 幼儿是指 12～36 个月大、走路不稳、蹒跚学步的儿童，包括刚学会走路的儿童和大运动技能发展较好的儿童。

儿童

- 儿童期是从婴儿期发育阶段到青春期这一段时期。
- 在幼儿期后，可以使用术语低龄儿童和大龄儿童；“学龄儿童”通常是指 5 岁及以上的儿童。
- 从法律上讲，儿童是指尚未达到“成年年龄”的个体。

青少年

- 已进入青春期但尚未完全达到“成人”成熟状态的年轻人（源自拉丁语“adolescere”，意为“长大”）。

Differences between Children and Adults

Paediatric Radiology

CHAPTER OUTLINE:

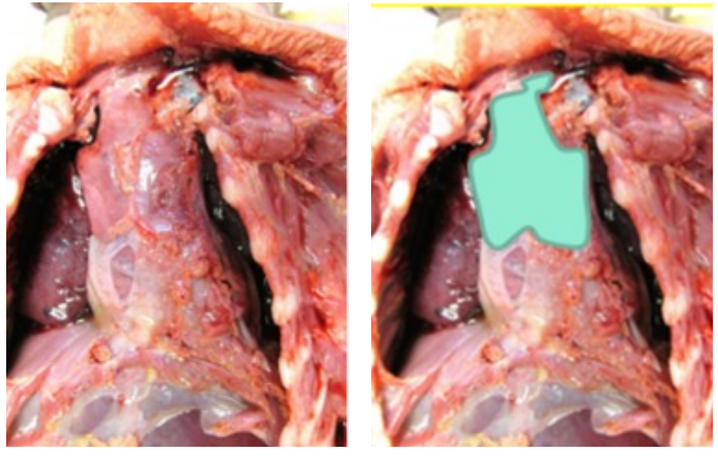
儿科放射学

章节大纲：

儿童和成人之间的差异

/ Normal Paediatric Anatomy – **Chest Radiographs**

The **thymus gland** is prominent in **infants**. It has variable size and shape, sharp contour and causes anterior mediastinal widening. It is soft and its contour is indented by the ribs and often has a 'wavy' appearance (arrows in A). It may extend to the minor fissure exhibiting the "sail" sign (arrow in B), overlie the heart and can mimic a mediastinal mass or cardiomegaly. It never displaces or compresses adjacent structures. If in doubt, ultrasound can demonstrate the "starry sky" pattern of the thymus (arrow in image C).



The thymus gland can be seen in the anterior mediastinum (overlaid in green on the right-sided image). Image courtesy of A. Patterson, MD, Royal Belfast Hospital for Sick Children, UK

/ Paediatric Radiology

CHAPTER OUTLINE:

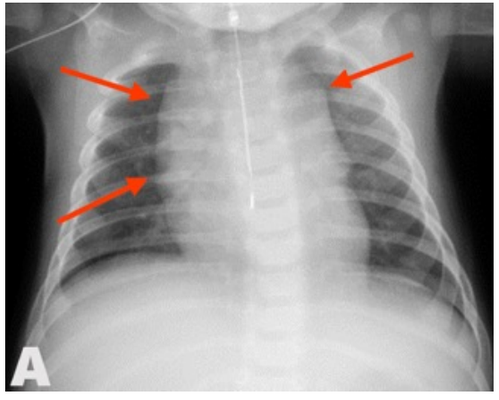
/ 正常儿科解剖学 - **胸片**

婴儿的**胸腺**很明显。大小形状不一，轮廓清晰，导致前纵隔增宽。胸腺较软，轮廓被肋骨压陷，通常呈“波浪状”外观（A 中的箭头）。可能会延伸至小裂隙，呈“帆”征（B 中的箭头），覆盖心脏，可能与纵隔肿块或心脏扩大类似。不会移位或压迫邻近结构。如果存疑，超声检查可显示胸腺呈“星空”状（图像 C 中的箭头）。

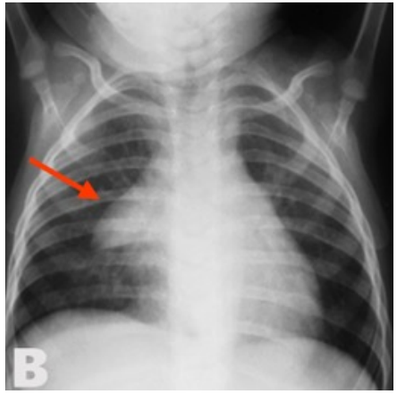
/ 儿科放射学

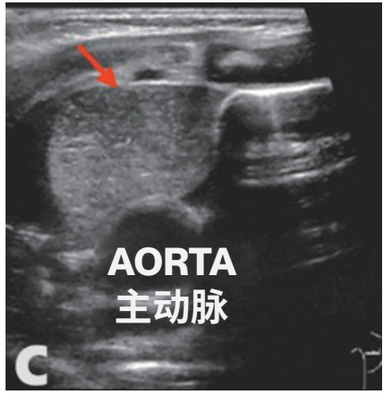
章节大纲：

在前纵隔中可见胸腺（右侧图像中的绿色阴影）。图像由 A.Patterson（MD，英国皇家贝尔法斯特儿童医院）提供



The **transverse diameter of the heart** in young infants may measure up to 60% of the transverse thoracic diameter, compared to 50% in older children and adults. Note too, how **the ribs** on these conventional radiographs lie more horizontally compared to those of older children. Given that the transverse diameter of the barrel-shaped paediatric chest is wider than the anteroposterior diameter, and abnormalities are mostly seen on AP radiographers, lateral chest radiographs are rarely performed in children.





/ Paediatric Radiology

CHAPTER OUTLINE:

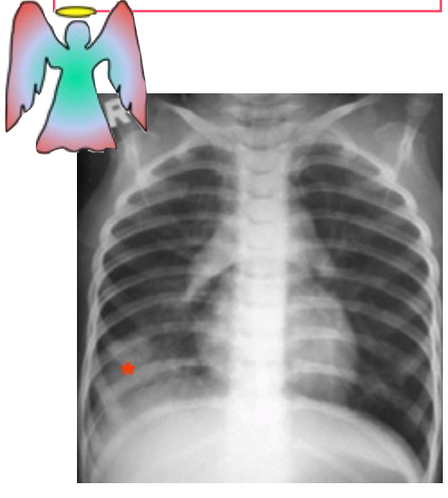
/ 儿科放射学

章节大纲：

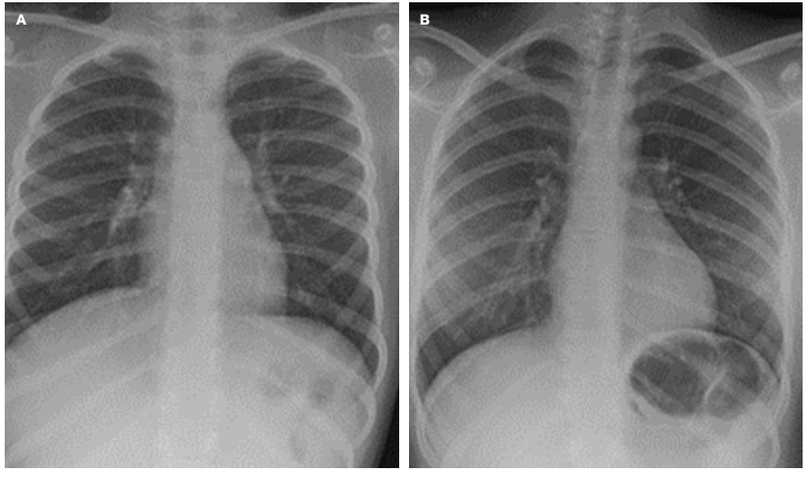
小婴儿的**心脏横径**可达到胸廓横径的 60%，而大龄儿童和成人仅为 50%。还要注意的是，这些常规胸片上的**肋骨**与大龄儿童的肋骨相比更加呈水平状。鉴于儿童胸部呈桶状，其横径大于前后径，而异常情况大多出现在前后位 (AP) 胸片上，所以很少对儿童进行侧位胸片检查。

<!> ATTENTION

The thymus grows throughout childhood reaching maximal volume in adolescence. It then involutes during adulthood. The gland regresses in unwell neonates and it may not be visible on chest radiographs.



Pneumomediastinum following blunt chest trauma. The two lobes of the thymus are elevated and outlined by air (and thus easy to visualise) - this is known as the 'Angel Wing' sign. Also note the opacity at right lung base (*) which in this context is consistent with lung contusion.



6-year-old (**A**) and 13-year-old (**B**). The thymus is present but proportionately smaller when compared to younger children and consequently is no longer visible. Note the developing breast shadows in the adolescent patient (densities over lower chest).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科 放射学

章节大纲：

<!> 注意

胸腺在整个儿童期都在生长，到青春期达到最大体积。之后在成年期逐渐萎缩。不健康的新生儿的腺体会退化，胸片上可能看不到。

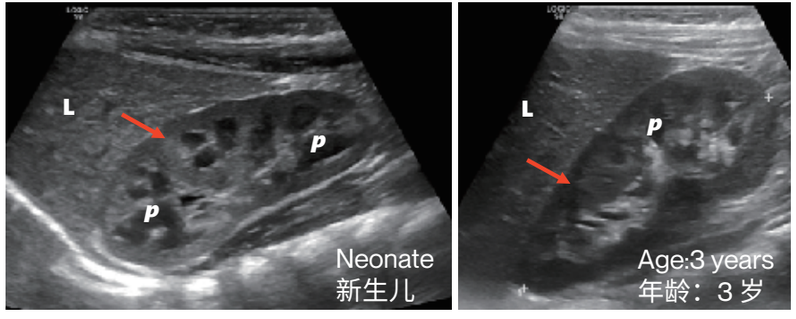
钝性胸部创伤后纵隔气肿。胸腺的两叶隆起并被空气勾勒出轮廓（因此很容易观察到）- 这被称为“天使翼”征。还应注意右肺底的阴影 (*)，在该情况下与肺挫伤相符。

6 岁 (**A**) 和 13 岁 (**B**)。胸腺存在，但与低龄儿童相比成比例缩小，因此不再可见。注意青少年患者正在发育的乳房阴影（下胸部的致密影）。

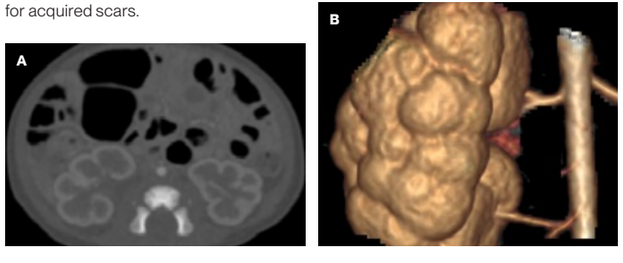
/ Normal Paediatric Anatomy – **Kidneys**

Ultrasonography in children can be extremely rewarding and may reveal details in anatomy due to the smaller patient size and lack of fat.

In neonatal kidneys, the cortex may appear equally echogenic ("bright") compared to the liver, making pyramids prominent and less echoic (black): these should not be mistaken for cysts or dilatation. Persistent fetal lobulation is normal in neonates.



Compare the appearances of a neonatal and paediatric kidney to the liver (L). The renal cortex (arrows) is more echogenic in the neonatal kidney and pyramids (P) stand out.



Incidental foetal lobulation, here seen on axial CT (A) and 3D reconstruction from CT images (B) should not be mistaken for acquired scars.

<!> ATTENTION

Knowledge of normal values and morphological features during development is important to appreciate normality from pathology.

<↑> HYPERLINK

The Radiology Assistant : Normal Values in Pediatric Ultrasound

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 正常儿科解剖学 – **肾脏**

对于儿童患者而言，超声检查往往能带来极好的效果，由于儿童体型较小且体内脂肪较少，超声检查能够更清晰地显示其解剖结构。

在新生儿肾脏中，皮质的回声强度可能与肝脏相等（“明亮”），使锥体突出且回声较弱（黑色）：不可将这些误认为囊肿或扩张。新生儿保持胚胎期分叶状肾是正常现象。

比较新生儿和儿童肾脏与肝脏 (L) 的外观。新生儿肾脏的肾皮质（箭头）回声更强，锥体 (P) 突出。

偶然性胚胎期分叶，如轴位 CT 图像 (A) 和 CT 图像的三维重建图 (B) 中所见，不应被误认为是后天性疤痕。

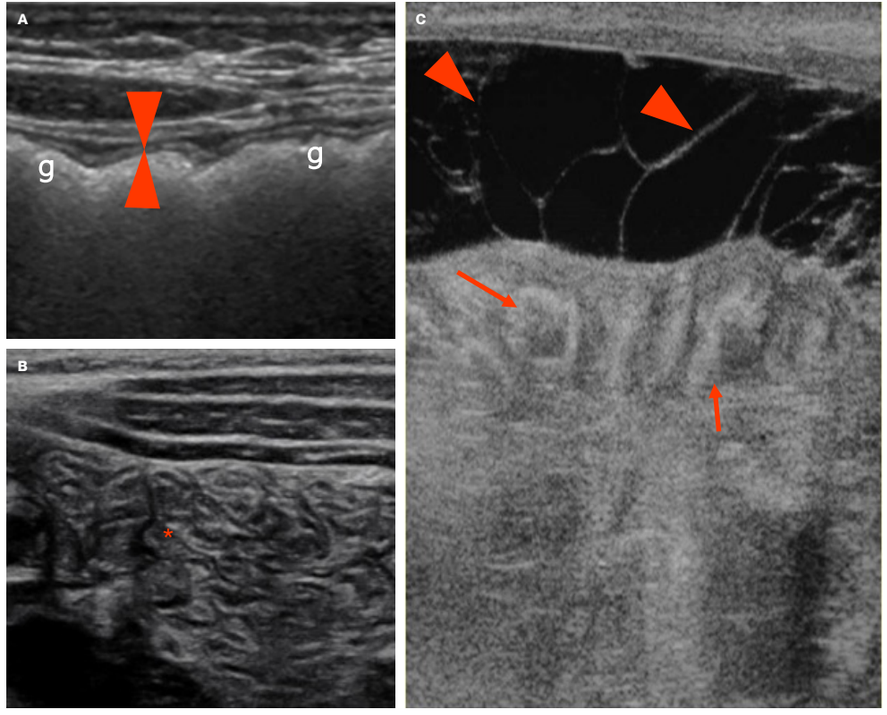
<!> 注意

了解发育过程中的正常值和形态特征对于从病理学角度认识正常状态非常重要。

<↑> 超链接

The Radiology Assistant : Normal Values in Pediatric Ultrasound

At ultrasonography, the bowel wall is clearly visible with the 5-layered pattern called "the gut signature".



A. Normal colonic wall is visualised as alternating white and black lines (between arrowheads) forming curves. Intraluminal gas (g) casts an artefactual echogenicity with "dirty" shadowing. **B**. US appearances of normal collapsed small bowel loops (*) known as the mucus pattern. **C**. US image of a neonate with perforated necrotizing enterocolitis. Fluid with fibrin strands (arrowheads) should not be mistaken as bowel. Collapsed bowel exhibits the "gut signature" and echogenic mucosa (arrows).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

在超声检查中，肠壁上清晰可见被称为“肠道特征”的 5 层纹路。

章节大纲：

A. 正常结肠壁显示为白色和黑色交替线条（箭头之间），形成曲线状。管腔内气体 (g) 会产生“脏”阴影的伪回声。**B**. 正常小肠袢塌陷的 US 表现 (*)，称为粘液型。**C**. 穿孔性坏死性小肠结肠炎新生儿的 US 图像。不可将含纤维蛋白丝的液体（三角箭头）误认为肠。肠塌陷表现为“肠道特征”和强回声黏膜（箭头）。

/ Normal Paediatric Anatomy – **Paediatric Brain**

Brain Imaging in Children: Indications

/ Brain imaging in children depends on age and clinical indication:

  / In neonates, sonography (ultrasound) is mainly performed through the anterior fontanelle as the first imaging modality.

  / In older children and in emergency settings, CT is recommended, mainly for traumatic brain injuries and when MRI is unavailable for the exclusion of space occupying lesions.

  / Due to radiation exposure with CT and the increased sensitivity of MRI, MRI is the test of choice to depict brain abnormalities in most circumstances, when available.

Brain Imaging in Children: Anatomy

/ During foetal and neonatal development, the evolution of migration, sulcation and myelination can be appreciated with MRI.

/ In relation to myelin maturation, grey-white matter differentiation is progressively accentuated on CT in older children and on MRI appears inverted on T1-weighted (T1W) and T2-weighted (T2W) MRI sequences.

/ **Paediatric** Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 正常儿科解剖学 - **儿科大脑**

儿童脑部影像学检查：适应证

/ 儿童脑部影像学检查取决于年龄和临床适应证：

  / 新生儿超声检查（超声）主要通过前囟进行，是首选影像学检查方法。

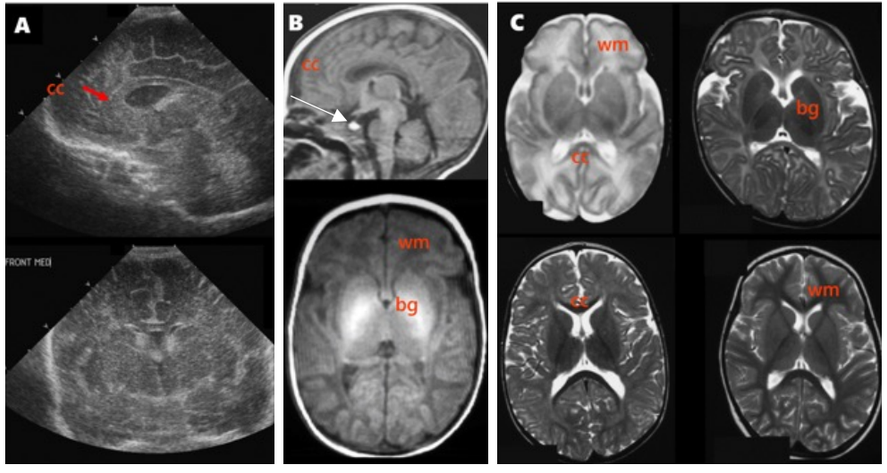
  / 对于大龄儿童和急诊情况，建议进行 CT 检查，主要用于创伤性脑损伤和无法通过 MRI 排除占位性病变的情况。

  / 由于 CT 存在辐射暴露风险且 MRI 的灵敏度更高，在大多数情况下，如果有条件，MRI 是描述脑部异常的首选检查。

儿童脑部影像学检查：解剖结构

/ 在胎儿和新生儿发育过程中，通过 MRI 可以观察到迁移、脑沟形成和髓鞘形成的演变。

/ 关于髓鞘的成熟情况，大龄儿童的 CT 上灰白质分化逐渐增强，MRI 上 T1 加权 (T1W) 和 T2 加权 (T2W) 序列上灰白质分化倒置。



A. Cranial sonography, sagittal (top) and coronal (bottom) views. Corpus callosum (cc).

B. T1W sagittal image (top) in a neonate demonstrating a hyperintense anterior pituitary gland (arrow), which does not occur in older children and adults. Axial (bottom) view in a 3-month-old infant showing unmyelinated white matter (wm) and hyperintense basal ganglia (bg).

C. T2W axial images in a premature neonate (top left), 5 months-old (top right), 10 months-old (bottom left) and 3 years-old (bottom right) showing progression of myelination.

>|< COMPARE

Compare the aspects of corpus callosum (cc) and white matter (wm), turning from hyperintense (unmyelinated) to hypointense (myelinated) on T2W images.

Also compare the relatively stable signal intensity of the grey matter within the cortex and basal ganglia (bg) with age, and the evolution of cortical folding from blunt in the premature brain, to complete in an older brain.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

>|< 比较

比较胼胝体 (cc) 和白质 (wm) 的变化，即从高信号（无髓鞘）到 T2W 图像上低信号（髓鞘化）的变化。

同时比较皮质和基底节 (bg) 内灰质的信号强度随年龄增长呈相对稳定，以及皮质褶皱从早产儿大脑的平滑状态发展至成熟大脑的完整状态的演变过程。

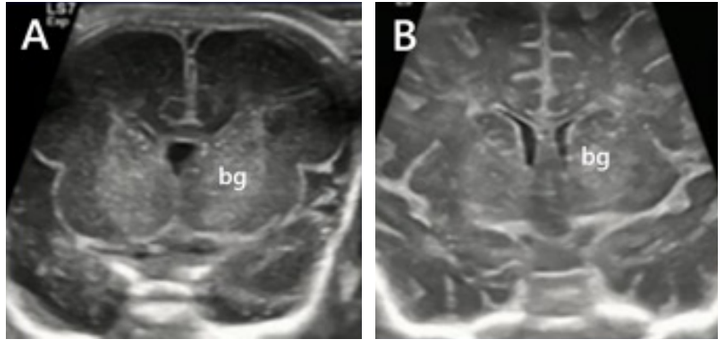
A. 头颅超声检查，矢状位（上图）和冠状位（下图）切面视图。胼胝体 (cc)。

B. 新生儿的 T1W 矢状位图像（上图），显示垂体前叶高信号（箭头），这种情况不会出现在大龄儿童和成人中。3 月龄婴儿的轴位（下图）视图，显示无髓鞘白质 (wm) 和高信号基底节 (bg)。

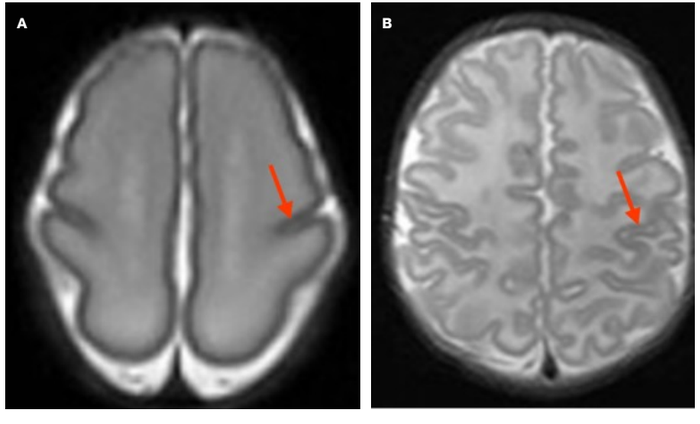
C. 早产儿（左上）、5 月龄婴儿（右上）、10 月龄婴儿（左下）和 3 岁幼儿（右下）的 T2W 轴位图像，显示髓鞘形成的进程。

Evolution of Sulcation

Sulci appear in a predictable fashion and can be appreciated on sonography and MRI. Awareness of normal appearances for age is important to enable differentiation from pathology/abnormality (examples below).



Normal cranial ultrasound examinations, coronal views. A 26-week gestational age premature neonate (**A**) and a 40-week gestational age term neonate (**B**). The simplified gyral pattern and the echogenic basal ganglia (bg) are normal only in A.



MRI, T2W sequences, axial views in two different neonates. In the 26-week gestational age neonatal (**A**), there is a normal simplified gyral pattern with a prominent central sulcus (arrow) and shallow remaining sulci. In the term 40-week neonate (**B**), the central sulcus (arrow) and all other sulci have now developed and a simplified gyral pattern.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

脑沟形成的演变

脑沟的出现形式可预测，可通过超声和 MRI 观察到。了解不同年龄段的正常表现对于区分病理/异常情况非常重要（示例如下）。

正常头颅超声检查，冠状位视图。胎龄 26 周的早产新生儿 (**A**) 和胎龄 40 周的足月新生儿 (**B**)。仅图像 A 的简化脑回模式和基底节回声 (bg) 正常。

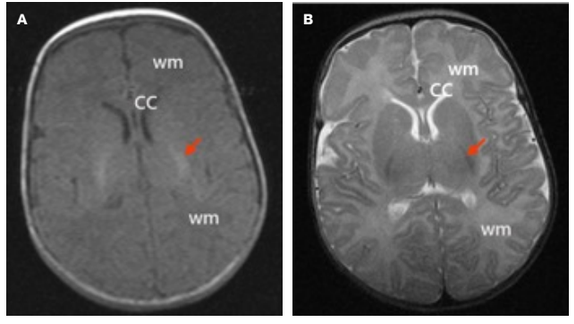
两种不同新生儿的 MRI，T2W 序列、轴位视图。胎龄 26 周的新生儿 (**A**) 显示简化脑回模式正常，中央沟（箭头）突出，其余沟较浅。足月 40 周新生儿 (**B**) 的中央沟（箭头）和所有其他沟现在已发育，形成简化脑回模式。

Evolution of Myelination

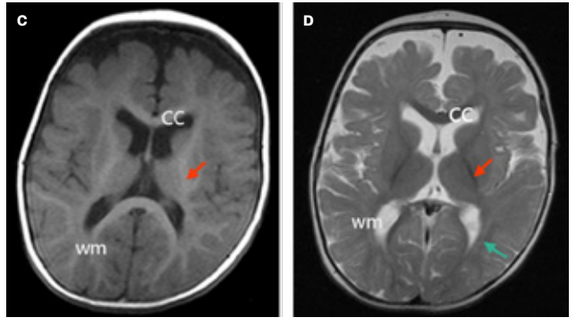
Myelin is a lipid-rich glycoprotein that wraps around oligodendrocytes eliminating water (hydrophobic). Thus, it appears hyperintense on T1W (A, C) and hypointense on T2W (B, D) sequences.

>|< COMPARE >=< FURTHER KNOWLEDGE

Compare the myelinated white matter at the posterior limbs of the internal capsules (PLIC), corpus callosum (CC) and periventricular white matter (wm) on T1W and T2W sequences between the neonatal and the 11-month-old brain. Myelinated wm in the new-born is visible mostly in the PLIC (**orange arrows**). At age 11 months, it is seen around the ventricles and in the subcortical white matter, reaching the adult pattern on T1W sequence and exhibiting spared areas around the trigones (**green arrow**) on T2W sequence.



Term neonate (40 weeks gestational age), T1W (left), T2W (right)



Age 11 months

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

髓鞘形成的演变

髓鞘是一种富含脂质的糖蛋白，它会包裹在少突胶质细胞周围，从而消除水分（即具有疏水性）。因此，其在 T1W（A、C）序列上表现为高信号，在 T2W（B、D）序列上表现为低信号。

>|< 比较 >=< 进阶知识

比较新生儿和 11 月龄大脑在 T1W 和 T2W 序列上内囊后肢 (PLIC)、胼胝体 (CC) 和脑室周围白质 (wm) 的髓鞘化白质。新生儿的髓鞘化 wm 主要见于 PLIC（**橙色箭头**）。11 月龄时，脑室周围和皮质下白质中可见髓鞘化白质，在 T1W 序列中达到成人模式，在 T2W 序列中表现为三角区周围存在缺损区域（**绿色箭头**）。

足月新生儿（胎龄 40 周），T1W（左），T2W（右）

11 月龄

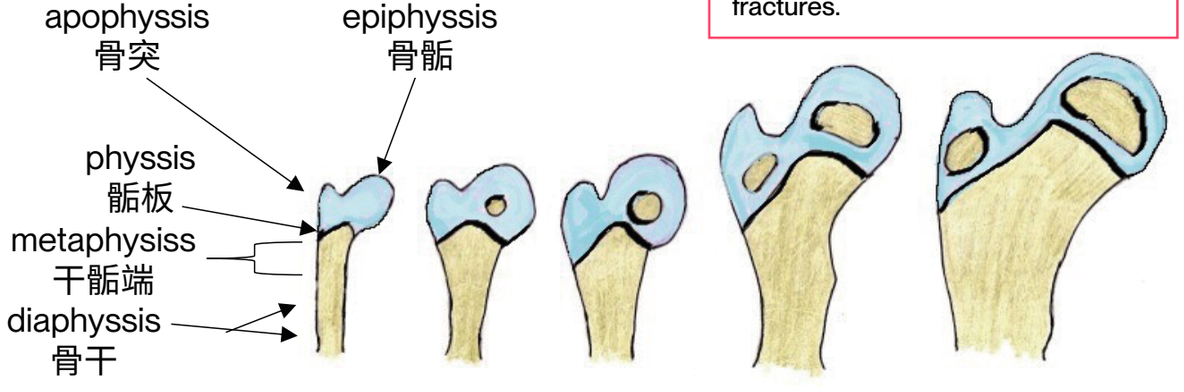
/ Normal Paediatric Anatomy – **Bones**

- As children grow and develop, their bones undergo changes that are seen on imaging.
- An understanding of this helps us to understand what is normal and abnormal.
- Growth plates (called physes) at the ends of long bones start to 'fuse' with age (see hand radiographs on next page).
- Cartilage around the joints is initially more than bone but reduces in volume (see also knee MRI on next slide).

<!> ATTENTION

Epiphyses are completely cartilaginous at birth and become gradually ossified. Ossification centers at epiphyses gradually enlarge as children grow.

Ossification centers at apophyses, where a muscle or tendon attaches, are separated by cartilage from the remaining bone during childhood, which makes them prone to avulsion fractures.



/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 正常儿童解剖学 - **骨骼**

- 随着儿童的成长和发育，他们的骨骼会发生变化，这些变化通过影像学检查都能看到。
- 了解这一点有助于我们理解什么是正常，什么是异常。
- 随着年龄的增长，长骨末端的生长板（称为骺板）开始“融合”（见下一页的手部 X 线片）。
- 关节周围的软骨最初比骨骼多，但体积会缩小（另见下一张幻灯片中的膝关节 MRI）。

<!> 注意

骨骺在出生时是完全软骨化的，之后逐渐骨化。随着儿童成长，骨骺的骨化中心逐渐扩大。

骨化中心位于骨突（肌肉或肌腱附着处），在儿童期被软骨与剩余骨分开，因此容易发生撕脱性骨折。

3 years
3 岁

7 years
7 岁

10 years
10 岁

14 years
14 岁

< In these hand radiographs in children of different ages, carpal bones (red arrows) are seen at different ages, and the growth plates at the wrist (white arrows) become narrower, until the metaphyses and epiphyses fuse with increasing age and eventually are not visible.

1 year
1 岁

2.5 years
2.5 岁

7 years
7 岁

13 years
13 岁

< In these knee MRIs of different children at different ages, you can see the 'white area' representing cartilage becoming less prominent with increasing age.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

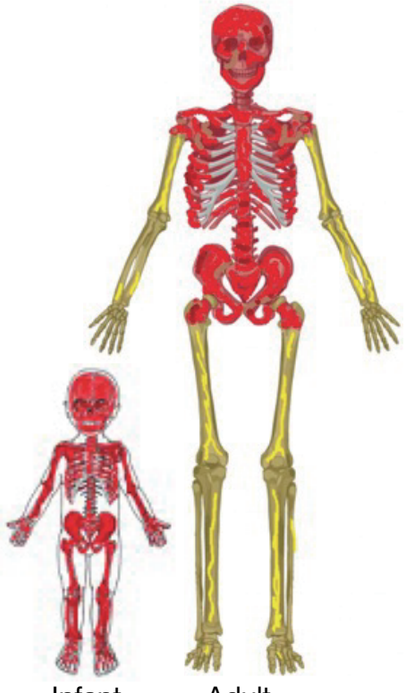
章节大纲：

< 在这些不同年龄儿童的手部 X 线片中，可以看到不同年龄段的腕骨（红色箭头），腕部的生长板（白色箭头）逐渐变窄，直到干骺端和骨骺随着年龄的增长而融合，最终不可见。

< 在这些不同年龄段儿童的膝关节 MRI 中，可以看到代表软骨的“白色区域”随着年龄的增长而变得不那么明显。

Normal Paediatric Anatomy – **Bone Marrow**

- Children are born with red marrow. As they grow, their bone marrow undergoes transition from red (containing mostly haematopoietic cells) to yellow (containing mostly adipocytes), until only few flat bones remain with red marrow.
- These changes occur in a predictable pattern in long bones from peripheral to central, from diaphysis to metaphysis and from central to endosteal, symmetrically on both sides.
- Red marrow distribution can be appreciated on MRI. On T1W sequences, fatty marrow is hyperintense and red marrow is relatively hypointense but never more hypointense compared to muscle in children older than 2 years.



Infant 婴儿　　Adult 成人

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

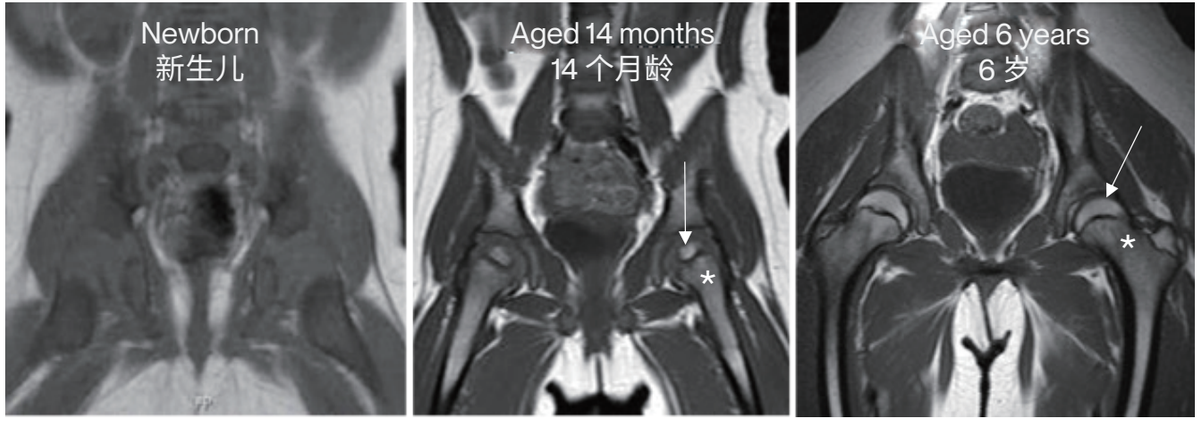
章节大纲：

正常儿童解剖学 - **骨髓**

- 儿童出生时为红骨髓。随着成长，他们的骨髓会从红色（主要包含造血细胞）转变为黄色（主要包含脂肪细胞），直到只有少数扁平骨保留红色骨髓。
- 这些变化在长骨中的发生模式可预测，从外周到中心，从骨干到干骺端，从中心到骨内膜，两侧对称。
- MRI 可显示红骨髓分布。在 T1W 序列上，脂肪骨髓呈高信号，红骨髓呈相对低信号，但对 2 岁以上的儿童，红骨髓的信号不会低于肌肉。

>|< COMPARE

Compare the bone marrow appearance of the pelvis and proximal femur on T1W sequences. In the new-born, the red marrow is extremely cellular and more hypointense than muscle. In older children, the red marrow predominates at the proximal femoral metaphyses (*) and exhibits higher signal intensity compared to cartilaginous discs and to muscle, due to progressive loss of cellularity. Epiphyses are fatty and hyperintense (arrows).



Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

>|< 比较

比较 T1W 序列上骨盆和股骨近端的骨髓表现。在新生儿中，红骨髓的细胞成分极为丰富，且其信号强度比肌肉要低。在大龄儿童中，红骨髓主要位于股骨近端干骺端 (*)，信号强度高于软骨盘和肌肉，因为细胞已逐渐丧失。骨骺脂肪多且呈高信号（箭头）。

/ Effects of Ionising Radiation

Stochastic (or Probabilistic) Effects

- Where the severity of the result is the same, but the probability of occurrence increases with radiation dose, e.g., development of cancer.
- **There is no threshold** for stochastic effects (all or nothing effect of ionizing radiation - **any** amount **may** cause an effect and is cumulative).
- Example: cancer.
- There is a small risk for stochastic effects following diagnostic procedures that involve radiation exposure making radiation protection measures mandatory.
- This risk is not individual but applies to a population.

Deterministic Effects

- Where the severity depends upon the radiation dose, e.g., skin burns.
- The higher the dose, the greater the effect.
- **There is a threshold** for deterministic (i.e., can be determined) effects which varies by individual.
- Examples: skin burns, cataract, infertility following irradiation of gonads.
- There is no risk for deterministic effects following diagnostic procedures that involve radiation exposure provided that radiation protection measures have been applied.

"Stochastic" comes from the Greek word "στόχος" which means aim or target.

Paediatric Radiology

RISK OF	STAFF	PATIENT
Death	x	x
Skin burn	x	x
Infertility	x	x
Cataract	x	x
Cancer	small	small

<!> ATTENTION

The effects of ionizing radiation are not a child-only issue. They apply to both children and adults; they are emphasized in this section due to the relatively increased radiosensitivity of children.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 电离辐射的影响

随机（或概率）效应

- 结果的严重程度相同，但发生概率随辐射剂量的增加而增加，例如癌症的发展。
- 随机效应**没有阈值**（电离辐射的影响是要么有，要么无 - **任何量的辐射都可能造成效应，并且是累积性的**）。
- 例如：癌症。
- 在涉及辐射暴露的诊断程序后，存在较小的随机效应风险，因此必须采取辐射防护措施。
- 这种风险并非针对个体，而是适用于群体。

确定性效应

- 严重程度取决于辐射剂量，例如，皮肤烧伤。
- 剂量越高，影响越大。
- 确定性（即可确定）效应有一个**阈值**，因人而异。
- 例如：皮肤烧伤、白内障、性腺照射后不育。
- 如果采取了辐射防护措施，则在涉及辐射暴露的诊断程序后不存在确定性效应风险。

“随机”一词源于希腊语“στόχος”，意为目的或目标。

儿科放射学

风险	工作人员	患者
死亡	x	x
皮肤烧伤	x	x
不育	x	x
白内障	x	x
癌症	较小	较小

<!> 注意

电离辐射的影响不是仅涉及儿童的问题。儿童和成人都会受到电离辐射的影响；由于儿童的辐射敏感性相对较高，本节予以着重介绍。

/ Radiosensitivity of Children

Children are more radiosensitive than a middle-aged adult by a factor of 2-5 to 10 due to:

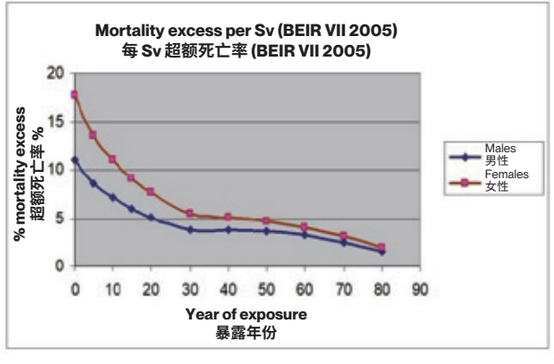
- Increased mitotic activity (more vulnerable tissue).
- Longer life expectancy (enough time to develop cancer).
- Radiation is cumulative (increased possibility of repeated tests).

Girls are considered more radiosensitive than boys.

Radiosensitivity is greater in younger children:

- Neonates are more radiosensitive than infants.
- Infants are more radiosensitive than children.
- Children are more radiosensitive than adolescents.
- Children are 2-3 times more susceptible to radiation in the development of leukaemia.

- Adults exposed to radiation during childhood have an increased probability of developing breast, thyroid and brain cancer, with a clear dose-response relationship for the development of both leukaemia and brain tumours: the risk increases with increasing cumulative radiation dose.
- Consequently, the overall benefit to an individual from the diagnostic capabilities of an indicated test should be much greater than the potential risk from the associated ionising radiation - the smallest radiation dose for size should be meticulously applied in children (see **ALARA** in later slides).



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Raissaki MT. Pediatric radiation protection. European Radiology Supplements March 2004 DOI: 10.1007/s10406-004-0011-7

Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. The Lancet 2012

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 儿童的辐射敏感性

儿童的辐射敏感性是中年人的 2～5 倍至 10 倍，原因如下：

- 有丝分裂活性增加（组织更脆弱）。
- 预期寿命更长（有足够时间患癌）。
- 辐射具有累积性（重复测试的可能性增加）。

女孩比男孩对辐射更敏感。

低龄儿童的**辐射敏感性**更高：

- 新生儿比婴儿对辐射更敏感。
- 婴儿比儿童对辐射更敏感。
- 儿童比青少年对辐射更敏感。
- 儿童受辐射影响而引发白血病的几率高达 2～3 倍。

- 儿童时期受到辐射的成年人患乳腺癌、甲状腺癌和脑癌的几率增加，且白血病和脑瘤的发病存在明显的剂量-反应关系：风险随着累积辐射剂量的增加而增加。
- 因此，个体从指定检查的诊断效能中获得的总体益处应远大于相关电离辐射的潜在风险 - 应谨慎确定用于儿童的最小辐射剂量（见后续幻灯片中的 **ALARA**）。

<∞> 参考文献

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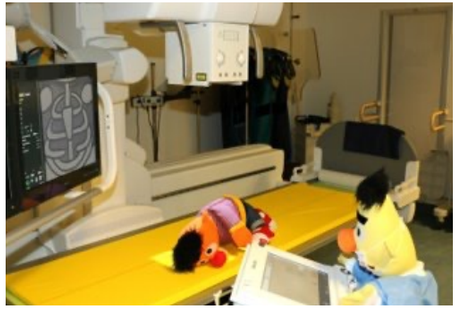
Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. The Lancet 2012

/ Paediatric-friendly Environment

Very young children or those with developmental delay may have difficulty understanding what is going to happen during a scan and they can be scared by large machinery. This means that they may struggle to sit still for their scan, leading to non-diagnostic image quality.

Distraction tactics (e.g., cartoons, songs, pictures on the wall), bribery tactics (e.g., with candies, stickers, certificates) can be helpful. In some hospitals a '**play therapist**' may be employed to help calm and settle patients. Sedation and anaesthesia do carry some small associated risks (e.g., drug allergy) and are performed only when necessary.



Demonstrating how an image will be taken using dolls and pictures helps children to understand what is going to be done in a less intimidating manner.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 儿童友好型环境

年幼的儿童或发育迟缓的儿童可能难以理解扫描过程，可能会被大型机器吓到。这意味着他们可能难以在扫描时保持安静不动，从而导致图像质量无法达到诊断标准。

分散注意力的策略（例如，播放动画片、唱儿歌、在墙上展示图片）和贿赂策略（例如，分发糖果、贴纸、证书）可能会有所帮助。有些医院可能会聘请“**游戏治疗师**”来帮助安抚患者。镇静和麻醉确实存在一些小的相关风险（例如药物过敏），仅在必要时进行。

使用玩偶和图片演示如何拍摄图像，可以帮助儿童更轻松地理解将要进行的操作。

Having colorful lights (arrows), cartoons on the wall, or on the side of the scanning machines help to create a calm and inviting environment.

A ceiling- mounted television (arrow) (or iPad/ Phone) with cartoons and toys in the department help distract nervous patients.

Images kindly provided by :S. Shelmerdine, GOSH Children's Hospital, London, and J. Jürgens, Pediatric UKE, Hamburg, DE

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

在墙上或扫描仪的侧面装饰彩色的灯（箭头）和卡通图案有助于营造一个安静、温馨的环境。

科室内安装悬挂式电视机（箭头）（或提供 iPad/手机）播放动画片并提供玩具，有助于分散紧张患者的注意力。

图片由 S.Shelmerdine（伦敦 GOSH 儿童医院）和 J. Jürgens（德国汉堡 Pediatric UKE）提供

Communication Skills and Attitudes

- Each child is not a single patient. Children come with parents/carers and a referring physician who may all be stressed about the urgency for imaging, the procedure and the results of imaging tests. Consequently, communication skills are paramount.
- Discussion of tests before and after imaging **between the referring physician and the radiologist** results in mutual decisions on whether to image, on the best imaging modality and is vital for appropriately tailoring the examination to each individual patient. The choice of imaging test may also be influenced by the patient's ability to cooperate. After an examination, prompt feedback from the radiologist on unexpected or urgent findings ensures proper and **safe** care.
- The **parent or carers'** understanding, cooperation and consent are vital for success. Parent and children's anxieties should be alleviated, and family should remain as relaxed, comfortable and reassured as possible, through proper information and a confident attitude by the radiologists and technicians (also known as radiographers/ sonographers).
- Communication with **the child** is modified depending on the child's age and abilities. Compromises are required. Protocols are tailored to deliver the relevant information using the shortest possible time and the lowest possible radiation dose. The most exciting part of the daily routine is turning a frightened child into a co-operative smiling patient.
- **The delivery of results** to patients and families by radiologists is a delicate matter and requires collaboration with referring physicians, a clear understanding of the results and their significance, appreciation of what the family already know of their child's condition, appreciation of the environment and support available to the child and family, appreciation of confidentiality issues in older children and adolescents, empathy and sensitivity.
- The paediatric radiologist carries an important and often pivotal role in **multidisciplinary meetings** where results are delivered, limitations and certainties are highlighted and therapeutic decisions can be made based on imaging findings.

"The paediatric radiologist has an intensely varied and stimulating role. Each day is different to the last and we are continually tested and stretched in terms of scientific knowledge, communication skills and time management. Energy, pragmatism, humility, empathy and a sense of humour are vital characteristics for this job, but if you have these and enjoy a challenge, the rewards are immense."

Kath Halliday, Consultant Paediatric Radiologist, Nottingham, UK

<∞> REFERENCE

Katharine Kalliday, What does a paediatric radiologist do? P 8-11, IDoR2015 Paediatric Imaging Book FINAL | PDF | Medical Imaging | Radiology (scribd.com)

Paediatric Radiology

CHAPTER OUTLINE:

沟通技巧和态度

- 每个患儿都并非独自就诊。通常会由父母/看护人和转诊医生陪同前来，面对影像学检查的紧迫性、程序和检查结果，他们可能都有压力。因此，沟通技巧至关重要。
- **转诊医生与放射科医生**就影像学检查前后的相关检查进行讨论，从而共同决定是否进行影像学检查、选择哪种检查方法最佳，这对于为每位患者量身定制恰当的检查方案至关重要。影像学检查的选择也可能受到患者配合度的影响。检查结束后，放射科医生会对意外或紧急检查结果及时反馈，以确保患者得到恰当且安全的治疗。
- 父母或看护人的理解、合作和同意对成功完成检查至关重要。放射科医生和技术人员（也称为放射技师/超声技师）应提供适当的信息并展现自信的态度，以减轻父母和儿童的焦虑，使家属尽可能保持轻松、舒适和放心。
- 应根据儿童的年龄和能力调整与儿童的沟通方式。需要作出妥协。定制检查方案，用尽可能最短的时间和最低的辐射剂量获得相关检查结果。日常工作中最令人愉悦的部分就是把一个惊恐的孩子变成一位愿意配合的微笑患者。
- 放射科医生向患者和家属提供检查结果是一件棘手的事情，需要与转诊医生合作，清楚地理解检查结果及其意义，了解家属对孩子病情的了解程度，了解孩子和家属所处的环境和可获得的支持，了解大龄儿童和青少年的病情保密问题，还需要同理心和感受性。
- 儿科放射科医生在**多学科会议**中发挥着重要且通常至关重要的作用，在会议上，放射科医生通常提供检查结果，强调检查的局限性和确定性，并根据检查结果做出治疗决策。

"儿科放射科医生的职责极其多样且令人振奋。每一天都带来新的挑战与体验，在科学知识、沟通技巧和时间管理能力上不断接受考验、挑战极限。活力、务实、谦逊、同理心与幽默感是这份工作的核心特质，如果你具备这些品质且热爱迎接挑战，回报将无比丰厚。"

Kath Halliday, Consultant Paediatric Radiologist, Nottingham, UK

儿科放射学

章节大纲：

<∞> 参考文献

Katharine Kalliday, What does a paediatric radiologist do? P 8-11, IDoR2015 Paediatric Imaging Book FINAL | PDF | Medical Imaging | Radiology (scribd.com)

Indications, Strengths and Weaknesses of Imaging Techniques

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

影像学检查技术的适应证、优势和劣势

/ Conventional Radiographs (CXR)

>|< COMPARE

INDICATIONS:

/ Initial examination of chest, abdomen and bones.

/ Particularly important in skeletal trauma (accidental and inflicted injury), infection, dysplasia.

/ A mainstay of paediatric practice.

ADVANTAGES:

+ Widely available, inexpensive.

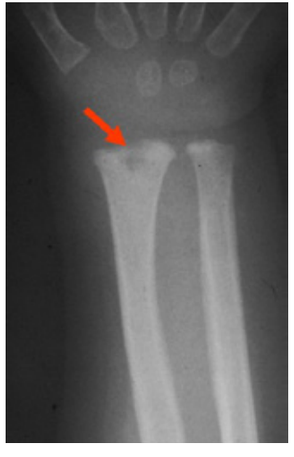
+ Often the 'starter' (first line modality) for other tests.

DISADVANTAGES:

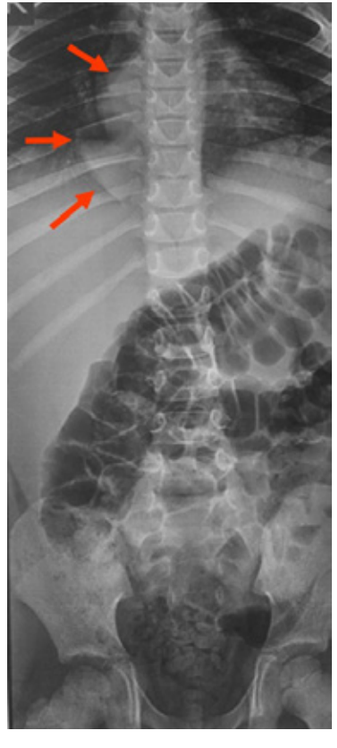
– Limited demonstration of soft tissue.

– Less detail than CT.

– Exposes the patient to ionising radiation.



Radiograph of the hand in a child with fever, local pain and tenderness. There is a lytic focus (arrow) at the metaphysis, a typical location of hematogenous spread of infection in children.



AP radiograph of the spine in a child with low back pain obtained to look for spondylolysis. A posterior mediastinal mass (arrows) was identified. Subsequent MRI confirmed metastatic neuroblastoma.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 常规 X 线片 (CXR)

>|< 比较

适应证：

/ 胸部、腹部和骨骼的初步检查。

/ 对骨骼创伤（意外伤害和故意伤害）、感染、发育不良的诊断尤为重要。

/ 是儿科诊疗的主要技术手段。

优点：

+ 广泛普及、价格低廉。

+ 通常是其他检查的“起始”（一线检查方法）。

缺点：

– 软组织显示有限。

– 没有 CT 详细。

– 患者暴露于电离辐射。

发热、局部疼痛和压痛患儿的手部 X 线片。干骺端有一个溶骨性病灶（箭头），这是儿童感染血行播散的典型部位。

腰背痛患儿的脊柱前后位 X 线片，为检查椎弓峡部裂。发现后纵隔肿块（箭头）。后续 MRI 证实为转移性神经母细胞瘤。

/ Ultrasonography (US)

>|< COMPARE

INDICATIONS:

- / Foetal pathology.
- / Neonatal brain and spinal cord.
- / Palpable lumps including neck lesions.
- / Suspected abnormalities of lungs.
- / Suspected abdominal anomalies including pelvis and bowel.
- / Musculoskeletal system abnormalities including neonatal hips.
- / Vascular anomalies – Doppler applications.
- / Guidance for interventional procedures.

ADVANTAGES:

- \+ Efficient and the test of choice for many indications.
- \+ Readily available, inexpensive.
- \+ Can deliver exquisite detail in children.
- \+ Can appreciate movement, e.g., bowel peristalsis.
- \+ Portable.
- \+ No ionising radiation.
- \+ Potential of advanced applications (power doppler, elastography, contrast-enhanced US & voiding US.

DISADVANTAGES:

- – Can be challenging in non-cooperative children.
- – Deep structures may be obscured by bowel gas.
- – Less easy to standardise, requires training, skill and experience.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 超声检查 (US)

>|< 比较

适应证：

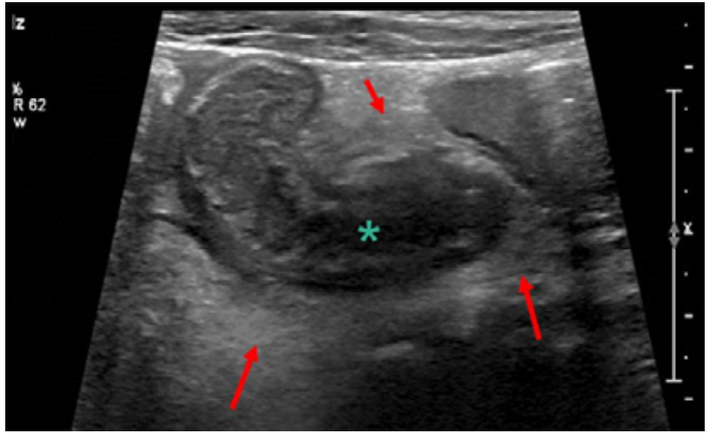
- / 胎儿病理学。
- / 新生儿大脑和脊髓。
- / 可触及肿块，包括颈部病变。
- / 疑似肺部异常。
- / 疑似腹部异常，包括骨盆和肠道。
- / 骨骼肌肉系统异常，包括新生儿髋关节。
- / 血管病变 - 多普勒应用。
- / 介入治疗指南。

优点：

- \+ 高效并且是多种适应证的首选检查方法。
- \+ 容易使用，价格低廉。
- \+ 可以显示精确的儿童身体细节。
- \+ 能识别运动，如肠蠕动。
- \+ 设备便携。
- \+ 无电离辐射。
- \+ 具有先进的应用潜力（能量多普勒、弹性成像、对比增强 US 和排尿 US）。

缺点：

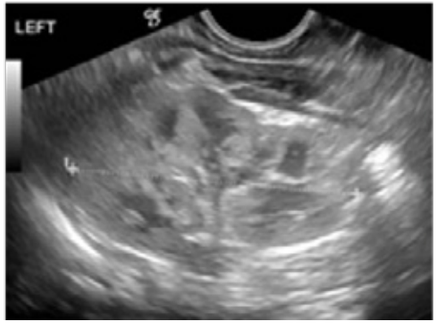
- – 不配合的儿童可能检查难度大。
- – 深部结构可能被肠道气体所掩盖。
- – 不太容易标准化，需要培训、技能和经验。

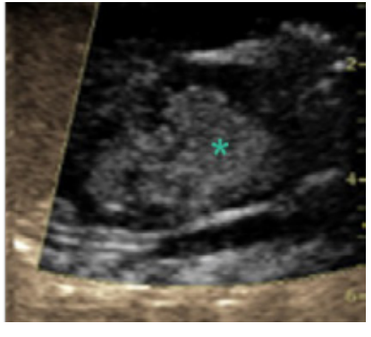


Appendicitis – swollen non-compressible appendix with a dilated lumen (*) surrounded by oedematous echogenic fat (arrows).

>|< COMPARE

Reflux nephropathy. The right kidney is smaller compared to the left with loss of corticomedullary differentiation. Contrast-enhanced voiding ultrasonography (VUS, third image) following instillation of echogenic microbubbles into the bladder via a nasogastric tube shows an echogenic dilated pelvis (*) indicating gross reflux.





/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

>|< 比较

阑尾炎 - 阑尾肿胀，无法压迫，管腔扩张 (*)，周围有水肿的强回声脂肪（箭头）。

反流性肾病。右肾较左肾小，皮髓质分界消失。通过鼻胃管将强回声微泡滴入膀胱后的对比增强排尿超声检查（VUS，第三张图像）显示强回声扩张肾盂 (*)，表明存在严重反流。

/ Fluoroscopy

>|< COMPARE

INDICATIONS:

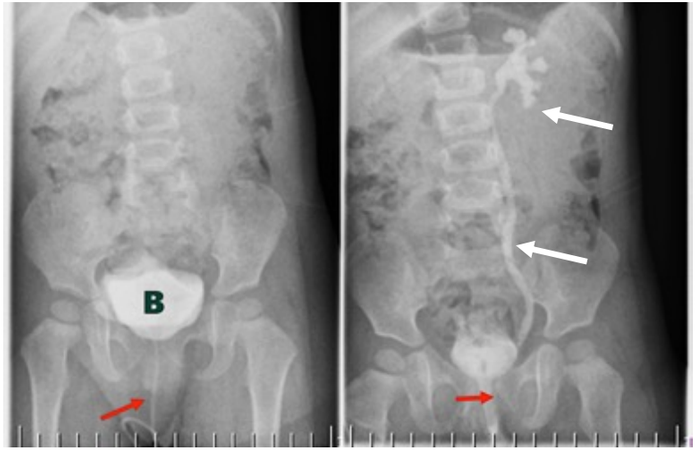
- / Acute neonatal conditions manifesting as (bilious) vomiting and failure to pass meconium.
- / Real-time contrast examinations of the gastro-intestinal (GI) tract, for example GI stenoses.
- / Real time contrast examinations of the urinary tract, for example voiding cystourethrography, including critical diagnoses such as posterior urethral valves (PUV).

ADVANTAGES:

- \+ Widely available.
- \+ Classic features in some acute/ critical diagnoses.
- \+ Useful post operatively, e.g., leaking viscus.
- \+ Can be used therapeutically, e.g., meconium ileus.

DISADVANTAGES:

- – Operator dependent.
- – Exposes patient to ionising radiation.
- – No information on 'surrounding structures'.



Micturating cystourethrography (MCUG) in an 11-month-old female with previous febrile UTI. Freeze-frame digital fluoroscopic image of the abdomen during bladder filling (left image) shows contrast in the bladder (B) and the catheter used for contrast infusion (arrow). During voiding (right image), left-sided vesicoureteric reflux (VUR, white arrows) is demonstrated. Note the normally short female urethra (arrow).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ X 线透视检查

>|< 比较

适应证：

- / 表现为（胆汁性）呕吐和胎粪无法排出的急性新生儿疾病。
- / 胃肠道 (GI) 的实时造影检查，例如，GI 狭窄。
- / 尿路实时造影检查，例如，排尿期膀胱尿道造影，包括后尿道瓣膜 (PUV) 等危急病症诊断。

优点：

- \+ 广泛普及。
- \+ 一些急性/危急病症诊断的典型特征。
- \+ 可用于术后，例如内脏渗漏。
- \+ 可用于治疗，例如胎粪性肠梗阻。

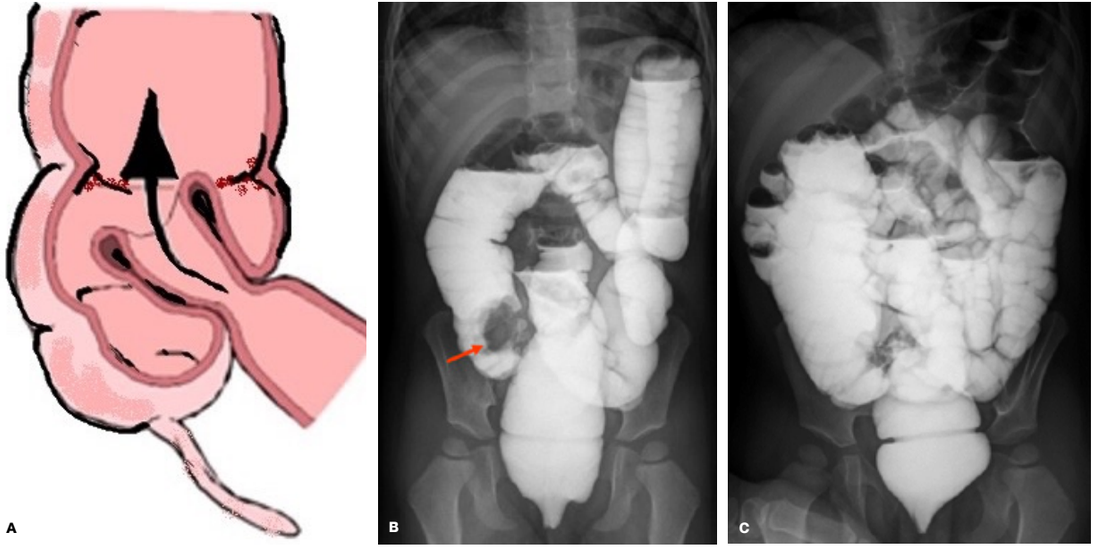
缺点：

- – 依赖操作者。
- – 患者暴露于电离辐射。
- – 无法提供“周围结构”的信息。

一例 11 月龄女童既往患发热性尿路感染 (urinary tract infection, UTI) 后的排尿性膀胱尿道造影 (Micturating cystourethrography, MCUG)。膀胱充盈时腹部的定格数字透视图像（左图）显示膀胱中的对比剂 (B) 和用于输注对比剂的导管（箭头）。排尿期间（右图），显示左侧膀胱输尿管反流（vesicoureteric reflux [VUR]，白色箭头）。注意女性尿道（箭头），正常较短。

/ Fluoroscopy – Guided Intussusception Reduction

>|< COMPARE



Intussusception is the telescoping of bowel into adjacent bowel with resulting compression of trapped mesenteric vessels and ischaemia of the telescoped bowel, if not reduced in a timely fashion. Most cases are ileocolic (A). Reduction of the intussusception under fluoroscopic guidance can be done using contrast enema (B and C) or air. The intussusception was diagnosed with US and is seen here (B) as a filling defect at the ileocecal valve area (arrow). Further administration of contrast resulted in reflux into the small bowel, a finding indicative of successful reduction (C). Intussusception reduction may be performed under ultrasonographic guidance using water or air enema in many European centres.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ X 线透视检查 – 引导肠套叠复位

>|< 比较

肠套叠是指肠管套入邻近肠管，如果不及时复位，会导致套入部分的肠系膜血管受压和套入肠管缺血。大多数病例为回结肠型肠套叠 (A)。可在荧光透视引导下通过对比剂灌肠（B 和 C）或空气灌肠来实现肠套叠复位。肠套叠经 US 诊断，如图所示 (B)，为回盲瓣区充盈缺损（箭头）。进一步给予对比剂后，小肠出现反流，提示成功复位 (C)。许多欧洲医疗中心可能会在超声引导下通过水或空气灌肠进行肠套叠复位。

/ Computed Tomography (CT)

>|< COMPARE

INDICATIONS:

/ Trauma and acute presentations in any area of the body.

/ Neurological, chest and cardiac disease.

/ Oncological diagnosis and staging when MRI are not available or when lung staging is necessary.

/ Detailed imaging of cortical bone.

ADVANTAGES:

+ Greater detail than radiographs, information separately for each plane.

+ Deep structures well visualised (compared to US).

+ Quick – reducing the need for sedation or anaesthesia.

+ Guidance for interventional procedures.

+ Multiplanar 'reproducible' images.

DISADVANTAGES:

– Radiation dose higher than radiography.

– Sedation occasionally needed.

– May require intravenous ionising contrast material which carries the risk of nephrotoxicity and allergic reaction.

– Less soft tissue contrast than MRI.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 计算机断层扫描 (CT)

>|< 比较

适应证：

/ 身体任何部位的创伤和急性病症。

/ 神经系统疾病、胸部疾病和心脏疾病。

/ 无法进行 MRI 或需要进行肺部分期时，用于肿瘤的诊断与分期。

/ 皮质骨的详细影像学检查。

优点：

+ 比 X 线片更详细，每个平面的信息单独提供。

+ 深部结构清晰可见（与 US 相比）。

+ 快速 - 减少镇静或麻醉需求。

+ 介入治疗指南。

+ 多平面“可再现”图像。

缺点：

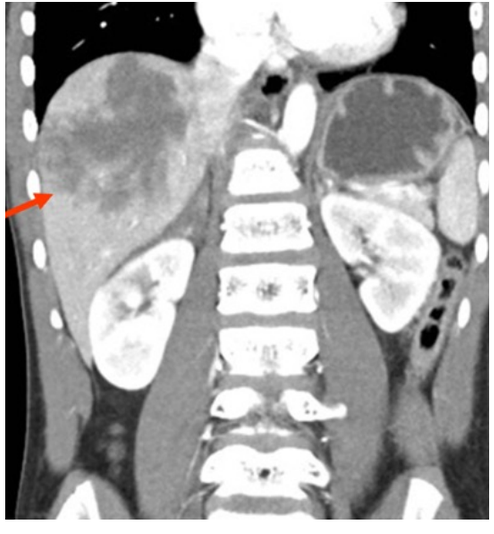
– 辐射剂量高于 X 线摄影。

– 有时需要镇静。

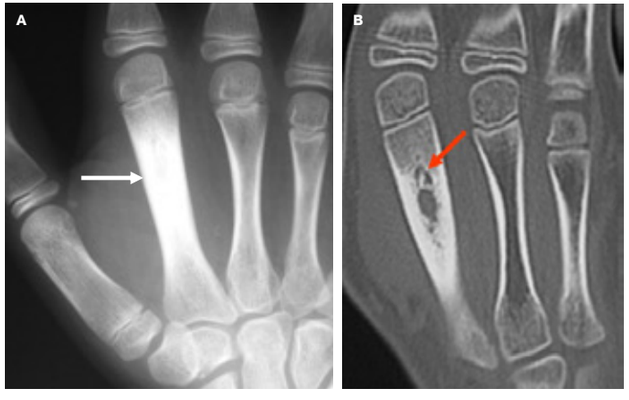
– 可能需要静脉注射具有肾毒性和过敏反应风险的电离对比剂。

– 软组织对比度低于 MRI。

/ Computed Tomography (CT) – Illustrative Examples



Post contrast CT (coronal plane) showing an extensive liver laceration as an area of diminished contrast enhancement (arrow).



>|< COMPARE

Compare the radiograph and the CT scan of an 11-year-old child with chronic pain and swelling of the hand. The radiograph (A) shows sclerosis and thickening of the left index finger metacarpal diaphysis (white arrow). CT scan, coronal reconstruction image (B) shows evidence of chronic osteomyelitis with cortical thickening, a contained cavity with a small sequestrum (which is a necrotic piece of bone, shown by the orange arrow).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 计算机断层扫描 (CT) - 示例说明

造影后 CT（冠状位）显示广泛肝裂伤，表现为对比增强减少的区域（箭头）。

>|< 比较

比较一例手部慢性疼痛和肿胀的 11 岁儿童的 X 线片和 CT 扫描结果。X 线片 (A) 显示左食指掌骨干硬化和增厚（白色箭头）。CT 扫描冠状位重建图像 (B) 显示慢性骨髓炎伴皮质增厚迹象，腔隙有限，内夹一小块死骨片（为坏死的骨块，橙色箭头所示）。

/ Magnetic Resonance Imaging (MRI)

>|< COMPARE

INDICATIONS:

/ The first line tool for all paediatric cross-sectional imaging, e.g., CNS, MSK, abdomen, pelvic, cardiac, vascular pathologies. Used for lung assessment as a second-line tool in some centres.

/ Antenatal imaging of the foetus in selected cases.

ADVANTAGES:

+ Excellent soft tissue differentiation and detail, even without intravenous contrast administration.

+ No radiation. Good if multiple follow up examinations, e.g., oncology.

+ Very sensitive for early or subtle changes.

+ Provides unique information with different sequences and specialised techniques, e.g., diffusion weighted imaging (DWI), spectroscopy, perfusion studies, etc.

+ Multiplanar 'reproducible' images.

DISADVANTAGES:

– Less widely available.

– Young children usually require sedation or anaesthesia.

– Cannot be performed in operated children having implanted MR-non-compatible devices or in claustrophobic children.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 磁共振成像 (MRI)

>|< 比较

适应证：

/ 适用于所有儿科横断面成像的一线工具，如中枢神经系统 (central nervous system, CNS)、骨骼肌肉 (musculoskeletal, MSK)、腹部、骨盆、心脏、血管病变。在部分医疗中心用作肺部评估的二线工具。

/ 部分病例的胎儿产前影像学检查。

优点：

+ 即使不静脉注射对比剂，也能很好地分辨软组织和细节。

+ 无辐射。适用于多次随访检查，如肿瘤检查。

+ 对早期或细微变化非常敏感。

+ 通过不同序列和专业技术提供独特信息，例如，扩散加权成像 (DWI)、波谱分析、灌注检查等。

+ 多平面“可再现”图像。

缺点：

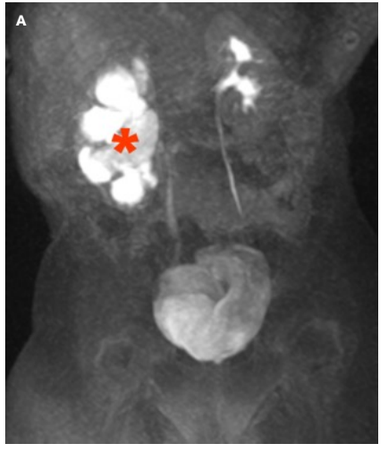
– 普及性不高。

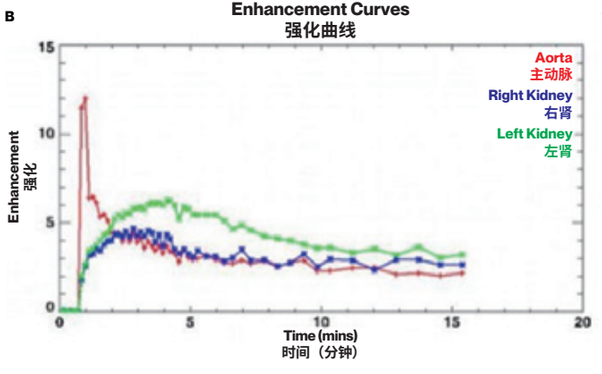
– 低龄儿童通常需要镇静或麻醉。

– 不能在植入磁共振不兼容设备的手术患儿或患有幽闭恐惧症的儿童中进行。

/ Magnetic Resonance Imaging (MRI) – Illustrative Examples

MR Urography, post-contrast T1W sequence, multiplanar reconstruction in the coronal plane (A), shows dilated right pelvicalyceal system (*). Following a perfusion study, image postprocessing (B) shows a descending right excretory curve, indicating dilatation without obstruction.





Foetal MRI, T2W sequence, coronal plane of a 28-week-old foetus. There is a huge, mostly cystic, pelvic and exophytic mass (arrows), indicative of a sacro-coccygeal teratoma.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 磁共振成像 (MRI) - 示例说明

MR 尿路造影，造影后 T1W 序列，冠状位多平面重建 (A)，显示右侧肾盂肾盏系统扩张 (*)。灌注检查后，图像后处理 (B) 显示右侧排泄曲线下降，表明扩张无梗阻。

28 周龄胎儿 MRI，T2W 序列、冠状位。显示盆腔和外生性巨大肿块（箭头），大部分为囊性，提示骶尾部畸胎瘤。

/ Nuclear Medicine

>|< COMPARE

INDICATIONS:

/ Functional studies of the urinary and GI tracts, skeletal and endocrine system.

/ Tumour staging, e.g., MIBG in neuroblastoma.

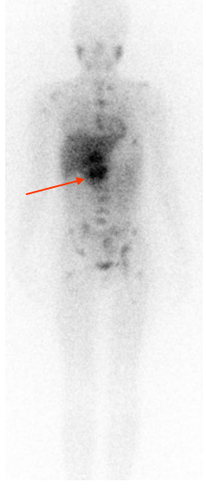
/ Investigation of pain (MSK) and occult fractures.

ADVANTAGES:

+ High Sensitivity.
+ Multiplanar potential, e.g., SPECT.
+ Functional information can be fused with anatomical studies – hybrid imaging (e.g., PET-CT).
+ No need for sedation for scintigraphy for most tests.

DISADVANTAGES:

– Specificity may be low.
– Lesser anatomical detail with non-hybrid techniques.
– Hybrid imaging not universally available.
– PET-CT technically challenging in young children requiring anaesthesia.
– Radiation penalty.



MIBG (meta-iodobenzylguanidine) scan showing neuroblastoma (**arrow**).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 核医学

>|< 比较

适应证：

/ 尿路和胃肠道、骨骼及内分泌系统的功能性检查。

/ 肿瘤分期，如神经母细胞瘤 MIBG

/ 疼痛 (MSK) 和隐匿性骨折检查。

优点：

+ 高敏感性。
+ 多平面电势，例如 SPECT。
+ 功能性信息可与解剖学检查融合 - 混合成像（例如，PET-CT）。
+ 大多数检查中闪烁扫描检查不需要镇静。

缺点：

– 特异性可能较低。
– 与非混合技术相比，获得的解剖细节较少。
– 混合成像并不普及。
– 对于需要麻醉的低龄儿童，PET-CT 检查技术难度较大。
– 辐射风险。

Radiation Protection in Paediatric Imaging

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

儿科影像学检查的辐射防护

The Justification Principle in Paediatric Radiology

- An imaging procedure should only be carried out if it provides a net benefit greater than the potential harm it might cause.
- The radiology request is a key document that must be filled in with the greatest care and diligence by the referring physician.

<!> ATTENTION

The risk of omitting of a radiograph and/or CT examination should not be underestimated given that omitting an indicated necessary examination may endanger the patient.

- Every request for an imaging procedure that involves exposure to ionising radiation should follow the conviction that the test is indicated and will result in a net benefit for the patient by considering the following questions:
  - **Has the scan/test already been performed?** Scans performed in the same or other institutions should be retrieved and reviewed, particularly if they have been performed recently. On many occasions, the answer to the clinical problem is available already.
  - **Do I need the scan?** Only scans that are expected to alter patient treatment and care (i.e., clinical management) should be performed.
  - **Is the requested investigation the appropriate test done at the appropriate time?** Institutional, national and international practical guidelines are important in the investigation of specific conditions. Knowledge of the relevant clinical, laboratory and imaging findings should be considered within the relevant clinical context. Practices should be audited and revised regularly.
  - **Have I explained the problem? Have I discussed my thoughts?** Close co-operation and common language between referring physicians and radiologists constitutes essential steps in the elimination of unnecessary radiation exposures and facilitates the optimisation of techniques, particularly for complex, non-standard examinations.
  - **Are there any alternatives?** Alternatives should always be considered, such as ultrasound and MRI that do not involve exposure to ionising radiation, or fluoroscopic studies and radiographs (lower dose) over CT.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学的正当性原则

- 影像学检查只有在净获益大于可能造成的潜在危害时，才能进行。
- 放射学申请属于重要文件，必须由转诊医生以认真、谨慎填写。
- 对于涉及电离辐射暴露的影像学检查，每次申请时都应考虑到以下问题，并确信该检查适用且将为患者带来净获益：
  - **是否进行过该扫描/检查？**应检索和审查在相同机构或其他机构进行的扫描，尤其是最近进行的扫描。很多情况下，这已经可以解决临床问题。
  - **我需要进行扫描吗？**只有预期会改变患者治疗和护理（即临床管理）的扫描才应进行。
  - **所要求的检查是否是在适当的时间进行的适当检查？**机构、国家和国际实践指南对于特定病症的检查非常重要。应在相关临床背景下考虑相关临床、实验室和影像学检查结果的有关知识。应定期对诊疗活动进行审计和修订。
  - **我是否已经解释清楚问题？我是否讨论了自己的想法？**转诊医生和放射科医生之间的密切合作和共同语言是消除不必要辐射暴露的重要步骤，也有助于优化技术，尤其是复杂的非标准检查。
  - **是否有替代方法？**应始终将替代方法纳入考虑范围，例如，不涉及电离辐射暴露的超声检查和 MRI，或优于 CT 的荧光透视检查和 X 线摄影（低剂量）。

<!> 注意

切不可低估省略 X 线摄影和/或 CT 检查的风险，因为省略必要的检查可能会对患者有害。

儿科放射学

章节大纲：

The ALARA Principle in Paediatric Radiology

<!> ATTENTION

- Optimisation in radiology means that doses should be kept **'As Low As Reasonably Achievable'** (the ALARA principle) whilst maintaining the minimum image quality necessary for accurate diagnosis.
- In practice, this means that paediatric radiologists accept 'noisy' (i.e., of lower quality) images to minimise dose **in order** to make a diagnosis.
- Minimising radiation exposure is a multifactorial exercise and is a shared responsibility between referring physicians, radiologists, technologists, medical physicists, the industry - this varies amongst institutions.
- Technology provides us with options to reduce radiation exposure whilst maintaining image quality.
- European Dose Reference Levels (DRLs) for the most common paediatric radiologic examinations, known as PiDRLs, are available in RP185, a document published by the European Commission.
- These values should not be consistently exceeded in clinical practice and facilitate implementation of the ALARA principle. PiDRLs are extremely important when considering high burden radiation investigations like CT and fluoroscopy-guided procedures.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

儿科放射学的 ALARA 原则

<!> 注意

- 放射学优化是指在保持准确诊断所需的最低图像质量的同时，将剂量控制在**“可合理达到的最低水平”**（ALARA 原则）。
- 在实践中，这意味着儿科放射科医生要接受“嘈杂”（即质量较低）的图像以尽量减少剂量，**从而**做出诊断。
- 尽量减少辐射暴露是一项多因素工作，是转诊医生、放射科医生、技术人员、医学物理师和业界的共同责任，各机构的情况各不相同。
- 技术为我们提供了在保持图像质量的同时减少辐射暴露的选择。
- 最常见的儿科放射学检查的欧洲剂量参考水平 (European Dose Reference Levels, DRL)，即 PiDRL，载于欧盟委员会发布的文件 RP185。
- 临床实践中不可持续超过这些参考值，这有助于实施 ALARA 原则。在考虑诸如 CT 和荧光透视引导等高辐射检查时，PiDRL 显得尤为重要。

Disorders in Children

Paediatric Radiology

CHAPTER OUTLINE:

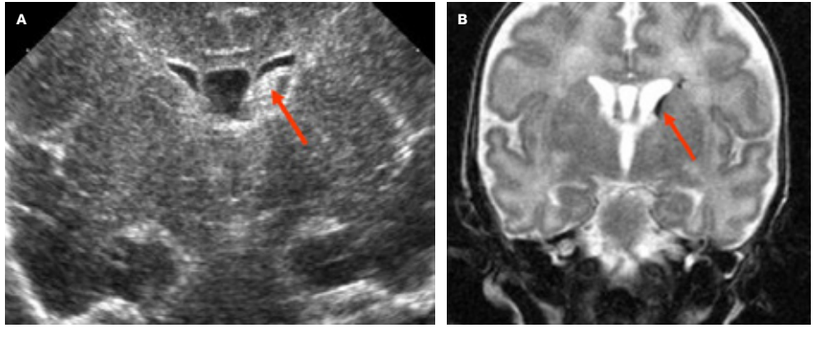
儿童疾病

儿科放射学

章节大纲：

Brain Diseases: Neonatal Encephalopathy – Premature Baby

- Brain haemorrhagic disease and periventricular leukomalacia are the most common central nervous system (CNS) complications of prematurity.
- Brain sonography performed in the intensive care unit in the incubator (top right image) is the first imaging tool and grading of haemorrhage is associated with prognosis.
- MRI may confirm the diagnosis and look for other lesions.



Haemorrhage at the vulnerable subependymal lining of the ventricles, called the germinal matrix. A germinal matrix haemorrhage grade 1 is seen in the left caudothalamic groove as an echogenic spot (arrow) on the coronal US view (**A**), and as hypointensity (black area , arrow in **B**) on the coronal T2W MRI sequence.

Paediatric Radiology

CHAPTER OUTLINE:

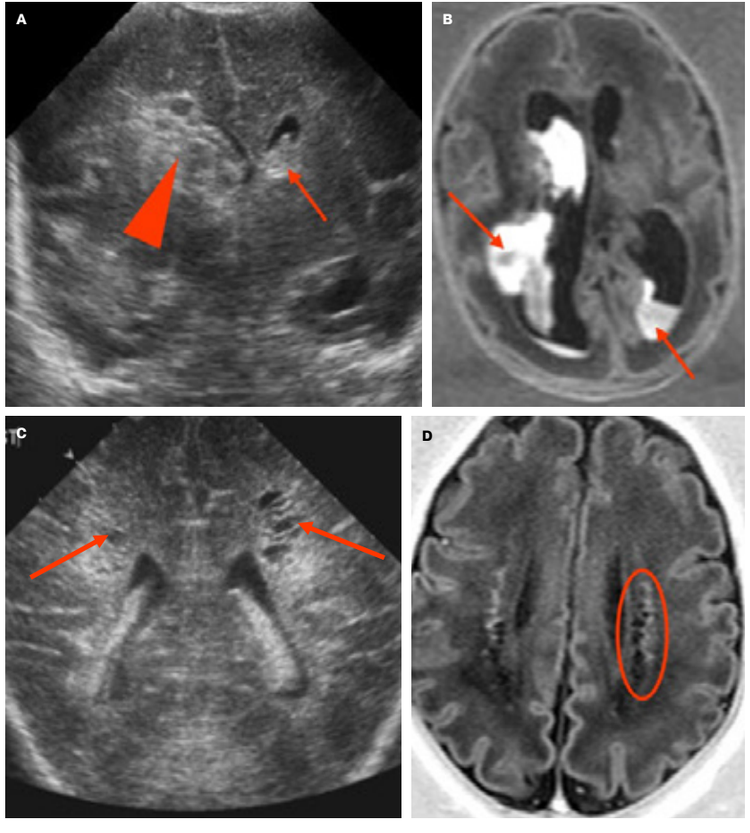
儿科放射学

章节大纲：

脑部疾病：新生儿脑病 - 早产儿

- 脑出血和脑室周围白质软化是早产儿最常见的中枢神经系统 (CNS) 并发症。
- 对重症监护室保温箱中的患儿进行的脑部超声检查（见右上图）是首选的影像学评估方法，其出血分级与患儿的预后密切相关。
- MRI 可确诊疾病并可排查其他病变。

发生于脑室壁脆弱的室管膜下区（即生发基质区域）的出血。在冠状面超声图像上 (**A**)，左侧尾状核-丘脑沟处可见生发基质 1 级出血，表现为点状回声（箭头所示）；在冠状位 T2 加权 MRI 序列上表现为低信号（黑色区域，**B** 图箭头所示）。



Bilateral germinal matrix haemorrhage with intraventricular hemorrhage (arrows) and associated haemorrhagic venous cerebral infarct (arrowhead) seen as space occupying echogenicities on coronal US (**A**) and as hyperintensities with ventriculomegaly on axial T1W MRI (**B**).

>|< COMPARE

Compare the US (A, C) to the MRI (B, D) appearance of **periventricular leukomalacia** which is ischaemia with secondary cyst formation. It is visualised as multiple anechoic cysts (arrows in C) within echogenic periventricular white matter on US images, and as alternating hypointense cysts and hyperintense petechial haemorrhagic spots on MRI (within the red oval).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

双侧生发基质出血伴脑室双侧生发基质出血伴脑室内出血（箭头所示）和相关出血性静脉性脑梗死（楔形箭头所示），其在冠状位 超声 上表现为占位回声灶 (A)，在横断位 T1W MRI 上表现为高信号加权伴脑室扩张 (B)。

>|< 比较

对比超声（图 A、C）与磁共振（图 B、D）中**脑室周围白质软化 (PVL)** 的影像学表现：该病变本质上是缺血性损伤伴继发性囊腔形成。该病变在超声图像上表现为强回声脑室周围白质内的多发性无回声囊性结构（C 图箭头所示），在磁共振图像上则呈现为低信号囊腔与高信号点状出血灶交替存在的特征（红圈标示区域）

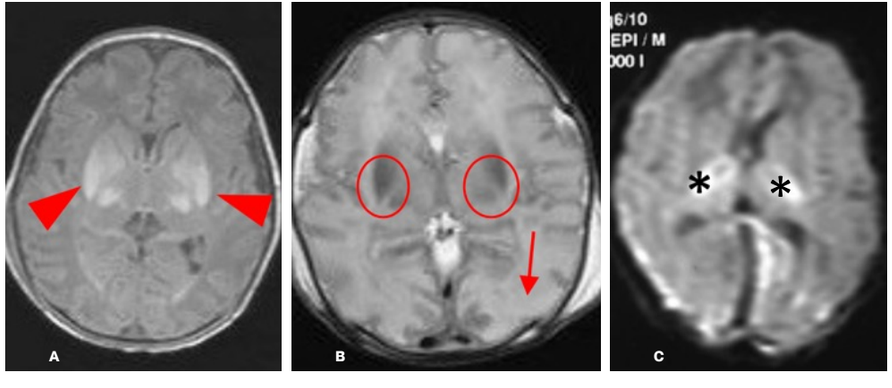
/ Brain Diseases: Neonatal Encephalopathy – Term Baby

/ Hypoxic ischaemic injury in term babies typically results in lesions of basal ganglia and thalami. Initial diagnosis is difficult with sonography; MRI with diffusion is very helpful in this regard.

/ Neonatal stroke occurs mainly after transient occlusion of the middle cerebral artery.

/ Traumatic delivery could lead to subdural haemorrhage, or less frequently epidural haemorrhage.

>▪< FURTHER KNOWLEDGE



Severe hypoxic neonatal encephalopathy on T1W (**A**), T2W (**B**) and diffusion-weighted MRI sequences (**C**): hyperintense deep grey matter (arrowheads), loss of PLIC alongside white mater oedema (arrow), restriction of diffusion in both thalami (*).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 脑部疾病：新生儿脑病 - 足月儿

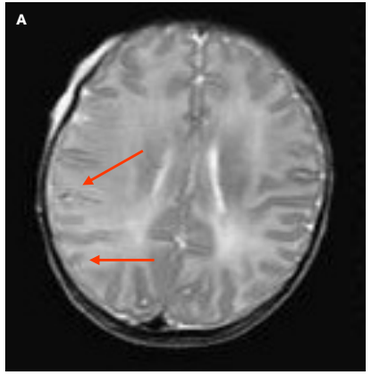
/ 足月儿缺氧缺血性损伤通常导致基底节和丘脑病变。超声检查很难做出初步诊断，而 MRI 弥散成像对诊断很有帮助。

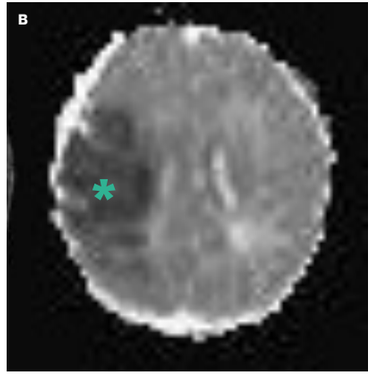
/ 新生儿脑卒中主要发生在大脑中动脉短暂闭塞后。

/ 创伤性分娩可能导致新生儿硬膜下出血，较少情况下会导致硬膜外出血。

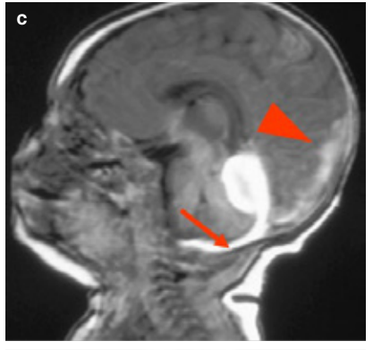
>▪< 进阶知识

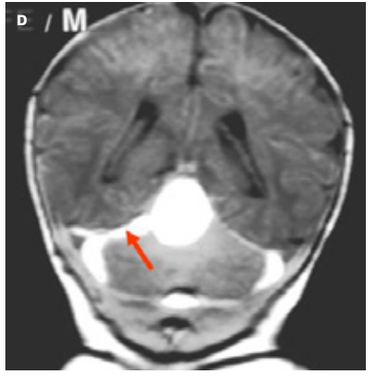
新生儿重度缺氧性脑病在 T1 加权 (**A**)、T2 加权 (**B**) 和弥散加权 MRI 序列 (**C**) 上表现为：深部灰质呈高信号（楔形箭头所示），内囊后肢 (PLIC) 信号缺失伴白质水肿（箭头所示），双侧丘脑弥散受限（*）。





Acute stroke in the right middle cerebral artery territory. On the T2W sequence, there is loss of the hypointense cortical ribbon (**A, arrow**), and the ADC map (**B**) exhibits restricted diffusion (*****).





Subdural haematoma in the posterior fossa after breech delivery on T1W sequences, sagittal (**C, arrow**) and coronal planes (**D, arrow**); supratentorial subarachnoid haemorrhage is also seen (**C, arrowhead**).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

右侧大脑中动脉供血区急性卒中。在 T2 加权序列上，低信号皮质带缺失（**A，箭头**），ADC 图 (**B**) 显示弥散受限（*****）。

T1W 序列矢状位（**C，箭头**）和冠状位（**D，箭头**）视图显示臀位分娩后颅后窝硬膜下血肿；还可见幕上蛛网膜下腔出血（**C，箭头**）。

Brain Diseases: TORCH Infections

- **TORCH** is the acronym for congenital infections caused by transplacental transmission of pathogens:
  - **T**oxoplasmosis
  - **O**ther (e.g., syphilis, Zika virus, HIV),
  - **R**ubella
  - **C**ytomegalovirus (CMV)
  - **H**erpes

CNS manifestations depend upon the age of the foetus at time of infection.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

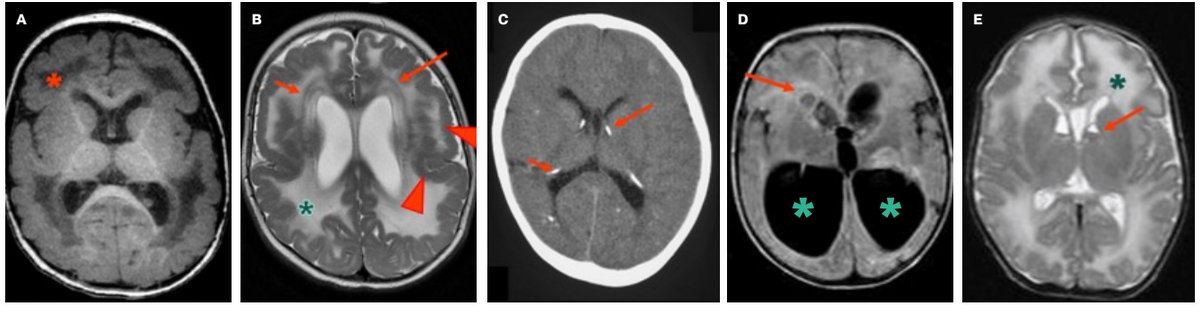
章节大纲：

脑部疾病：TORCH 感染

- **TORCH** 是由病原体经胎盘传播导致的先天性感染的首字母缩写：
  - **T** - 弓形虫病
  - **O** - 其他（例如，梅毒、寨卡病毒、艾滋病毒），
  - **R** - 风疹病毒
  - **C** - 巨细胞病毒 (CMV)
  - **H** - 单纯疱疹病毒

中枢神经系统 (CNS) 表现取决于感染时胎龄多大。

/ Brain Diseases: TORCH Infections & Imaging Features



Early foetus infection with CMV results in white matter signal abnormality (* in **A** and **B**) and migration disorders: heterotopia (arrows) and pachygyria (**arrowheads**).

Grey matter heterotopia = grey matter is present in inappropriate locations in the brain due to interruption of cortical cell migration to the correct location.

Pachygyria = (from the Greek "pachy" meaning "thick" or "fat" gyri) is a congenital malformation of the cerebral hemisphere. It results in unusually thick convolutions of the cerebral cortex.

Two cases of congenital toxoplasmosis. **C**: the mild form with periventricular calcification (**arrows**). **D**: severe form with parenchymal lesions (**arrow**) and ventriculomegaly (**asterisks**).

Rubella (**E**): subependymal haemorrhagic cysts (**arrow**) and white matter hyperintensity (*).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 脑部疾病：TORCH 感染和影像学特征

胎儿早期感染 CMV 导致白质信号异常（**A** 和 **B** 中 *）和移行异常：灰质异位（箭头所示）和巨脑回（**楔形箭头所示**）。

灰质异位灰质异位症是皮质神经元细胞迁移过程中断导致灰质异常定位於非常规脑区的神经发育异常现象。

巨脑回 =（来自希腊语“pachy”，意思是“增厚”或“肥大”脑回）是大脑半球的一种先天性畸形。会导致大脑皮层脑回异常增厚。

两例先天性弓形虫病。**C**：轻度，伴脑室周围钙化（箭头）。**D**：重度，伴有实质病变（箭头）和脑室扩张（星号）。

风疹 (**E**)：室管膜下出血性囊肿（箭头）和白质高信号（*）。

Brain Diseases: Post-natal CNS Infection

- Bacterial meningitis is frequent in childhood, including the neonatal period. Emergency treatment is mandatory, and treatment **should not** be delayed in order to undertake imaging.
- In neonates, US is the first line imaging modality. MRI is also useful in suspected complications which include ventriculitis, hydrocephalus, venous thrombosis, cerebral abscesses and empyema.
- Acute encephalopathy may be directly related to the viral infection/load but also with an inflammatory auto-immune postinfectious disease, called Acute Disseminated Encephalomyelitis (ADEM).

Paediatric Radiology

CHAPTER OUTLINE:

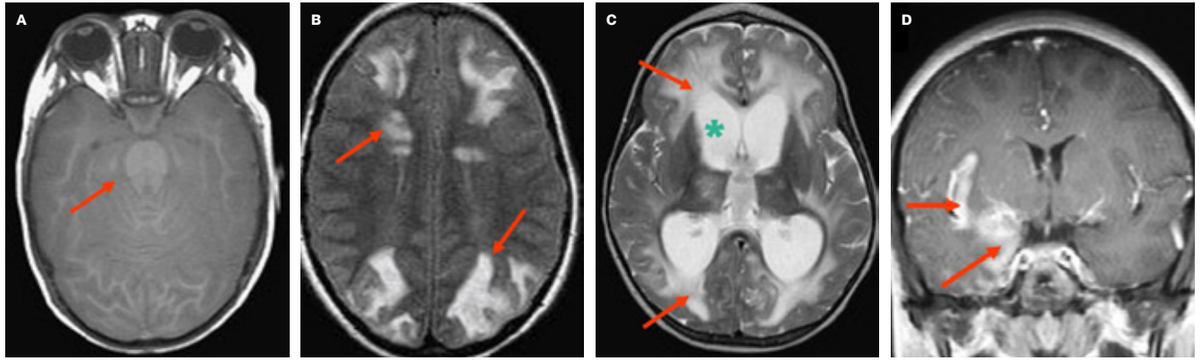
儿科放射学

章节大纲：

脑部疾病：出生后 CNS 感染

- 细菌性脑膜炎常见于儿童期，包括新生儿期。必须进行急诊治疗，**不得**为完成影像学检查而延误治疗。
- 对新生儿来说，超声是一线影像学检查方法。MRI 有助于疑似并发症的评估，包括脑室炎、脑积水、静脉血栓形成、脑脓肿和积脓症。
- 急性脑病可能与病毒感染/病毒载量直接相关，但也可能与感染后炎症性自身免疫疾病——即急性播散性脑脊髓炎 (ADEM) 有关。

/ Brain Diseases: Post-natal CNS Infection – Illustrative Examples



Meningococcal meningitis in a comatose patient (**A**). MRI T1W sequence after lumbosacral tap showing excessive brain oedema, effaced peripheral sulci and basal cistern (arrow).

Pneumococcus meningitis in a 7-year-old (**B**), causing vasculitis and resulting in ischaemic lesions within junctional vascular territories (**arrows**).

T2W image obtained one week after bacterial meningitis in a 5-year-old (**C**): hydrocephalus with ventriculomegaly (*) and trans-ependymal CSF migration shown as periventricular hyperintensities (arrows).

Coronal T1W post contrast image in a child with partial seizures, fever and acute Herpes Virus HSV1 encephalitis. There is a characteristic right temporal and insula involvement with gyral enhancement (arrows).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

/ 脑部疾病：出生后 CNS 感染 - 示例说明

章节大纲：

昏迷患者的脑膜炎球菌性脑膜炎 (**A**)。腰骶部穿刺后 MRI T1W 序列显示脑水肿加剧、外周脑沟和基底池变浅消失（箭头）。

7 岁儿童患肺炎球菌性脑膜炎 (**B**)，引起血管炎并导致分水岭区出现缺血性改变（箭头）。

5 岁儿童细菌性脑膜炎后一周的磁共振 T2W 图像 (**C**)：脑积水伴脑室扩大 (*)，以及脑室周围高信号（箭头），为脑脊液 (cerebrospinal fluid, CSF) 跨室管膜迁移的表现（箭头）。

急性疱疹病毒 HSV1 病毒性脑炎儿童伴发局灶性癫痫、发热的冠状位 T1 加权增强图像。右颞叶和岛叶有明显受累，脑回强化（箭头）。

/ Brain Diseases: Posterior Fossa Tumours

<!> ATTENTION

/ In children, tumours of the posterior fossa comprise more than 50% of all brain tumours.

/ Headaches and vomiting are related to elevated intracranial pressure.

/ Cerebellar tumours include medulloblastoma and pilocytic astrocytoma.

/ Ependymoma and brainstem glioma are also frequent.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 脑部疾病：后颅窝肿瘤

/ 头痛和呕吐与颅内压升高有关。

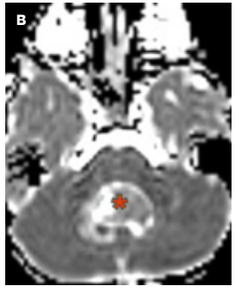
/ 小脑肿瘤包括髓母细胞瘤和毛细胞型星形细胞瘤。

/ 室管膜瘤和脑干胶质瘤也很常见。

<!> 注意

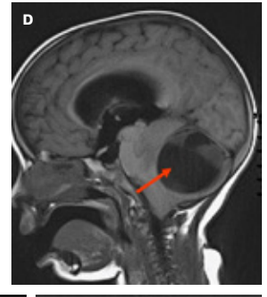
/ 在儿童中，颅后窝肿瘤占所有脑肿瘤的 50% 以上。

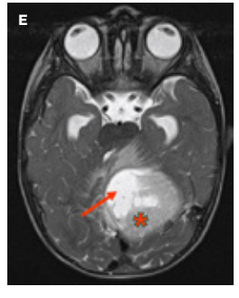
/ Brain Diseases: Posterior Fossa Tumours – Illustrative Examples

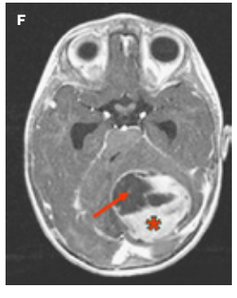


Tumour arising from the anterior part of the vermis (arrow), shows inhomogeneous signal intensity on T2W axial image (A), restricted diffusion as low intensity signal on the ACD map (* in B). Enhancing cauda equina masses (* in C) compatible with metastases within the thecal sac from anaplastic medullo-blastoma.

Sagittal T1W (D), axial T2W (E) and axial contrast-enhanced T1W (F) images showing a tumour within the left cerebellar hemisphere with cystic (arrows) and enhancing solid portions (*) in a patient with a pilocytic astrocytoma.







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CHAPTER OUTLINE:

/ 儿科放射学

/ 脑部疾病：后颅窝肿瘤 - 示例说明

章节大纲：

源于小脑蚓部前部的肿瘤（箭头），在 T2加权横断位图像上显示信号不均匀 (A)，在 ACD 图像上显示弥散受限的低信号（B 中的 *）。马尾神经区见肿块增强（C 中 *），符合间变性髓母细胞瘤硬膜囊内转移。

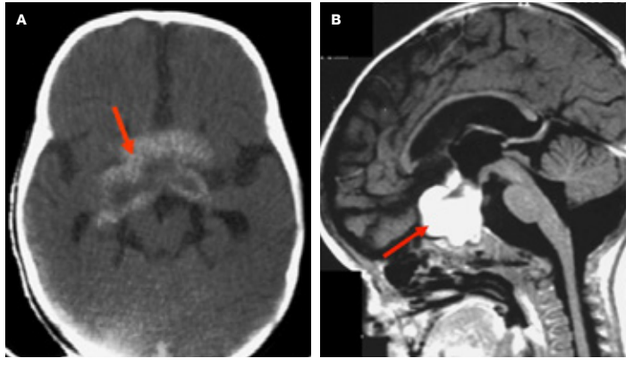
毛细胞型星形细胞瘤患者：矢状位 T1 加权 (D)、横断位 T2 加权 (E) 和横断位 T1 加权增强 (F) 图像显示：左小脑半球可见一肿瘤，含囊性成分（箭头所示）和增强强化的实性成分 (*)。

/ Brain Diseases: Suprasellar Tumours

/ The most frequent suprasellar tumours in children are craniopharyngioma and optic nerve glioma.

/ Craniopharyngioma may present with endocrine symptoms (Growth Hormone [GH] deficiency) or elevated intracranial pressure. A cystic component, calcification and solid portions are characteristic.

/ Optic nerve and chiasmatic gliomas can be isolated or associated with neurofibromatosis type 1 (NF1).



Axial CT image (A) and sagittal contrast-enhanced T1W image (B) of a suprasellar tumour in the region of the visual pathways which exhibits enhancement following contrast injection (arrows).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

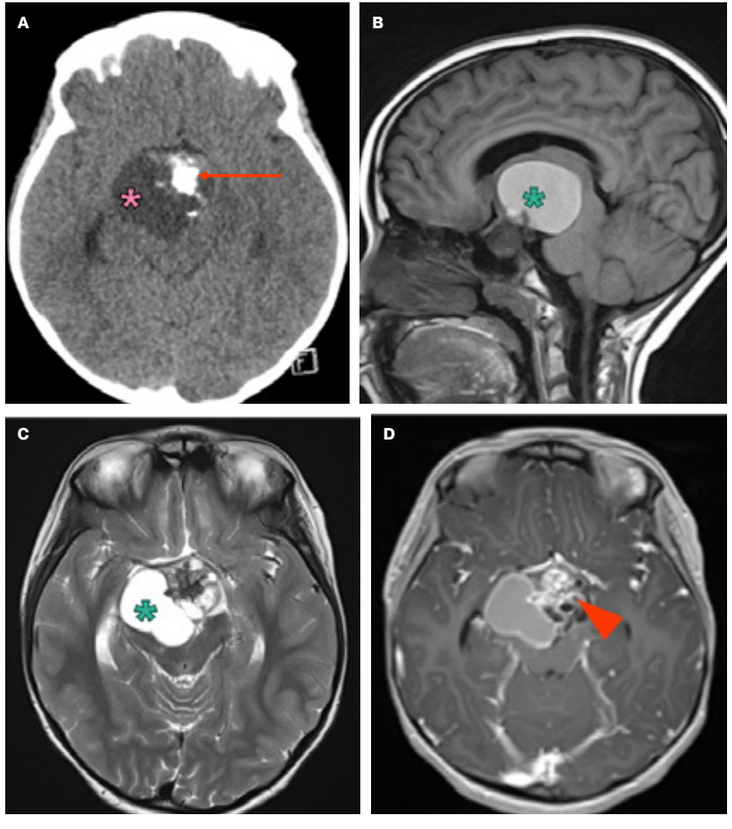
/ 脑部疾病：鞍上肿瘤

/ 儿童最常见的鞍上肿瘤是颅咽管瘤和视神经胶质瘤。

/ 颅咽管瘤可能表现为内分泌症状（生长激素 [Growth Hormone, GH] 缺乏）或颅内压增高。其特征包括囊性成分、钙化以及实性部分。

/ 视神经和视交叉胶质瘤可以是孤立性或与 1 型神经纤维瘤病 (neurofibromatosis type 1, NF1) 伴发。

A 图为 CT **横断位**图像，B 图为磁共振矢状位 T1 加权增强图像，鞍上视觉通路区域可见一肿瘤，增强后出现强化（如箭头所示）。



Non-enhanced axial CT (A) and sagittal T1W (B), axial T2W (C) and axial T1W post contrast (D) images of a suprasellar tumour which is partly cystic (*). The cystic tumour part has a high signal intensity on T1W images (* in B). Calcification is seen on the left side of the lesion (arrow). Contrast enhancement is present in the solid part (arrowhead) of the tumour. Imaging findings are characteristic for craniopharyngioma.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

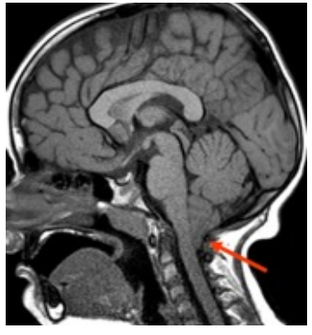
鞍上含囊性成分的肿瘤 (*) CT 非增强横断位 (A) 和 MRI 矢状位 T1 加权 (B)、横断位 T2 加权 (C) 和增强横断位 T1 加权图像 (D)。肿瘤囊性部分在 T1加权 图像上显示高信号（B 中的 *）。病灶左侧可见钙化（箭头）。肿瘤的实性部分（箭头）增强后强化。影像学检查结果符合颅咽管瘤的典型特征。

/ Congenital Malformations of Brain and Spine

Chiari Malformations are a heterogeneous group of malformations characterised by downward hindbrain displacement. Unlike Chiari II and III malformations, Chiari I is usually asymptomatic unless the descent of the cerebellar tonsils exceeds 5 mm, there is brain stem compression, syringomyelia or scoliosis.

>▪< FURTHER KNOWLEDGE

Chiari I



Ectopia of the cerebellar tonsils (**arrow**) into the foramen magnum.

Subtype of Chiari I malformation. Chiari 1.5 is characterised by caudal displacement of brain stem and a cervicomedullary kink (**arrow**). Note the hydrosyringomyelia which is a frequent association with Chiari I malformations (**arrowheads**).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 先天性脑和脊柱畸形

Chiari 畸形是特征为后脑组织向下移位的一组异质性畸形。与 Chiari 畸形 II 型和 III 型不同，Chiari 畸形 I 型通常临床无症状，影像上却显示有小脑扁桃体下降超过 5 mm、存在脑干受压、脊髓空洞症或脊柱侧弯。

>▪< 进阶知识

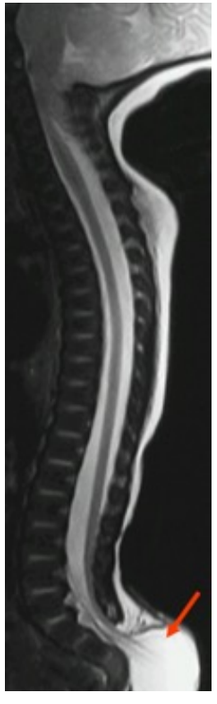
Chiari I 型

小脑扁桃体异位（箭头）至枕骨大孔。

Chiari I 型畸形的亚型。Chiari 1.5 的特征是脑干向尾部移位和颈髓延髓交界处扭结（箭头）。注意脊髓积水空洞症，它常与 Chiari 畸形 I 型（三角箭头）并发。

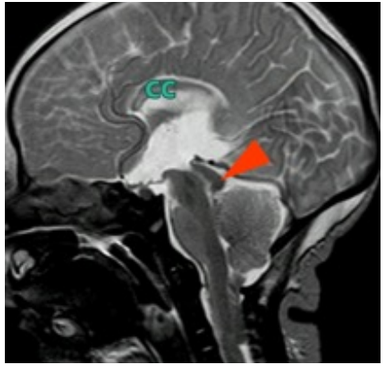
>▪< FURTHER KNOWLEDGE

Chiari II

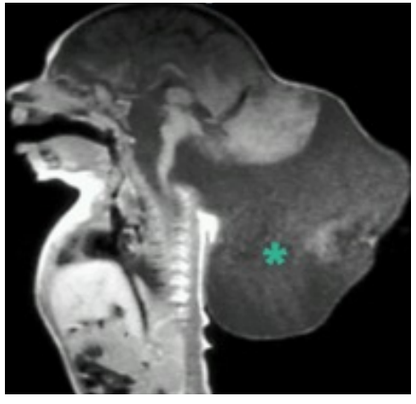


Small posterior fossa with herniation of the hindbrain, a beaked tectum (**arrowhead**), an elongated 4th ventricle, a dysplastic corpus callosum (cc) in a patient with open spinal dysraphism and a myelomeningocele (**arrow**).

Chiari II malformations can be reversed with prenatal surgical correction of the spinal defect.



Chiari III



Herniation of the hindbrain into an occipito-cervical cephalocele (*).

<!> ATTENTION

The brain should be carefully inspected for tumours and other causes/evidence of intracranial hypertension to ensure that there is not secondary cerebellar tonsillar ectopia (and therefore not a Chiari I malformation).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

>・<进阶知识

Chiari II 型

开放性椎管闭合不全及脊髓脊膜膨出患者，后颅窝小，伴有后脑疝、喙状顶盖（箭头）、第四脑室细长、胼胝体发育不良 (cc)（箭头）。

Chiari 畸形 II 型可通过产前脊柱缺陷宫内手术矫正实现病理解剖结构的可逆性改变。

Chiari III 型

后脑疝形成枕颈脑膜膨出（*）。

<!> 注意

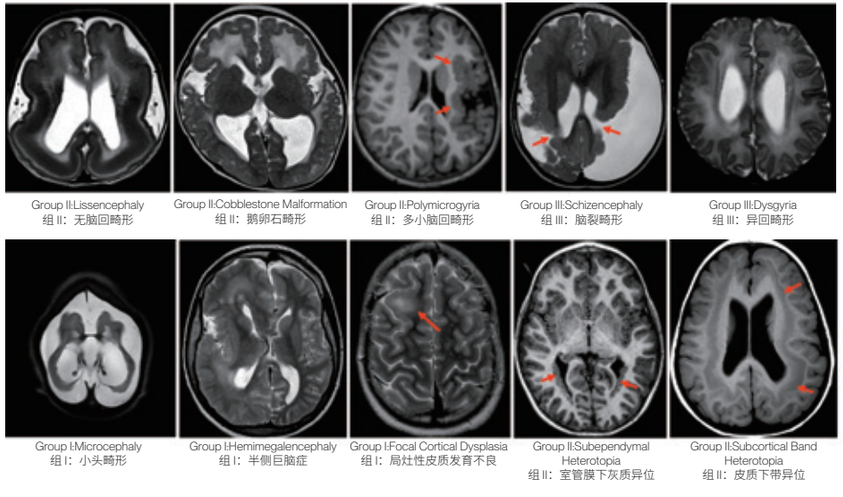
应仔细检查脑部是否有肿瘤和颅内压增高的其他原因/迹象，以确保非继发性原因导致小脑扁桃体异位（从而排除 Chiari I 型畸形）。

/ **Malformations of cortical development** are a major cause of intellectual disability, autism, epilepsy and cerebral palsy. They exist in **3%** of intellectual disabilities, **25%** of paediatric partial seizures, **5-15%** of adult epilepsy and **20-40%** of therapy-resistant epilepsy.

/ There are **3 main categories**: disorders of cell proliferation and apoptosis (Group I), disorders of neuronal migration (Group II) and post-migrational (cortical organisational) disorders (Group III).

/ The neurological outcome is extremely variable depending on the type, extent and severity of the malformation and the involved genetic pathways of brain development. Examples of the **ten main malformation patterns** are shown below:

>▪< FURTHER KNOWLEDGE



Group II:Lissencephaly 组 II：无脑回畸形
Group II:Cobblestone Malformation 组 II：鹅卵石畸形
Group II:Polymicrogyria 组 II：多小脑回畸形
Group III:Schizencephaly 组 III：脑裂畸形
Group III:Dysgyria 组 III：异回畸形
Group I:Microcephaly 组 I：小头畸形
Group I:Hemimegalencephaly 组 I：半侧巨脑症
Group I:Focal Cortical Dysplasia 组 I：局灶性皮质发育不良
Group II:Subependymal Heterotopia 组 II：室管膜下灰质异位
Group II:Subcortical Band Heterotopia 组 II：皮质下带异位

Barkovich AJ, Guerrini R, Kuzniecky RI, Jackson GD, Dobyns WB. A developmental and genetic classification for malformations of cortical development: update 2012. Brain 2012; 135: 1348-1369 [PMID: 22427329 DOI: 10.1093/brain/aws019]

Severino M, Geraldo AF, Utz N, Tortora D, Pogledic I, Klonowski W, Triulzi F, Arrigoni F, Mankad K, Leventer RJ, Mancini GMS, Barkovich JA, Lequin MH, Rossi A. Definitions and classification of malformations of cortical development: practical guidelines. Brain. 2020 Aug 10:awaa174. doi: 10.1093/brain/awaa174.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ **皮质发育畸形**是导致智力障碍、自闭症、癫痫和脑瘫的主要原因。**3%** 的智力障碍患者、**25%** 的儿童局灶性癫痫患者、**5%~15%** 的成人癫痫患者和 **20%~40%** 的难治性癫痫患者都存在这种畸形。

/ **主要分为 3 类：**细胞增殖和凋亡异常（第 I 组）、神经元迁移障碍（第 II 组）和迁移后（皮质组织构建）障碍（第 III 组）。

/ 根据畸形的类型、范围和严重程度以及涉及的大脑发育遗传通路，神经系统预后存在极大差异。**10 种主要畸形类型**示例如下：

>▪< 进阶知识

Spinal Dysraphism

Spine and spinal cord malformations result from abnormal development occurring during the early stages of embryonic development:

- gastrulation (weeks 2-3).
- primary neurulation (weeks 3-4).
- secondary neurulation (weeks 5-6).

Spinal dysraphism is categorised into:

- **open spinal dysraphism** (abnormal neural tissue protruding through a posterior skin defect; myelomeningocele is the most frequent; associated with Chiari II malformation).
- **closed spinal dysraphism** (abnormal neural tissue covered by the integuments).

Closed spinal dysraphism is further subcategorised:

- With tumefaction (subcutaneous mass indicating underlying malformation; lipomyelocele, lipomyelomeningocele, meningocele, myelocystocele and limited dorsal myeloschisis).
- Without tumefaction (no subcutaneous mass but often other stigmata such as hairy tuft, capillary malformations, dimple/holes and dyschromia).

Clinical features:

- Open spinal dysraphism presents at birth with an open defect that must be corrected urgently to avoid infection; variable impairment of gait, scoliosis and urinary incontinence may develop.
- Closed spinal dysraphism often presents with a tethered cord syndrome and a low-lying (below L2) conus.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

椎管闭合不全

脊柱和脊髓畸形是由胚胎发育早期阶段的发育异常所致：

- 原肠胚形成（第 2～3 周）。
- 初级神经管形成（第 3～4 周）。
- 次级神经管形成（第 5～6 周）。

椎管闭合不全分为：

- **开放性椎管闭合不全**（异常神经组织通过后部皮肤缺损突出；脊髓脊膜膨出最常见；与 Chiari II 型畸形有关）。
- **闭合性椎管闭合不全**（异常神经组织被体被覆盖）。

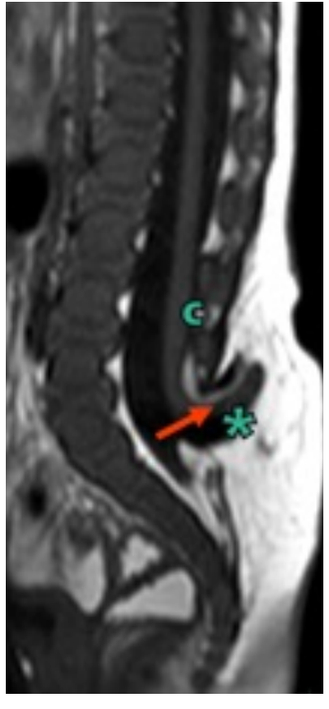
闭合性椎管闭合不全又进一步细分为：

- 肿胀（皮下包块提示潜在畸形；脂肪脊髓膨出、脂肪脊髓脊膜膨出、脊膜膨出、脊髓囊肿状突出和局限性背侧脊髓裂）。
- 无肿胀（无皮下包块，但通常有其他特征，如毛发痣、毛细血管畸形、皮肤小凹/窦道和色素异常）。

临床特征：

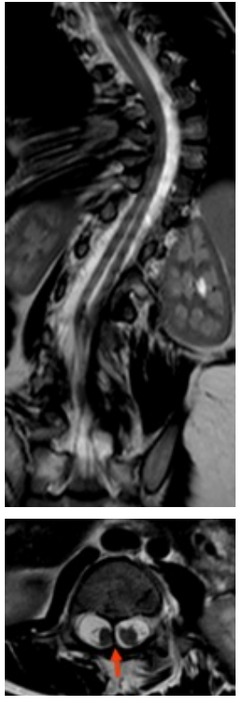
- 开放性椎管闭合不全在出生时表现为开放性缺损，必须紧急手术修补以避免感染；后续可能出现不同程度的步态障碍、脊柱侧弯和尿失禁等神经功能损害。
- 闭合性椎管闭合不全常表现为脊髓栓系综合征和圆锥低位（L2 以下）。

Sagittal spine T1-w image of a new-born with lumbosacral myelomeningocele (*) and an associated Chiari II malformation (arrow) with hydrocephalus (h).



New-born with a lumbosacral lipomyelomeningocele producing a skin-covered tumefaction. Note the low-lying conus (c), c-shaped fat (arrow) and CSF (*) protruding outside the canal.

5-year-old boy with a hyperintense (white) lipoma of the filum terminale (arrow). The conus is stretched into a low position at the level of L3.



6-year-old girl with scoliosis seen on coronal T2W imaging and a diastematomyelia with intervening bony spur (arrow), best appreciated on the axial image (bottom).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

新生儿磁共振矢状位脊柱 T1 加权图像显示：腰骶部脊髓脊膜膨出 (*) 和伴随 Chiari II 畸形（箭头）伴脑积水 (h)。

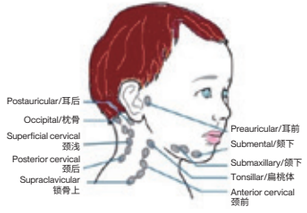
新生儿腰骶部脂肪脊髓脊膜膨出，形成皮肤覆盖的肿胀包块。注意低位圆锥 (c)、c 形脂肪（箭头）和突出椎管外的 CSF (*)。

5 岁男童终丝高信号（白色）脂肪瘤（箭头）。圆锥被拉伸到 L3 低位水平。

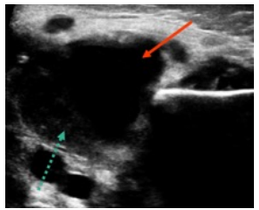
6 岁女童磁共振冠状位 T2 加权图像显示脊柱侧弯、脊髓纵裂畸形伴椎管中间有骨刺（箭头），横断位图像（底部）显示最清楚。

Cervical Lymph Nodes and Lymphadenopathy

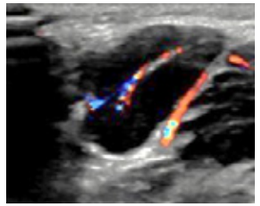
- Palpable cervical lymph nodes (CLNs) are common and found in nearly up to 60% of otherwise healthy children.
- Lymphadenopathy is defined as abnormal lymph nodes in terms of size (enlarged), number (widespread) and/or consistency (firm, hard, rubbery, non-mobile).
- Palpable CLNs < 1 cm (short-axis) are considered physiological, even if persistent for many months.
- Cervical lymphadenopathy is also common and is reported in up to 90% of children between 4 and 8 years of age.
- CLNs > 2 cm persisting for > 6 weeks warrant referral for assessment: cervical lymphadenopathy, particularly supraclavicular, with associated splenomegaly, night sweats, weight loss, bone pain, symptoms/signs of a mediastinal mass, are all concerning for malignancy.
- Ultrasound is best suited to assessing CLN, but no single feature can determine the nature of an enlarged CLN – the combination of features and clinical context are key.
- Ultrasound cannot reliably differentiate between the changes from benign (e.g., reactive or infection) and malignant (lymphoma) causes.
- As such, ultrasound **should not** be used as a screening tool to 'exclude malignancy'.
- Ultrasound is occasionally used to show liquefaction requiring drainage in suppurative lymphadenitis (bottom image, right).



This image illustrates the normal distribution of CLNs in children which are easily palpated due to relative lack of subcutaneous fat. The distinction should be made between normal palpable CLN and lymphadenopathy.



Lymph node abscess on ultrasound in a 20-month-old male. He presented with fever and a right-sided neck swelling. The necrosis (orange arrow) is arising from an infected right submandibular lymph node (turquoise arrow). He proceeded to an incision and drainage (I&D).



Normal cervical lymph node on ultrasound in a well 20-month-old male with normal shape, size, visible hilum and blood flow. This child had normal palpable CLN but was mislabelled as "lymphadenopathy" for which this ultrasound was performed.

<∞> REFERENCES

Paddock M, et al. Do otherwise well, healthy children with palpable cervical lymph nodes require investigation with neck ultrasound? Arch Dis Child 2020. DOI: 10.1136/archdischild-2020-319648

https://connect.springerpub.com/content/book/978-0-8261-5021-9/part/part02/part/section02/chapter/ch13

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

颈部淋巴结和淋巴结病

- 可触及的颈部淋巴结 (Palpable cervical lymph nodes, CLN) 较为常见，在近 60% 的健康儿童中都能发现。
- 淋巴结病是指淋巴结大小（肿大）、数量（广泛分布）和/或质地（坚硬、结实、有弹性、不可移动）方面的异常。
- 可触及的 CLN < 1 cm（短轴）时，视为生理性，即使已持续数月。
- 颈部淋巴结病也很常见，据报道，高达 90% 的 4～8 岁儿童患有此病。
- CLN > 2 cm 持续超过 6 周时需要转诊评估：颈部淋巴结病，特别是锁骨上淋巴结，伴有脾肿大、盗汗、体重减轻、骨痛、纵隔占位的症状/体征，均提示恶性肿瘤。
- 超声检查是评估 CLN 的首选方法，但单一影像特征不足以确定肿大 CLN 的性质，关键是要结合各种特征和临床资料。
- 超声检查难以可靠区分良性（例如反应性或感染）和恶性（如淋巴瘤）病因所致的淋巴结改变。
- 因此，不得将超声检查作为“排除恶性肿瘤”的筛查工具。
- 偶尔可通过超声检查来显示化脓性淋巴结炎中需要引流的液化情况（右下图）。

这张图像显示了儿童 CLN 的正常分布情况，由于儿童皮下脂肪相对缺乏，很容易触摸到。应区分正常可触及的 CLN 与淋巴结病。

超声检查显示一例 20 月龄健康男婴颈部淋巴结，可见形态、大小、淋巴门和血流均正常。该幼儿的可触及 CLN 正常，但被错误、归为“淋巴结病”，因此进行了此次超声检查。

超声检查显示一例 20 月龄男婴淋巴结脓肿。患儿出现发热和右侧颈部肿胀。坏死（橙色箭头）源自感染的右颌下淋巴结（蓝绿色箭头）。患儿接受了切开引流术 (incision and drainage, I&D)。

<∞> 参考文献

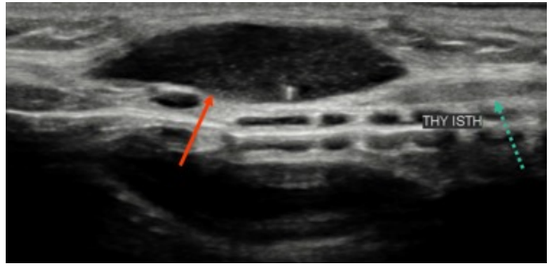
Thyroglossal Duct Cyst

- As the most common congenital neck cyst in children, it is usually midline or adjacent to the midline, i.e., paramedian (within 2 cm).
- They may occur anywhere along the course of the thyroglossal duct which runs from the foramen caecum at the base of the tongue to the thyroid gland (illustration).
- As such, these cysts move upward with swallowing and on tongue protrusion which can help to distinguish it from other entities (mainly dermoid cysts and nodes).
- The majority (90%) typically present before the age of 10 years and are usually non-tender, fluctuant masses which may only be noticed as they gradually increase in size.
- They often remain asymptomatic unless they become infected (see grey box), prompting treatment.
- Ultrasound is the ideal modality to assess these cysts (top image), but they can also be seen on CT and MRI.
- Complete resection of the cyst and the thyroglossal duct up to the foramen caecum is curative, with only a small recurrence rate (< 3%).
- The presence of the normal thyroid gland should be sought, as should the presence of any ectopic thyroid tissue which may be associated with these cysts.

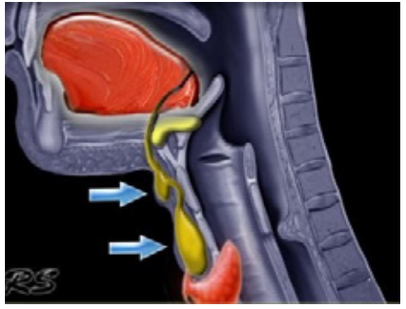
<!> ATTENTION

Do not forget the cardinal signs of inflammation, defined by the 1st century AD Roman scholar Celsus (in Latin):

Calor - heat | Dolor - pain | Rubor - redness (also known as erythema, from the Greek, erythros, meaning 'red') | tumour - swelling.



Thyroglossal duct cyst (orange arrow) in a 9-year-old girl who presented with a midline swelling which moved on swallowing and tongue protrusion. US, longitudinal image shows that it lies just above the thyroid isthmus (turquoise arrow).



The potential locations of thyroglossal duct cysts, indicated by the blue arrows, may occur anywhere along the path of the thyroglossal duct from the base of the tongue to the thyroid gland.

<∞> REFERENCE

Image from https://radiologyassistant.nl/head-neck/neck-masses/neck-masses-in-children

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

甲状舌管囊肿

- 作为儿童最常见的先天性颈部囊肿，通常位于中线或中线旁，即正中旁（2 cm 以内）。
- 甲状舌管囊肿可发生于舌盲孔至甲状腺间的甲状舌管走行路径的任何部位。
- 因此，这类囊肿会随着吞咽和伸舌而上移，这有助于将其与其他疾病（主要是皮样囊肿和淋巴结）区分开来。
- 大多数囊肿 (90%) 在 10 岁前出现，通常为无触痛、波动性肿块，只有在逐渐增大时才会引起注意。
- 患者通常无症状，除非发生感染（见灰框）需要治疗。
- 超声是评估这类囊肿的理想检查方法（上图），但 CT 和 MRI 也可显示。
- 沿甲状舌管路径完整切除囊肿直至舌盲孔可达根治效果，术后复发率很低 (< 3%)。
- 需确认正常甲状腺组织的存在，并探查是否伴有与此类囊肿相关的异位甲状腺组织。

<!> 注意

不要忘了公元 1 世纪罗马学者 Celsus（拉丁语）提出的炎症基本体征：

Calor - 热 | Dolor - 疼痛 | Rubor - 发红（也称为红斑，源自希腊语 erythros，意为“红色”）| 肿瘤 - 肿胀。

一例 9 岁女童甲状舌管囊肿（橙色箭头），表现为中线肿胀，随吞咽和伸舌而移动。超声纵向图像显示位于甲状腺峡部正上方（蓝绿色箭头）。

甲状舌管囊肿的潜在发生位置（蓝色箭头指示）可出现在从舌根到甲状腺的甲状舌管沿线的任何位置。

<∞> 参考文献

图像来源：https://radiologyassistant.nl/head-neck/neck-masses/neck-masses-in-children

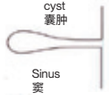
Branchial Cleft Anomalies

- The branchial (or pharyngeal) apparatus is a complex embryological structure comprised of several paired symmetrical arches, pouches, clefts and membranes which are precursors to several important structures in the head and neck.
- Anomalies of the branchial clefts usually result in **cysts**.
- **Fistulas** and **sinuses** may also occur but are less common.
- The 2nd to 4th branchial clefts form the cervical sinus (transient depression in the embryonic neck) which obliterates when these clefts fuse.
- The commonest abnormalities are remnant 2nd branchial cleft cysts which may present following minor trauma or infection, and can be visualised with ultrasound, CT and MRI.

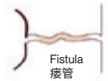
'Branchial' is Greek for gill, so named for the externally visible 'gills' in the developing embryo.

Definitions:

Cyst - an abnormal thin-walled membranous sac or cavity which contains fluid.



Sinus - a hollow space or cavity in the body, or blind track passing between epithelial surfaces and organs or tissue.



Fistula - an abnormal connection between the lumen of one viscus to the lumen of another (internal), or to the exterior (external).

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

鳃裂畸形

- 鳃（或咽）器是一种复杂的胚胎结构，由若干对对称的弓、囊、裂和膜组成，是头颈部多个重要结构的前体。
- 鳃裂畸形通常会导致囊肿。
- 也可能发生瘘管和窦道，但不太常见。
- 第二至四鳃裂共同形成颈窦（胚胎颈部的一个短暂性凹陷结构），随着这些鳃裂的融合而颈窦消失。
- 最常见的鳃裂畸形是残留的第二鳃裂囊肿，可能在轻微创伤或感染后出现，超声、CT 和 MRI 均可显示。

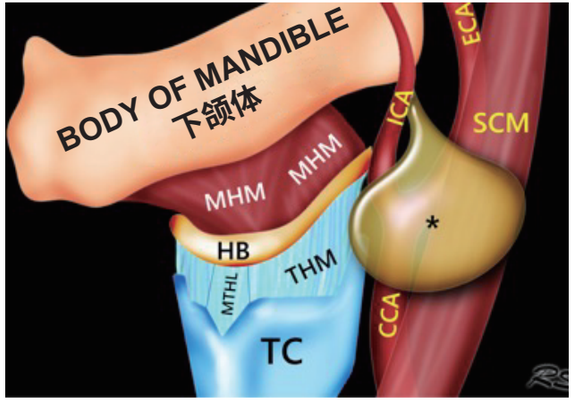
“Branchial”在希腊语中是鳃的意思，因发育中的胚胎外部可见的“鳃”状结构而得名。

定义：

囊肿 - 含有液体的异常薄壁膜性囊状结构或腔体。

窦 - 体内的空腔或管道，或指上皮表面和器官或组织之间穿行的盲管。

瘘管 - 指两个空腔脏器内腔之间（内瘘），或空腔脏器内腔与体表之间（外瘘）的异常通道。



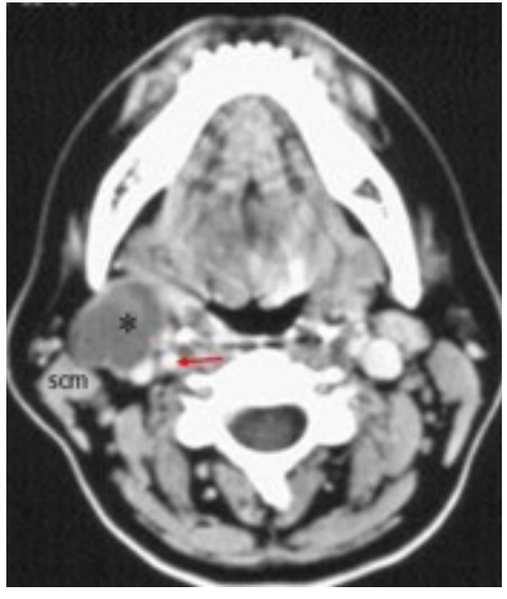
ANATOMY REVIEW: Branchial cleft cyst (BCC, *); CCA, common carotid artery; ECA, external carotid artery; HB, hyoid bone; ICA, internal carotid artery; MHM, mylohyoid muscle; MTHL, median thyrohyoid ligament; SCM, sternocleidomastoid muscle; TC, thyroid cartilage; THM, thyrohyoid membrane.

<∞> REFERENCE

Image from https://radiologyassistant.nl/head-neck/neck-masses/neck-masses-in-children

<∎> CORE KNOWLEDGE

Common associations with **branchial arch** anomalies:
1st - Treacher Collins syndrome; Pierre Robin sequence.
3rd - DiGeorge syndrome.



Note the typical location of the 2nd BCC (*) in the above illustration and the CT scan (left). It lies just below/posterior to the angle of the mandible, anterior to the SCM and lateral to the CCA (red arrow). The tail of the cyst can lie in between the ICA and ECA, as can the body of the cyst if it lies more superiorly.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科 放射学

章节大纲：

解剖学综述：鳃裂囊肿（BCC，*）；CCA，颈总动脉；ECA，颈外动脉；HB，舌骨；ICA，颈内动脉；MHM，下颌舌骨肌；MTHL，甲状舌骨正中韧带；SCM，胸锁乳突肌；TC，甲状软骨；THM，甲状舌骨膜。

<∞> 参考文献

图像来源：https://radiologyassistant.nl/head-neck/neck-masses/neck-masses-in-children

<∎> 核心知识

与鳃弓异常有关的常见病症：

第 1 - 特-柯二氏综合征；Pierre Robin 序列征。

第 3 - DiGeorge 综合征。

注意上图中第 2 个 BCC (*) 的典型位置和 CT 扫描（左）。它位于下颌角正下方/后方、胸锁乳突肌前缘和颈总动脉外侧（红色箭头）。鳃裂囊肿尾部可位于颈内动脉与颈外动脉之间，如果囊肿体部位置较高时，也是位于这两个动脉之间的间隙。

/ Vascular Anomalies

Vascular Malformations:

- / Venous
- / Lymphatic — *slow flow lesions*
- / Capillary
- / Arterial*
- / Arteriovenous (AV)*
- / Mixed

Haemangiomas & other Vascular Tumours:

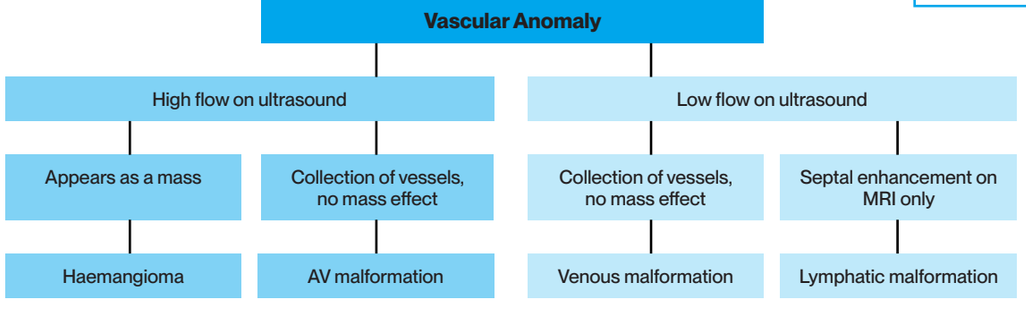
- / Common infantile haemangiomas*
- / Congenital haemangiomas*:
  - / Rapidly involuting (RICH)
  - / Non-involuting (NICH)
- / Other vascular tumours:
  - / Kaposiform haemangioendothelioma (KHE)
  - / Tufted angioma*

*= high flow lesions

<▪> CORE KNOWLEDGE

The International Society for the Study of Vascular Anomalies (ISSVA) has standardised the international nomenclature of vascular anomalies. Given the ubiquity of older terminology and misnomers ingrained in clinical practice, the convention is to now state the ISSVA term followed by "traditional" term in parentheses, e.g., cerebral cavernous venous malformation (cavernoma).

Pathway for vascular anomalies on imaging



Diagrams kindly provided by Dr Alex Barnacle, Consultant Paediatric Interventional Radiologist, Great Ormond Street Hospital, UK

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲:

/ 血管异常

血管畸形:

- / 静脉
- / 淋巴 — *慢流速病变*
- / 毛细血管
- / 动脉*
- / 动静脉 (AV)*
- / 混合

血管瘤和其他脉管性肿瘤:

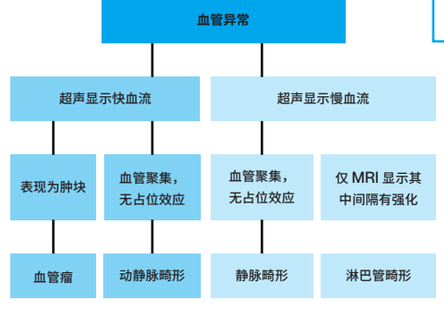
- / 常见婴幼儿血管瘤*
- / 先天性血管瘤*:
  - / 快速消退型 (RICH)
  - / 非消退型 (NICH)
- / 其他脉管性肿瘤:
  - / 卡波西样血管内皮瘤 (KHE)
  - / 丛状血管瘤*

* = 高血流病变

<▪> 核心知识

国际脉管性疾病研究学会 (International Society for the Study of Vascular Anomalies, ISSVA) 对脉管性异常的国际术语进行了标准化统一。鉴于旧术语使用的普遍性和临床实践中根深蒂固的用词不当，目前的惯例是使用 ISSVA 术语，在其后用括号加上“传统”术语，例如，脑海绵状静脉畸形（海绵状血管瘤）。

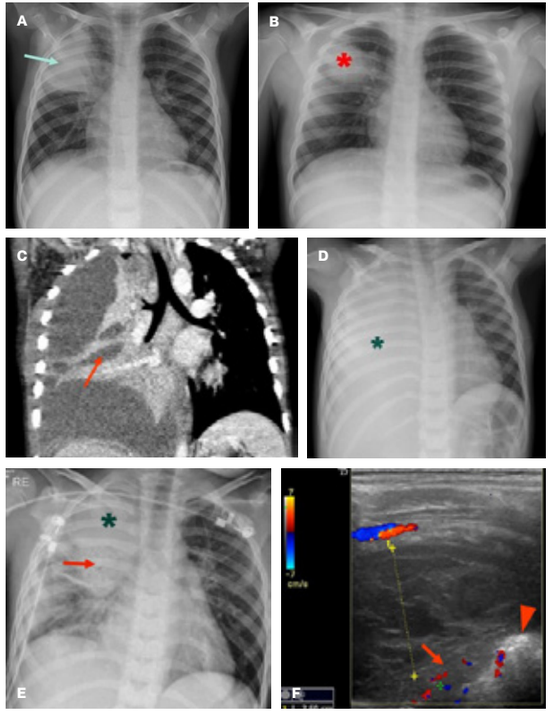
影像学上的血管异常通路



图表由英国大奥蒙德街医院儿科介入顾问放射科医生 Alex Barnacle 博士友情提供

Respiratory Tract Infection

- A wheezy child (asthma or viral bronchiolitis) does not routinely require imaging with chest radiography. The radiograph is typically normal or may show hyperinflation, peribronchial cuffing or minor atelectasis which will not influence treatment choices. Most paediatric respiratory tract infections are viral in aetiology, especially in younger children.
- Imaging is only indicated if there is fever, localised chest signs/symptoms, a persistent cough or a severe illness which may indicate bacterial pneumonia or a complication (e.g., pneumothorax) and may require hospitalisation for intravenous antibiotic treatment.
- With bacterial pneumonia, alveolar air is displaced by inflammatory infiltrate/pus and appears dense (white) on the radiograph, obliterating mediastinal, vascular, diaphragmatic contours.
- Pneumonia may opacify an entire segment or lobe (right upper lobe pneumonia, blue arrow in A). Less common pneumonia in younger children may look circular, known as a round pneumonia (red * in B).
- A CT scan (coronal soft tissue window, C) may reveal areas of non-enhancing pulmonary parenchyma in keeping with necrotising pneumonia (red arrow in C). A parapneumonic effusion in the pleural space combined with pneumonia and atelectasis may result in complete opacification (white-out, green * in D) of the hemithorax with deviation of the mediastinum away from the side of the effusion.
- US delineates the amount of simple (clear = black) or complex (echogenic = thick or with lines= fibrin strands) pleural effusion while consolidated lung has a "hepatisation"/liver-like appearance.



>|< COMPARE

Compare the radiograph (E) and targeted US image (F) in a child with fever. There is a right apical density (*) which exhibits an air-bronchogram at its lower part only (arrow). US shows a mixed anechoic/hypoechoic area with multiple septae and debris, consistent with a complex apical effusion (between yellow crosses). Note the hepatisation of adjacent consolidated lung (arrow) and echogenic air-containing lung (arrowhead). A parapneumonic effusion complicating an apical pneumonia was diagnosed.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

呼吸道感染

- 喘息患儿（哮喘或病毒性毛细支气管炎）通常无需胸片检查。胸片通常正常，或者可能显示过度充气、支气管袖套征或轻微肺不张，这些不影响治疗选择。大多数儿童呼吸道感染的病因都是病毒，尤其是低龄儿童。
- 影像学检查仅在出现发热、局部胸部体征/症状、持续性咳嗽或可能提示细菌性肺炎或并发症（例如气胸）的重症病例中适用；此类病人需要住院接受静脉抗生素治疗。
- 出现细菌性肺炎时，肺泡内气体被炎性浸润/脓液取代，在胸片上表现为致密影（白色），纵隔、血管和横膈的轮廓消失。
- 肺炎可使整个肺段或肺叶透亮度降低、密度增高（右上叶肺炎，A 图中的蓝色箭头）。低龄儿童中较少见的肺炎可呈圆形表现，称为球形肺炎（B 图中的红色 *）。
- CT 扫描（冠状位软组织窗，C 图）可显示无强化肺实质区域符合坏死性肺炎表现（C 图中的红色箭头所示）。肺炎旁胸腔积液、肺炎和肺不张可导致一侧胸腔完全不透光（白肺征，D 图中绿色 *），伴纵隔向积液对侧移位。
- 超声可清晰显示单纯（无回声 = 黑色）或复杂（回声增强 = 稠厚或伴有线样=纤维条索）胸腔积液的量，而实变肺呈“肝样变”/肝样外观。

>|< 比较

比较发热儿童的 X 线片（E 图）和靶向超声图像（F 图）。右肺尖有致密影 (*)，仅在病变下部显示支气管充气征（箭头所示）。超声显示混合无回声/低回声区伴多个纤维分隔和碎屑沉积，符合复杂性肺尖胸腔积液（黄色十字之间）。注意邻近实变肺组织的肝样变（箭头）和含气肺组织高回声表现（箭头）。诊断为肺炎旁胸腔积液，继发于肺尖部肺炎。

Foreign Bodies (FB)

- Young children may ingest, aspirate or insert a foreign body in other orifices like the ears, nose, vagina or urethra.
- Fluoroscopy images can identify radiopaque FB (e.g., metal, bone, glass) using a very low dose. Non-radiopaque FB, like food particles, paper, wood, wax, gems are not directly visible on radiographs or fluoroscopy.
- Aspirated FB manifest with a choking episode which can range from mild coughing to severe respiratory arrest due to airway obstruction. If choking goes unnoticed, the child may present following an asymptomatic interval with respiratory complications like chronic wheezing, recurrent respiratory tract infection, "asthma-like" manifestations and/or airway obstruction.
- Aspirated FB can be indirectly identified because they can cause incomplete bronchial obstruction with air trapping, bronchial obstruction with atelectasis or even nothing. If a suggestive history and auscultation are present, even when radiographs are negative, bronchoscopy or CT may be undertaken.
- Ingested FB usually come out naturally and uneventfully unless sharp, or large. Imaging should also rule out button batteries that are corrosive and should be removed immediately, alongside multiple magnets because they can cause fistulas, perforation and peritonitis.

<!> ATTENTION

Any "double rim" or "halo" sign in a circular opacity differentiates a button battery from a coin (the latter appearing solid) and should prompt removal from the oesophagus within 2 hours.

4-year-old boy who presented with fever. Note that besides a right middle and lower lobe pneumonia (*), the FB (arrow) is radiopaque.

2-year-old boy with paroxysmal coughing. Paucity/thin vessels and increased left lung volume, indicated air-trapping which was due to aspirated nuts.

7-year-old boy who developed ARDS. The pistachio shell (arrow) was first seen with CT. Note the basal atelectasis bilaterally (*).

5-year-old girl who ingested her mother's engagement ring. Note that the stone is not radiopaque (invisible).

"Double rim" or "halo" sign (arrow) consistent with a button battery: **EMERGENCY SITUATION!**

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

异物 (Foreign Bodies, FB)

- 低龄儿童可能会误食、吸入异物或将异物塞入耳朵、鼻子、阴道或尿道等其他孔口。
- 透视检查可以在很低剂量下识别不透射线的异物（例如，金属、骨、玻璃）。透射线的 FB，如食物颗粒、纸张、木头、蜡块、宝石等，在 X 线摄片或透视检查中无法直接看到。
- 吸入异物后表现为呛咳，程度从轻度咳嗽到气道阻塞引起严重呼吸骤停。如果未及时发现呛咳，患儿可能在无症状一段时间后出现呼吸系统并发症，如慢性喘息、反复呼吸道感染、"哮喘样"表现和/或气道阻塞。
- 误吸异物可能会被间接发现，因为可能导致支气管不完全阻塞伴空气潴留、支气管阻塞伴肺不张，或者甚至什么征象都没有。如果存在提示性病史和听诊发现异常，即使 X 线片结果为阴性，也要考虑进行支气管镜或 CT 检查。
- 摄入的异物通常能自然顺利排出，除非是尖锐的或大的异物。影像检查还应排除具有腐蚀性的纽扣电池，应立即取出，同时还有多种磁性异物，因为它们可能导致瘘管、穿孔和腹膜炎。

<!> 注意

圆形不透光阴影中若出现"双环征"或"光环征"，即可区分纽扣电池和硬币（后者呈均匀致密影），应在 2 h 内将异物从食管中取出。

4 岁男童，发热。注意，除了右中叶和下叶肺炎 (*)，异物（箭头）不透射线。

2 岁男童，阵发性咳嗽。肺血管稀疏/纤细和左肺体积增大，提示存在空气潴留，是误吸坚果所致。

7 岁男童，急性呼吸窘迫综合征（Acute Respiratory Distress Syndrome, ARDS)。最初通过 CT 观察到开心果壳（箭头）。注意双侧基底肺不张 (*)。

5 岁女童，误食母亲的订婚戒指。注意，戒指并非不透射线（不可见）。

"双环征"或"光环征"征象与（箭头所示）纽扣电池符合：**紧急情况!**

/ Congenital Heart Disease (CHD)

- / CHD is the *most frequent malformation at birth* (1 per 100 live births).
- / Most CHD patients will now survive to adulthood thanks to current treatment.

>‑< FURTHER KNOWLEDGE

CHD evaluation requires a **multi-disciplinary and multi-modality imaging approach:**

Non-invasive imaging

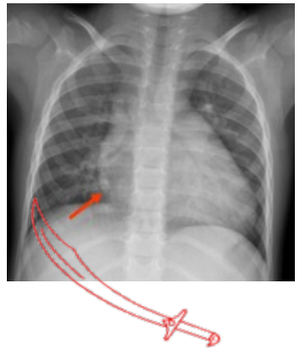
- / Echocardiography (Echo)
  - / **First-line** exam in the **initial evaluation and follow-up.**
  - / May be **limited by poor acoustic window/operator-dependency and for extracardiac/complex anatomical/functional evaluation.**
- / Chest Radiography (CXR)
  - / **Complementary** examination.
  - / Information on **heart size, pulmonary vasculature and parenchyma.**
- / Cardiac Computed Tomography (CCT)
  - / **Second-line** examination for **extracardiac/complex and coronary anatomy.**
- / Cardiac Magnetic Resonance (CMR)
  - / **Second-line** examination for **intracardiac and extracardiac/complex anatomical/functional evaluation.**
  - / **Gold-standard** for **ventricular volumes/function and flow/shunt quantification.**

Invasive imaging

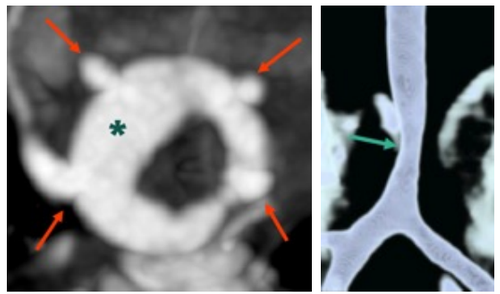
- / Cardiac Catheterization (Cath)
  - / Mainly reserved for **hemodynamic measurements** and **intervention.**

<!> ATTENTION

The correct execution, post-processing and interpretation of all imaging modalities require direct involvement of specialised physicians with knowledge of relevant technical and clinical aspects related to CHD.



4-year-old boy with scimitar syndrome (scimitar = curved sword). CXR shows a smaller (hypoplastic) right lung with ipsilateral mediastinal shift, right heart enlargement and shunt vascularity. A tubular structure parallel to the right heart (arrow) can be seen (scimitar sign) which represents partial anomalous pulmonary venous return to the inferior vena cava. This is one of the few CHDs where CXR can be diagnostic, otherwise it is usually a complementary examination.



6-month-old girl with a vascular ring presenting with stridor. Cardiac CT imaging reconstructed so that the, vessels can be seen from above in an axial plane. There is a double aortic arch with right dominance (*) and left hypoplasia, as is usually the case. The epiaortic vessels (red arrows) have a characteristic pattern, each with their origin from each carotid and subclavian artery from the respective ipsilateral arch. Coronal reconstructed image demonstrates air-filled structures: the trachea is stenotic with malacia at the same level (turquoise arrow).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 先天性心脏病

- / 先天性心脏病 (CHD) 是*最常见的出生畸形*（每 100 例活产中就有 1 例）。
- / 受益于目前的治疗方法，大多数先天性心脏病患者现在都可以活到成年。

>‑< 进阶知识

先天性心脏病的评估需要采用**多学科协作、多模态的影像学检查方法：**

无创影像学检查

- / **超声心动图**
  - / **初始评估和随访中的一线检查。**
  - / **此影像方法可能受限于声窗差/操作者依赖性，且对于心外结构/复杂解剖/功能评估也存在局限性。**
- / **胸片**
  - / **补充检查。**
  - / **提供有关心脏大小、肺血管和肺实质的信息。**
- / **心脏计算机断层扫描**
  - / **心脏 CT 是心外/复杂结构和冠状动脉解剖的二线检查。**
- / **心脏磁共振**
  - / CMR 用于心内和心外/复杂解剖/功能评价的二线检查。
  - / CMR 是评估心室容积/功能和血流/分流定量的金标准。

侵入性影像学检查

- / **心导管检查 (Cardiac Catheterization, Cath)**
  - / **心导管检查主要用于血液动力学测量和介入治疗。**

4 岁男童，弯刀综合征（弯刀 = 弯曲的刀）。胸部 X 光片显示右肺体积较小（右肺发育不良），同侧纵隔移位、右心增大和分流性血管征象。可见与右心平行的管状结构（箭头所示）（弯刀征），代表部分性肺静脉异常引流至下腔静脉。这是少数几种胸部 X 光片可诊断的先天性心脏病之一，除此之外胸片仅作为辅助检查手段。

6 月龄女婴，血管环导致临床出现喘鸣症状。心脏 CT 需要在原始横断位图像的基础上进行三维重建，以获取心血管多角度多方位的三维图像。双主动脉弓，右弓优势 (*)，左弓发育不良，这是双主动脉弓的常见类型。主动脉发出的头臂血管（红色箭头）具有独特的结构特征，双侧的颈总动脉和锁骨下动脉均起源于同侧的主动脉弓。冠状位重建图像可显示充气结构：气管在此处狭窄并伴有软化（蓝绿色箭头）。

<!> 注意

所有影像学检查方法的规范操作、后处理和解读均需由掌握先天性心脏病的相关技术和临床知识的专科医生直接参与完成。

>|< COMPARE

Cardiac Computed Tomography (CCT)

- Extracardiac/complex and coronary anatomy:
  - Superior to CMR for imaging small blood vessels due to the higher spatial resolution.
- Concurrent airway/pulmonary parenchyma evaluation.
- Uncooperative patients:
  - Neonates/infants and younger children.
  - Critically ill patients.
- Metallic devices and calcifications (e.g., stents):
  - Superior to CMR due to lower susceptibility to artefacts.
- CMR contraindications (e.g., non-compatible devices):
  - Inferior to CMR for ventricular volumes/function quantification due to lower temporal resolution, no flow information and increased radiation exposure.

CCT Indications:

- Coronary artery anomalies.
- Vascular rings/slings.
- Tetralogy of Fallot with pulmonary atresia ± major aorto-pulmonary collateral arteries (TOF/PA/MAPCAs).
- Aortic anomalies.
- Anomalies of systemic and pulmonary veins.

Cardiac Magnetic Resonance (CMR)

- Ventricular volumes/function quantification:
  - Superior to Echo for the right ventricle.
- Flow/shunt quantification:
  - Superior to Echo for pulmonary regurgitation.
  - Inferior to Echo for stenosis.
  - Equal to Cath for QP/QS.
  - Right/left lung perfusion.
- Intracardiac and extracardiac anatomical/functional evaluation (if Echo is insufficient).
- Co-operative patients:
  - Older children/adolescents and adults.
  - Sedation/anaesthesia for uncooperative patients.
- Serial follow-up due to no radiation exposure.

Main Clinical Settings for CMR:

- Repaired Tetralogy of Fallot (rTOF).
- Systemic right ventricle.
- Single ventricle (Fontan).
- Shunts of uncertain haemodynamic significance.
- Aortic anomalies.
- Anomalies of systemic and pulmonary veins.

Paediatric Radiology

CHAPTER OUTLINE:

>|< 比较

儿科放射学

章节大纲：

心脏计算机断层扫描

- 心外/复杂和冠状动脉解剖：
  - （心脏 CT）空间分辨率较高，在小血管成像方面优于 CMR。
- 同时进行气道/肺实质评估。
- 不配合的患者：
  - 新生儿/婴儿和低龄儿童。
  - 危重患者。
- 金属装置和钙化物（例如支架）：
  - 对伪像的敏感性较低，优于 CMR。
- CMR 禁忌证（例如磁共振不兼容的装置）：
  - 与 CMR 相比，其在心室容积/功能量化评估方面存在局限性：时间分辨率较低，无法提供血流动力学信息，且存在电力辐射风险。

心脏 CT 适应证：

- 冠状动脉异常。
- 血管环/肺动脉吊带。
- 法洛四联症合并肺动脉闭锁 ± 大型主-肺动脉侧支血管 (TOF/PA/MAPCA)。
- 主动脉异常。
- 体静脉和肺静脉异常。

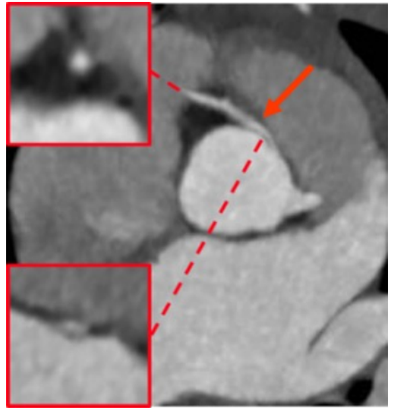
心脏磁共振 (CMR)

- 心室容积/功能量化评估：
  - 右心室容积和功能评估方面优于 Echo。
- 血流/分流定量评估：
  - 肺动脉瓣反流定量评估优于 Echo。
  - 狭窄病变评估方面不如 Echo。
  - 和心导管一样，CMR 可进行 QP/QS 测定。
  - 右/左肺灌注。
- 心内和心外解剖结构/功能评估（适合于超声心动图检查不充分时）。
- 配合性患者：
  - 大龄儿童/青少年和成人。
  - 不配合的患者给予镇静/麻醉。
- 因无辐射暴露风险，CMR 可作为长期随访工具。

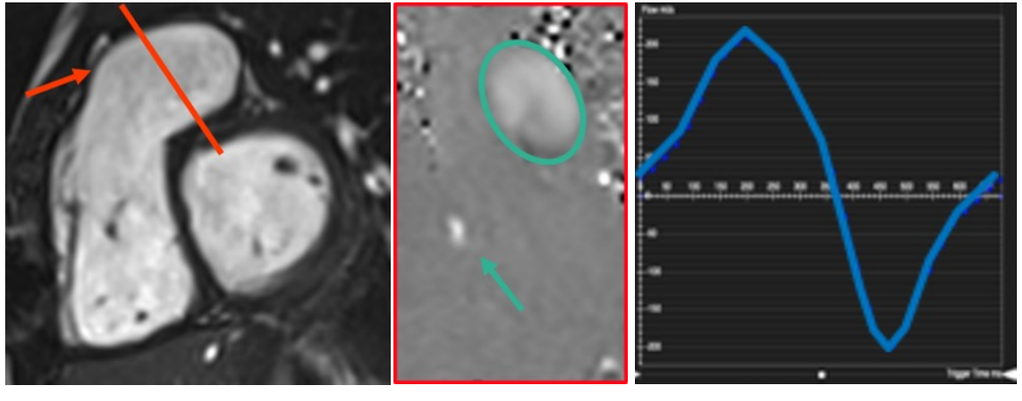
CMR 的主要临床应用场景：

- 法洛四联症术后。
- 承担体循环功能的右心室。
- 单心室 (Fontan)。
- 血流动力学意义不明的分流。
- 主动脉异常。
- 体静脉和肺静脉异常。

CMR in a 14-year-old boy with rTOF (transannular patch and ventricular septal defect closure). **Left**: Cine-SSFP image shows dilation of the right ventricle (RV) with right ventricular outflow tract (RVOT) aneurysm (orange arrow). **Centre**: Velocity-encoded phase-contrast image perpendicular to the RVOT is acquired to quantify pulmonary flow (turquoise circle). Tricuspid regurgitation (turquoise arrow) is also seen. **Right**: Pulmonary flow/time curve, obtained through post-processing reveals severe pulmonary regurgitation (regurgitant fraction 54%). These are typical findings in rTOF and are usually monitored with CMR to decide on pulmonary valve replacement.



CCT in a 6-year-old boy with a coronary artery anomaly. Maximum-intensity projection (MIP) axial image (with embedded vessel cross-section insets): anomalous origin of the right coronary artery (arrow) from the left aortic sinus with iuxta-junctional and juxta-commisural ostium. The vessel has a proximal interarterial and intramural course (the latter suspected by the acute take-off angle, slit-like orifice, and elliptical lumen). This is considered a malignant variant at risk for sudden cardiac death, especially during exercise.



Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

一例 14 岁 rTOF（跨瓣补片和室间隔缺损关闭术）男童的 CMR。**左侧**：Cine-SSFP 图像显示右心室 (RV) 扩大伴右心室流出道 (right ventricular outflow tract, RVOT) 瘤样改变（橙色箭头）。**中心**：采集垂直于右心室流出道 (RVOT) 的速度编码相位对比图像，以量化肺血流（青绿色圈行标识）。也可见三尖瓣反流（青绿色箭头所示）。**右侧**：肺血流量/时间曲线，通过后处理获得，显示重度肺动脉瓣反流（反流分数 54%）。这些是 rTOF 的典型表现，通常用 CMR 监测以决定是否行肺动脉瓣置换术。

6 岁冠状动脉异常男童的心脏 CT。最大密度投影 (Maximum-intensity projection, MIP) 横断位图像（内含血管横截面插图）：右冠状动脉（箭头所示）异常起源于左冠窦，其开口位于窦冠连接处及瓣膜联合紧邻区。该血管近端走行于动脉间和壁内（以下特征提示壁内走行：锐角起点、裂缝样开口和椭圆形管腔）。目前此变异被认定为恶性类型，具有心源性猝死风险，尤其是在运动状态下更为显著。

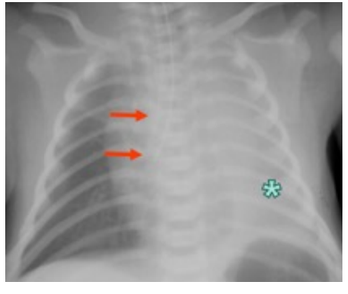
Lines and Tubes in Neonates

- Neonates may be supported via endotracheal tubes (ETT), umbilical venous catheters (UVC) and umbilical arterial catheters (UAC), amongst others.
- The optimal range for the ETT tip is between the thoracic inlet to one vertebral body above the carina.
- The UVC can be misplaced and lie within the portal venous system, superior vena cava or it can cross the foramen ovale to lie in the left heart and pulmonary veins.

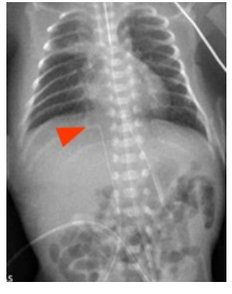
<!> ATTENTION

The ETT tip mirrors chin movement: The tip moves down (towards feet) with neck flexion and up (towards head) with head extension.

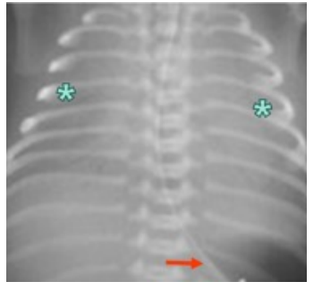
- UAC characteristically course inferiorly within the umbilical artery before turning superiorly to cross the internal iliac artery and reach the aorta. The tip of UAC should lie away from the aortic branch vessels (ideally above T10 or below L3 vertebral levels) to prevent thrombosis/emboli.



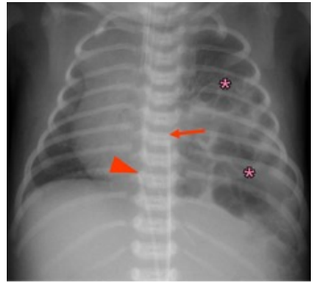
The **endotracheal tube (ETT)** has been advanced down the right bronchus and there is consequent collapse of the left lung (*) which has lost volume and appears dense (white).



Umbilical venous catheters (UVC) traverse the left portal vein and patent ductus venosus to reach their optimal position within the IVC near the right atrium (arrowhead).



Respiratory distress syndrome in a premature neonate due to surfactant deficiency. The lungs (*) are dense, exhibit small volume and are usually treated with surfactant delivered via the ETT. Note the nasogastric tube (arrow).



Congenital diaphragmatic hernia with hypoplasia of the left lung, bubbly appearance of air-filled bowel loops into the chest (*) and shift of the mediastinum to the right. Diaphragmatic defects in CDH are usually posterior and left-sided, requiring surgical repair. Prognosis is influenced by the degree of pulmonary hypoplasia. Note the tips of UAC (arrow) and UVC (arrowhead).

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

新生儿治疗过程中生命支持的那些线和管道

- 新生儿生命支持可能涉及气管插管 (ETT)、脐静脉导管 (UVC) 和脐动脉导管 (UAC) 等各类管路。
- 气管插管尖端的最佳位置范围是从胸廓入口到气管隆突上方一个椎体之间。
- 脐静脉导管可能会移位，包括位于门静脉系统、上腔静脉内，或穿过卵圆孔，进入左心和肺静脉内。
- 脐动脉导管的特征性走行：先在脐动脉内向下走行，然后转向向上跨过髂内动脉，最终到达主动脉。脐动脉导管的尖端应远离主动脉分支血管（最好高于 T10 或低于 L3 椎体水平），以防止血栓形成/栓塞。

<!> 注意

气管插管尖端位置与下颌运动同步：颈部弯曲时，尖端向下（朝向足）移动，头部伸展时，尖端向上（朝向头部）移动。

气管插管 (ETT) 过深进入右支气管向，导致左肺塌陷 (*)，体积减小且呈致密影（白色）。

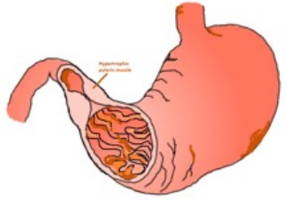
脐静脉导管经门静脉左支和未闭的静脉导管，其导管尖端理想放置位置是在右心房附近的下腔静脉内（箭头）。

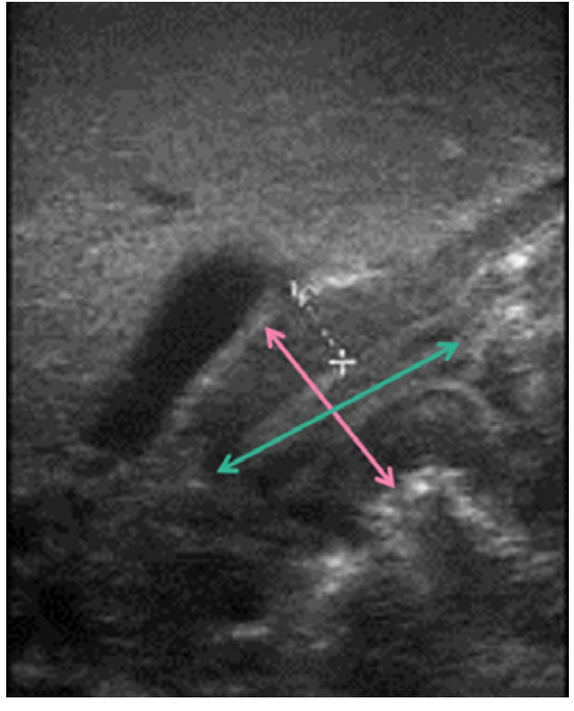
早产儿呼吸窘迫综合征，肺表面活性物质缺乏导致。肺 (*) 致密，体积小，通常通过气管插管给予表面活性物质进行治疗。注意鼻胃管（箭头所示）。

先天性膈疝 (CDH) 伴左肺发育不全、充气肠袢呈气泡状外观，进入胸腔 (*)，纵隔向右移位。先天性膈疝的膈肌缺损通常位于后方和左侧，需要手术修复。肺发育不良的程度会影响预后。注意脐动脉导管（箭头）和脐静脉导管（箭头）的尖端。

Hypertrophic Pyloric Stenosis (HPS)

- Hypertrophy of circular muscle causing gastric outlet obstruction.
- The aetiology is uncertain.
- Risk factors: male 4:1, first born and positive family history, 13%.
- Symptoms: projectile non-bilious vomiting at 2-12 weeks of age, palpable “olive” at epigastrium, visible gastric hyperperistalsis. In late stages, electrolyte imbalance and weight loss/emaciation.
- Imaging method of choice: **ultrasound before and during feeding.**
- US findings: thickness of the muscle > 3 mm (between cursors shown in this longitudinal US view of the pylorus) and lack of passage of gastric contents through the pylorus typifies HPS making the diagnosis. A distended stomach in a vomiting unfed child is an indirect sign of delayed gastric emptying.
- Additional findings (coloured arrows seen on the adjacent US image): **Antero-posterior pyloric diameter** > 15 mm, **elongated channel (pyloric canal)** > 18 mm.
- Pitfalls: pylorospasm (transient abnormal appearance, important for the US operator to wait for the pyloric muscle to relax and look again).
- Treatment: surgery with Haller's pyloromyotomy.





Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

肥厚性幽门狭窄

- 幽门环肌肥大导致胃出口梗阻。
- 病因尚不明确。
- 风险因素：男性 4:1，头胎和阳性家族史，13%。
- 症状：2～12 周龄时出现喷射性非胆汁性呕吐，上腹部可触及“橄榄状”包块，可见胃蠕动亢进。晚期出现电解质紊乱和体重减轻/消瘦。
- 首选影像检查方法：**进食前和进食期间进行超声检查。**
- 超声检查结果：幽门肌层厚度 > 3 mm（图示幽门纵切面超声游标间测量值），且胃内容物无法通过幽门，是肥厚性幽门狭窄的典型特征，可以确诊。未进食的呕吐患儿，出现胃扩张是胃排空延迟的间接征象。
- 其他结果（相邻超声图像上可见彩色箭头标识）：**幽门前后径** > 15 mm，**细长通道（幽门管）** > 18 mm。
- 鉴别诊断：幽门痉挛（短暂异常表现，超声操作员必须等待幽门肌肉放松后再观察）。
- 治疗方法：Haller 幽门肌切开术。

Intussusception

- This is a common condition seen in young children, usually between 5-9 months (with range between, 3 months and 3 years).
- The majority are idiopathic (90%) and preceded by viral infection. The commonest subtype is ileo-colic intussusception.Secondary intussusception due to pathological lead points, including Meckel's diverticulum, lymphoma, duplication cyst, polyp, and haematoma should be excluded in children younger than 2 months and older than 3-4 years of age.
- Traditionally children present with irritability, abdominal pain, pulling the legs up to the abdomen and 'red currant jelly' type stools. Since many children present with non-specific symptoms, this diagnosis **must be excluded** in acute abdominal pain in certain age groups.
- There is a risk of bowel infarction if not managed quickly by prompt reduction. If this cannot be managed radiologically the child may need surgical reduction.
- Emergency US establishes the diagnosis by showing a target sign, typically in the right side of the abdomen. Abdominal radiographs are subsequently not indicated but if performed, they may demonstrate a soft tissue density, relative paucity of gas within the right abdomen and possibly upstream small bowel obstruction.
- Radiological management is undertaken by reduction that can be done by an air enema or a fluid enema, under fluoroscopy or ultrasound guidance – this depends on local expertise and availability. Recurrent post reduction may occur. The main risk of the reduction procedure is perforation (low in expert hands).

Paediatric Radiology

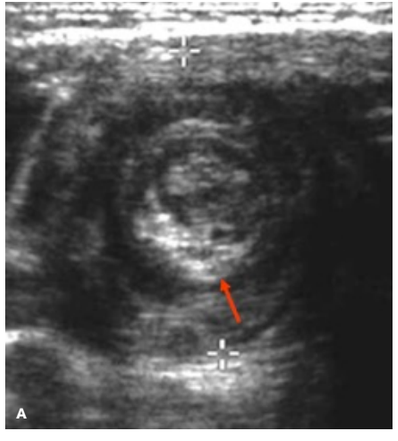
CHAPTER OUTLINE:

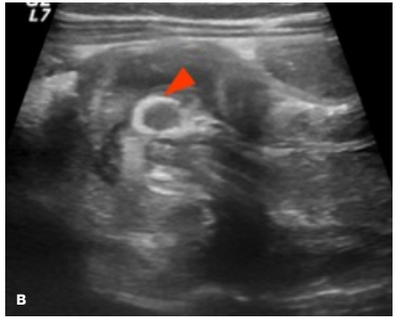
儿科放射学

章节大纲：

肠套叠

- 这是一种幼儿常见病，高发期通常在 5～9 个月（年龄范围可跨越3 月龄至 3 岁）。
- 大多数为特发性（90%），且发病前有病毒感染。最常见的亚型是回肠结肠型肠套叠。对于 2 个月以下和 3～4 岁以上的患儿，应排除由病理性诱因导致的继发性肠套叠，包括梅克尔憩室、淋巴瘤、肠重复囊肿、息肉和血肿等。
- 患儿通常会出现烦躁、腹痛、屈膝体位以及排果酱样血便等症状。鉴于多数患儿临床症状缺乏特异性，对于某些特定年龄段的急性腹痛患者，必须排除肠套叠的可能性。
- 如果不能及时复位治疗，则有肠梗死的风险。若影像学复位失败，则需要手术复位治疗。
- 急诊超声可通过显示腹部右侧“靶环征”来确诊。腹部平片虽非必需检查，但若实施该检查，则可显示软组织密度影、右腹气体稀疏征象，或伴发近端小肠梗阻表现。
- 放射学复位治疗是操作者在透视或超声引导下，通过空气灌肠或液体灌肠进行复位，具体方案取决于当地专业水平和医疗条件。复位后可能再复发。复位治疗的主要风险是穿孔（在技术娴熟的操作者手中发生率较低）。





US scan showing intussusception. Transverse (A) and oblique/longitudinal (B) views reveal the "donut" formed by concentric rings of oedematous bowel. Note a trapped echogenic crescent of fat (arrow) and a trapped lymph node (arrowhead).

Red currant jelly

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

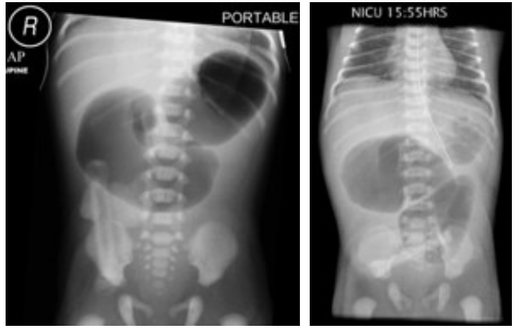
章节大纲：

果酱样血便

超声显示肠套叠。横切面 (A) 和斜/纵切面 (B)显示水肿肠管形成同心环状“靶环”征。注意观察被套入的强回声脂肪新月体（箭头所示）和被套入的淋巴结（箭头所示）。

Neonatal Proximal GI Obstruction

- Obstruction of the gastrointestinal (GI) tract in neonates can be detected antenatally with abnormally distended loops of bowel on foetal US/ MRI or postnatally in babies who do not follow the normal feeding expectations, e.g., they aspirate and vomit or fail to pass meconium.
- A plain radiograph is the initial imaging test. Normally, gas fills the stomach and proximal small bowel by 6 hours, the entire small bowel by 12 hours and reaches the rectum by 24 hours.
- Radiographs help neonatologists decide if an obstruction is present, where it is likely to be, give a differential and guide what to do next.
- It is difficult to differentiate small and large bowel on radiographs of small children and dilated loops differentiate "upper" vs. "lower" obstruction.
- Upper obstruction is commonly due to an atresia (complete congenital occlusion) or a stenosis (fixed narrowing) in the proximal bowel (most commonly involving the duodenum, jejunum and less so the stomach outlet in that order).
- In congenital upper obstruction radiographs demonstrate a limited number of significantly distended loops of bowel (depending on which of the above segments are involved), usually less than four.
- If no gas is seen beyond these dilated loops of bowel, then an atresia is likely. If some distal gas is appreciated, then a stenosis is more likely.
- When appearances are those of complete obstruction then the surgical team often proceeds directly to the operating room without requiring further imaging. If appearances are not classical and the course is uncertain, an upper GI study may be performed.



Plain films in 2 neonates demonstrating abnormal dilated loops of bowel with no distal bowel gas compatible with atresia – the baby on the left has a 'double bubble sign' and duodenal atresia was confirmed at surgery. The neonate on the right demonstrates a triple bubble and jejunal atresia was found at surgery.

>=< FURTHER KNOWLEDGE

Differential diagnosis for the "double bubble" with distal gas:

- Duodenal stenosis
- Duodenal web
- Annular pancreas
- Preduodenal portal vein
- Ladd's bands in malrotation (see specific slide on malrotation)

Similar scenario with a proximal obstruction in a neonate with a dilated stomach and duodenum. In this case distal gas can be appreciated (arrows). This is secondary to incomplete obstruction from a duodenal stenosis.

Berrocal et al. GI emergencies in the Neonate. Chapter in: Radiological imaging of the digestive tract in infants and children. 2nd edition. (2016) Stafrace & Blickman Editors Springer publishers.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

新生儿上消化道梗阻

- 新生儿胃肠道梗阻可通过产前和产后两种途径发现：产前超声/MRI 可见肠袢异常扩张；产后出现喂养异常（如呛吸和呕吐）或胎粪排出障碍。
- 最初影像学检查为 X 线平片。正常情况下，出生后气体在 6 h 内充满胃和近端小肠，12 h 内充满整个小肠，24 h 内到达直肠。
- 腹部平片有助于新生儿科医生判断是否存在梗阻、定位梗阻可能发生的部位、提供鉴别诊断并指导后续诊疗方案。
- 婴幼儿腹部平片中小肠与结肠难以区分，需依据肠袢扩张模式鉴别高位与低位梗阻。
- 高位梗阻常见病因包括闭锁（先天性完全梗阻）或狭窄（固定性管腔缩窄），多发生于近端肠管（好发部位依次为十二指肠、空肠，胃流出道相对少见）。
- 先天性高位梗阻的腹平片显示少量显著扩张肠袢（具体数量取决于受累肠段），通常少于 4 个。
- 若扩张肠袢远端未见气体征象，则提示闭锁可能性大。若扩张肠袢远端有气体，则更可能为狭窄所致。
- 当腹平片呈现完全性梗阻征象时，外科团队通常无需进一步影像检查而直接施行手术。若腹平片表现不典型且病程不确定，可行上消化道检查。

>=< 进阶知识

“双泡征”伴远端气体存在的鉴别诊断：

- 十二指肠狭窄
- 十二指肠蹼
- 环状胰腺
- 十二指肠前门静脉
- Ladd 索带肠旋转不良（见肠旋转不良专题幻灯片）

2 例新生儿的腹平片显示肠袢异常扩张伴远端无长段无气体，符合肠闭锁表现。左侧婴儿有“双泡征”表现，手术证实十二指肠闭锁。右侧新生儿显示三泡征，手术时证实空肠闭锁。

相同情况可发生在胃和十二指肠扩张的新生儿近端梗阻。此时可见远端气体（箭头所示）。这种情况继发于十二指肠狭窄引起的不完全性梗阻。

Berrocal et al. GI emergencies in the Neonate. Chapterin: Radiological imaging of the digestive tract ininfants and children. 2nd edition. (2016) Stafrace& Blickman Editors Springerpublishers.

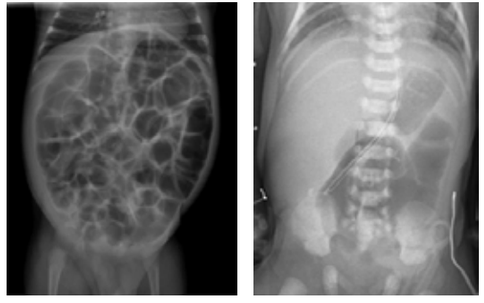
Neonatal Obstruction – Distal Obstruction

- Obstruction that involves the bowel from the **distal** ileum onwards is referred to as distal obstruction.
- In simple terms, this means that there are too many dilated loops of bowel to count on the radiograph!
- Obstruction can again be due to atresia or stenosis of the distal bowel (more commonly the ileum). Other considerations include:
- Inspissated abnormal meconium causing obstruction in the distal small bowel termed '**meconium ileus**'; the latter is a presentation of **cystic fibrosis**.
- Congenital anorectal malformations (ARM).
- Abnormalities with the innervation of the bowel resulting in abnormal or absent peristalsis, i.e., Hirschsprung disease.
- Functional immaturity of the colon.
- In neonates with a distended abdomen, delayed passage of meconium and distal obstruction on radiographs, anal atresia should be excluded clinically first which will allow a fluoroscopic retrograde contrast enema to be performed. In some centres, this is replaced or preceded by an ultrasound-guided saline enema.
- In the above scenario, the enema is diagnostic but may also be therapeutic, e.g., in meconium ileus and functional immaturity of the colon.

Berrocal et al. GI emergencies in the Neonate. Chapter in Radiological imaging of the digestive tract in infants and children. Stafrace & Blickman Editors. 2nd edition (2016) Springer publishers.

<!> ATTENTION

When neonates undergo an enema investigation or any fluoroscopic investigation, care must be taken to keep them warm. Neonates get cold very quickly!



First abdominal radiograph (A) of a neonate with delayed passage of meconium, demonstrating multiple dilated gas-filled loops of bowel in all four quadrants; these appearances are not specific but are sufficient to identify distal obstruction.

Neonate with abdominal distension and failure to pass meconium. The abdominal radiograph (left image) demonstrates multiple dilated bowel loops consistent with distal obstruction. The enema (fluoroscopic image on the right) demonstrates a 'microcolon/unused colon' of small calibre. Some contrast also retrogradely fills collapsed distal small bowel (red arrow) with dilated gas-filled bowel more proximally. The diagnosis was ileal atresia.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

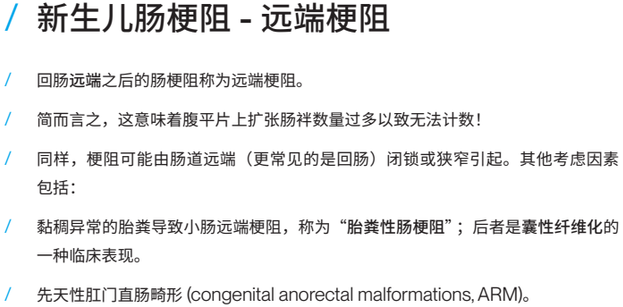
章节大纲：

新生儿肠梗阻 - 远端梗阻

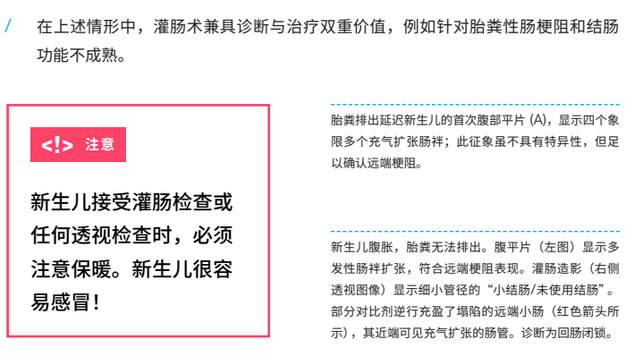
- 回肠远端之后的肠梗阻称为远端梗阻。
- 简而言之，这意味着腹平片上扩张肠袢数量过多以致无法计数！
- 同样，梗阻可能由肠道远端（更常见的是回肠）闭锁或狭窄引起。其他考虑因素包括：
- 黏稠异常的胎粪导致小肠远端梗阻，称为“**胎粪性肠梗阻**”；后者是**囊性纤维化**的一种临床表现。
- 先天性肛门直肠畸形 (congenital anorectal malformations, ARM)。
- 肠道神经支配异常导致蠕动异常或缺失，即先天性巨结肠。
- 结肠功能不成熟。
- 对于腹部膨隆、胎粪排出延迟和 X 线片显示远端肠梗阻的新生儿，应首先通过临床排查排除肛门闭锁，继而实施透视下逆行造影灌肠术。部分医疗中心采用超声引导下生理盐水灌肠术替代或先行于该项检查。
- 在上述情形中，灌肠术兼具诊断与治疗双重价值，例如针对胎粪性肠梗阻和结肠功能不成熟。

<!> 注意

新生儿接受灌肠检查或任何透视检查时，必须注意保暖。新生儿很容易感冒！



胎粪排出延迟新生儿的首次腹部平片 (A)，显示四个象限多个充气扩张肠袢；此征象虽不具有特异性，但足以确认远端梗阻。



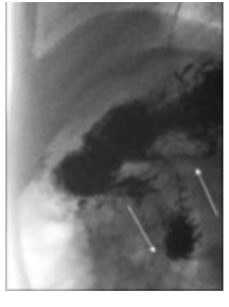
新生儿腹胀，胎粪无法排出。腹平片（左图）显示多发性肠袢扩张，符合远端梗阻表现。灌肠造影（右侧透视图像）显示细小管径的“小结肠/未使用结肠”。部分对比剂逆行充盈了塌陷的远端小肠（红色箭头所示），其近端可见充气扩张的肠管。诊断为回肠闭锁。

Malrotation - Midgut Volvulus

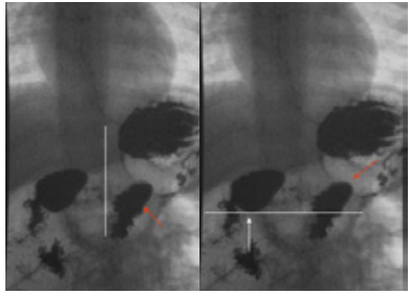
- Normal rotation and fixation of the bowel results in a long mesentery between the duodenal-jejunal (DJ) flexure in the left upper quadrant and the caecum in the right lower quadrant of the abdomen.
- When this developmental process is abnormal, the mesentery is short, and the bowel is prone to twisting on itself around the mesenteric vessels causing acute obstruction and potentially fatal bowel ischaemia.
- Congenital bowel obstruction may also result from abnormal peritoneal bands (Ladd's bands) that cross over the duodenum.
- Malrotation can present at any age and is a **clinical emergency**.
- Infants with malrotation and volvulus present early in life, classically with bilious (green) vomiting (90% in the first 3 months).
- An emergency, targeted ultrasound may demonstrate the "whirlpool sign" of small bowel and mesentery with swirling vessels wrapped around the superior mesenteric artery. If US is inconclusive, an upper GI contrast study, the gold standard examination, **must** be done which evaluates the position of the DJ flexure and assesses for secondary volvulus.
- On a fluoroscopic AP image, the DJ flexure should be positioned to the left of the adjacent vertebral pedicle, with its upper aspect at least at the level of the lower margin of the pylorus.
- On a lateral fluoroscopic image, the 2nd, 3rd and 4th part of the duodenum are situated retroperitoneally, with the 3rd part more caudally and posteriorly to the 2nd and 4th parts.

>▪< FURTHER KNOWLEDGE

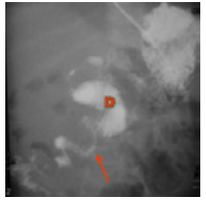
- When malrotation is complicated with volvulus the DJ flexure is abnormally **positioned** and a "corkscrew sign" is classically demonstrated. Alternatively, there may be a complete cut off at the level of the 2nd part of the duodenum.



Normal retroperitoneal course of the duodenum on the lateral projection which proceeds posteriorly before descending.



Normal position of the DJ flexure (red arrows) on the AP fluoroscopic images from an upper GI examination which lies to the left of the left pedicles (vertical line) and above the lower margin of the pylorus (horizontal line).



Classical malrotation and volvulus with dilated proximal duodenum (D) leading to the "corkscrew sign" (red arrow).

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

旋转不良 - 中肠扭转

- 肠道正常旋转与固定后，可在左上腹十二指肠空肠曲与右下腹盲肠之间形成长的肠系膜。
- 当该发育过程出现异常时，肠系膜变短，肠道易围绕肠系膜血管自行扭转，导致急性梗阻及潜在致死性的肠缺血。
- 先天性肠梗阻也可能由横跨十二指肠的异常腹膜索带（Ladd 索带）引起。
- 肠旋转不良可能出现在任何年龄段，是一种临床急症。
- 肠旋转不良和肠扭转的婴儿在出生后不久就会发病，典型表现为胆汁性（绿色）呕吐（90% 发生于出生后 3 个月内）。
- 急诊超声可显示“漩涡征”，即小肠与系膜环绕肠系膜上动脉旋转形成的血管涡流征象。若超声无法明确诊断，则必须进行上消化道造影检查（金标准检查），以评估十二指肠空肠曲位置并检测继发性肠扭转。
- 在透视前后位 (AP) 图像上，十二指肠空肠曲应位于相邻椎弓根的左侧，其上缘至少位于幽门管下缘水平。
- 在侧位透视图像上，十二指肠的第 2、第 3 和第 4 部分位于腹膜后，第 3 部分在第 2 和第 4 部分的尾侧和后方。

>▪< 进阶知识

- 肠旋转不良并发肠扭转时，十二指肠空肠曲的位置异常，典型表现为“螺旋征”。或者，也有可能在十二指肠的第 2 部分处完全中断。

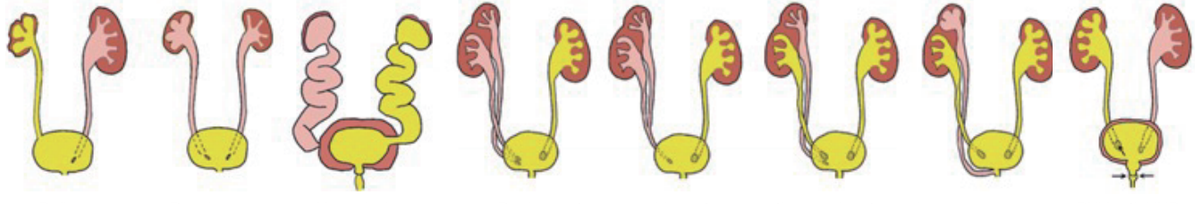
十二指肠在侧位投照上的正常腹膜后走行，先向后延伸，然后下降。

上消化道造影的前后位透视图像上显示十二指肠空肠曲的正常位置（红色箭头所示），位于左椎弓根连线的左侧（竖线）和高于幽门下缘水平线（横线）。

典型的肠旋转不良伴肠扭转，近端十二指肠扩张，导致“螺旋征”（红色箭头所示）。

Congenital Anomalies of Kidney and Urinary Tract (CAKUT)

- These result from failure of the normal development of nephrons and the urinary collecting system (nephropathy and uropathy):
  - **Malformation of the renal parenchyma:** renal agenesis, renal dysplasia, multicystic dysplasia.
  - **Abnormalities of embryonic migration of the kidneys:** renal ectopia, fusion anomalies (horseshoe kidney).
  - **Abnormalities of the developing urinary collecting system:** duplicate collecting systems, posterior urethral valves (PUV), pelvi-ureteric junction obstruction (PUJO), vesico-ureteric junction (VUJ) obstruction.
- Most may be accompanied by vesicoureteral reflux (VUR) and predispose to urinary tract infection (UTI).
- Most CAKUT manifest with some degree of dilatation of the collecting system and/or ureter with or without parenchymal anomalies.
- Dilatation and gross reflux that result in deterioration of renal function are treated operatively and with endoscopic sclerotherapy.



Reflux nephropathy 反流性肾病 | Dysplasia 发育不良 | Hypoplasia Obstruction VUR 发育不全梗阻 VUR | Duplex systems, variable ureteric insertions and ureterocele 双腔系统、可变输尿管插入和输尿管囊肿 | PUV with VUR 带 VUR 的 PUV

Images above modified from Dr. Pieter Dik, paediatric urologist, UMC Utrecht

Paediatric Radiology

CHAPTER OUTLINE:

先天性肾脏和尿路畸形

- 此类异常源于肾单位和泌尿集合系统未能正常发育（肾病性和尿路性发育异常）：
  - **肾实质畸形：**肾缺如、肾发育不良、多囊性发育不良。
  - **肾脏胚胎移行异常：**肾异位、融合异常（马蹄肾）。
  - **泌尿集合系统发育异常：**重复集合系统、后尿道瓣膜 (posterior urethral valves, PUV)、肾盂输尿管连接部梗阻 (pelvi-ureteric junction obstruction, PUJO)、膀胱输尿管连接部 (vesico-ureteric junction, VUJ) 梗阻。
- 大多数情况下还会伴有膀胱输尿管反流 (vesicoureteral reflux, VUR)，并容易引发尿路感染 (urinary tract infection, UTI)。
- 大多数先天性肾脏和尿路畸形表现为集合系统和/或输尿管有一定程度的扩张，伴或不伴实质异常。
- 导致肾功能恶化的尿路扩张和严重反流可行手术治疗及内镜下硬化治疗。

儿科放射学

章节大纲：

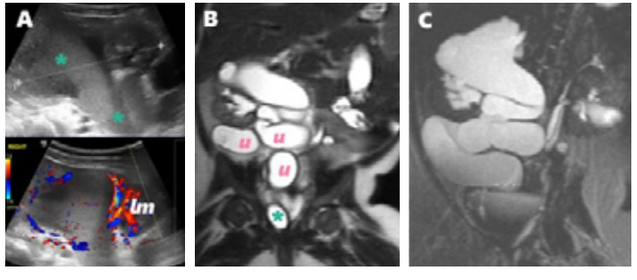
上图改编自 UMC Utrecht 小儿泌尿科 Pieter Dik 博士

Paediatric Radiology

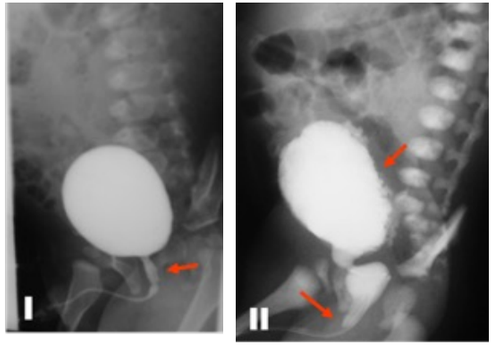
CORE KNOWLEDGE

- US of bladder, ureters, kidneys on a well hydrated child, with emphasis on parenchyma, and excretory system (measurements of anteroposterior diameter of pelvis, ureters, pre and post void) is used for antenatal and postnatal diagnosis and follow-up.
- Micturating cystourethrography (MCUG) is used for the diagnosis of VUR and PUV by retrograde instillation of contrast into the bladder via a catheter, with images obtained during filling and voiding using fluoroscopy, US or scintigraphy.
- Morphological and functional images, including split renal function, can be performed by MR urography.
- Functional images and split renal function can also be obtained by renography.
- Intravenous urography has no routine place in imaging of the paediatric renal tract.

FURTHER KNOWLEDGE



A. Longitudinal US scan of the right kidney in a febrile child with urinary tract infection. The lower renal moiety is normal and well-perfused (lm). The upper renal moiety exhibits parenchymal thinning and gross dilatation of pelvis and ureter with echogenic content suggestive of pyonephrosis (*).
B. MRI coronal T2-w sequence shows tortuous upper moiety ureter (u) ending in an ectopic position (*).
C. MRI multiplanar reconstruction oblique coronal plane demonstrates a dilated duplex system on the right and an uncomplicated duplex system on the left.



COMPARE

Compare the MCUG images during micturition of contrast in a normal male (I) and male with posterior urethral valves (II). Normally the bladder is smooth, and the posterior urethra (arrow) is slightly wider than the anterior urethra (I). In (II), there is a trabeculated bladder (arrow) and a dilated posterior urethra with a thin shelf-like filling defect (thick arrow) at the site of posterior urethral valves (PUV).

CHAPTER OUTLINE:

儿科放射学

- 对身体水分充足的儿童进行膀胱、输尿管和肾脏超声检查，重点评估肾实质以及排泄系统（测量肾盂、输尿管的前后径、排尿前后膀胱容量），适用于产前和产后诊断及随访检测。
- 排尿性膀胱尿道造影是通过导管将对比剂逆行注入膀胱，采用透视、超声或核医学显像技术于充盈期及排尿期采集图像用于诊断膀胱输尿管反流和后尿道瓣膜。
- 磁共振尿路成像可获取形态学和功能性的图像，包括分肾功能评估。
- 肾动态显像获得功能性图像和分肾功能检测结果。
- 静脉尿路造影在儿童泌尿系统影像学评估中已非标准常规检查。

进阶知识

章节大纲：

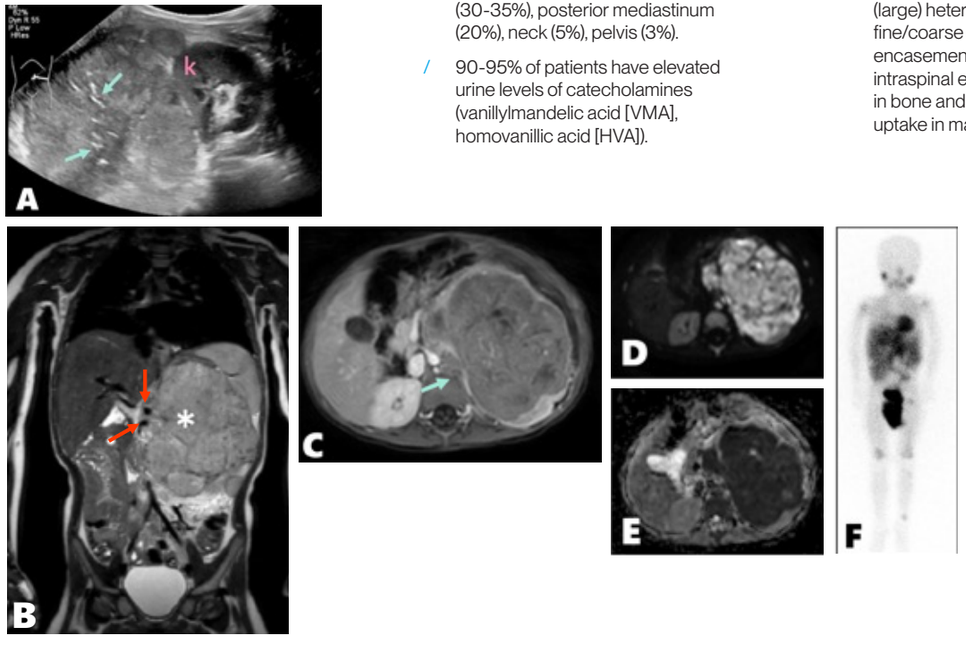
A.发热患儿尿路感染时右肾的长轴超声扫描。下肾部灌注良好，功能正常。上肾部实质变薄，肾盂和输尿管显著扩张，高回声提示肾盂积脓 (*)。
B. MRI 冠状位 T2加权序列显示迂曲的上肾部输尿管 (u)，其末端异位开口 (*)。
C. MRI 多平面重建斜冠状位图像显示，右侧存在扩张的重复肾系统，而左侧无并发症存在的重复肾系统。

比较

比较正常男性 (I) 和有后尿道瓣膜的男性 (II) 在对比剂排尿期间的排尿性膀胱尿道造影图像。正常情况下膀胱壁光滑，后尿道（箭头所示）比前尿道 (I) 略宽。在 (II) 中，存在小梁样膀胱（箭头所示）和后尿道扩张，后尿道瓣膜 (PUV) 处可见薄膜样充盈缺损（粗箭头所示）。

Neuroblastoma

- Malignant ganglion cell tumour derived from primordial neural crest cells that form the sympathetic nervous system.
- 8-10% of childhood cancers, median age at presentation = 22 months (95% ≤ 10 y).
- Sites of origin: adrenal medulla (35%), extra-adrenal retroperitoneum (30-35%), posterior mediastinum (20%), neck (5%), pelvis (3%).
- 90-95% of patients have elevated urine levels of catecholamines (vanillylmandelic acid [VMA], homovanillic acid [HVA]).
- For staging and therapy response, assessment with both MRI (or CT) and 123MIBG scintigraphy is mandatory.
- Imaging characteristics include (large) heterogeneous mass(es), fine/coarse calcifications, vascular encasement, retro-aortic extension, intraspinal extension, metastases in bone and liver with MIBG tracer uptake in majority of cases.



A. Axial US scan of the left adrenal region shows a large heterogeneous mass with small central spots of calcifications (arrows). There is displacement and compression of the left kidney (k). B. MRI, coronal T2W sequence shows a large T2 hyperintense mass (*) in the left adrenal region with partial encasement of the coeliac trunk and superior mesenteric artery (arrows). C. Contrast-enhanced T1W sequence shows heterogeneous tumour enhancement, and retro-aortic nodal extension (arrow). D & E: Diffusion-weighted and ADC map images show extensive diffusion restriction indicative of a cellular tumour. F. 123MIBG scintigraphy shows pathologic tracer uptake in the large retroperitoneal mass and in multiple skeletal metastases.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

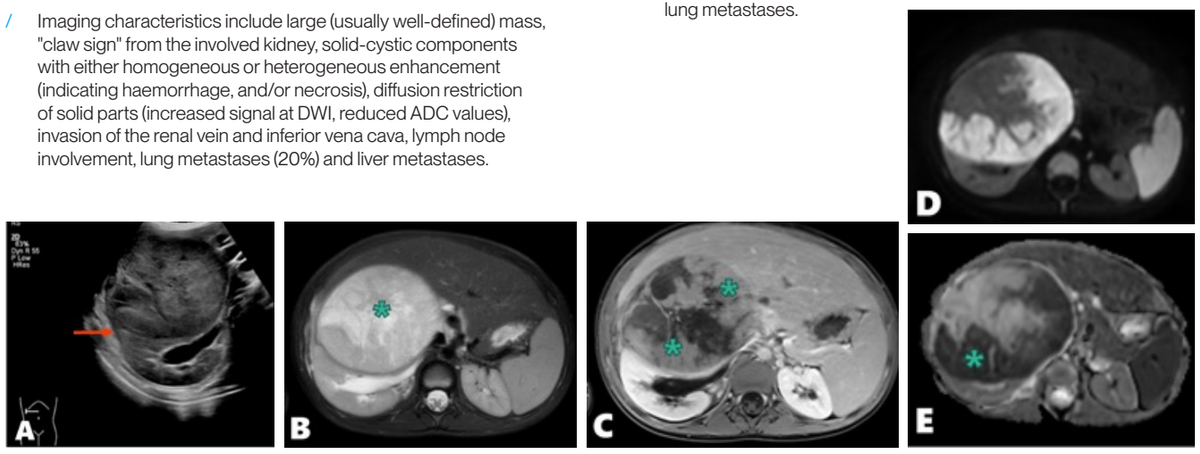
神经母细胞瘤

- 恶性神经节细胞瘤，源自形成交感神经系统的原始神经嵴细胞。
- 占儿童癌症的 8%～10%，发病年龄中位数 = 22 个月（95% ⩽ 10 岁）。
- 原发部位：肾上腺髓质 (35%)、肾上腺外腹膜后 (30%～35%)、后纵隔 (20%)、颈部 (5%)、盆腔 (3%)。
- 90%～95% 的患者尿液中儿茶酚胺（香草扁桃酸 [VMA]、高香草酸 [HVA]）水平升高。
- 进行分期和治疗反应评估时，必须联合采用 MRI（或 CT）和^{123}I-MIBG 显像进行检查。
- 影像学特征包括（巨大）不均质肿块、细/粗钙化灶、血管包绕、主动脉后延伸、椎管内侵犯、骨和肝转移，大多数病例存在 MIBG 示踪剂摄取。

A.左肾上腺区域轴位超声扫描显示巨大不均质肿块伴中心点状钙化（箭头所示）。左肾移位和受压 (k)。B.MRI 冠状位 T2 加权序列显示左肾上腺区巨大的 T2 高信号肿块 (*)，并且包绕腹腔干和肠系膜上动脉（箭头所示）。C.对比增强 T1 加权序列显示肿瘤不均匀强化和主动脉后淋巴结侵犯（箭头）。D & E：弥散加权和 ADC 图显示广泛的弥散受限，显示高细胞密度肿瘤。F.^{123}I-MIBG显像显示腹膜后巨大肿块和多发性骨转移灶存在病理性示踪剂摄取。

Wilms Tumour (Nephroblastoma)

- Most common renal malignancy in children with peak incidence at 3 years of age (80%, 1-5 years of age).
- Usually asymptomatic but the patient may present with a palpable abdominal mass.
- It can be bilateral (5%), may be associated with overgrowth disorders (e.g., Beckwith-Wiedemann syndrome) and other genetic disorders (e.g., DICER1 mutations).
- Imaging characteristics include large (usually well-defined) mass, "claw sign" from the involved kidney, solid-cystic components with either homogeneous or heterogeneous enhancement (indicating haemorrhage, and/or necrosis), diffusion restriction of solid parts (increased signal at DWI, reduced ADC values), invasion of the renal vein and inferior vena cava, lymph node involvement, lung metastases (20%) and liver metastases.
- Ultrasonography is used for initial evaluation of a palpable abdominal mass and to identify a renal tumour.
- MRI (or CT) are used to further characterise tumour extent/invasion and to assist with staging.
- Chest CT (or CXR) is used to evaluate for the presence of lung metastases.



A. Axial US image of the right kidney shows a large slightly heterogeneous mass with a neighbouring "beak" of kidney (arrow) indicating intrarenal origin.
B. MRI axial T2W sequence shows a large hyperintense mass (*) in the right abdomen, arising from the right kidney.
C. Axial contrast-enhanced T1W sequence shows heterogeneous enhancement (*).
D and E. Diffusion-weighted images show extensive diffusion restriction in the solid enhancing parts of the mass (*) arising from the right kidney

Paediatric Radiology

CHAPTER OUTLINE:

Wilms 瘤（肾母细胞瘤）

儿科放射学

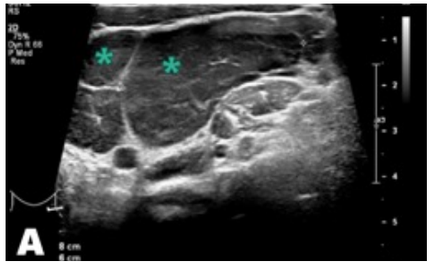
章节大纲：

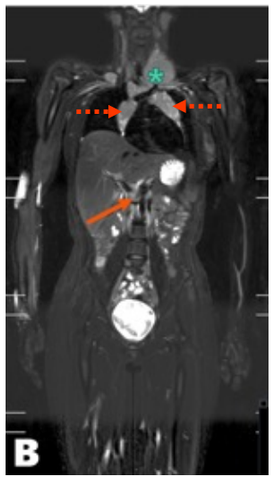
- 儿童中最常见的肾恶性肿瘤，发病高峰为 3 岁（80%，1~5 岁）。
- 通常无症状，但患者可能出现可触及的腹部肿块。
- 可为双侧受累 (5%)，可能与过度生长疾病（如 Beckwith-Wiedemann 综合征）和其他遗传疾病（如 DICER1 基因突变）有关。
- 影像学特征包括：巨大肿块（通常边界清晰）、受累肾脏呈“爪征”、具有均匀或不均匀增强的实性-囊性成分（提示出血和/或坏死）、实性部分的弥散受限（DWI 高信号，ADC 值降低）、肾静脉和下腔静脉侵犯、淋巴结受累、肺转移 (20%) 和肝转移。
- 超声检查用于初步评估可触及的腹部肿块和识别肾脏肿瘤。
- MRI（或 CT）用于进一步明确肿瘤范围/侵犯程度，并协助分期。
- 胸部 CT（或 CXR）用于评估是否存在肺转移。

A. 右肾轴位超声图像显示有一个大的轻度不均质肿块，邻近的肾脏呈“喙状”凸起（箭头所示），提示病灶起源于肾内。
B. MRI 横断位 T2 加权序列显示右腹部一巨大的高信号肿块 (*)，起源于右肾。
C. 横断位 T1 加权增强序列显示不均匀强化 (*)。
D 和 E：弥散加权图像显示来自右肾的肿块实性增强部分 (*) 广泛弥散受限

Lymphoma

- Lymphoreticular malignancy: third most common malignancy in children (most common malignancy in adolescents).
- Main groups: Hodgkin Lymphoma (HL), Non-Hodgkin Lymphoma (NHL), Post-Transplant Lymphoproliferative Disease (PTLD):
- HL: teenagers/adolescents, 4 histological subtypes, > 90% survival, cervical/mediastinal masses (75-80%).
- NHL: younger age group, > 40 histological subtypes, survival variable, abdominal presentation (> 50%).
- Staging mainly based on disease involvement above/below diaphragm and presence/absence of extranodal involvement:
- HL: Ann Arbor/Cotswold (1989) or Lugano classification (2014).
- NHL: St. Jude/Murphy (1980) or IPNHLSS (2015).
- Imaging characteristics include lymphadenopathy anywhere in the body, splenic involvement (diffuse/focal), extranodal involvement (most commonly lungs, liver, kidneys, gastrointestinal tract and bone marrow).
- Ultrasonography and CXR are often the first line modalities utilised at presentation/diagnosis.
- MRI (or CT) and/or 18FDG-PET are mandatory for staging and therapy response assessment (depending on subtype).





A. Axial US scan of the left cervical region shows enlarged hypoechoic lymph nodes (*) in the left cervical region in a patient with Hodgkin lymphoma.
B. MRI coronal T2W STIR sequence shows bulky hyperintense lymphadenopathy in the lower cervical region (*) on both sides as well as in the mediastinum (dashed arrows). Smaller pathologic lymph nodes are seen in the porta hepatis below the diaphragm (arrow).
C. 18FDG-PET scan shows extensive tracer uptake in the cervical lymph node masses on both sides of the diaphragm, i.e., in the mediastinum and in the porta hepatis and splenic hilum (arrows).

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

淋巴瘤

- 淋巴网状细胞恶性肿瘤：儿童中第三大常见的恶性肿瘤（青少年中最常见恶性肿瘤）。
- 主要分组：霍奇金淋巴瘤 (Hodgkin Lymphoma, HL)、非霍奇金淋巴瘤 (Non-Hodgkin Lymphoma, NHL)、移植后淋巴细胞增生性疾病 (PTLD)：
- 霍奇金淋巴瘤（HL）：青少年，4 种组织学亚型，生存率 > 90%，颈部/纵隔肿块为主 (75%~80%)。
- 非霍奇金淋巴瘤（NHL）：低龄组，> 40 种组织学亚型，生存率各异，腹部症状为主 (> 50%)。
- 主要根据膈上/膈下病灶累及范围和有无结外受累进行分期：
- HL：Ann Arbor/Cotswold (1989) 或 Lugano 分类 (2014)。
- NHL：St. Jude/Murphy (1980) 或 IPNHLSS (2015)。
- 影像学特征包括：全身任何部位的淋巴结肿大、脾脏受累（弥漫性/局灶性）以及结外受累（最常见于肺、肝、肾、胃肠道和骨髓）。
- 超声和胸片通常是初诊/诊断时的首选影像学检查方法。
- MRI（或 CT）和/或 18FDG-PET 是分期和疗效评估的必需方法（具体取决于亚型）。

A. 霍奇金淋巴瘤患者左颈部轴位超声扫描显示左颈部低回声肿大淋巴结 (*)。
B. MRI 冠状位 T2 加权 STIR 序列显示双侧下颈部区域 (*) 以及纵隔（虚线箭头）存在高信号的肿大淋巴结。膈下的肝门可见病理性小淋巴结（箭头所示）。
C. 18FDG-PET 扫描显示膈肌两侧颈部淋巴结肿块，如纵隔、肝门和脾门（箭头所示），均有广泛示踪剂摄取。

/ Osteosarcoma

- / Accounts for 20% of all bone tumours.
- / Typically in patients under the age of 20 years (usually at puberty).
- / Presents with bone pain, soft tissue mass and swelling or with a (pathological) fracture through the lesion.
- / Mostly located at the metaphysis of femur or tibia.
- / On imaging, it is associated with bone destruction, aggressive periosteal reaction and a soft tissue mass.
- / Osteosarcomas commonly metastasize to the lungs and adjacent bones.
- / Curative treatment requires aggressive resection of the lesion (amputation or limb-salvage excision) with chemotherapy.

This lateral radiograph of the distal femur in a child with osteosarcoma demonstrates the aggressive periosteal reaction of the bone (**pink arrows**) and soft tissue swelling (**orange arrows**) representing the mass associated with this aggressive tumour.

/ Ewing Sarcoma

- / Second most common malignant bone tumour in children (after osteosarcoma).
- / Typically in children aged 10-20 years old, on average, slightly younger than osteosarcoma.
- / Presenting symptoms and signs include pain, soft tissue mass, fracture and sometimes fever.
- / Commonly located in the lower limbs or pelvis.
- / On imaging they appear destructive, aggressive with a soft tissue mass.
- / They can also metastasize to lung and other bones.
- / Chemotherapy +/- surgery and radiotherapy are used for treatment.

In this contrast enhanced MRI of the pelvis in a 13-year-old boy, a large mass (arrows) is seen cantered over the right pubic bone and iliac crest. This was found to be Ewing sarcoma.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 骨肉瘤

- / 占所有骨肿瘤的 20%。
- / 常见于 20 岁以下的患者（多为青春期）。
- / 表现为骨痛、软组织肿块和肿胀或病变部位（病理性）骨折。
- / 多位于股骨或胫骨的干骺端。
- / 影像学检查可见骨质破坏、侵袭性骨膜反应和软组织肿块。
- / 骨肉瘤通常会转移至肺和邻近骨。
- / 根治性治疗需要彻底切除病灶（截肢或保肢切除）并结合化疗。

此例儿童骨肉瘤股骨远端侧位 X 线片，显示侵袭性骨膜反应（**粉红色箭头所示**），同时伴有软组织肿胀（**橙色箭头所示**），代表该侵袭性肿瘤相关的肿块特征。

/ 尤因肉瘤

- / 儿童中第二常见的恶性骨肿瘤（仅次于骨肉瘤）。
- / 通常发生于 10～20 岁的儿童，平均年龄略小于骨肉瘤。
- / 症状和体征包括疼痛、软组织肿块、骨折，有时还有发热。
- / 通常位于下肢或骨盆。
- / 影像学表现为破坏性、侵袭性特征，并伴有软组织肿块。
- / 还可能转移到肺部和其他骨骼。
- / 治疗采用化疗 +/- 手术和放疗。

此例 13 岁男童的盆腔增强 MRI 显示一巨大肿块（箭头所示）以右侧耻骨和髂嵴上为中心。发现其为尤因肉瘤。

/ Benign Bone Lesions

Benign bone lesions can sometimes look aggressive; however, knowledge of these and how they present on imaging can be very useful as the diagnosis does not usually require a biopsy or excision unless for cosmetic or functional reasons. They are therefore known as "**do not touch**" lesions.
Whilst many benign bone lesions exist, a few have been included here to demonstrate their varied appearances.

Exostoses (Osteochondromas)
These are benign outgrowths of bone (*) covered by a cartilaginous cap. They can be solitary or multiple and part of an underlying syndrome. They are mostly asymptomatic. They become of occasional significance when they fracture, cause pain or nerve/adjacent bone compression. Malignant transformation may occur, mainly after the age of 20 and is suspected if they enlarge and become painful.

Enchondromas
Benign cartilaginous tumours (*), peak incidence at 10-30 years of age. Usually an incidental finding, do not require treatment but can predispose to fractures. Commonly seen at hands and feet. Typical sharply demarcated lesions with cartilaginous stroma (rings and arches).

Bone cysts
These are fluid-filled cavities, usually incidental and asymptomatic. They can cause focal weakness, making the bone prone to pathological fracture. Commonly seen at the meta-diaphyseal proximal humerus and other long bones, causing radio-lucent lesions (*) with internal cortical scalloping (arrow).

Fibrous Cortical Defects (FCD)
Non-ossifying Fibroma (NOF)
Both lesions are similar in histology; however, those measuring > 3cm are referred to as NOFs. They predispose to bone fractures, are common in children 2-15 years and normally heal spontaneously. Usually asymptomatic, they cause cortical lucency (*) with sharp and sclerotic (during healing) borders.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 良性骨病变

良性骨病变有时看起来具有侵袭性，熟知这类病变及其影像学征象至关重要。此类病变通常可通过影像学检查明确诊断，除非出于美观或功能方面的考虑，一般无需组织活检或手术切除这类病变因此称为“**勿需处理**”病变。
尽管良性骨病变种类繁多，这里仅遴选部分典型病例予以展示，以阐释其影像学表现的多样性。

外生骨疣（骨软骨瘤）
这些是骨的良性增生物 (*)，表面覆盖有一层软骨帽。可以是孤立性或多发性，并且可能是潜在综合征的组成部分。大多无症状。当出现病理性骨折、引发疼痛或导致神经/邻近骨骼受压时，这类病变才具有临床干预意义。恶性转化可能发生于此类病变中，其好发于 20 岁以上人群；若病变体积增大并伴有疼痛症状，需高度警惕恶变可能。

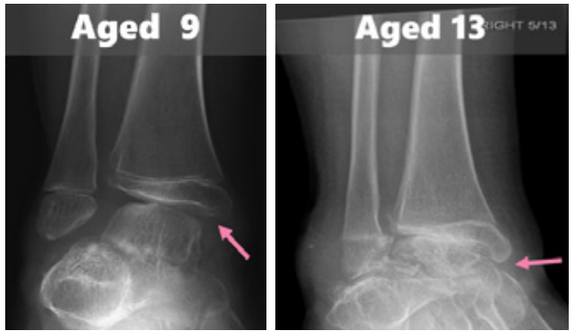
内生软骨瘤
良性软骨肿瘤（*），10～30 岁发病率最高。通常是偶然发现，不需要治疗，但容易导致骨折。多见于手、脚。典型表现为边界清晰锐利的病灶，其软骨基质呈现特征性的环状和弓状钙化。

骨囊肿
骨囊肿为充满浆液的单房性腔隙结构，多系偶然发现的无临床症状病变。该病变可导致局部骨结构力学强度减弱，从而显著增加病理性骨折的发生风险。好发于肱骨近端干骺端及其他长骨，典型影像学表现为边界清晰的溶骨性病灶（* 号标示），伴特征性内皮质扇贝样侵蚀征（箭头指示）。

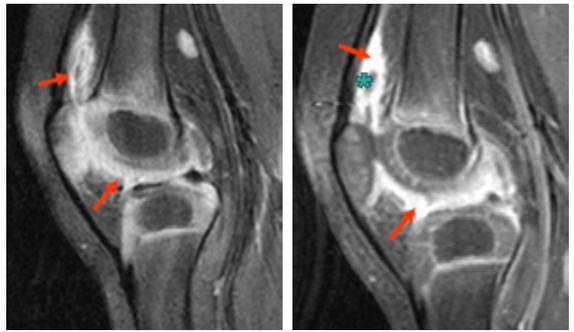
纤维性骨皮质缺损非骨化性纤维瘤
两种病变在组织学上相似；但病变测量 > 3 cm 的病变被称为非骨化性纤维瘤。这些病变易导致骨折，常见于 2～15 岁儿童，通常可自愈。此类病变多无明显临床症状，典型影像学表现为皮质内透亮区（* 号标示），边界清晰锐利，愈合期可呈现硬化边征象。

/ Juvenile Idiopathic Arthritis (JIA)

- / Autoimmune disease of unknown origin, characterised by joint swelling and synovial inflammation.
- / Onset < 16 years, lasting for > 6 weeks.
- / Classified into 7 subtypes according to ILAR; of which the oligoarticular form (up to 4 joints), is the most common.
- / Diagnosis is based on history, clinical examination and laboratory tests, in addition to imaging findings.
- / Radiographs of the joints are taken to exclude other causes (e.g. developmental issues, bone tumours etc.).
- / Typical imaging findings include effusion/synovial thickening with increased contrast enhancement (US, MRI) and later growth abnormalities / destructive changes (XR).
- / Anti-inflammatory medication, corticosteroids (including joint injections), disease modifying drugs (e.g. methotrexate) and 'biologic agents' (e.g. infliximab) can be helpful in slowing down the destructive process.



In these radiographs over 4 years, a young girl with JIA affecting her ankle shows progressive loss of joint space height (pink arrows) and destructive change, leading to leg length discrepancy and long-term disability – highlighting the importance of early treatment and follow-up.



MRI scan of a 2-year-old female with a joint swelling over 7 weeks. T2W sequence with fat saturation (left) shows increased signal intensity at the area of the joint (arrows). Post-contrast T1W sequence with fat saturation (right) shows synovial inflammation as enhancement of thickened synovium (arrows) with a small effusion (*).

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 幼年特发性关节炎

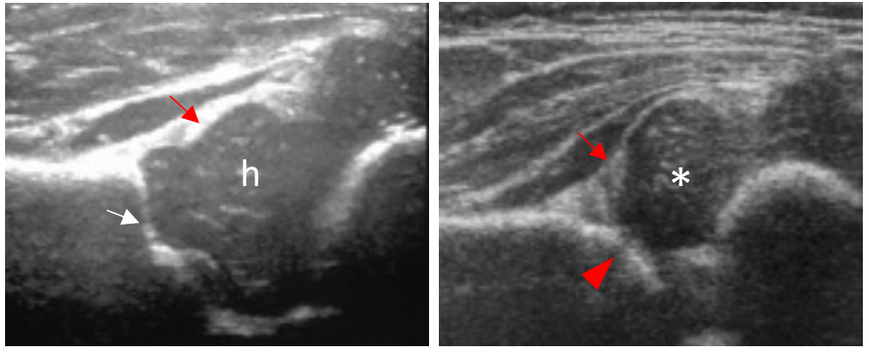
- / 一种病因不明的自身免疫性疾病，特征为关节肿胀和滑膜炎症。
- / 发病年龄 < 16 岁，持续时间 > 6 周。
- / 根据国际抗风湿病联盟 (ILAR) 分类标准，该病可分为7种亚型；其中少关节型（累及 ≤ 4 个关节）最常见。
- / 诊断需综合病史、临床检查、实验室检测及影像学发现进行多维评估。
- / 常规需行关节摄片检查，旨在排除其他病因（如发育性骨骼疾病、骨肿瘤等）。
- / 典型影像学表现包括：超声 (US) 与磁共振 (MRI) 可见关节积液/滑膜增厚伴增强强化；随病情进展，X 线摄影 (XR) 可显示生长障碍/骨质破坏性改变。
- / 抗炎药物、皮质类固醇（包括关节腔内注射药物）、疾病调节药物（如甲氨蝶呤）及生物制剂（如英夫利西单抗）有助于延缓关节破坏进程。

在这组历时 4 年的踝关节系列摄片中，一名幼年特发性关节炎 (JIA) 女孩的影像学演变显示：进行性关节间隙狭窄（粉色箭头标示）及破坏性改变，最终导致下肢长度差异与长期功能障碍——该病例充分体现了早期干预治疗和持续随访的重要性。

一名 2 岁女性患儿，持续关节肿胀 7 周，行磁共振成像 (MRI) 检查。脂肪抑制 T2 加权序列（左图）显示关节区域异常高信号（箭头所示）。增强后脂肪抑制 T1 加权序列（右图）显示滑膜炎症，表现为滑膜增厚强化（箭头所示）伴少量关节积液（* 号标记）。

Developmental Dysplasia of the Hip (DDH)

- Most common musculoskeletal disorder in children, with a reported prevalence of 1-3% in new-borns, according to definitions and method of ascertainment used. Around 1-3 per 1000 children is detected at a late stage (after one month of age).
- In new-borns, the dysplastic hip is characterised by a steep acetabulum with or without an unstable/dislocatable/dislocated femoral head. Clinical diagnosis with the Barlow/Ortolani tests in new-borns has poor sensitivity and specificity, thus, universal or selective screening (of the "at risk" group, including a significant family history of DDH, breech delivery, oligohydramnios, high birth weight) has been introduced (for details/recommendations, see www.espr.org, MSK task force).
- Ultrasound in the new-born period reveals that 84% of the babies have normal hips, of which 0.1% are dislocatable; 13% have immature (0.6% dislocatable), 2.4% have mildly dysplastic (60% dislocatable/dislocated) and 0.7% have severely dysplastic hips (100% dislocatable/dislocated) – see below.



Left: Ultrasound image of a normal neonatal hip, shows the cartilaginous femoral head (h) covered by the labrum (red arrow) and by the deep bony roof of the acetabulum (white arrow). Right: Ultrasound image of a de-centered dysplastic hip shows lateralization of the femoral head (*), incomplete coverage by the superiorly displaced labrum (arrow) and incomplete coverage by the shallow bony roof (arrowhead).

Rosendahl K, Markestad T, Lie RT. Developmental dysplasia of the hip: prevalence based on ultrasound diagnosis. Pediatr Radiol 1996;26:635-9.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

发育性髋关节发育不良

- 发育性髋关节发育不良 (DDH) 是儿童最常见的骨骼肌肉系统疾病。根据现行定义与确诊方法，新生儿的患病率在 1-3% 之间。每 1000 名儿童中约有 1-3 例在晚期（出生一个月后）才被确诊。
- 新生儿髋关节发育不良的典型特征为髋臼陡直，伴发股骨头不稳、可脱位或完全脱位等状态。新生儿期采用 Barlow/Ortolani 试验进行临床诊断的敏感性与特异性均较低。因此，目前推荐采用普遍性筛查或针对高危人群的选择性筛查策略（高危因素包括：DDH显著家族史、臀位分娩史、羊水过少、出生体重过重）（详情/建议请参见 www.espr.org，MSK 工作组）。
- 新生儿期超声筛查数据显示，84% 的婴儿髋关节正常，其中 0.1% 易脱位；13% 髋关节发育不成熟（0.6% 易脱位），2.4% 轻度发育不良（60% 易脱位/脱位），0.7% 髋关节重度发育不良（100% 易脱位/脱位）- 见下文。

左侧：正常新生儿髋关节的超声图像，显示软骨状股骨头 (h) 被盂唇（红色箭头所示）和髋臼的深骨顶（白色箭头）覆盖。右侧：偏心性发育不良髋关节的超声图像，显示股骨头向外侧移位 (*)、上移的盂唇（箭头）与浅平的骨性髋臼顶（箭头标志）均呈现覆盖不全征象。

Rosendahl K, Markestad T, Lie RT. Developmental dysplasia of the hip: prevalence based on ultrasound diagnosis.Pediatr Radiol1996;26:635-9.

In children over the age of 4.5 months, radiography, with measurement of the acetabular index (AI) (A) remains the imaging modality of choice. Based on the AI, and the standards by Tönnis and Brunken, the hips are classified as normal (B), acetabular ossification delay (C) or dysplastic (D).

Tönnis D, Brunken D. Eine Abgrenzung normaler und pathologischer Hüftpfannendachwinkel zur Diagnose der Hüftdysplasie. Arch Orthop Trauma Surg 1968;64:197-228.

Paediatric Radiology

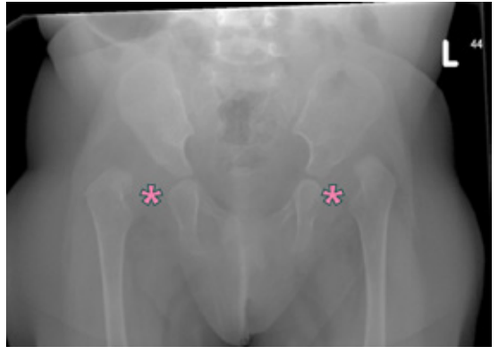
CHAPTER OUTLINE:

儿科放射学

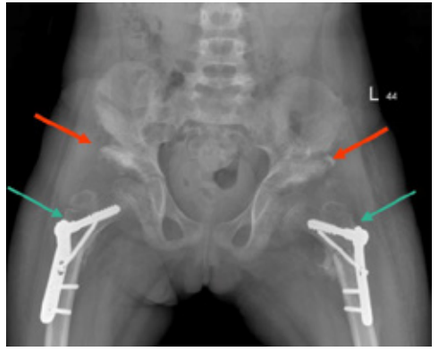
章节大纲：

对于年龄 > 4.5 个月的婴幼儿，X 线摄影测量髋臼指数 (AI)（A 图）仍是首选的影像学评估方法。根据髋臼指数 (AI) 测量结果，参照 Tönnis 与 Brunken 标准，髋关节发育状况可分为：正常型 (B)、髋臼骨化延迟型 (C) 及发育不良型 (D) 三类。

Aged 9 months/9 月龄



Aged 4 years/4 岁



Aged 6 years/6 岁

Severe DDH in a female, diagnosed at 9 months of age (first radiograph) with follow-up radiographs at 4 and 6 years of age. At 9 months, there are dysplastic acetabulae, and both proximal femora (unossified) are dislocated. The location within the joint at where they should have been cantered is marked with asterisks. At 4 years of age, both acetabulae are still severely dysplastic, and the femoral heads are subluxed. By 6 years of age the patient has undergone surgical correction with periacetabular osteotomies (**orange arrow**) to correct the acetabular angles, and relocation of both proximal femurs to restore containment and normal joint alignment.

重度 DDH 女孩，9 月龄时确诊（首张 X 线片），并在 4 岁和 6 岁时进行随访 X 线片检查。9 月龄时，髋臼发育不良，双侧股骨近端（未骨化）脱位。关节内正常解剖中心点位置以星号 (*) 标记所示。4 岁时，双侧髋臼仍重度发育不良，股骨头半脱位。至 6 岁时，该患者已接受髋臼周围截骨术（**橙色箭头表示**）进行手术矫正，纠正髋臼角度；同期行双侧股骨近端复位术，以恢复股骨头覆盖度及正常关节对合关系。

Paediatric Radiology

儿科放射学

CHAPTER OUTLINE:

章节大纲：

Perthes Disease

- This is an idiopathic osteonecrosis of the femoral epiphysis, most common in children 5-6 years old and which is more likely to occur in boys > girls.
- The femoral heads become radiographically sclerotic, collapsed (arrow), and fragmented with occasional metaphyseal changes. Radiographic findings might be delayed for up to 2-3 months. In these cases, MRI may be helpful.
- US may show fluid and deformity at later stages. MRI accurately depicts changes and joint congruity.
- Blood tests are typically normal.
- Alternative differential diagnoses need to be considered before assigning the diagnosis of Perthes (e.g., irritable hip, sickle cell, leukaemia, steroid administration).

- Treatment is largely supportive (self-limiting condition) but operative management may be undertaken for limb length discrepancies and to correct any structural abnormalities.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

Perthes 病

- 此为特发性股骨头骨骺坏死，好发于 5-6 岁儿童群体，且男孩较女孩更容易发病。
- 股骨头在 X 线片上表现为骨质硬化、结构塌陷（箭头指示）及碎裂征象，可伴有干骺端偶发性病理改变。X 线征象的出现可能存在 2-3 个月的延迟期。在这些情况下，MRI 可能会有所帮助。
- 后期超声可能显示积液和畸形。磁共振成像 (MRI) 可精准显示早期病理性改变及关节匹配度等。
- 实验室血液检测指标通常正常范围。
- 在确立 Legg-Calvé-Perthes 病诊断前，需考虑以下几个疾病的鉴别诊断：暂时性滑膜炎（激惹性髋关节）、镰状细胞病性骨坏死、白血病性关节浸润及激素性骨坏死等。
- 治疗主要为支持性治疗（自限性疾病），但对于肢体长度不一致和任何结构异常，可能需要进行手术治疗。

Slipped Upper Femoral Epiphysis, SUFE

- One of the commonest hip abnormalities in adolescents and is bilateral in 20% cases.
- The proximal femoral epiphysis 'slips' off the metaphysis due to repeated trauma and a background of mechanical/hormonal predisposing factors (e.g., obesity). (Image below left, white arrow)
- It is classified as a 'Salter Harris type 1' injury (see fracture section later).
- Surgical pinning (below, right image) is commonly used to fix the slipped femoral epiphysis in place.
- Sometimes prophylactic pinning of the other hip is also done given that asynchronous bilateral disease is relatively common.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

股骨头骨骺滑脱，SUFE

- 青少年中最常见的髋关节异常之一，20% 的病例为双侧。
- 在重复性微创伤及机械力学/内分泌易感背景（如肥胖）共同作用下，股骨头近端骨骺从干骺端滑脱。（下图左侧，白色箭头）
- 被归类为“Salter Harris 1 型”损伤（见下文骨折章节）。
- 手术钉固定术（下图右所示）是治疗股骨头骨骺滑脱的常规术式，来固定滑脱的股骨骨骺。
- 鉴于双侧非同步性病变相对常见，有时需对健侧髋关节行预防性固定术。

<!> ATTENTION

- Musculoskeletal injuries are common in children.
- They account for 15-20% of emergency department presentations.

Fracture patterns:

- Complete fracture: spiral, transverse or oblique.
- Plastic deformity (bowing fractures).
- Buckle fractures.
- Greenstick fractures.
- Physeal fractures.
- Apophyseal avulsion injuries.

The mechanism varies depends on the child's age

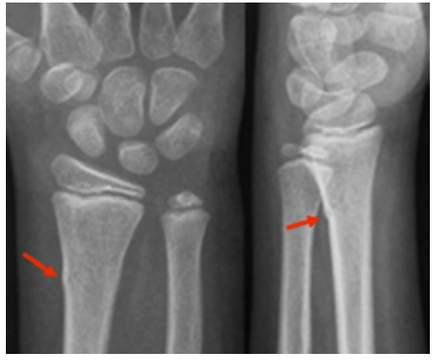
Clinical evaluation is paramount:
Always image the "point of maximum tenderness".

How to image:

- Radiography: two orthogonal planes.
- Ultrasound: "second imaging technique" for cartilaginous immature skeleton.
- Computed tomography: complex pelvic fractures or Salter–Harris knee or ankle injuries. Contrast CT angiography for vascular injury.
- MRI: bone marrow and soft tissue.
- Nuclear Medicine: occult trauma, occasionally child abuse.

Buckle or "torus" fracture:

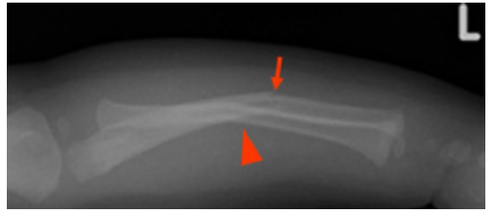
- The most common fracture in children due to compression when a child falls on outstretched hand.
- One of the most common recurrent diagnostic errors by radiology trainees.
- The angulated cortical outline = "little hill" = torus is easily missed.



Value of two projections:

There is minimal contour deformity on the right radiograph (**arrow**).

Greenstick fracture of the ulna (**arrow**) and **plastic deformity** of the radius (**arrowhead**) is better depicted on the orthogonal projection like the cross-table lateral view (left). Contralateral plain films may also be useful as a problem-solving tool if there is diagnostic uncertainty.



Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

<!> 注意

- 骨骼肌肉损伤在儿童中很常见。
- 占急诊科就诊病例的 15%～20%。

骨折类型：

- 完全性骨折：螺旋形、横形或斜形。
- 塑性变形（弓形骨折）。
- 扣带骨折。
- 青枝骨折。
- 骨骺骨折。
- 骨骺撕脱伤。

发病机制因儿童年龄而异

临床评估至关重要：务必对“最大压痛点”进行影像学检查。

影像学检查方法：

- X 线摄影：两个正交平面。
- 超声：针对软骨性未成熟骨骼的“次级影像学检查技术”推荐：
- 计算机断层扫描 (CT)：复杂骨盆骨折或 Salter-Harris 膝关节或踝关节损伤。血管损伤的增强 CT 血管成像。
- MRI：骨髓和软组织。
- 核医学：隐匿性创伤评估及偶发的儿童虐待筛查

扣带骨折或“骨皮质皱褶”骨折：▶

- 儿童跌倒时手伸展位手掌撑地时受压导致骨折为最常见。
- 放射科培训医师中最常见的复现性诊断错误之一。
- 成角的骨皮质轮廓呈“小山丘”样改变（骨隆突骨折），极易被漏诊。

双投照体位的诊断价值：▶

右侧投照 X 线片显示轮廓轻微变形（箭头）。

尺骨青枝骨折（箭头所示）和桡骨塑性变形（三角箭头所示）在正交投照位（水平投射侧位片）显示更清晰（左图）。如果诊断不确定，对侧平片也有助于解决问题、辅助诊断。

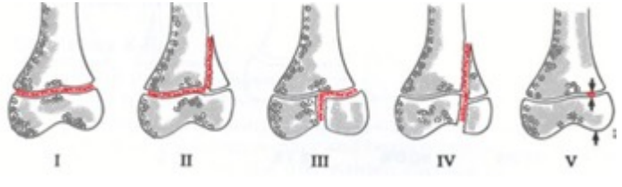
Physeal Fractures

- They involve the “weak point”, the growth plate.
- Account for approximately 15% of all fractures in children.
- The distal radial physis is the most frequent
- They may result in progressive angular deformity, limb-length discrepancy, or joint incongruity.

Salter-Harris (SH) classification

Mnemonic: SALTR
(**Slip** of physis or **Same** = type 1; **Above** physis = type 2; Lower than physis = type 3; **Through** the physis = type 4, **Rammed/Ruined** = type 5).

- SH classification has prognostic value.
- US is useful in immature cartilaginous skeleton
- CT is useful for the evaluation of articular extension of physeal fractures.
- MRI is a “non-ionizing” alternative with much better contrast for soft tissue and bone marrow when evaluating physeal injuries. Computed tomography: complex pelvic fractures or Salter–Harris knee or ankle injuries. Contrast CT angiography for vascular injury.



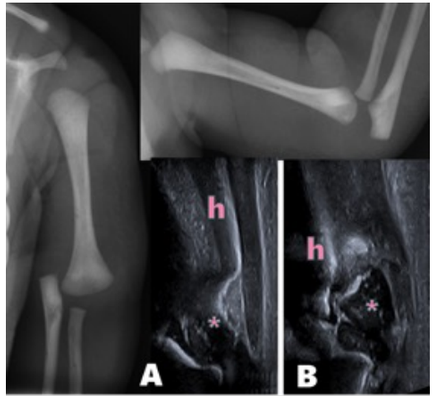
Distal humerus SH type I fracture in an infant with left elbow swelling and an apparent elbow malalignment and dislocation on radiographs.

A: posterior US view of the normal distal humerus (h) including the epiphysis (*).

B: posterior US view of the affected elbow showing posterior displacement of the distal epiphysis (*) related to the humerus (h).

Distal tibia SH type 3 fracture which is difficult to appreciate on radiographs as a gap (arrows). This is a "Tillaux" fracture in a 14-year-old child with almost obliterated physes and a "mature" skeleton.

CT is useful to demonstrate extension of physis fracture to the joint surface.



Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

骺板骨折

- 涉及“薄弱点”，即生长板。
- 约占所有儿童骨折的 15%。
- 桡骨远端骺板最常见
- 此类损伤可导致进行性成角畸形、肢体不等长或关节对合不良。

Salter-Harris (SH) 分型

助记符：SALTR
（**骺板滑脱或相同** = 1 型；**骺板及干骺端** = 2 型；骺板及其以下骨骺 = 3 型；**贯穿**骺板（包括干骺端及骨骺）= 4 型，**骺板挤压/破坏** = 5 型）。

- SH 分型具有预后评估价值。
- 超声适用于未成熟的软骨骨骼评估
- CT 适用于评估骺板骨折关节内延伸范围。
- MRI 是一种“非电离辐射”检查方法，评估骺板损伤时，在软组织和骨髓的对比度方面优于其他检查手段。计算机断层扫描 (CT)：复杂骨盆骨折或 Salter-Harris 膝关节或踝关节损伤。血管损伤的增强 CT 血管成像。

婴儿左肘肿胀，X 线片显示明显肘关节对位不良及脱位，为肱骨远端 Salter-Harris Ⅰ型骨折。

A：正常远端肱骨 (h) 后位 US 视图，包括骨骺 (*)。

B：患肘后位超声视图，显示与肱骨 (h) 相关的远端骨骺后移 (*)。

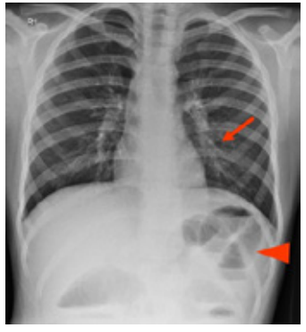
胫骨远端 SH 3 型骨折，在 X 线片上仅表现为细微裂隙（箭头所示），极易漏诊。这是一例 14 岁儿童的“Tillaux”骨折，其生长板近乎闭合，骨骼已达“成熟”状态。

CT 有助于显示骺板骨折向关节面的延伸情况。

<#> ATTENTION

Cystic Fibrosis (CF)

- CF is an inherited disorder that affects cells producing mucus, digestive juices and sweat.
- A faulty gene alters a protein that regulates salt movement in and out of cells.
- The major organs affected are the lungs and digestive system, including the pancreas.
- Secretions become thick and sticky, blocking the airways and drainage ducts.
- The condition can be diagnosed at birth before symptoms develop ('heel prick test') and later with a sweat test.
- Clinical presentation is variable but includes:
  - Shortness of breath and wheeze with recurrent chest infections, leading to chronic lung disease with fibrosis and bronchiectasis.
  - Reduced endo- and exocrine pancreatic function, resulting in malabsorption and consequent growth disturbance. Lack of insulin can cause diabetes in older patients.
  - Bowel obstruction due to thickened and sticky contents blocking the terminal ileum.
  - Liver disease secondary to blocked and inflamed bile ducts may ultimately cause cirrhosis and liver failure.



Chest radiograph of a patient with CF: the airways have thickened walls making the lungs appear "streaky" (arrow). In cross section, the thick airway walls look like "donuts" – these are mostly seen near the lung hila.

In the upper abdomen there are dilated small bowel loops with air-fluid levels (arrowhead) due to bowel obstruction resulting from surgery earlier in this child's life.

Adolescent boy presenting with recurrent chest infections. The chest radiograph shows streaky opacity due to dilated bronchi (arrows). Mottled patches represent mucus blocking the airways (arrowhead). The CT image (above) demonstrates detail of the dilated bronchi (arrows). These do not taper towards the lung periphery as they normally should.

CHAPTER OUTLINE:

章节大纲：

<#> 注意

囊性纤维化

- 囊性纤维化是一种遗传性疾病，会影响产生黏液、消化液和汗液的细胞功能。
- 缺陷基因导致调控细胞内外盐分进出的蛋白功能异常。
- 受影响的主要器官是肺和消化系统，包括胰腺。
- 分泌物黏稠，阻塞气道和引流管道。
- 此病症可在出生后出现症状之前诊断出来（"足跟采血检测"），后期则可通过汗液检测确诊。
- 临床表现多样，包括：
  - 呼吸困难和喘鸣，反复出现胸部感染，最终进展为伴纤维化和支气管扩张的慢性肺病。
  - 胰腺内、外分泌功能减退，导致吸收不良，继而引发生长障碍。缺乏胰岛素可能导致老年患者患糖尿病。
  - 肠内容物增厚、黏稠，阻塞末端回肠，引起肠梗阻。
  - 继发于胆管阻塞和炎症的肝病最终可能导致肝硬化和肝衰竭。

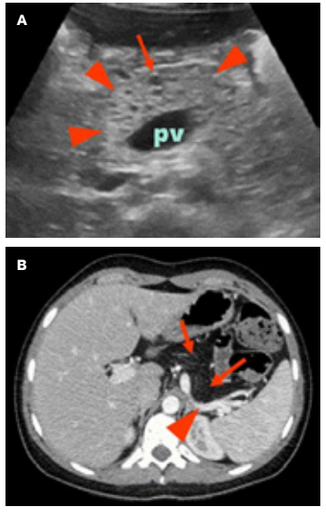
囊性纤维化患者的胸片：气道壁增厚，使肺部呈现"条纹状"改变（箭头所示）。在横断面上，增厚气道壁呈"甜甜圈"样改变，此类征象多见于肺门附近。

上腹部可见小肠袢扩张伴气液平（三角箭头所示），系该患儿既往手术所致肠梗阻的继发表现。

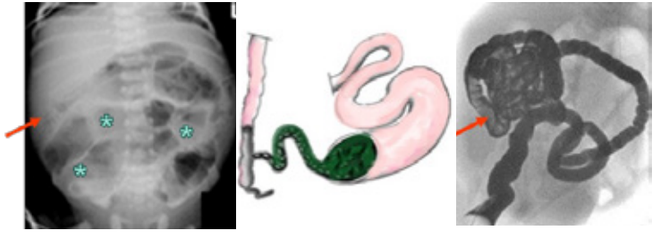
青春期男孩，以反复胸部感染为主诉就诊。胸片显示支气管扩张所致的条纹状阴影（箭头所示）。斑片状模糊影代表黏液阻塞气道（三角箭头所示）。CT 图像（上图）显示了扩张支气管的细节特征（箭头所示）。这些支气管不会像正常情况那样向肺外周逐渐变细。

<!> ATTENTION

- CF is a life-limiting condition.
- Approximately half of patients will live longer than 40 years.
- Therapy is supportive with the aim of controlling symptoms, preventing and reducing complications.
- Some patients may require lung or liver transplantation.
- CF patients are cared for by a multi-disciplinary hospital team.



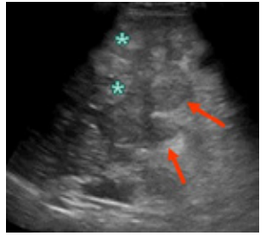
CF and the pancreas: the ultrasound image (A) shows a bright (fatty) pancreatic head (arrowheads) with small cysts (arrow). The bright (white) 'tadpole' of the portal vein (pv) is the anatomic marker for level of the pancreas. The CT image (B) demonstrates an "absent" pancreas – the organ has been replaced by fat which is demonstrated with a low density ('black') comparable to subcutaneous fat.



2-day-old neonate with distended abdomen who did not pass meconium following birth: abdominal radiograph (left image) shows gassy, dilated bowel loops (*) and a 'bubbly' pattern of faeces (arrow). The central sketch illustrates pellets of sticky faeces blocking the terminal ileum resulting in upstream bowel dilatation. A contrast enema (right image) performed by the paediatric radiologist shows a small calibre (unused) colon with contrast refluxing back into the ileum, which has filling defects (red arrow). The diagnosis is meconium ileus, a presentation of CF in neonatal life.

<=> CORE KNOWLEDGE

DIOS: distal intestinal obstruction syndrome



Ultrasound image of the liver in a child with cirrhosis: the liver edge is lobulated (arrows), and the texture is heterogeneous with nodules (*).

Abdominal radiograph in a child with abdominal pain and vomiting. Dilated central small bowel loops (*) indicate obstruction. There were inspissated faeces proximal to the ileo-caecal valve. This is DIOS in an older child with CF.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

<!> 注意

- 囊性纤维化是一种导致预期寿命显著缩短的疾病。
- 约一半患者的生存期可超过 40 年。
- 治疗为支持性措施为主，旨在控制症状、预防并减少并发症。
- 部分患者可能需要肺移植或肝移植。
- 囊性纤维化患者需要由多学科的医疗团队提供全程照护。

2 日龄新生儿，腹胀伴胎便排出延迟：腹部 X 线片（左图）显示肠袢积气扩张 (*) 及“泡沫样”粪便征（箭头所示）。中央示意图显示黏稠粪便团块阻塞回肠末端，导致近端肠管扩张。儿科放射科医生进行的灌肠（右图）造影显示，结肠肠腔细小（废用性改变），对比剂反流至回肠，其内可见充盈缺损（红色箭头所示）。诊断为胎粪性肠梗阻，是新生儿期囊性纤维化的一种表现。

<=> 核心知识

DIOS：远端肠梗阻综合征

囊性纤维化和胰腺：超声图像 (A) 显示胰头（三角箭头所示）明亮（脂肪性），伴有小囊肿（箭头所示）。门静脉 (portal vein, pv) 明亮（白色）“蝌蚪”状结构是定位胰腺水平的解剖学标志。CT 图像 (B) 显示胰腺“消失”- 该器官被脂肪替代，其密度低（“黑色”），与皮下脂肪密度相当。

儿童肝硬化肝脏超声图像：肝缘呈分叶状（箭头所示），肝实质回声不均匀伴结节样改变（* 标示）

腹痛和呕吐儿童的腹平片。中央小肠袢扩张 (*) 提示梗阻。回盲瓣近端可见稠厚粪便淤积。这是大龄囊性纤维化患儿的 DIOS 症状。

Child Abuse

- Child maltreatment, according to WHO, refers to all forms of physical and/or emotional or sexual abuse, deprivation and neglect of children, or commercial or other exploitation resulting in harm to the child's health, survival, development or dignity in the context of a relationship of responsibility, trust or power.
- Although the incidence of child abuse and neglect has been decreasing, almost 9.2 in every 1000 children in the United States were abused in 2018 according to the Children's Bureau. Children of any age may be abused; it is the youngest children, smaller than two years of age, whom are the most vulnerable. It is estimated that 26.7 per 1000 children are victims of child abuse and neglect in their first year of life. Approximately 25% of abused children are physically abused.
- Physically abused infants and children may present with unexplained skin marks (bruises, burns/scalds, bites), unexplained fractures, neurological and retinal injuries without a supporting history (abusive head trauma [AHT]), as well as with unexplained visceral (thoracic and abdominal) injuries.
- Paediatric radiologists are important members of an interdisciplinary team that look for, identify and interpret subtle imaging findings in favour of abuse or in favour of alternative diagnoses through specific imaging protocols. Their role is extremely important in non-verbal and vulnerable children younger than 2 years of age.

<!> ATTENTION

A highly detailed complete radiographic skeletal survey with focused views, CT of brain and MRI of brain and potentially the spine are performed in children younger than 2 years to identify and document clinically occult injuries, according to national and international guidelines.

Images kindly provided by Dr A. Patterson, UK. Right-hand image modified from Kleinman PK. Diagnostic imaging of child abuse. 2nd ed, St Louis, Mosby; 1998

<∞> REFERENCES

https://www.rcr.ac.uk/system/files/publication/field_publication_files/bfcr174_suspected_physical_abuse.pdf
Kleinman PK. Diagnostic imaging of child abuse. 2nd ed, St Louis, Mosby; 1998

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

儿童虐待

- 根据世界卫生组织 (WHO) 定义，儿童虐待指在负有责任、信任或权力关系的背景下，对儿童的一切形式包括身体和/或情感虐待、性侵犯、剥夺与忽视，以及商业或其他形式的剥削，导致对儿童健康、生存、发展或尊严造成实际或潜在伤害。
- 尽管虐待和忽视儿童事件的发生率持续下降，但根据美国儿童局 2018 年数据，每 1000 名儿童中就有近 9.2 人遭受虐待。任何年龄段的儿童均有可能遭受虐待，但年龄小于两岁幼儿最易受到伤害。据估计，每 1000 名儿童中就有 26.7 人在一岁以内遭受虐待与忽视。大约 25% 的受虐儿童遭受身体虐待。
- 遭受身体虐待的婴幼儿可表现为无法解释的皮肤痕迹（瘀伤、烧伤/疤痕、咬痕）、不明原因的骨折、无病史支持的神经系统和视网膜损伤（虐待性头部外伤 [AHT]），以及不明原因的内脏（胸腹部）损伤。
- 儿科放射科医生是多学科团队的重要成员，他们通过特定的影像检查方案，负责搜寻、识别和解读可能表明存在虐待行为或可能有其他诊断结果的细微影像学特征。其在两岁以下不会说话和易受伤害儿童的评估中具有至关重要的作用。

<!> 注意

根据国内和国际指南，对两岁以下儿童需进行高度详细的全身骨骼 X 线摄片（含特定部位及体位）、脑部 CT 和脑部 MRI（必要时包含脊柱），以识别并记录临床隐匿性损伤。

图片由英国 A.Patterson 博士友情提供。右图改编自 Kleinman PK Diagnostic imaging of child abuse. 2nd ed, St Louis, Mosby; 1998

<∞> 参考文献

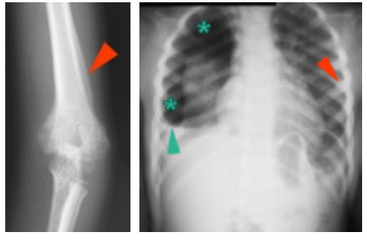
https://www.rcr.ac.uk/system/files/publication/field_publication_files/bfcr174_suspected_physical_abuse.pdf
Kleinman PK. Diagnostic imaging of child abuse. 2nd ed, St Louis, Mosby; 1998

Abusive Skeletal Injuries

- Fractures are the second most common finding in physically abused children, following skin lesions (e.g., bruises).
- One in 3 physically abused infants have fractures.
- Fractures resulting from physical violence can be found throughout the skeleton; they are likely to be multiple and can show diverse stages of consolidation and healing.
- Fractures may from result of accidental trauma. However, rib and metaphyseal fractures (classic metaphyseal lesions [CML]) are more frequently seen in abused infants provided that there is no accidental trauma or medical condition that result in fragile bones.
- Abused children may also be polytrauma patients.

<!> ATTENTION

"Children who do not cruise do not bruise"... or fracture. Up to 25% of fractures in children younger than 1 year-old are related to child abuse.



Child with multi-system recent and old injuries: healing distal humerus and rib fractures (arrowheads), right hemopneumothorax (*) with air-fluid level (turquoise arrowhead). There was also a liver laceration (not shown).

Detail of an oblique chest radiograph of an infant with clinically suspected abuse showing 3 acute left posterior rib fractures (arrows).

5 days later, a follow-up chest radiograph shows signs of healing on the 3 known rib injuries and additional healing fractures on the posterior arch of several other ribs (arrows).

<!> ATTENTION

Up to 26% of skeletal surveys performed in infants < 6 months demonstrate clinically unsuspected fractures.

Detail of an AP radiograph of the distal femur of an infant with clinically suspected abuse showing a "bucket handle" fracture (a curved chip of bone detached from the metaphysis), highly specific for child abuse.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

虐待性骨骼损伤

- 骨折是身体受虐儿童中第二常见的征象，仅次于皮肤损伤（如瘀伤）。
- 每 3 个遭受身体虐待的婴儿中就有 1 例存在骨折。
- 暴力导致骨折可见于全身骨骼；常表现为多发性，且可呈现不同阶段的愈合征象。
- 骨折可能由意外创伤引起。然而，在无意外创伤或导致骨骼脆弱的疾病等医疗状况下，肋骨和干骺端骨折（典型干骺端病变[classic metaphyseal lesions, CML]）在受虐婴儿中更为常见。
- 受虐儿童也可能是多发性创伤患者。

<!> 注意

"不会独立行走的幼儿不会出现瘀伤"……亦或骨折。在 1 岁以下儿童的骨折中，高达 25% 与虐待儿童有关。

多系统新旧伤并存的患儿：肱骨远端和肋骨骨折愈合期（三角箭头所示），右侧血气胸 (*) 伴气液平面（蓝绿色三角箭头所示）。还存在肝撕伤（未显示）。

临床疑似受虐婴儿斜位胸片细节显示 3 处急性左后肋骨折（箭头所示）。

5 天后，随访胸片显示原 3 处肋骨损伤有愈合迹象，其他多根肋骨后弓发现新增愈合性骨折（箭头所示）。

<!> 注意

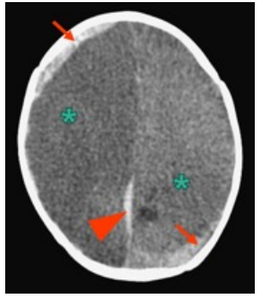
在对 6 月龄以下婴儿进行的骨骼检查中，高达 26% 的患儿可检出临床未疑及的骨折。

临床疑似受虐婴儿股骨远端正位片细节，显示"桶柄"状骨折（干骺端剥离的弧形骨片），是儿童虐待的高度特异性骨折。

<‧!> ATTENTION

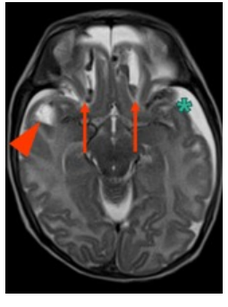
Abusive Head Trauma (AHT)

- AHT following **shaking** (violent "to and fro" head motion) and/or direct impact with or without skull fractures, may result in lethal or chronically debilitating injuries.
- Subdural hematomas (SDH) are seen at various sites and exhibit variable densities on CT as the first-line imaging test. They also exhibit variable signal intensities on MRI and are related to superficial vein rupture/thrombosis. Parenchymal injuries include brain contusions, shearing injuries and ischaemic lesions.
- Further investigations with fundoscopy to identify abuse-related retinal haemorrhages, radiographic skeletal survey for bone fractures and MRI of the spine for ligamentous injuries and subdural hematomas are advised, also.
- Children suspected of abuse should be protected during investigation and local child protection agencies notified.

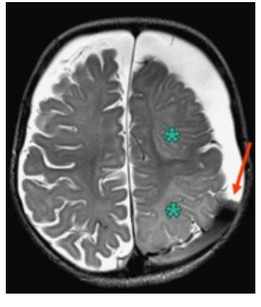


Axial CT. Hyperdense subdural haematomas of different densities (arrows), interhemispheric subdural haematoma (arrowhead), diffuse brain oedema-ischaemia (*) with hypodensity and obliteration of sulci.

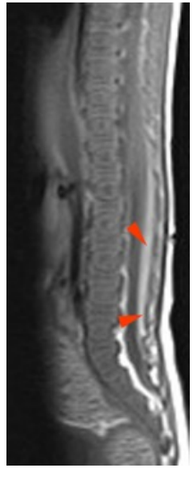
3D CT bone reconstruction of the skull shows a left parietal bone skull fracture (arrow).



T2W axial MRI in the same child as the 3D CT shows subdural haematoma (*), bilateral frontal shearing injuries (arrows) and right temporal lobe contusion (arrowhead).



T2W axial sequence shows bilateral subdural hematoma with blood-fluid level on left side (arrow) and parenchymal oedema with hyperintensity (*) in left hemisphere.



Abused infant with posterior fossa subdural haema-toma (not shown). Sagittal T1W sequence shows an unsuspected hyperintense subdural haematoma in the lumbar area (arrowheads).

<‧!> 注意

虐待性头部创伤

- 摇晃（头部剧烈“来回”运动）和/或直接撞击造成的虐待性头部创伤（伴或不伴颅骨骨折）均可导致致命或慢性致残性损伤。
- 作为一线影像学检查，CT 可显示不同部位硬膜下血肿 (SDH)，其密度表现呈多样性。该病变在 MRI 中亦呈现不同的信号强度特征，其形成与桥静脉破裂/血栓形成存在病理关联。脑实质损伤包括脑挫伤、撕裂伤和缺血性病变。
- 此外，还建议进一步行眼底镜检查以识别与虐待相关的视网膜出血，进行骨骼摄片以排查骨折情况，脊柱 MRI 检查韧带损伤和硬膜下血肿。
- 对疑似受虐儿童应在调查期间实施保护措施，并通知当地儿童保护机构。

轴位 CT。不同密度的高密度硬膜下血肿（箭头所示）、大脑半球间硬膜下血肿（三角箭头所示）、弥漫性脑水肿-缺血 (*)，伴脑沟消失及低密度改变。

颅骨的 3D CT 骨重建显示左侧顶骨骨折（箭头）。

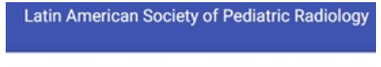
同例患儿的 T2 加权横断位 MRI 图像显示，硬膜下血肿 (*)、双侧额叶撕裂伤（箭头所示）和右颞叶挫伤（三角箭头所示）。

T2 加权横断位显示双侧硬膜下血肿伴左侧血液-液体平面（箭头所示），左半球脑实质水肿伴高信号改变 (*)。

受虐婴儿后颅窝硬膜下血肿（未显示）。矢状位 T1 加权序列显示腰椎区域意外发现的高信号硬膜下血肿（三角箭头所示）。

Paediatric radiology is much more... it is a world of ongoing information and collaboration!

The Image Gently Alliance



<↑> HYPERLINK

Contact your National Radiological Society and see if they have a paediatric radiology specialist interest group; the Paediatric Radiology society in your country; or the ESPR.

Further information on careers in radiology can be found here.

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学远不止于此……这是一个持续信息交互与多学科协作的领域！

儿科放射学

章节大纲：

<↑> 超链接

联系您所在国家的国家放射学会 (National Radiological Society)，了解他们是否有儿科放射学专家兴趣小组；您所在国家的儿科放射学会；或 ESPR。

有关放射学职业的更多信息，请点击此处。

/ Take-Home Messages

- Paediatric Radiology is an exciting, stimulating and rewarding subspecialty in radiology.
- Paediatric Radiologists master the art and skills of working with children and the knowledge regarding radiation protection principles and unique paediatric disease.
- Knowledge of all imaging modalities and their role depending on the indication is important for appropriate patient care and management.
- Being a paediatric Radiologist matters to children, families and society.
- Being a paediatric radiologist builds solid and fruitful bridges with numerous specialties including geneticists, neonatologists, paediatricians, paediatric surgeons, paediatric oncologists, paediatric neurologists, paediatric rheumatologists, paediatric orthopaedic surgeons, and many more...
- Paediatric Radiologists are crucial and visible members of multidisciplinary teams.

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 核心要点

- 儿科放射学是放射学领域一个充满活力、令人兴奋且极具成就感的分支学科。
- 小儿放射科医生精通与儿童打交道的技巧和方法，同时具备关于辐射防护原则和儿科疾病特性的专业知识。
- 了解所有影像学检查方法及其在具体适应证中的作用，对于提供恰当的患者护理和治疗至关重要。
- 作为一名小儿放射科医生，其工作对儿童、家庭以及整个社会都具有重要意义。
- 小儿放射科医生能够与众多专科领域建立坚实且富有成效的合作关系，包括遗传学家、新生儿科医生、儿科医生、小儿外科医生、小儿肿瘤学科医生、小儿神经科医生、小儿风湿科医生、小儿骨科医生，等等……
- 小儿放射科医生是多学科团队的重要成员，他们的作用显而易见。

References & Additional Literature

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Page 13:

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Page 24:

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Paediatric Radiology

CHAPTER OUTLINE:

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>▪< 进阶知识

儿科放射学

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第 13 页：

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Paediatric Radiology

CHAPTER OUTLINE:

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儿科放射学

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Test Your Knowledge

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

知识测试

Test Your Knowledge

<?> QUESTION

1 The angel wing sign is encountered in:

- ☐ Pneumothorax
- ☐ Intussusception
- ☐ Hypertrophic pyloric stenosis
- ☐ Pneumomediastinum
- ☐ Ascites

Paediatric Radiology

CHAPTER OUTLINE:

儿科放射学

章节大纲：

知识测试

<?> 问题

1 天使翼征见于：

- ☐ 气胸
- ☐ 肠套叠
- ☐ 肥厚性幽门狭窄
- ☐ 纵隔气肿
- ☐ 腹水

/ Test Your Knowledge

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/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

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/ Test Your Knowledge

<?> QUESTION

2 TORCH is the acronym for:

- ☐ Congenital CNS infections
- ☐ Congenital renal anomalies
- ☐ Congenital lung anomalies
- ☐ Types of growth plate fractures

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 知识测试

<?> 问题

2 TORCH 是以下哪个名词的缩写：

- ☐ 先天性中枢神经系统感染
- ☐ 先天性肾脏畸形
- ☐ 先天性肺发育畸形
- ☐ 生长板骨折的类型

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CHAPTER OUTLINE:

/ 知识测试

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/ Test Your Knowledge

<?> QUESTION

3 What is true for SALTER Harris classification?

- ☐ It has a prognostic significance
- ☐ In type 1 there is no fracture
- ☐ In type II there is extension of the fracture to the joint
- ☐ In type V there is extension of the fracture to the joint

CHAPTER OUTLINE:

章节大纲：

/ 知识测试

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3 以下哪项关于 SALTER Harris 分型的说法正确？

- ☐ 具有预后意义
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CHAPTER OUTLINE:

章节大纲：

/ 知识测试

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/ Test Your Knowledge

<?> QUESTION

4 What is the most appropriate statement for CAKUT?

- ☐ It is an acronym for anomalies resulting in potential nephropathy
- ☐ It is an acronym for anomalies resulting in potential uropathy
- ☐ It is an acronym for anomalies resulting in potential nephropathy and uropathy

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

4 以下哪项对 CAKUT 的说法最恰当？

- ☐ 是可能导致的肾脏畸形的首字母缩写
- ☐ 是可能导致的尿路畸形的首字母缩写
- ☐ 是可能导致的肾脏和尿路畸形的首字母缩写

Test Your Knowledge

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Paediatric Radiology

CHAPTER OUTLINE:

知识测试

儿科放射学

章节大纲：

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- ■ 是可能导致的肾脏和尿路畸形的首字母缩写

/ Test Your Knowledge

<?> QUESTION

5 The thymus:

- ☐ Is normally visible in radiographs of adolescents
- ☐ May cause a false impression of pneumomediastinum
- ☐ May cause a false impression of a mediastinal mass
- ☐ Cannot be appreciated on ultrasound

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

5 胸腺：

- ☐ 常见于青少年的 X 线片
- ☐ 可能造成纵隔气肿的假象
- ☐ 可能造成纵隔肿块的假象
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/ Test Your Knowledge

<?> QUESTION

6 Which of the following is true regarding aspirated or ingested foreign bodies?

- ☐ They can be indirectly identified due to air trapping, or atelectasis
- ☐ They cannot be identified unless they are metallic and radiopaque
- ☐ Ingested metallic objects require an operation
- ☐ Button batteries in the oesophagus usually come out naturally and uneventfully and should be left alone

CHAPTER OUTLINE:

/ 知识测试

章节大纲：

<?> 问题

6 关于吸入或吞咽的异物，下列哪一项正确？

- ☐ 可通过空气潴留或肺不张间接识别
- ☐ 除非是金属材质且不透射线，否则无法识别
- ☐ 摄入金属物体需要手术
- ☐ 食管中的纽扣电池通常会自然顺利排出，应不予理会

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/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 知识测试

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Test Your Knowledge

<?> QUESTION

7 What is the most appropriate modality for the investigation of hypertrophic pyloric Stenosis (HPS)?

- ☐ Abdominal radiograph
- ☐ Ultrasonography
- ☐ Computed tomography
- ☐ Fluoroscopy

Paediatric Radiology

CHAPTER OUTLINE:

知识测试

儿科放射学

章节大纲：

<?> 问题

7 肥厚性幽门狭窄 (HPS) 最合适的检查方式是什么？

- ☐ 腹部 X 线摄影
- ☐ 超声检查
- ☐ CT 检查
- ☐ X 线透视检查

Test Your Knowledge

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Paediatric Radiology

CHAPTER OUTLINE:

知识测试

儿科放射学

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- ☐ CT 检查
- ☐ X 线透视检查

/ Test Your Knowledge

<?> QUESTION

8 What is the most common abnormal finding in physically abused children?

- ☐ Bruises
- ☐ Fractures
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/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 知识测试

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8 遭受身体虐待儿童最常见的异常检查结果是什么？

- ☐ 瘀伤
- ☐ 骨折
- ☐ 头部创伤
- ☐ 脊柱创伤

/ Test Your Knowledge

<?> ANSWER

8 What is the most common abnormal finding in physically abused children?

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/ Paediatric Radiology

CHAPTER OUTLINE:

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9 What kind of lesions can be attributed to hypoxic ischemic injury in term babies?

- ☐ Lesions of basal ganglia and thalami
- ☐ Germinal matrix haemorrhage
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/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 知识测试

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10 Which of the following is a frequent suprasellar tumour in children?

- ☐ Craniopharyngioma
- ☐ Pituitary adenoma
- ☐ Meduloblastoma
- ☐ Choroid plexus papilloma

/ Paediatric Radiology

CHAPTER OUTLINE:

/ 儿科放射学

章节大纲：

/ 知识测试

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10 以下哪一项是儿童常见的鞍上肿瘤？

- ☐ 颅咽管瘤
- ☐ 垂体腺瘤
- ☐ 髓母细胞瘤
- ☐ 脉络丛乳头状瘤

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/ Paediatric Radiology

CHAPTER OUTLINE:

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