MODERN RADIOLOGY eBook

Endocrine System 内分泌系统

/ Preface

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

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

Although the initial version of the *ESR eBook* was created to provide basic knowledge for medical students and teachers of undergraduate courses, it has gradually expanded its scope to include more advanced knowledge for readers who wish to 'dig deeper'. As a result, *Modern*

Radiology covers also topics of the postgraduate levels of the *European Training Curriculum for Radiology*, thus addressing postgraduate educational needs of residents. In addition, it reflects feedback from medical professionals worldwide who wish to update their knowledge in specific areas of medical imaging and who have already appreciated the depth and clarity of the *ESR eBook* across the basic and more advanced educational levels.

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

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

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

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/ 前言

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

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

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

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

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

Minerva Becker，编辑
瑞士日内瓦大学放射学教授

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/ Endocrine System

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This is a translation of the Chapter of the **Modern Radiology eBook.**

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Endocrine System

TRANSLATED BY:
Prof. Nan Hong, Peking University People's Hospital
Prof. Feiyun Wu, Jiangsu Province Hospital

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

hongnan@bjmu.edu.cn
wufeiyundd@163.com

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/ 翻译致谢

本章节为《现代放射学电子书》的部分译文。

原文标题：
内分泌系统

翻译：
洪楠教授，北京大学人民医院
吴飞云教授，江苏省人民医院

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。

<↑> 超链接

hongnan@bjmu.edu.cn
wufeiyundd@163.com

/ Signage

<**•**> **CORE KNOWLEDGE**

<!> **ATTENTION**

<↑> **HYPERLINKS**

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<?> 问题

MODERN RADIOLOGY eBook

Based on the ESR Curriculum for Radiological Education

Endocrine System

AUTHORS

Sophie Neveü[1] | Edith Vasallo[2] | Emma Tabone[2] | Vincent Lenoir[1] | Minerva Becker[1]

AFFILIATION

[1] University Hospitals Geneva, University of Geneva, Geneva, Switzerland
[2] Mater Dei Hospital, Malta

<↑> **HYPERLINK**

sophie.neveu@hug.ch
edith.vassallo@gov.mt
emma.tabone.18@um.edu.mt
vincent.lenoir@hug.ch
minerva.becker@hug.ch

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章节大纲：

基于 ESR 课程的放射学教育

内分泌系统

作者

Sophie Neveü[1] | Edith Vasallo[2] | Emma Tabone[2] | Vincent Lenoir[1] | Minerva Becker[1]

所属机构

[1] 日内瓦大学医院 (University Hospitals Geneva, University of Geneva)，日内瓦大学 (University of Geneva)，瑞士日内瓦

[2] 马耳他国立圣母医院 (Mater Dei Hospital)，马耳他

<↑> **超链接**

sophie.neveu@hug.ch
edith.vassallo@gov.mt
emma.tabone.18@um.edu.mt
vincent.lenoir@hug.ch
minerva.becker@hug.ch

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- Pituitary gland
- Adrenal Glands
- Paraganglia

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- Multinodular Goitre
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> **<!> ATTENTION**
>
> Pancreas, ovaries and testes are not included in this chapter. They are dealt with in separate eBook chapters.

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    - 分期
    - 乳头状甲状腺癌
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> **<!> 注意**
>
> 本章不包含胰腺、卵巢和睾丸的相关内容。这些内容在单独的电子书章节中另做介绍。

Anatomy & Function

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/ Anatomy & Function: Thyroid and Parathyroids

The **thyroid gland** is located in the anterior lower visceral space of the neck. The gland has two lobes, connected by a thin midline portion called isthmus (**Fig. 1**). It produces hormones that regulate metabolism, growth, and development, including thyroxine (T4), triiodothyronine (T3) and calcitonin.

The parathyroids are small paired endocrine glands, typically located on the posterior surface of the thyroid lobes (**Fig. 1**). Most individuals have four parathyroid glands,

i.e., two superior and two inferior glands; however, about 15% of individuals have supernumerary parathyroids. Ectopy of the parathyroids is common. Typical ectopic locations include the superior

mediastinum, the submental space and the retro-oesophageal area (most common). The parathyroid glands produce the parathyroid hormone (PTH), which regulates the calcium level in the blood.
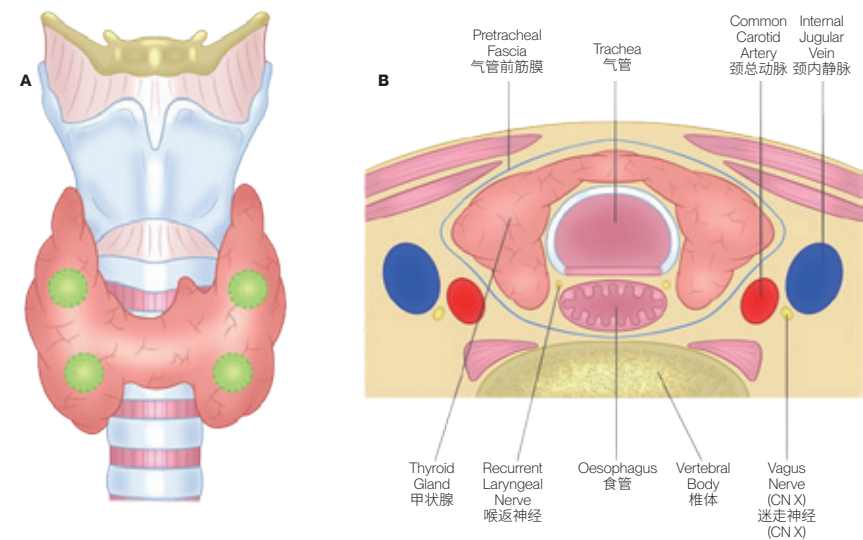

FIGURE 1

Schematic diagram of the thyroid and parathyroid glands (green dots) and their relationship to important anatomical landmarks. A. Frontal view. B. Axial cross-section.

/ 解剖学与功能：甲状腺和甲状旁腺

甲状腺位于颈部前下方的内脏间隙内。甲状腺有两个腺叶，由被称为峡部的较薄的中线部分连接（图 1）。它分泌调节代谢、生长和发育的激素，包括甲状腺素 (T4)、三碘甲状腺原氨酸 (T3) 和降钙素。

甲状旁腺是一对小型内分泌腺，通常位于甲状腺叶背侧（图 1）。大多数人有 4 个甲状旁腺，即两个上甲状旁腺和两个下甲状旁腺；然而，约 15% 的人有额外的甲状旁腺。甲状旁腺异位很常见。典型的异位位置包括上纵隔、颏下间隙和食管后区域（最常见）。甲状旁腺分泌甲状旁腺激素（parathyroid hormone，PTH），PTH 可调节血钙水平。

图 1

示意图：甲状腺和甲状旁腺（绿点）及其与重要解剖标志间的关系。A. 正视图。B. 轴向横截面。

Due to its superficial position, ultrasonography (US) is the imaging modality of choice to explore the thyroid gland (**Fig. 2**). On US, the gland appears hyperechoic compared to muscles and weakly vascularised. The volume (which depends on gender) is measured to diagnose gland atrophy versus enlargement (goitre).

CT or MRI (**Fig. 3**) are useful to evaluate gland extension into the mediastinum, tracheal compression or deep extension of a thyroid mass. The normal parathyroids are not visible on CT and MRI, however their position can be estimated based on the location of the inferior thyroid artery.

> **◄!► ATTENTION**
>
> Normal weight = 25 - 30 g
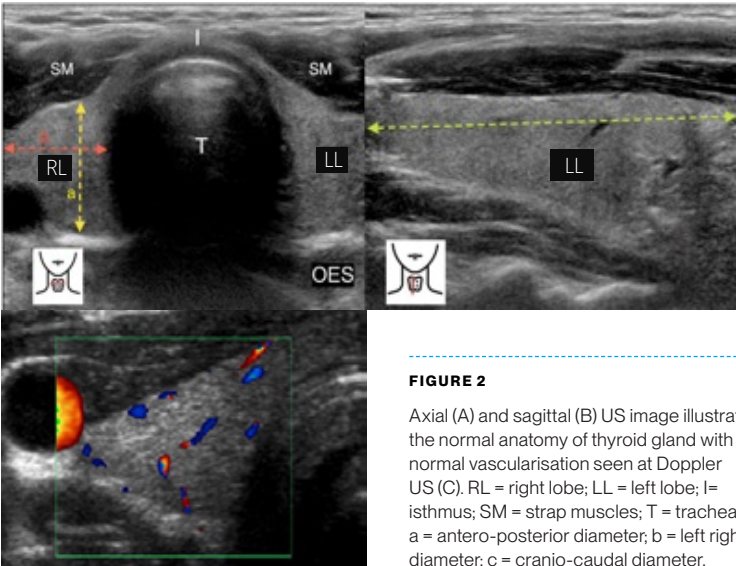> Normal volume = 5 cm^3 - 18 cm^3 ♀ / 20 cm^3 ♂

FIGURE 2

Axial (A) and sagittal (B) US image illustrating the normal anatomy of thyroid gland with normal vascularisation seen at Doppler US (C). RL = right lobe; LL = left lobe; I= isthmus; SM = strap muscles; T = trachea; a = antero-posterior diameter; b = left right diameter; c = cranio-caudal diameter.
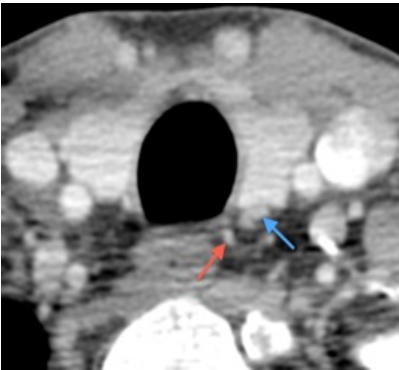

FIGURE 3

Normal thyroid gland on an axial contrast-enhanced CT image at the level of the cervical trachea. Red arrow (inferior thyroid artery) and blue arrow (inferior thyroid vein).

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由于甲状腺位于浅表，超声检查 (US) 是探查甲状腺的首选影像学检查方法（图 2）。在 US 影像中，与肌肉相比甲状腺呈强回声，且血流分布稀疏。通过测量体积（取决于性别）诊断腺体萎缩与肿大（甲状腺肿）。

CT 或 MRI（图 3）可用于评估甲状腺腺体向纵隔内延伸、气管受压或甲状腺肿块深部延伸的情况。正常甲状旁腺在 CT 和 MRI 上不可见，但其位置可根据甲状腺下动脉的位置进行推测。

> **◄!► 注意**
>
> 正常体重 = 25 - 30 g
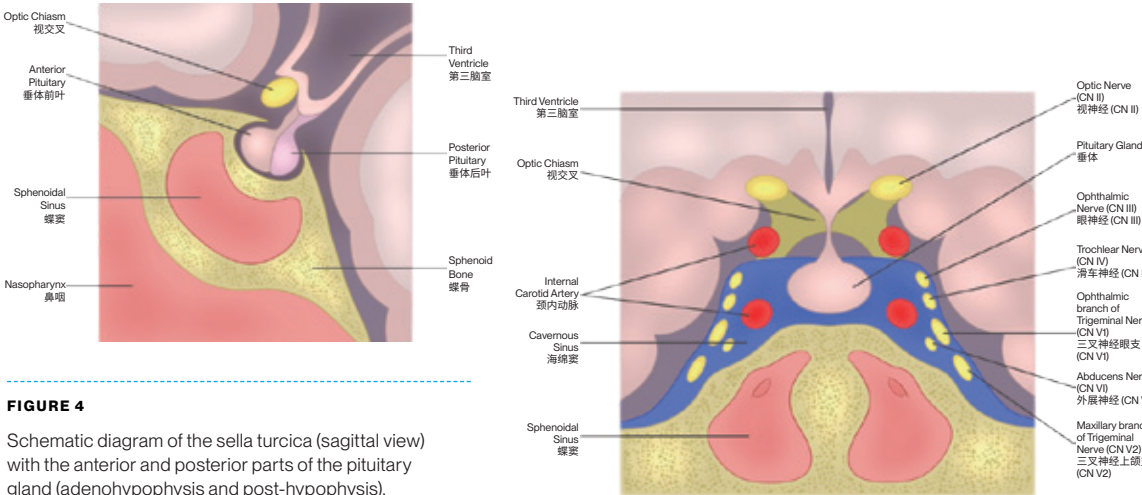> 正常体积 = 5 cm^3 - 18 cm^3 ♀ / 20 cm^3 ♂

图 2

轴位 (A) 和矢状位 (B) US 图像显示甲状腺正常解剖结构，多普勒超声可见正常血供 (C)。RL = 右叶；LL = 左叶；I = 峡部；SM = 带状肌；T = 气管；a = 前后径；b = 左右径；c = 上下径。

图 3

增强 CT 轴位图像颈部气管水平显示正常甲状腺。红色箭头示甲状腺下动脉，蓝色箭头示甲状腺下静脉。

/ Anatomy & Function: Pituitary Gland

The **pituitary gland** is a small endocrine gland located at the base of the brain, in a saddle-shaped depression of the sphenoid bone called the sella turcica (**Fig. 4**). The gland is divided into two parts, the anterior pituitary (ante-hypophysis or adenohypophysis) and the posterior pituitary (post-hypophysis). The pituitary stalk (also called infundibulum) connects the pituitary gland (especially the post-hypophysis) to the hypothalamus. The pituitary gland and stalk are located outside the blood-brain barrier. The cavernous sinuses are dural venous sinuses, which are located on both sides of the sphenoid bone and pituitary gland (**Fig. 5**).

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/ 解剖学与功能：垂体

垂体是位于颅底蝶鞍内的小型内分泌腺（**图 4**）。垂体分为垂体前叶（前垂体或腺垂体）和垂体后叶（后垂体）两部分。垂体柄（也称漏斗）连接垂体（尤其是垂体后叶）与下丘脑。垂体和垂体柄位于血脑屏障外。海绵窦为硬脑膜静脉窦，位于蝶骨及垂体两侧（**图 5**）。

FIGURE 4

Schematic diagram of the sella turcica (sagittal view) with the anterior and posterior parts of the pituitary gland (adenohypophysis and post-hypophysis).

FIGURE 5

Schematic diagram of the sella turcica with the pituitary gland (coronal view). The cavernous sinuses are rendered in blue. The internal carotid artery and cranial nerves III, IV, V1, V2 and VI traverse the cavernous sinuses. Superiorly the main suprasellar structure located in proximity is the optic chiasm.

图 4

蝶鞍示意图（矢状位），显示垂体前叶和后叶（腺垂体和后垂体）。

图 5

蝶鞍示意图（冠状位），显示垂体。海绵窦以蓝色标注。颈内动脉及第 III、IV、V1、V2 和 VI 对脑神经均穿过海绵窦。鞍上的主要邻近结构为视交叉。

The volume of the pituitary gland changes depending on the hormonal status and age. In adults > 50 years, the gland gradually decreases in size.

> **◄!► ATTENTION**
>
> MRI is the imaging modality of choice to evaluate the pituitary gland (**Fig. 6**).
>
> On MRI, the posterior pituitary gland has a high signal on T1-weighted (T1W) images because of the storage of vasopressin (see next page).
>
> Because the pituitary gland and the stalk are located outside the brain blood barrier, they both show enhancement after intravenous administration of contrast material on CT and MRI.
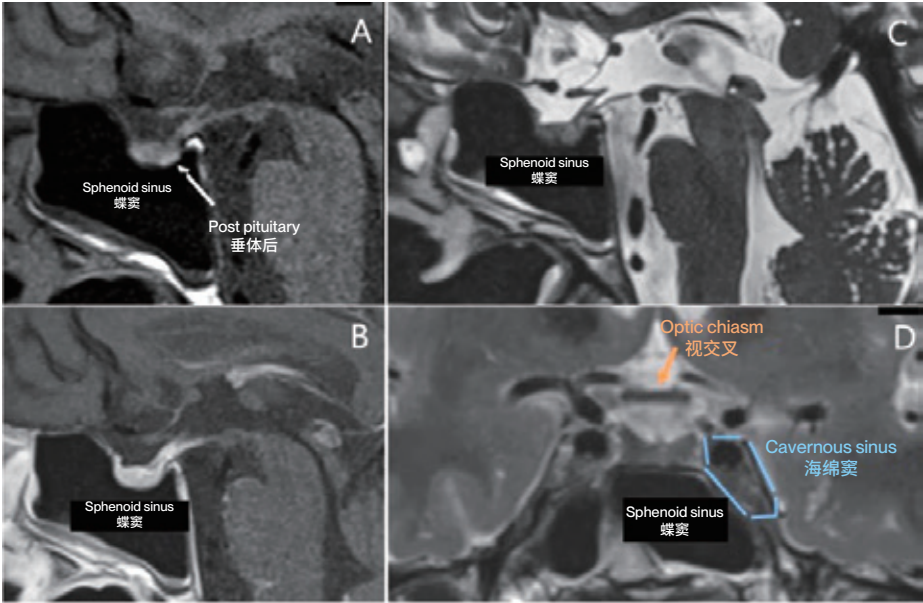

FIGURE 6

Sagittal T1W MR image (A) shows normal high signal of the post-hypophysis. Corresponding contrast-enhanced T1W (B) image demonstrates normal homogenous enhancement of the gland and pituitary stalk. Sagittal (C) and coronal (D) T2W images show the anatomical position of pituitary fossa just above the sphenoid sinus, in between the paired cavernous sinuses and below the optic chiasm.

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垂体体积随激素水平及年龄变化。50 岁以上成人的垂体逐渐缩小。

> **◄!► 注意**
>
> MRI 是评估垂体的首选影像学检查方法（**图 6**）。
>
> 在 MRI 上，由于储存血管加压素，垂体后叶在 T1 加权 (T1W) 图像上呈现高信号（见下页）。
>
> 由于垂体及垂体柄位于血脑屏障外，因此在静脉注射对比剂后，在CT 和 MRI 上垂体及垂体柄均显示强化。

图 6

矢状位 T1W MR 图像 (A) 显示后垂体呈正常高信号。相应的对比增强 T1W 图像 (B) 显示垂体和垂体柄呈正常均匀强化。矢状位 (C) 和冠状位 (D) T2W 图像显示垂体窝的解剖位置在蝶窦上方、成对海绵窦之间和视交叉下方。

The pituitary gland plays an important role in controlling the hormonal secretion of most other endocrine glands (**Fig. 7**). Its activity is mainly controlled by the hypothalamus. The hormones produced by the pituitary gland are released in bursts of a few hours, following a circadian rhythm or depending on other factors (e.g., menstrual cycle).

The adenohypophysis produces five hormones :

/ Growth hormone (GH) or somatotropin

/ Prolactin (PRL)

/ Adrenocorticotropic hormone (ACTH)

/ Thyroid stimulating hormone (TSH)

/ Follicle stimulating hormone (FSH) and

/ Luteinising hormone (LH)

The post-hypophysis stores and releases two hormones produced by the hypothalamus:

/ Antidiuretic hormone (ADH), also known as vaso-pressin, which regulates water balance

/ Oxytocin, which stimulates uterine contractions during childbirth and promotes milk ejection during breastfeeding

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<!> **ATTENTION**

Hormonal testing is crucial in the context of adrenal pathologies. However hormonal assessment may be challenging due to circadian rhythm , sex /age, drug interactions, etc.
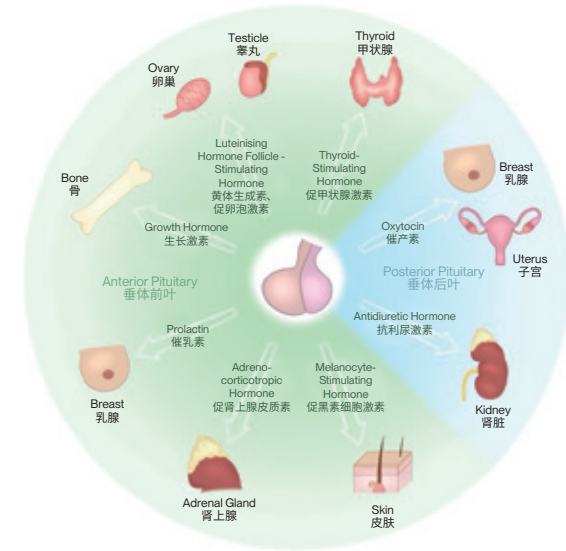

FIGURE 7

Hormonal testing is crucial in the context of adrenal pathologies. However hormonal assessment may be challenging due to circadian rhythm , sex /age, drug interactions, etc.

/ **Endocrine System**

/ **内分泌系统**

垂体在调控大部分其他内分泌腺的激素分泌中起重要作用（图 7）。其活动主要由下丘脑控制。垂体分泌的激素以数小时为周期脉冲式释放，遵循昼夜节律或受其他因素（如月经周期）影响。

腺垂体分泌 5 种激素：

/ 生长激素（GH，又称促生长素）

/ 泌乳素 (PRL)

/ 促肾上腺皮质激素 (ACTH)

/ 促甲状腺激素 (TSH)

/ 促卵泡激素 (FSH)

/ 黄体生成素 (LH)

后垂体储存并释放下丘脑分泌的 2 种激素：

/ 抗利尿激素（ADH），又称血管加压素，调节水盐平衡

/ 催产素，在分娩过程中刺激子宫收缩，在哺乳过程中促进乳汁排出

<!> 注意

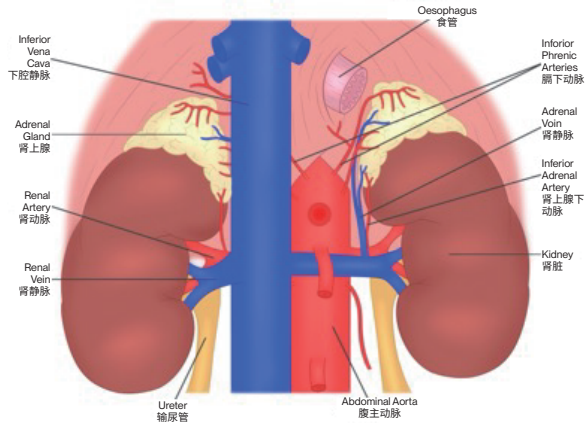激素检测在肾上腺疾病诊疗中至关重要。然而，由于昼夜节律、性别/年龄、药物相互作用等，激素评估可能具有挑战性。

图 7

激素检测在肾上腺疾病诊疗中至关重要。然而，由于昼夜节律、性别/年龄、药物相互作用等，激素评估可能具有挑战性。

/ Anatomy & Function: Adrenal Glands

The **adrenal glands (Figs. 8 and 9)** are a pair of small, triangular-shaped glands located on top of each kidney. Each gland is formed by an outer cortex and an inner medulla. The adrenal cortex is divided into three zones. The **zona glomerulosa** produces mineralocorticoids, e.g., aldosterone, which regulates the balance of electrolytes and blood pressure. The **zona fasciculata** produces glucocorticoids (cortisol and cortisone), which regulate metabolism, immune system and stress response. The **zona reticularis** produces androgens.

The adrenal medulla releases two hormones, i.e., epinephrine (adrenaline) and norepinephrine (nor-adrenaline). These hormones are involved in the "fight or flight" rapid body response to stress.
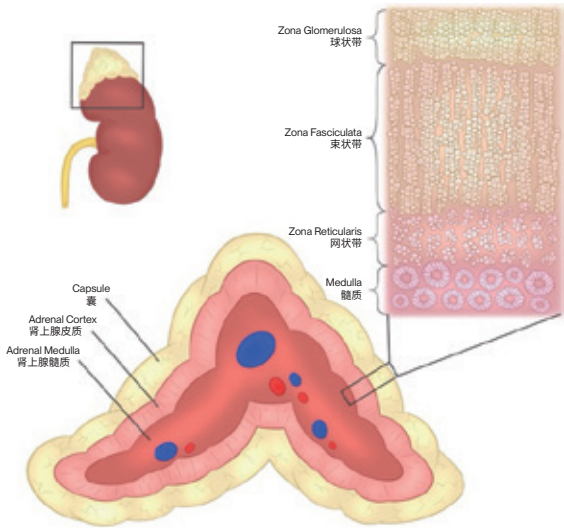

FIGURE 8

Schematic illustration of the adrenal glands and surrounding anatomic structures (coronal view).

FIGURE 9

Schematic drawing of an adrenal gland and its different components.

/ Endocrine System

/ 内分泌系统

/ 解剖学与功能：肾上腺

肾上腺（图8 和图 9）是一对小型三角形腺体，分别位于左右肾脏的上方。每个肾上腺均由外层皮质和内层髓质构成。肾上腺皮质分为三个区。**球状带**分泌盐皮质激素（如醛固酮），用于调节电解质平衡及血压。**束状带**分泌糖皮质激素（皮质醇和皮质酮），可调节代谢、免疫系统和应激反应。**网状带**分泌雄激素。

肾上腺髓质分泌两种激素：肾上腺素和去甲肾上腺素。这些激素参与机体对应激的"战逃"快速反应。

图 8

肾上腺及周围解剖结构示意图（冠状位视图）。

图 9

肾上腺及其不同组成部分示意图。

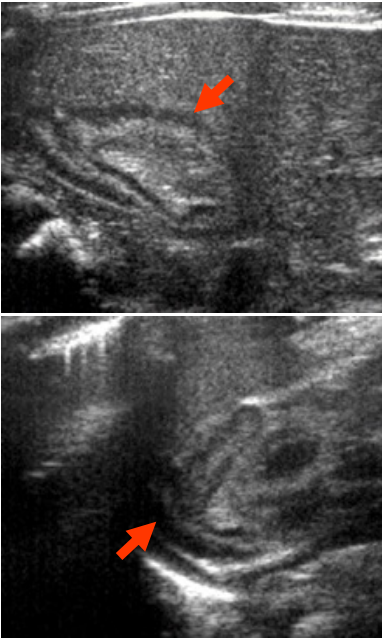The right adrenal gland has a maximum width of 6 mm and the

FIGURE 10

Newborn abdominal ultrasound showing normal adrenal glands. The glands appear as an Y shaped structure surrounded by a hypoechoic rim (arrows).

left adrenal gland has a maximum width of 8 mm. Proportionally, the size of the adrenal glands is larger in new-borns and infants, being almost a third of the size of the kidneys. In young children, the adrenal glands are easily seen on abdominal US (**Fig. 10**). However,
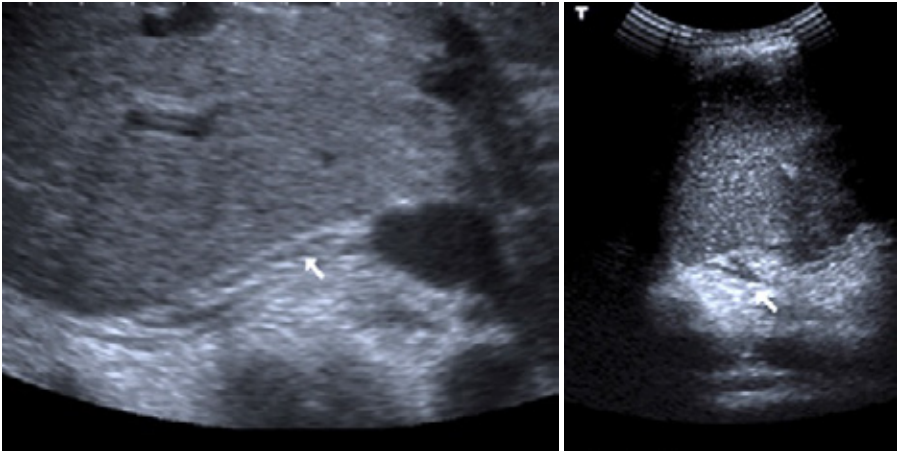

FIGURE 11

Adult abdominal ultrasound. White arrows showing two small adrenal glands. As mentioned above, it's not uncommon not to see them on US. In adults, CT or MRI are better suited for adrenal gland imaging.

in adolescents and adults, the normal adrenal glands are less well visible on US (**Fig. 11**), especially in large or obese patients unless they are enlarged. In general, the left adrenal gland is more difficult to visualise than the right.

/ Endocrine System

CHAPTER OUTLINE:

Anatomy and Function

/ Adrenal Glands

Choice of Imaging Techniques

Thyroid & Parathyroid Pathology

Paraganglioma

Pituitary Gland Lesions

Adrenal Gland Pathology

Take-Home Messages

References

Test Your Knowledge

/ 内分泌 系统

章节大纲：

解剖学与功能

/ 肾上腺

影像学检查技术的 选择

甲状腺和甲状旁腺 病理学

副神经节瘤

垂体病变

肾上腺病理学

核心要点

参考文献

知识测试

右肾上腺最大宽度为 6 mm，左肾上腺最大宽度为 8 mm。新生儿及婴儿的肾上腺体积比例更大，几乎相当于肾脏大小的三分之一。婴幼儿腹部 US 通常可清晰显示肾上腺（图 10）。但青少年及成人的正常肾上腺在 US 上不太明显（图 11），尤其是体型较大或肥胖者，除非肾上腺增大。一般来说，左肾上腺比右肾上腺更难显示。

图 10

新生儿腹部超声显示正常肾上腺。肾上腺呈 Y 形结构，伴有周围低回声缘（箭头）。

图 11

成人腹部超声。白色箭头示两个小肾上腺。如上所述，在 US 上显示不清的情况并不罕见。CT 或 MRI 更适用于成人肾上腺的影像学检查。

In general, the right adrenal gland is slightly smaller than the left adrenal gland and it has a triangular shape on axial images (**Fig. 12**).

In contrast, the left adrenal gland can either appear as crescent shaped or as triangular on axial images (**Fig. 12**).

The right adrenal gland is posterior to the inferior vena cava and adjacent to the right liver.

The left adrenal gland is located medially to the spleen with the splenic pedicle running along its lateral limb.

The adrenal glands typically show enhancement after intravenous contrast administration.

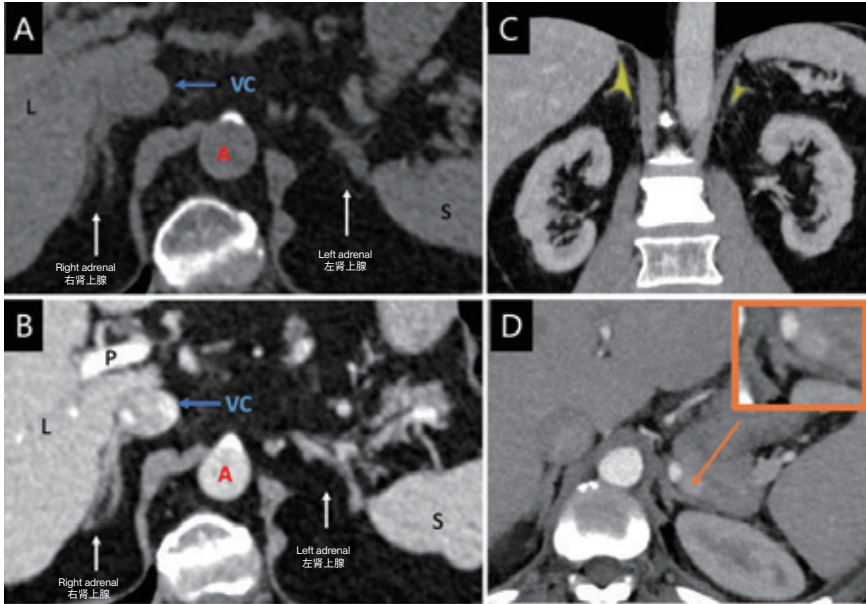On coronal images , both adrenal glands have a triangular shape (Fig. 12).

FIGURE 12

Axial (A and B) CT images obtained in the same patient without (A) and with contrast administration (B). Liver (L), spleen (S), aorta (A), portal vein (P), inferior vena cava (VC). Coronal (C) and axial (D) images in a different patient. On the coronal image, the adrenal glands are rendered in yellow.

/ **Endocrine** System

/ 内分泌 系统

一般而言，右肾上腺略小于左肾上腺，轴位图像中呈三角形（图 12）。

而左肾上腺在轴位图像中可表现为新月形或三角形（图 12）。

右肾上腺位于下腔静脉后方，紧邻右侧肝脏。

左肾上腺则位于脾脏内侧，脾蒂沿其外侧缘走行。

静脉注射对比剂后，肾上腺通常可见强化。

冠状位图像中，双侧肾上腺均呈三角形（图 12）。

图 12

同一患者未注射对比剂 (A) 和注射对比剂 (B) 的轴位（A 和 B）CT 图像。肝 (L)、脾 (S)、主动脉 (A)、门静脉 (P)、下腔静脉 (VC)。不同患者的冠状位 (C) 和轴位 (D) 图像。冠状位图像中，肾上腺呈现黄色。

/ Anatomy & Function: Paraganglia

Paraganglia are neuroendocrine cell clusters associated with the autonomic nervous system.

Depending on their location, they can be classified as sympathetic (made of chromaffin cells) or parasympathetic (made of nonchromaffin glomus cells).

Sympathetic paraganglia have an endocrine function, whereas parasympathetic paraganglia have primary chemoreceptor function. Paraganglia with chemoreceptor function detect changes in blood pH, O_2 and CO_2 levels and thus regulate circulation and respiration.

Sympathetic paraganglia can be found in the adrenal medulla or in extra-adrenal locations along the sympathetic nervous system, including the organ of Zuckerkandl.

Parasympathetic paraganglia are found the carotid and aortic bodies, along the vagus (X) and glosso-pharyngeal (IX) nerves and their branches.

⟨!⟩ ATTENTION

Tumours arising in paraganglia are called paragangliomas.

Chromaffin paragangliomas are called pheochromocytomas.

> See pages 51-53 in this chapter

/ Endocrine System

/ 内分泌 系统

/ 解剖学与功能：副神经节

副神经节是与自主神经系统相关的神经内分泌细胞簇。

根据其位置不同，副神经节可分为交感神经副神经节（由嗜铬细胞构成）和副交感神经副神经节（由非嗜铬性球细胞构成）。

交感神经副神经节具有内分泌功能，而副交感神经副神经节主要具有化学感受器功能。具有化学感受器功能的副神经节可监测血液 pH 值、O_2 和 CO_2 水平的变化，从而调节循环和呼吸。

交感神经副神经节可见于肾上腺髓质或沿交感神经系统分布的肾上腺外部位，包括 Zuckerkandl 器。

副交感神经副神经节则分布于颈动脉体、主动脉体，以及迷走神经 (X)、舌咽神经 (IX) 及其分支周围。

⟨!⟩ 注意

起源于副神经节的肿瘤被称为副神经节瘤。

嗜铬性副神经节瘤被称为嗜铬细胞瘤。

> 参阅本章第 51-53 页

Choice of Imaging Techniques

Endocrine System

内分泌系统

影像学检查技术的选择

/ Ultrasonography for the Thyroid Gland

Indications

/ Characterisation and classification of thyroid lesions.

/ US has a high sensitivity for identifying malignant lesions based on certain sonographic criteria such as: hypoechoic, ill-defined margins, microcalcifications, shape (taller-than-wide), high vascularity (Fig. 13).

/ US is used to distinguish benign from malignant lymph nodes based on their shape, size and pattern of vascularity (Fig. 14).

ADVANTAGES:

+ Quick and cheap.
+ Non-invasive.
+ No ionising radiation.
+ Aids in guiding fine needle aspiration (FNA) or biopsy in suspected thyroid gland lesions or lymph node metastases.
+ Excellent spatial resolution (the ability to distinguish small structures or features).

DISADVANTAGES:

− Operator dependent.
− No standardised, reproducible imaging documentation.
− Unable to assess retrosternal lesions.
− Cannot reliably distinguish benign from malignant follicular lesions (see below).

FIGURE 13

Transverse US shows a strongly hypoechoic lesion with irregular margins, containing microcalcifications (small hyperechoic areas) in the right thyroid lobe. This was a histologically proven papillary carcinoma. T = trachea; I = isthmus
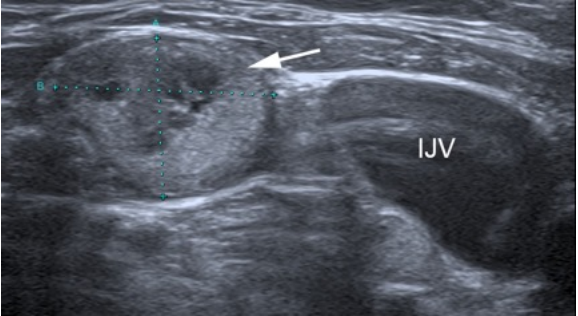

FIGURE 14

US shows a pathological lymph node (white arrow) lying lateral to the internal jugular vein (IJV), with no fatty hilum, internal cystic changes and internal echogenic foci, consistent with microcalcifications.

/ Endocrine System

CHAPTER OUTLINE:

/ 内分泌系统

章节大纲：

/ 甲状腺超声检查

适应证

/ 甲状腺病变的定性及分类。

/ US 根据特定超声标准识别恶性病变的敏感性较高，例如：低回声、边缘模糊、微钙化、形态（纵径大于横径）、富血供（图 13）。

/ US 可根据淋巴结的形态、大小和血供模式，区分良性与恶性淋巴结（图 14）。

优点：

+ 快速、便宜。
+ 无创。
+ 无电离辐射。
+ 有助于引导甲状腺可疑病变或淋巴结转移的细针穿刺抽吸 (FNA) 或活检。
+ 空间分辨率高（可清晰分辨微小结构或特征）。

缺点：

− 操作者依赖性。
− 缺乏标准化、可重复的影像学记录方式。
− 无法评估胸骨后病变。
− 无法可靠区分良性与恶性滤泡性病变（见下文）。

图 13

横断面 US 显示甲状腺右侧叶内一显著低回声病灶，边缘不规则，内部可见微钙化（小片状高回声区）。经组织学证实为乳头状癌。T = 气管；I = 峡部

图 14

US 显示一病理性淋巴结（白色箭头），位于颈内静脉 (IJV) 外侧，无脂肪门，内部伴囊性改变及强回声灶，符合微钙化表现。

/ Ultrasonography Guided Fine Needle Aspiration (FNA)

Indications

/ Characterising thyroid nodules or lymph nodes

ADVANTAGES:

+ No ionising radiation.
+ Aids in guiding the exact site of fine needle aspiration (FNA) or biopsy in suspected thyroid gland lesions (**Figs. 15 & 16**) or lymph node metastases.

DISADVANTAGES:

− Operator dependent.
− If lymphoma is suspected, a biopsy is necessary.

<!> ATTENTION

If lymphoma is suspected, whether in the thyroid gland or in pathological lymph nodes, US guided biopsy is preferred to FNA as it aids in reaching a more conclusive and precise diagnosis in certain lymphoma types.
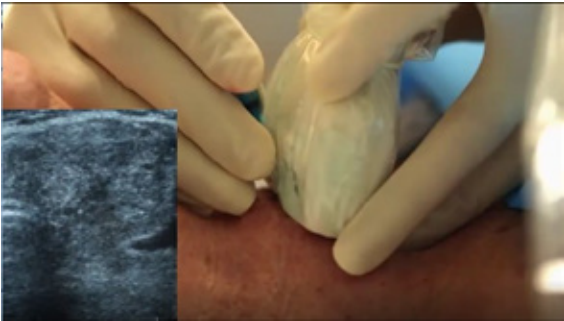
FIGURE 16

US image demonstrates the needle (double arrowheads) within a nodule in the left thyroid lobe.

FIGURE 15

Photograph of an FNA being performed with the corresponding US image.

<∞> REFERENCES

Bernadette Koch, Bronwyn E. Hamilton, Patricia Hudgins, H. Ric Harnsberger (2017). Diagnostic Imaging: Head and Neck, 3rd edn. Elsevier, Philadelphia. https://www.sciencedirect.com/science/article/pii/S1879729616301399

/ Endocrine System

CHAPTER OUTLINE:

/ 内分泌系统

章节大纲：

/ 超声引导下细针穿刺抽吸 (FNA)

适应证

/ 甲状腺结节或淋巴结的定性

优点：

+ 无电离辐射。
+ 有助于引导甲状腺可疑病变（图15 和 16）或淋巴结转移的细针穿刺抽吸 (FNA) 或活检的进针位置。

缺点：

− 操作者依赖性。
− 如果怀疑淋巴瘤，有必要进行活检。

图 15

FNA 的操作图像及对应的 US 图像。

图 16

US 图像显示甲状腺左侧叶内结节内的穿刺针（双箭头）。

<∞> 参考文献

Bernadette Koch, Bronwyn E. Hamilton, Patricia Hudgins, H. Ric Harnsberger (2017). Diagnostic Imaging: Head and Neck, 3rd edn. Elsevier, Philadelphia. https://www.sciencedirect.com/science/article/pii/S1879729616301399

<!> 注意

如果怀疑淋巴瘤，（无论发生于甲状腺或病理性淋巴结），超声引导下活检均优于FNA，因其有助于某些类型淋巴瘤的确诊及精准诊断。

/ Computed Tomography (CT) for the Thyroid Gland

Indications

/ Reserved for locally advanced cases where there is a strong suspicion of deep invasion and/or metastatic disease and for surgical planning:

ADVANTAGES:

+ Can allow evaluation of retrosternal extent in large lesions to guide surgical management.
+ Helps characterise large lesions and clearly demonstrates necrosis and extracapsular extension (**Fig. 17**).
+ Able to identify deep seated metastatic lymph nodes lying behind the manubrium or behind the clavicle.
+ High resolution CT can be used to detect very small lung metastases.
+ MRI is superior to CT for assessing invasion of trachea/oesophagus (less suited for the lungs).

DISADVANTAGES:

− Iodine based contrast agents are contraindicated in differentiated thyroid malignancies because they delay radioiodine therapy by 6 months.
− Radiation penalty.
− Unable to characterise smaller thyroid nodules due to its limited spatial resolution compared to US.

FIGURE 17

CT scan of the neck after contrast administration demonstrates a thyroid mass with necrotic centre (asterisk) and ill-defined margins, causing severe contralateral tracheal shift, and associated with intraluminal invasion of the trachea (arrow). This was a biopsy proven poorly differentiated thyroid carcinoma.

<∞> **REFERENCE**

https://radiopaedia.org/articles/thyroid-malignancies

/ Endocrine System

/ 内分泌 系统

/ 甲状腺计算机断层扫描 (CT)

适应证

/ 适用于高度怀疑深部浸润或转移性疾病的局部晚期病例及手术规划：

优点：

+ 可评估大病灶的胸骨后侵犯范围，指导手术方案制定。
+ 有助于明确大病灶的特征，清晰显示坏死及包膜外侵犯（图 17）。
+ 能够识别位于胸骨柄后方或锁骨后方的深部转移性淋巴结。
+ 高分辨 CT 可检出微小肺转移灶。
+ MRI 在评估气管/食管受侵方面优于 CT（但不适用于评估肺部）。

缺点：

− 甲状腺分化型癌患者禁用碘对比剂，因其会使放射性碘治疗延迟 6 个月。
− 辐射风险。
− 与 US 相比，其空间分辨率有限，无法准确评估小甲状腺结节。

图 17

注射对比剂后颈部 CT 扫描显示甲状腺肿块伴中心坏死（星号），边缘不清，导致严重的对侧气管移位及气管管腔侵犯（箭头）。经活检证实为低分化甲状腺癌。

<∞> 参考文献

https://radiopaedia.org/articles/thyroid-malignancies

/ Magnetic Resonance Imaging (MRI) for the Thyroid Gland

Indications

/ Not the first imaging modality.

/ Can help identify retropharyngeal lymph node metastases (rare).

ADVANTAGES:

+ Non-invasive.

+ No ionising radiation.

+ Useful in the context of locally advanced thyroid cancer to determine extrathyroidal extension and invasion of regional structures.

+ Staging of lymph node metastases.

+ Can determine the degree of retrosternal extension in large thyroid goitre and the degree of locoregional spread including the degree of vessel encasement (Fig. 18).

+ Can be used in the follow-up of goitres in patients who are not ideal candidates for surgery avoiding repeated ionising radiation exposure.

DISADVANTAGES:

– Limited spatial resolution in comparison to US.

– Patient claustrophobia may preclude its use.

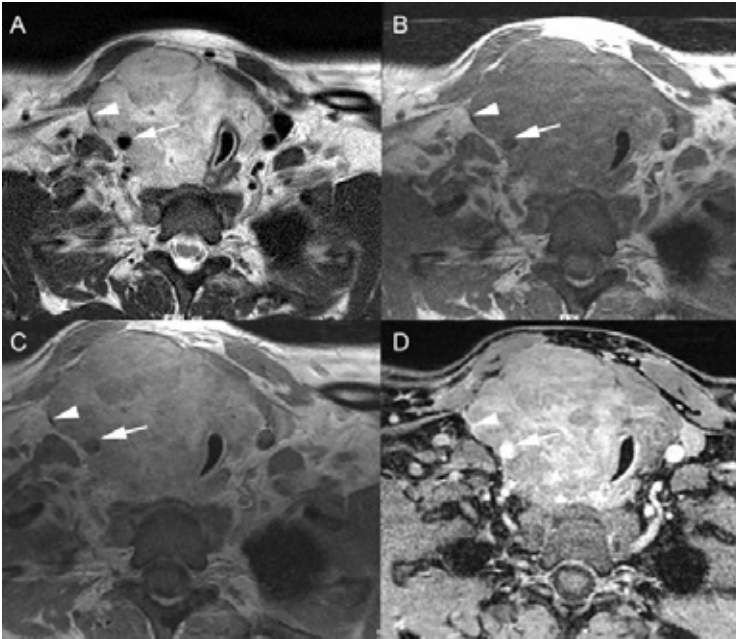– Motion and swallowing artifacts in lesions with tracheal compression/ invasion degrade image quality.

FIGURE 18

A. T2 weighted sequence at the level of the thyroid gland shows complete infiltration of the thyroid gland, particularly on the right, by a hyperintense mass, encasing the right common carotid artery (arrow) and effacing the internal jugular vein (arrowhead). The mass has a low signal on T1 (B) and enhances in a heterogeneous fashion after contrast on T1 weighted sequences before and after fat suppression (C and D).

/ Endocrine System

/ 内分泌 系统

/ 甲状腺磁共振成像 (MRI)

适应证

/ 非首选影像学检查方法。

/ 有助于识别咽后淋巴结转移（罕见）。

优点：

+ 无创。

+ 无电离辐射。

+ 对局部晚期甲状腺癌的甲状腺外侵犯范围及周围区域结构侵袭评估有价值。

+ 可用于淋巴结转移分期。

+ 可评估大甲状腺肿的胸骨后延伸程度、局部区域扩散范围，包括血管包绕程度（图18）。

+ 适用于无法接受手术治疗的甲状腺肿患者随访，避免反复电离辐射暴露。

缺点：

– 与 US 相比，空间分辨率有限。

– 幽闭恐惧症患者可能无法使用。

– 对于气管受压/侵犯的病变，运动和吞咽伪影会降低图像质量。

图 18

A. 甲状腺水平 T2 加权序列显示高信号肿块完全浸润甲状腺（右侧为著），包绕右侧颈总动脉（箭头）并几乎完全侵蚀颈内静脉（箭头）。T1 上肿块呈低信号 (B)，在脂肪抑制前后注射对比剂 T1 加权序列显示肿块不均匀强化（C 和 D）。

/ Nuclear Medicine Studies for the Thyroid Gland

Indications

/ Iodine-123 and Iodine-131 in cases of differentiated thyroid cancer for the detection of nodal and distant metastases (staging) and also in the diagnosis of Graves' disease.

/ Iodine-131 is useful as ablation therapy in post-thyroidectomy patients, detection of nodal recurrence and ablative therapy in patients with Graves' disease.

/ Indium-111 labelled octreotide and PET / CT with 68Ga-DOTA-TATE are used for medullary thyroid cancer.

/ FDG PET-CT is useful in staging medullary thyroid cancer and in poorly differentiated thyroid cancers that are non-iodine avid (**Fig. 19**).

/ Technetium-99m pertechnetate used in the diagnosis of Graves' disease.

/ SPECT/CT improves the diagnostic accuracy of the 131I scan in the context of differentiated thyroid cancer.

ADVANTAGES:

+ Can sometimes differentiate benign from malignant nodules based on their uptake, with "hot" nodules conventionally suggestive a benign aetiology. Conversely "cold" nodules raise the suspicion of malignancy.

+ Can distinguish between Graves' disease and other thyroid disorders.

+ Iodine-123 produces the best whole body image quality in follow-up studies and is most sensitive in differentiated thyroid cancer metastases.

+ SPECT/CT helps to better distinguish cervical lymph node metastases from residual thyroid tissue, lung from mediastinal metastases and bone from soft tissue metastases.

DISADVANTAGES:

− Radiation exposure.

− Contraindicated in pregnancy and lactation within past two months.

− Iodine-131 is contraindicated in severe uncontrolled thyrotoxicosis, while its effect on thyroid orbitopathy is somewhat controversial.

− With respect to cancer imaging sensitivity:

　− depends on tumour volume and histology.

　− is reduced by increased total body iodine from diet, intravenous iodinated contrast material, amiodarone and carbimazole.
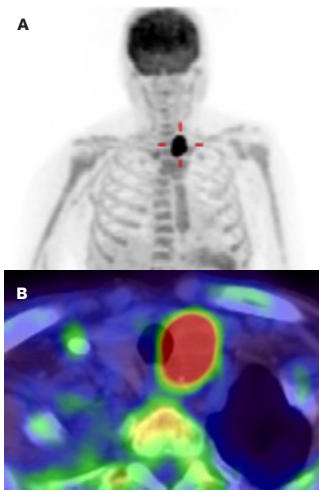
A

B

FIGURE 19

A. MIP and B. fused axial 18F-FDG PET/CT scan demonstrating avid uptake of FDG in the left thyroid bed. This was a histologically proven medullary thyroid carcinoma detected incidentally on a staging PET/CT performed for multiple myeloma

/ Endocrine System

/ 内分泌 系统

/ 甲状腺核医学检查

适应证

/ 碘-123 和碘-131 可用于甲状腺分化型癌淋巴结及远处转移检测（分期）以及诊断 Graves 病。

/ 碘-131 可用于甲状腺切除术后患者的消融治疗、淋巴结复发检测以及 Graves 病患者的消融治疗。

/ 铟-111 标记的奥曲肽和 68Ga-DOTA-TATE PET/CT 用于甲状腺髓样癌。

/ FDG PET-CT 可用于甲状腺髓样癌及非摄碘性低分化甲状腺癌的分期（图 19）。

/ 锝-99m 高锝酸盐用于 Graves 病诊断。

/ SPECT/CT 可提高甲状腺分化型癌 I-131 扫描的诊断准确性。

优点：

+ 有时可根据结节摄取差异区分良性与恶性结节，通常认为"热结节"倾向良性，而"冷结节"则应警惕恶性。

+ 可区分 Graves 病和其他甲状腺疾病。

+ 碘-123 在随访研究中能提供最佳的全身图像质量，对甲状腺分化型癌转移灶敏感性最高。

+ SPECT/CT 有助于更好地区分颈部淋巴结转移与残留甲状腺组织、肺转移与纵隔转移、骨转移与软组织转移。

缺点：

− 存在辐射暴露风险。

− 妊娠期及哺乳期近两月内禁用。

− 碘-131 禁用于未控制的重度甲状腺功能亢进患者，而其对甲状腺相关眼病的疗效尚存争议。

− 关于癌症影像学检查的敏感性：

　− 依赖于肿瘤体积和组织学类型。

　− 受饮食中总碘含量增加、静脉注射碘对比剂、胺碘酮及卡比马唑的影响而降低。

图 19

A. MIP 和 B. 18F-FDG PET/CT 扫描融合轴位显示甲状腺左侧叶区域对 FDG 摄取活跃。此病例为组织学证实的甲状腺髓样癌，在进行多发性骨髓瘤分期中的 PET/CT 检查中偶然发现。

/ Ultrasonography for the Parathyroid Glands

Indications

/ Excellent at identifying parathyroid lesions adjacent to the thyroid gland (**Fig. 20**).

/ Pivotal role in diagnosing parathyroid lesions in patients with clinically confirmed hyperparathyroidism but a negative 99mTc-Sestamibi SPECT study.

/ Complimentary to nuclear medicine studies.

ADVANTAGES:

+ Quick and cheap.
+ Non-invasive.
+ No ionising radiation..
+ Excellent spatial resolution and morphological evaluation.
+ Allows concurrent US guided aspiration for PTH levels in case of intrathyroidal lesions.

DISADVANTAGES:

− Operator dependent.
− Relies only on the structural characteristics of the lesion.
− Limited to superficial evaluation.
− May be more difficult to detect in patients with short necks or patients with large thyroid goitres.
− No standardised, reproducible imaging documentation.
− Unable to assess ectopic parathyroid lesions.
− It can be difficult to distinguish between the following:
  − Parathyroid lesions within the thyroid gland.
  − Small solitary parathyroid nodules and paratracheal lymph nodes.
  − Cystic parathyroid lesions (Fig. 21) and cystic metastases from thyroid papillary or squamous cell carcinoma.
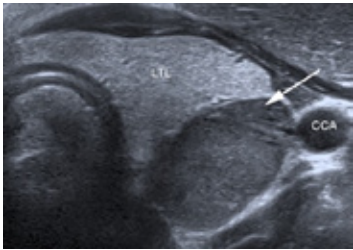

FIGURE 20

US image shows a sizeable, sharply circumscribed, hypoechoic, solid nodule (white arrow), lying inferior to the left thyroid lobe (LTL) and medial to the common carotid artery (CCA). This was a histologically proven parathyroid adenoma.
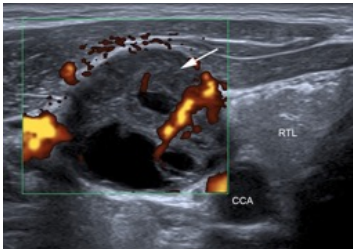

FIGURE 21

US image shows a hypoechoic nodule (arrow) of mixed cystic and solid composition lying lateral to the right thyroid lobe (RTL) and common carotid artery (CCA). It exhibits modest vascularity at Doppler interrogation. This was a histologically confirmed parathyroid adenoma with cystic degeneration.

/ **Endocrine** System

/ 内分泌 系统

/ 甲状旁腺超声检查

适应证

/ 擅于识别毗邻甲状腺的甲状旁腺病变（图 20）。

/ 对临床确诊甲状旁腺功能亢进症但 99mTc-Sestamibi SPECT 检查阴性的患者，在甲状旁腺病变诊断中具有关键作用。

/ 与核医学检查互补。

优点：

+ 快速、便宜。
+ 无创。
+ 无电离辐射。
+ 具有优异的空间分辨率及形态学评估能力。
+ 对于甲状腺内病变，可同时进行超声引导下穿刺以测定甲状旁腺激素 (PTH) 水平。

缺点：

− 操作者依赖性。
− 仅依赖病变的结构特征。
− 仅限于浅表评估。
− 对于颈部短小或甲状腺肿大的患者，可能更难检出。
− 缺乏标准化、可重复的影像学记录方式。
− 无法评估异位甲状旁腺病变。
− 以下情况难以区分：
  − 甲状腺内甲状旁腺病变。
  − 孤立性甲状旁腺小结节与气管旁淋巴结。
  − 甲状旁腺囊性病变（图 21）以及甲状腺乳头状癌或鳞状细胞癌的囊性转移。

图 20

US 图像显示甲状腺左侧叶 (LTL) 下方和颈总动脉 (CCA) 内侧一较大的边缘清晰、低回声实性结节（白色箭号）。经组织学证实为甲状旁腺腺瘤。

图 21

US 图像显示甲状腺右侧叶 (RTL) 和颈总动脉 (CCA) 外侧一囊实混合性成分的低回声结节（箭头）。多普勒检查显示中等血流信号。经组织学证实为甲状旁腺腺瘤伴囊性变。

/ Computed Tomography (CT) for the Parathyroid Glands

Indications

/ Sometimes referred to as 4D CT, CT is the imaging modality of choice in patients with primary hyperparathyroidism who are being worked-up for surgery.

ADVANTAGES:

+ Allows accurate preoperative imaging localisation of a single parathyroid adenoma (PTA) thereby allowing minimally invasive parathyroidectomy (**Fig. 22**).

+ Provides anatomic localisation of ectopic PTA discovered with radionuclide exam.

+ Useful when there are discordant findings between US and scintigraphy studies.

+ Provides clarification in the context of multinodular goitre which may obscure findings on both US and Technetium scans.

+ Provides critical information about number, size and specific location of the parathyroid lesion with respect to important anatomical landmarks.

+ Can identify important vascular anomalies associated with a nonrecurrent laryngeal nerve.

+ Used in the postoperative neck (recurrent/persistent hyperparathyroidism, failed surgery) in combination with scintigraphy.

DISADVANTAGES:

− Ionising radiation particularly given that it is a multiphase study.

− Uses iodinated contrast agents, which are contraindicated in patients with severe renal failure (see chapter on contrast media).

− Cannot reliably distinguish an intrathyroidal parathyroid adenoma from a thyroid nodule.
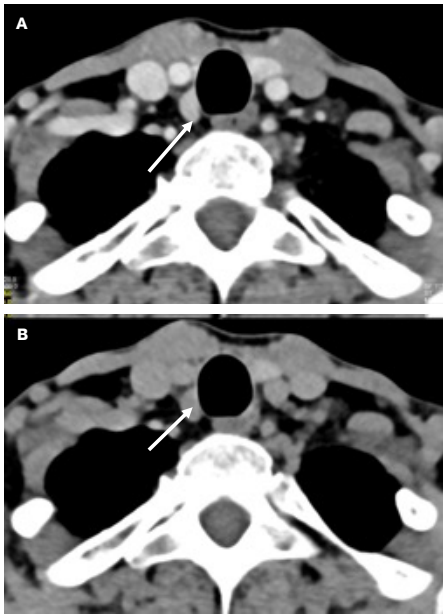

FIGURE 22

Images from a 4DCT in the arterial and venous phases (A and B) demonstrate a small parathyroid adenoma below and separate from the right thyroid lobe.Images courtesy of Dr Reuben Grech MD FRCR ESHNRD ESNRD PhD (Mater Dei Hospital Malta)

Bunch PM, Randolph GW, Brooks JA, George V, Cannon J, Kelly HR. Parathyroid 4D CT: What the Surgeon Wants to Know. Radiographics. 2020 Sep-Oct;40(5):1383-1394. doi: 10.1148/rg.2020190190.

/ Endocrine System

CHAPTER OUTLINE:

Anatomy and Function

Choice of Imaging Techniques

/ Computed Tomography

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知识测试

/ 甲状旁腺计算机断层扫描 (CT)

适应证

/ CT（有时被称为四维 CT）是原发性甲状旁腺功能亢进症患者术前评估的首选影像学检查方法。

优点：

+ 可进行单发甲状旁腺腺瘤 (PTA) 的术前精准影像定位，从而实现微创甲状旁腺切除术（图 22）。

+ 可为核素检查发现的异位 PTA 提供解剖学定位。

+ 当超声与闪烁扫描结果不一致时具有重要价值。

+ 对于 US 及锝扫描可能难以观察的多结节性甲状腺肿患者，可辅助明确诊断。

+ 可提供甲状旁腺病变的数量、大小以及相对于重要解剖标志的具体位置等关键信息。

+ 可识别与非喉返神经相关的重要血管异常。

+ 可联合闪烁扫描用于术后颈部评估（复发/持续性甲状旁腺功能亢进、手术失败）。

缺点：

− 存在电离辐射，尤其这是一项多期相检查。

− 需使用碘对比剂，而重度肾衰竭患者禁用（参阅对比剂章节）。

− 无法可靠区分甲状腺内甲状旁腺腺瘤与甲状腺结节。

图 22

4D CT 动脉期及静脉期图像（A、B）显示甲状腺右侧叶下方一孤立的小甲状旁腺腺瘤。图片来源：Dr Reuben Grech MD FRCR ESHNRD ESNRD PhD (Mater Dei Hospital Malta)

Bunch PM, Randolph GW, Brooks JA, George V, Cannon J, Kelly HR. Parathyroid 4D CT: What the Surgeon Wants to Know. Radiographics. 2020 Sep-Oct;40(5):1383-1394. doi: 10.1148/rg.2020190190.

/ Magnetic Resonance Imaging (MRI) for the Parathyroid Glands

Indications

/ Complimentary to nuclear medicine studies.

ADVANTAGES:

+ No ionising radiation.
+ High spatial and temporal resolution.
+ Can allow identification of ectopic parathyroid tissue.
+ In a small proportion of patients with atypical parathyroid lesion characteristics, contrast enhanced MRI can increase sensitivity.
+ In addition to providing information on structural features, it also provides information on enhancement characteristics which can better help distinguish parathyroid from adjacent structures.

DISADVANTAGES:

– Long scanning times.
– It can be difficult to distinguish between the following:
  – Parathyroid lesions within the thyroid gland.
  – Small solitary parathyroid nodules and paratracheal lymph nodes.
  – Cystic parathyroid lesions and cystic metastases from thyroid papillary or squamous cell carcinoma.

‹∞› **REFERENCE**

Lopez Hänninen E, et al. Preoperative contrast-enhanced MRI of the parathyroid glands in hyperparathyroidism. Invest Radiol. 2000 Jul;35(7):426-30.

/ Endocrine System

/ 内分泌系统

/ 甲状旁腺磁共振成像 (MRI)

适应证

/ 与核医学检查互补。

优点：

+ 无电离辐射。
+ 空间与时间分辨率高。
+ 可识别异位甲状旁腺组织。
+ 在少数具有非典型甲状旁腺病变特征的患者中，对比增强 MRI 可提高敏感性。
+ 除提供结构特征信息外，还能通过强化特征信息更好地帮助区分甲状旁腺与邻近结构。

缺点：

– 扫描时间长。
– 以下情况难以区分：
  – 甲状腺内甲状旁腺病变。
  – 孤立性甲状旁腺小结节与气管旁淋巴结。
  – 甲状旁腺囊性病变以及甲状腺乳头状癌或鳞状细胞癌的囊性转移。

‹∞› 参考文献

Lopez Hänninen E, et al. Preoperative contrast-enhanced MRI of the parathyroid glands in hyperparathyroidism. Invest Radiol. 2000 Jul;35(7):426-30.

/ Nuclear Medicine Studies for the Parathyroid Glands

Indications
Tc-99m MIBI (methoxyisobutylisonitrile) scan

/ Often used as a first line imaging tool in primary hyperparathyroidism.

/ Similar sensitivity and specificity to US in experienced hands.

/ Works on the principle that MIBI washes out more rapidly from the thyroid than from abnormal parathyroid tissue (**Fig. 23**).

ADVANTAGES:

+ Single radiotracer, dual-phase acquisition

+ Can be combined with SPECT with/ without CT for accurate localisation.

Subtraction Technique

/ Dual radiotracer, dual-phase acquisition.

/ The radioisotopes Tc-99m pertechnetate and I-123 (radioiodine) are only taken up by the thyroid gland.

/ Conversely, the radioisotope Tc-99m MIBI is taken up by thyroid and parathyroid glands.

/ Subtraction studies remove the thyroid uptake, leaving only parathyroid uptake.

ADVANTAGES:

+ Can be used when multinodular goitre or thyroid masses risk obscuring parathyroid uptake.
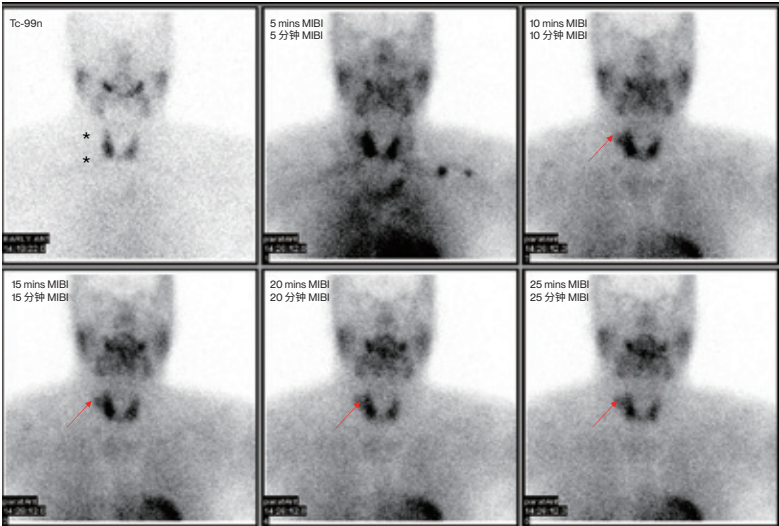

FIGURE 23

Thyroid and parathyroid scintigraphy performed following IV administration of Tc 99m and Tc 99m MIBI respectively show a focus of increased tracer uptake lateral to the upper pole of the right thyroid lobe on the Tc 99m MIBI images (red arrows) that is not evident on technetium thyroid map (asterisk).

/ Endocrine System

/ 内分泌系统

/ 甲状旁腺核医学检查

适应证
Tc-99m MIBI（甲氧基异丁基异腈）扫描

/ 常作为原发性甲状旁腺功能亢进症的一线影像学检查工具。

/ 在经验丰富的操作者手中，其敏感性与特异性可与 US 相当。

/ 其原理基于 MIBI 从甲状腺洗脱的速度快于异常甲状旁腺组织（图 23）。

优点：

+ 单放射性示踪剂，双相采集

+ 可通过与 SPECT 联合（联合或不联合 CT）实现精准定位。

减影技术

/ 双放射性示踪剂，双相采集。

/ 放射性同位素 Tc-99m 高锝酸盐和 I-123（放射性碘）仅被甲状腺摄取。

/ 而放射性同位素 Tc-99m MIBI 可被甲状腺和甲状旁腺共同摄取。

/ 减影技术会去除甲状腺摄取信号，仅保留甲状旁腺摄取信号。

优点：

+ 当多结节性甲状腺肿或甲状腺肿块可能掩盖甲状旁腺摄取情况时，可使用该技术。

图 23

分别经静脉注射 Tc 99m 和 Tc 99m MIBI 后行甲状腺与甲状旁腺闪烁扫描显示，在 Tc 99m MIBI 图像上，甲状腺右侧叶上极外侧见一放射性摄取增高区（红色箭头），而锝甲状腺显像图（星号）未见明确显示。

ATTENTION

Both Tc-99m MIBI scan and subtraction techniques:

/ Have a crucial role in diagnosing ectopic and intrathyroidal parathyroid lesions in the context of hyperparathyroidism.

DISADVANTAGES:

- Low spatial resolution in localising parathyroid lesions.
- Sometimes difficult to differentiate thyroid nodules from parathyroid lesions (Spanu A, et al. SPECT/CT in hyperparathyroidism. Clin Transl Imag. 2014).
- May give false negatives in cases of cystic parathyroid lesions, small size.
- False positive may occur in the presence of a solid thyroid nodule, thyroid carcinoma, lymphoma and lymphadenopathy.
- Less sensitive for detecting hyperplastic parathyroid glands.
- Less sensitive for detecting multi-gland disease than solitary gland disease.

ADVANTAGES:

SPECT-CT offers a number of advantages over 131-Iodine scan including:

+ Better attenuation correction.
+ Increased specificity.
+ Accurate depiction of the localisation of disease and of possible involvement of adjacent tissue.

< ∞ > REFERENCES

Christopher J. Palestro, Maria B. Tomas, Gene G. Tronco, Radionuclide Imaging of the Parathyroid Glands, Seminars in Nuclear Medicine, Volume 35, Issue 4, 2005, Pages 266-276, ISSN 0001-2998 Ishii, S. et al. Causes of false negatives in technetium-99 m methoxyisobutyli-sonitrile scintigraphy for hyperparathyroidism: influence of size and cysts in parathyroid lesions. Ann Nucl Med 34, 892–898 (2020).

/ Endocrine System

/ 内分泌 系统

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注意

Tc-99m MIBI 扫描和减影技术：

/ 在甲状旁腺功能亢进症中，对异位及甲状腺内甲状旁腺病变的诊断起关键作用。

缺点：

- 定位甲状旁腺病变时空间分辨率低。
- 有时难以区分甲状腺结节与甲状旁腺病变 (Spanu A, et al. SPECT/CT in hyperparathyroidism. Clin Transl Imag. 2014)。
- 对于囊性甲状旁腺病变或病灶较小的情况可能出现假阴性。
- 当存在实性甲状腺结节、甲状腺癌、淋巴瘤及淋巴结肿大时可能出现假阳性。
- 检测甲状旁腺增生的敏感性较低。
- 检测多腺体疾病的敏感性低于单腺体疾病。

优点：

相较于碘-131 扫描，SPECT-CT 具有多项优势，包括：

+ 更优的衰减校正。
+ 更高的特异性。
+ 可精准显示病变位置及邻近组织受累情况。

< ∞ > 参考文献

Christopher J. Palestro, Maria B. Tomas, Gene G. Tronco, Radionuclide Imaging of the Parathyroid Glands, Seminars in Nuclear Medicine, Volume 35, Issue 4, 2005, Pages 266-276, ISSN 0001-2998 Ishii, S. et al. Causes of false negatives in technetium-99 m methoxyisobutylisonitrile scintigraphy for hyperparathyroidism: influence of size and cysts in parathyroid lesions. Ann Nucl Med 34, 892–898 (2020).

Thyroid and Parathyroid Pathology

甲状腺和甲状旁腺病理学

Endocrine System

内分泌系统

/ Congenital Malformations

/ Thyroglossal Duct Cyst

/ During embryologic develop-ment, the thyroid gland origi-nates as a small outpouching of endodermal tissue in the base of the tongue. This tissue migrates downwards along the neck midline guided by the thyroglossal duct (TGD), to reach its final position in the lower neck. As the thyroid gland descends, the TGD normally disappears, leaving behind a solid thyroid gland.

/ However, in some cases, the TGD fails to disappear com-pletely, leaving behind a cystic structure that can become infected or inflamed, causing pain and swelling in the neck.
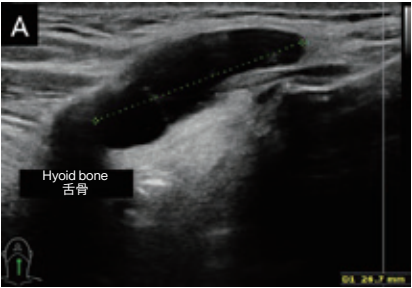
FIGURE 24

Sagittal US (A) and sagittal T1W post-gadolinium with fat saturation (B) showing a homogenous hypoechoic and non-enhancing cystic formation in the midline right below the hyoid bone, typical of a TGD cyst. As shown in B, the wall of the cyst is thin and frequently shows enhancement (green arrow). In case of infection, the wall becomes thicker.
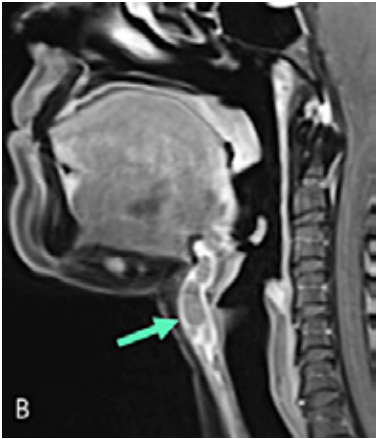
> **<!> ATTENTION**
>
> The cyst can be located anywhere along the path of the TGD, but it is most commonly found in the midline of the neck, just below the hyoid bone (Fig. 24).
>
> Less frequently, migration arrest can lead to persistent thyroid tissue in the base of the tongue, called "lingual thyroid".

/ **Endocrine** System

/ 内分泌 系统

/ 先天畸形

/ 甲状舌管囊肿

/ 在胚胎发育过程中，甲状腺最初起源于舌根部内胚层组织的小突起。该组织在甲状舌管（thyroglossal duct，TGD）的引导下沿颈部中线向下迁移，最终到达下颈部的正常位置。随着甲状腺向下迁移，TGD 通常会消失，仅遗留实性的甲状腺。

/ 然而，在某些情况下，TGD 不能完全消失，遗留一个囊性结构，该结构可能发生感染或炎症，导致颈部疼痛和肿胀。

图 24

矢状位 US (A) 和钆造影后脂肪抑制矢状位 T1W (B) 显示舌骨正下方中线处一均匀低回声、无强化的囊性病变，符合 TGD 囊肿的典型特征。如 B 所示，囊肿壁较薄，常可见强化（绿色箭头）。若发生感染，囊壁会增厚。

> **<!> 注意**
>
> TGD 囊肿可沿其迁移路径发生于任何部位，但最常见于颈部中线、舌骨正下方（图 24）。
>
> 较少见的情况是，迁移停滞可能导致舌根部残留甲状腺组织，称为"舌甲状腺"。

/ Ectopic Parathyroid

/ The parathyroid glands descend embryologically from the third and fourth pharyngeal pouches (**Fig. 25**).

/ Ectopic parathyroid glands are the result of aberrant migration during early development.

/ If missed during initial patient work-up these can result in failed surgery and persistent hyperparathyroidism. Prevalence is about 2–43% in anatomical series and up to 16% and 14% in patients with primary and secondary hyperparathyroidism, respectively.

/ The most common location for ectopic **inferior** parathyroid glands is the **anterior mediastinum**, adjacent to the thymus or thyroid gland. Conversely, ectopic **superior** parathyroids are usually located in the **tracheo-oesophageal groove** and retro-oesophageal region. Ectopic parathyroid glands can also be found in the carotid sheath and in the thyroid gland itself. To complicate matters, supernumerary gland are not uncommon accounting for about 13% of cases.

/ In general, US has a low sensitivity for detecting ectopic parathyroid glands. This can however, be improved when combined with 99mTc MIBI scans and with the addition of SPECT or SPECT/CT.

<∞> **REFERENCES**

Farah Karipineni, Zeyad Sahli, Helina Somervell, Aarti Mathur, Jason D. Prescott, Ralph P. Tufano, Martha A. Zeiger, Are preoperative sestamibi scans useful for identifying ectopic parathyroid glands in patients with expected multigland parathyroid disease?, Surgery, Volume 163, Issue 1, 2018, Pages 35-41, ISSN 0039-6060
Noussios, G.; Anagnostis, P.; Natsis, K. Ectopic Parathyroid Glands and their Anatomical, Clinical and Surgical Implications (Review). Experimental and Clinical Endocrinology & Diabetes 2012; 120(10): 604 – 610. DOI: 10.1055/s-0032-1327628
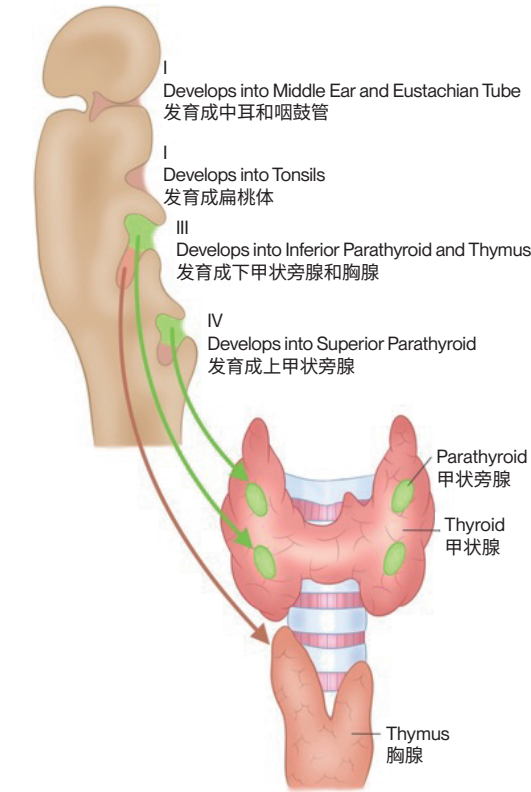
I
Develops into Middle Ear and Eustachian Tube
发育成中耳和咽鼓管

I
Develops into Tonsils
发育成扁桃体

III
Develops into Inferior Parathyroid and Thymus
发育成下甲状旁腺和胸腺

IV
Develops into Superior Parathyroid
发育成上甲状旁腺

Parathyroid
甲状旁腺

Thyroid
甲状腺

Thymus
胸腺

FIGURE 25

Schematic drawing depicting the embryology of the parathyroid glands.

/ Endocrine System

/ 内分泌 系统

/ 异位甲状旁腺

/ 甲状旁腺在胚胎发育过程中自第三、第四咽囊向下迁移（图 25）。

/ 异位甲状旁腺是发育早期异常迁移的结果。

/ 若在患者初始诊断检查时漏诊，可能导致手术失败及持续性甲状旁腺功能亢进症。其发生率在解剖学研究中约为 2–43%，在原发性和继发性甲状旁腺功能亢进患者分别高达 16% 和 14%。

/ 异位下甲状旁腺最常见的位置是前纵隔，毗邻胸腺或甲状腺。而异位上甲状旁腺通常位于气管食管沟及食管后区。异位甲状旁腺也可发生于颈动脉鞘或甲状腺内。更复杂的是，甲状旁腺数目异常（多腺体）并不少见，约占 13% 的病例。

/ 一般来说，超声检测异位甲状旁腺的敏感性较低。但联合 99mTc MIBI 扫描以及加用 SPECT 或 SPECT/CT 可提高敏感性。

<∞> 参考文献

Farah Karipineni, Zeyad Sahli, Helina Somervell, Aarti Mathur, Jason D. Prescott, Ralph P. Tufano, Martha A. Zeiger, Are preoperative sestamibi scans useful for identifying ectopic parathyroid glands in patients with expected multigland parathyroid disease?, Surgery, Volume 163, Issue 1, 2018, Pages 35-41, ISSN 0039-6060
Noussios, G.; Anagnostis, P.; Natsis, K. Ectopic Parathyroid Glands and their Anatomical, Clinical and Surgical Implications (Review). Experimental and Clinical Endocrinology & Diabetes 2012; 120(10): 604 – 610. DOI: 10.1055/s-0032-1327628

图 25

甲状旁腺胚胎发育过程示意图。

/ Dysthyroidism

/ Graves' Disease (Basedow Disease)

Graves' disease or Basedow disease is an autoimmune disease. It is the most common cause of hyperthyroidism. In Graves' disease, the body produces antibodies called TRAK (Thyrotropin Receptor Antibodies) that bind to the TSH receptor resulting in increased T3 and T4 production and release. Symptoms include: tremor, heat sensitivity, goitre, anxiety and weight loss.

On US, Graves' disease causes diffuse enlargement of the thyroid gland («diffuse toxic goitre»). Typically, the gland appears homogeneously enlarged with a lobular surface contour. (**Fig. 26**) Thyroid parenchyma is diffusely hypoechoic and vascularity is increased. This pattern at Doppler US is called **"thyroid inferno"** or **"thyroid storm"**. Doppler US can be useful to detect increased velocity in the thyroid arteries (mean systolic velocity >100 cm/sec in most patients at initial evaluation). Diastolic velocity can also be increased due to vascular shunts.

On iodine-123 and Tc-99m pertechnetate scans, there is a homogenously increased activity of the enlarged gland.
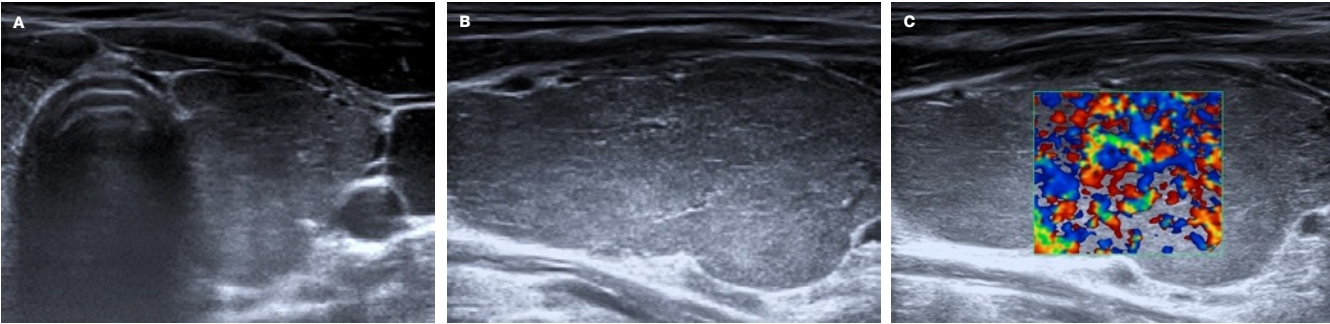
FIGURE 26

Axial (A) and longitudinal (B) US views showing a lobulated, enlarged left thyroid lobe and diffuse hypoechoicity with fine reticulations. C. Power Doppler US demonstrating the typical aspect of a « thyroid inferno » due to diffusely increased parenchymal vascularity.

/ Endocrine System

/ 内分泌系统

/ 甲状腺功能异常

/ Graves 病（Basedow 病）

Graves 病或 Basedow 病是一种自身免疫性疾病。它是甲状腺功能亢进症最常见的病因。Graves 病患者体内会产生名为 TRAK（促甲状腺素受体抗体）的抗体，这类抗体可与 TSH 受体结合，导致 T3 和 T4 的分泌和释放增加。此病的症状包括：震颤、畏热、甲状腺肿、焦虑和体重减轻。

US 检查可见 Graves 病引起甲状腺弥漫性肿大（称为"弥漫性毒性甲状腺肿"）。典型表现为甲状腺整体均匀增大，轮廓呈分叶状。（图 26）甲状腺实质呈弥漫性低回声，血流信号增多。这种多普勒超声下的血供特征被称为"甲状腺火海征"或"甲状腺风暴"。多普勒超声可检测到甲状腺动脉血流速度增快（多数患者初诊时平均收缩期流速 >100 cm/s）。舒张期血流速度也可因血管分流而增快。

在碘-123 和 Tc-99m 高锝酸盐扫描中，增大的甲状腺呈均匀性放射性增高。

图 26

轴向 (A) 及纵向 (B) US 图像显示甲状腺左侧叶分叶状增大，并呈弥漫性低回声伴细密网状回声。C. 能量多普勒超声图像显示因甲状腺实质血流信号弥漫性增多，呈现典型的"甲状腺火海征"。

/ Thyroid-Associated Orbitopathy (TAO)

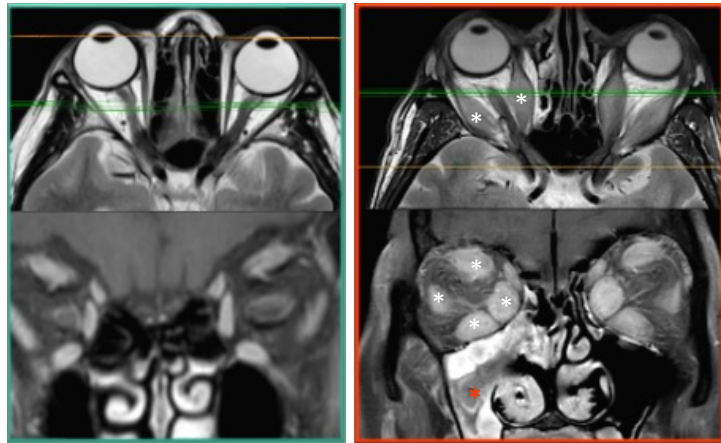In Graves' disease, the autoimmune response can cause inflammation and swelling of the tissues surrounding the eyes. Up to 50% of individuals with Graves' disease develop thyroid-associated orbitopathy (TAO) clinically presenting with proptosis and lid retraction.

On orbital MRI (**Fig. 27**), the changes due to TAO include thickening and enhancement of extra-ocular muscles, lacrimal gland enlargement, and accumulation of fat in the orbit. In long-standing cases; chronic inflammation and collagen deposition leads to fibrosis.

FIGURE 27

Axial T2W and coronal post-gadolinium fat saturated T1W MRI in two different patients. Normal MRI (images on the left, contoured in green). MRI findings in TAO (images on the right, contoured in red). Note exophthalmos and bilateral extra-ocular muscle enlargement (white asterisks show enlarged muscles in the right orbit). Red asterisk shows sinusitis of the right maxillary sinus.

<!·> ATTENTION   >■< FURTHER KNOWLEDGE

In TAO, muscle enlargement typically spares the anterior tendon. This appearance is described as the "Coca-Cola bottle" sign.

Muscle enlargement most often affects (in decreasing order) the inferior rectus, medial rectus, superior rectus and lateral rectus muscles.
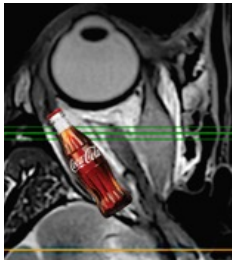
/ Endocrine System

/ 内分泌系统

/ 甲状腺相关眼病 (TAO)

在 Graves 病中，自身免疫反应可引发眼睛周围组织的炎症与肿胀高达 50% 的 Graves 病患者会发生甲状腺相关眼病 (TAO)，临床表现为眼球突出和眼睑回缩。

在眼眶 MRI 上（图 27），TAO 的典型改变包括眼外肌增厚与强化、泪腺肿大，以及眼眶内脂肪堆积。在长期病例中，慢性炎症与胶原沉积会导致纤维化。

图 27

2 例不同患者的轴位 T2W 和冠状位钆造影后脂肪抑制 T1W MRI。左侧图像为正常 MRI（绿色轮廓）。右侧图像为 TAO 的 MRI 表现（红色轮廓）。注意眼球突出及双侧眼外肌增厚（白色星号标记右眼眶内增厚的肌肉）。红色星号表示右侧上颌窦的鼻窦炎。

<!·> 注意   >■< 进阶知识

TAO 患者的肌肉增厚通常不累及前肌腱。此特征被称为"可乐瓶"征。

受累肌肉最常见顺序（从高到低）为：下直肌、内直肌、上直肌、外直肌。

/ Hashimoto Thyroiditis

Hashimoto thyroiditis, also known as **chronic lymphocytic thyroiditis** is an autoimmune disorder leading to hypothyroidism.

In Hashimoto thyroiditis, the thyroid gland may appear enlarged, normal, or reduced in size on an US scan, depending on the stage and severity of the disease. Initially, the gland may appear enlarged due to inflammation, which can cause transitory elevation of thyroid hormones ("hashitoxicosis"), but over time, it may become scarred and atrophied, resulting in a smaller-than-normal gland and hypothyroidism.

◀!▶ ATTENTION

Hashimoto thyroiditis patients have an increased risk of developing papillary thyroid cancer and lymphoma compared to the general population:

/ The risk is estimated to be up to 3-4 times higher in individuals with Hashimoto thyroiditis than those without

/ > 85% of patients with primary thyroid lymphoma have coexistent Hashimoto thyroiditis

---

US can show an heterogeneous aspect, with areas of increased and decreased echogenicity also known as the pseudo-nodular appearance or **"giraffe pattern" (Fig. 28)**.
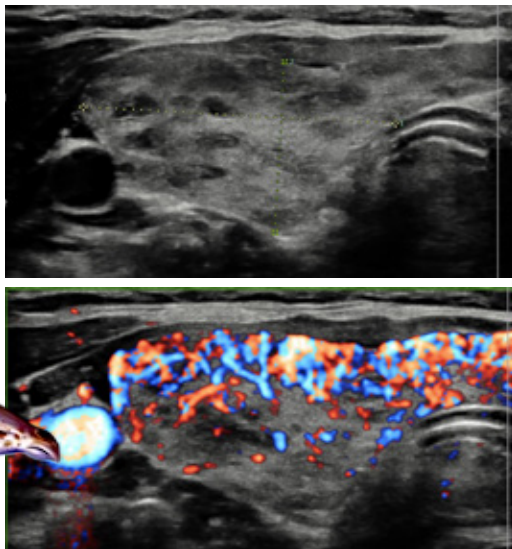

FIGURE 28

Transverse US and corresponding Doppler US image of the right thyroid lobe in a patient with an initial stage Hashimoto thyroiditis presenting with a characteristic "giraffe pattern" .

/ Endocrine System

/ 内分泌系统

/ 桥本氏甲状腺炎

桥本氏甲状腺炎也称为慢性淋巴细胞性甲状腺炎，是一种导致甲状腺功能减退的自身免疫性疾病。

在桥本氏甲状腺炎中，US 扫描显示甲状腺可能增大、正常或缩小，具体取决于疾病的阶段和严重程度。疾病初期，甲状腺可能因炎症反应而增大，并可能引起短暂性甲状腺激素升高（"桥本甲亢"），但随着病程进展，甲状腺可逐渐纤维化、萎缩，最终导致腺体体积小于正常水平，并引起甲状腺功能减退症。

US 可见甲状腺呈现不均质回声，表现为高低回声混杂区，也称为假结节样表现或"长颈鹿皮征"（图 28）。

◀!▶ 注意

相较于普通人群，桥本氏甲状腺炎患者发生甲状腺乳头状癌及淋巴瘤的风险显著升高：

/ 据估计，桥本氏甲状腺炎患者的风险是普通人群的 3-4 倍

/ >85% 的原发性甲状腺淋巴瘤患者同时患有桥本氏甲状腺炎

图 28

桥本氏甲状腺炎初期患者的甲状腺右侧叶横断 US 及对应的多普勒超声图像，可见特征性的"长颈鹿皮征"。

/ Thyroid Nodules

/ Toxic Nodule

In some cases, hyperthyroidism may be due to the presence of a «toxic nodule». The exact cause of toxic nodules is not fully understood, but it is believed to be related to TSH receptor mutations in the gland cells leading to autonomous production of excess thyroid hormone.

> **ATTENTION**
>
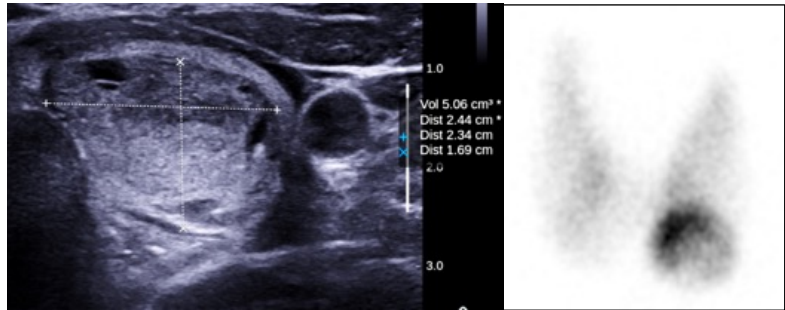> > **Hot nodules** are rarely malignant. **Cold nodules** carry an estimated 10% - 20% risk of malignancy (Fig. 30).

Toxic nodules can mimic malignancy and present as solid nodules with irregular borders and increased vascularity at US (**Fig. 29**).

If a toxic nodule is suspected, scintigraphy can help in combination with FNA. Scintigraphy will help identify areas of overactivity, such as a "hot" nodule (**Fig. 29**), and it can also help to differentiate benign from malignant nodules based on the pattern of iodine uptake.
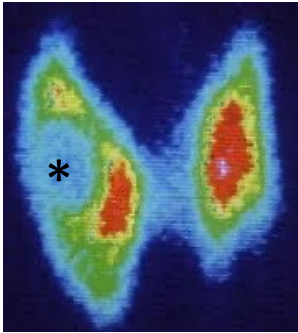
FIGURE 29

Axial US showing a solid nodule of the left thyroid lobe. Scintigraphy showing an increased focal uptake of Iodine-123 in the left thyroid lobe corresponding to a "hot" nodule.

FIGURE 30

Scintigraphy showing focal absence of fixation (asterisk), due to a "cold" nodule in the right thyroid lobe.

/ **Endocrine** System

/ 内分泌 系统

/ 甲状腺结节

/ 毒性结节

部分甲状腺功能亢进症可能是由于存在"毒性结节"。毒性结节的确切病因尚未完全明确，但目前认为可能与甲状腺细胞内 TSH 受体突变相关，导致过量甲状腺激素自主性分泌。

毒性结节在 US 下可类似恶性肿瘤，表现为边缘不清的实性结节伴血流信号增多（图 29）。

若怀疑毒性结节，需结合闪烁扫描与 FNA。闪烁扫描可识别过度活跃区域（如"热结节"，图 29），还可根据碘摄取模式区分良性与恶性结节。

> **注意**
>
> > **热结节**极少为恶性。**冷结节**的恶性风险估计为 10%-20%（图 30）。

图 29

轴位 US 显示甲状腺左侧叶实性结节。闪烁扫描显示甲状腺左侧叶碘-123 局部摄取增高，对应"热结节"。

图 30
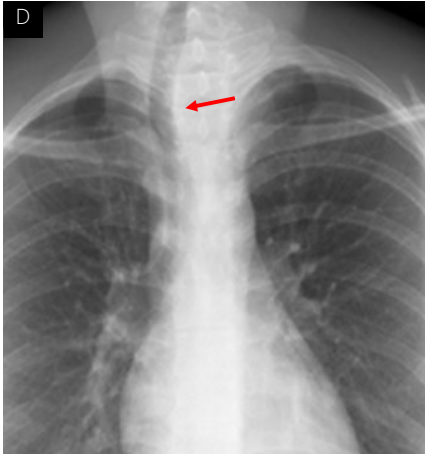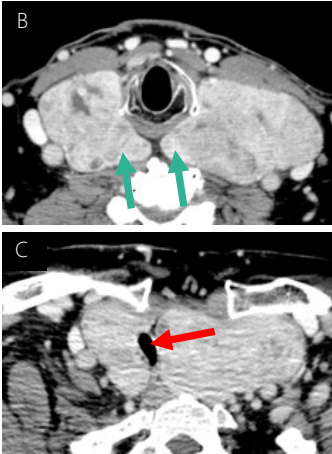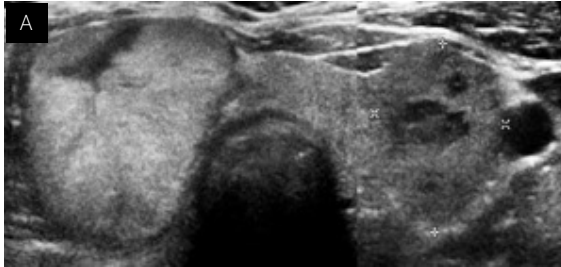
闪烁扫描显示甲状腺右侧叶碘摄取局灶性缺失（星号），提示"冷结节"。

/ Multinodular Goitre (MNG)

Multinodular goitre (MNG) is defined as an enlarged thyroid gland with multiple nodules. It develops following repeated episodes of stimulation and involution. MNG occurs in females in the 4th – 6th decades. Most goitres have euthyroid nodules. However, hyper- or hypofunctioning nodules can lead to systemic symptoms. A MNG with hyperthyroidism is called "toxic MNG".

/ **US** is the imaging modality of choice allowing to screen for suspicious malignant nodules (see ACR-TIRADS criteria) and to perform FNA, whenever indicated. Benign nodules in MNG are typically iso- or hyperechoic and usually have a hypoechoic halo (**Fig. 31**).

/ On **nuclear medicine studies**, MNG is seen as an enlarged gland with heterogeneous Tc-99m pertechnetate or radioiodine uptake.

/ Although **CT** is not the primary imaging modality for MNG, it is used to plan surgery in patients with airway compression and to assess the retrosternal extent.

/ On **frontal chest radiography**, a MNG extending into the anterior mediastinum manifests with a positive cervico-thoracic sign (CTS) and it can also deviate the trachea (**Fig. 31**). A positive CTS is caused by anterior mediastinal masses as the anterior mediastinum ends at the level of the clavicles. Posterior mediastinal masses have a negative CTS.

FIGURE 31

Different patients with MNG. A. Transverse US image showing an enlarged thyroid gland with bilateral nodules. B and C. Contrast-enhanced CT showing a MNG with retropharyngeal spread (green arrows) and massive tracheal compression (red arrow). D. Deviation of the trachea (arrow) and positive cervico-thoracic sign, i.e., indistinct borders above the clavicles in a patient with MNG.

/ Endocrine System

/ 内分泌 系统

CHAPTER OUTLINE:

Anatomy and Function

Choice of Imaging Techniques

Thyroid & Parathyroid Pathology

/ Thyroid Nodules

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Test Your Knowledge

章节大纲：

解剖学与功能

影像学检查技术的选择

甲状腺和甲状旁腺病理学

/ 甲状腺结节

副神经节瘤

垂体病变

肾上腺病理学

核心要点

参考文献

知识测试

/ 多结节性甲状腺肿 (MNG)

多结节性甲状腺肿 (MNG) 是指伴多发结节的甲状腺肿大，它是在反复的刺激和退化后逐渐形成。MNG 多见于 40~60 岁女性。大多数甲状腺肿存在功能正常的结节，然而，功能亢进或功能减退的结节可引发全身症状。合并甲状腺功能亢进症的多结节性甲状腺肿称为"毒性 MNG"。

/ **US** 是筛查可疑恶性结节（见 ACR-TIRADS 标准）并指导 FNA 的首选影像学检查方法。MNG 中的良性结节通常表现为等回声或高回声，常伴低回声晕（图 31）。

/ 在核医学检查中，MNG 表现为甲状腺增大伴 Tc-99m 高锝酸盐或放射性碘摄取不均。

/ 虽然 **CT** 并非 MNG 的主要影像学检查方法，但其可用于为气道受压患者制定手术方案，还可评估胸骨后病变范围。

/ 在胸部正位 X 片上，延伸至前纵隔的 MNG 表现为颈胸征 (CTS) 阳性，并可能导致气管偏移（图 31）。前纵隔肿块因前纵隔终止于锁骨水平，故可表现为 CTS 阳性。后纵隔肿块表现为 CTS 阴性。

图 31

不同 MNG 患者的图像示例。A. 横断 US 图像显示甲状腺增大伴双侧结节。B 和 C. 对比增强 CT 显示 MNG 伴咽后延伸（绿色箭头）和严重气管受压（红色箭头）。D. 气管偏移（箭头）和颈胸征阳性，即 MNG 患者锁骨以上边缘不清。

/ Epidemiology and Risk Factors

/ Thyroid nodules are relatively common, with a prevalence of approximately 49% in the general population. Many studies suggest a prevalence of 2-6% at palpation, up to 35% at US, and 65% in autopsy data.

/ Thyroid nodules are often benign.

/ Their incidence increases with age, in people with iodine deficiency, and after radiation exposure. They are also more common in women.
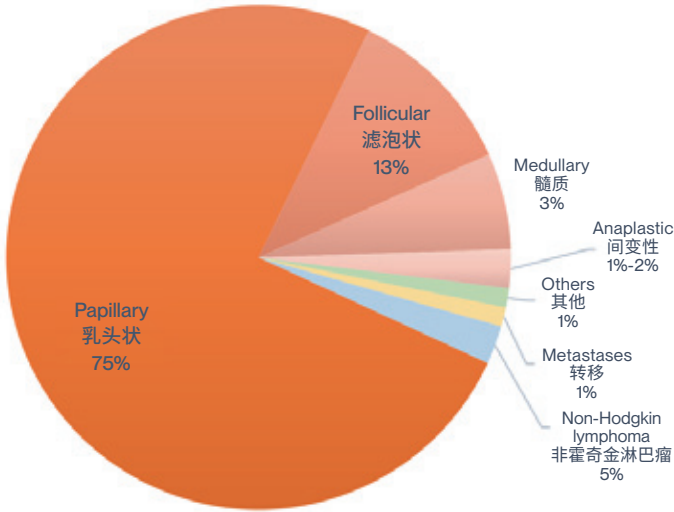
FIGURE 32

Diagram showing the distribution of the main histological types of thyroid neoplasms..

<∞> REFERENCE

Jiang H, et al. The Prevalence of Thyroid Nodules and an Analysis of Related Lifestyle Factors in Beijing Communities. Int J Environ Res Public Health. 2016 Apr 22;13(4):442. doi: 10.3390/ijerph13040442.

/ **Endocrine** System

/ 内分泌 系统

/ 流行病学和危险因素

/ 甲状腺结节较为常见，普通人群中的患病率约为 49%。多项研究显示，触诊检查其患病率为 2%-6%，超声检查检出率可达 35%，尸检数据则高达 65%。

/ 甲状腺结节多为良性，

/ 其发病率随年龄增长而升高，在碘缺乏人群、有辐射暴露史者中更高，且在女性中更为常见。

图 32

图示为甲状腺肿瘤主要组织学类型的分布情况。

<∞> 参考文献

Jiang H, et al. The Prevalence of Thyroid Nodules and an Analysis of Related Lifestyle Factors in Beijing Communities. Int J Environ Res Public Health. 2016 Apr 22;13(4):442. doi: 10.3390/ijerph13040442.

/ Thyroid Cancer

/ Aetiology, Genetics & Epidemiology

Thyroid cancer is the most common endocrine malignancy and accounts for 1.8% of all cancers with an increasing incidence during the past decades. Women account for 76% of new cases.

Genetics:

/ 5-10% of patients have a positive family history for papillary thyroid cancer.

/ More frequent in women than men (F:M = 3:1).

/ Risk increases with age; peaks earlier for women (40s or 50s) than for men (60s or 70s).

/ Majority are sporadic.

Risk factors:

/ Prior radiation to the head and neck increases risk by 30%.

/ Iodine deficiency; possibly alcohol excess, Hashimoto's thyroiditis.

/ Age: *Papillary*: 30-40 years.
　　　 Follicular: 40-70 years.

/ Follicular and anaplastic carcinoma predominate in areas with iodine-deficient diets.

/ Papillary carcinoma is more common in areas with iodine-rich diets.

Associations:

/ **Gardner syndrome:** Thyroid cancer has a prevalence of around 0.6% in patients with Gardner's syndrome >= 150-fold risk compared to the general population

/ **Cowden syndrome:** risk of follicular cancer.

/ **Hashimoto thyroiditis:** thyroid lymphoma & papillary thyroid carcinoma.

/ **Multiple endocrine neoplasia (MEN) 2:** medullary carcinoma.

<■> **REFERENCE**

Harned RK, Buck JL, Olmsted WW, Moser RP, Ros PR. Extracolonic manifestations of the familial adenomatous polyposis syndromes. AJR Am J Roentgenol. 1991 Mar;156(3):481-5. doi: 10.2214/ajr.156.3.1847274. PMID: 1847274.
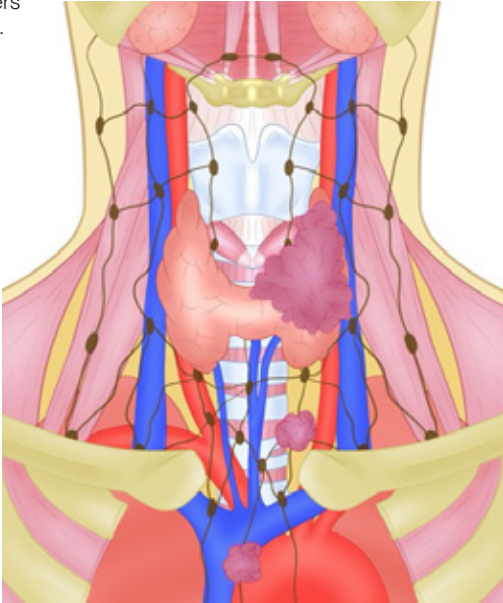
FIGURE 33

Schematic diagram depicting malignancy of the thyroid gland with metastatic lymph nodes in the central neck compartment.

/ **Endocrine** System

/ **内分泌** 系统

/ 甲状腺癌

/ 病因学、遗传学和流行病学

甲状腺癌是最常见的内分泌恶性肿瘤，占所有癌症的 1.8%，近几十年来发病率呈上升趋势。新发病例中女性占 76%。

遗传学：

/ 5%-10% 的患者有甲状腺乳头状癌阳性家族史。

/ 女性发病率显著高于男性（女:男 = 3:1）。

/ 风险随年龄增长而升高；女性发病高峰（40-50 岁）早于男性（60-70 岁）。

/ 多数病例呈散发性。

危险因素：

/ 头颈部既往放疗可使风险增加 30%。

/ 碘缺乏；可能与酒精过量摄入、桥本氏甲状腺炎相关。

/ 年龄分布： *乳头状癌*：30-40 岁。
　　　　　 滤泡状癌：40-70 岁。

/ 在碘缺乏饮食地区，甲状腺滤泡状癌与未分化甲状腺癌更为常见。

/ 而在富碘饮食地区，甲状腺乳头状癌更常见。

相关联症候群：

/ **加德纳综合征：** 加德纳综合征患者的甲状腺癌患病率约为 0.6%，较普通人群风险升高 ≥ 150 倍。

/ **Cowden 综合征：** 滤泡状癌风险升高。

/ **桥本氏甲状腺炎：** 甲状腺淋巴瘤与甲状腺乳头状癌风险升高。

/ **多发性内分泌腺瘤病 (MEN) 2 型：** 髓样癌风险升高。

<∞> **参考文献**

Harned RK, Buck JL, Olmsted WW, Moser RP, Ros PR. Extracolonic manifestations of the familial adenomatous polyposis syndromes. AJR Am J Roentgenol. 1991 Mar;156(3):481-5. doi: 10.2214/ajr.156.3.1847274. PMID: 1847274.

图 33

甲状腺恶性肿瘤伴颈中央区淋巴结转移的示意图。

/ Classification

According to the 8th edition of the AJCC and TNM staging system for all thyroid cancers, the same T, N and M criteria apply:

/ **T classification**: influenced by tumour size and extent, e.g., invasion of strap muscles, larynx, trachea, …

/ **N classification**: influenced by the presence or absence of nodal metastases in the central compartment (**Fig. 33**), other neck levels or retropharyngeal nodes

/ **M classification**: influenced by the presence/absence of spread to distant organs

However, the tumour **stage (I, II, III, IVA and IVB)** depends on

/ **Tumour type**: differentiated thyroid carcinoma (papillary and follicular carcinomas) is staged differently from medullary and anaplastic carcinoma

/ **Age at diagnosis ≥ 55 years**: influences the staging of papillary and follicular carcinoma (as younger individuals have a better prognosis, patients <55 years can have only stage I or II disease, whereas patients ≥ 55 years can have stage I – IVC disease depending on T, N and M category

Prognosis in **differentiated thyroid cancer (DTC)** is influenced by:

/ T, N and M category, post-treatment thyroglobulin levels

/ BRAF and V600E mutations and molecular profile

/ Age and gender

/ Post-treatment residual disease

/ Endemic goitre

Prognosis in **medullary carcinoma** is influenced by:

/ Pre- and post-treatment calcitonin level

/ MEN

/ Age

/ Molecular profile

/ **Endocrine** System

/ 内分泌 系统

/ 分期

根据美国癌症联合委员会（American Joint Commission on Cancer，AJCC）第 8 版 TNM 分期系统，所有甲状腺癌均采用统一的 T、N、M 分期标准：

/ **T 分期**：受肿瘤大小和侵犯程度影响，例如侵犯带状肌、喉、气管等

/ **N 分期**：受中央区（图 33）、其他颈区或咽后是否存在淋巴结转移影响

/ **M 分期**：受是否存在远处转移影响

但是，肿瘤分期（I、II、III、IVA 和 IVB）取决于

/ **肿瘤类型**：甲状腺分化型癌（乳头状癌与滤泡状癌）的分期标准不同于髓样癌与未分化癌

/ **确诊年龄 ≥ 55 岁**：影响乳头状癌与滤泡状癌的分期（因年轻患者预后较好，< 55 岁患者可能仅为 I 或 II 期，而 ≥ 55 岁患者则可能为 I-IVC 期，具体取决于 T、N、M 分期）

甲状腺分化型癌 (DTC) 的预后受以下因素影响：

/ T、N、M 分期，治疗后甲状腺球蛋白水平

/ BRAF 及 V600E 突变情况与分子特征

/ 年龄和性别

/ 治疗后残留病灶

/ 地方性甲状腺肿

髓样癌的预后受以下因素影响：

/ 治疗前后降钙素水平

/ 多发性内分泌腺瘤病 (MEN)

/ 年龄

/ 分子特征

/ Papillary Thyroid Carcinoma (PTC)

Papillary thyroid carcinoma (PTC) accounts for 85% of all thyroid cancers and for 1% of all malignant tumours. PTC is also the most common form of differentiated thyroid cancer (DTC).

PTC is usually sporadic, but it can also be associated with increased radiation exposure. It occurs 3 x more frequently in females.

PTC takes up iodine and produces thyroglobulin in response to TSH stimulation. Thyroglobulin levels can be used in the surveillance of patients who have been treated with surgery and radioiodine therapy.

The 10-year survival rate is 96%. Only a minority of PTCs are aggressive.

Lymph node spread is common and distant metastatic spread is seen in 5-10% of cases. About 10-20% of PTCs are multifocal and 70% are solid.

Imaging:

/ **US:** Is the imaging modality of choice showing typical features, i.e., hypoechoic, irregular margins, internal microcalcifications +/- metastatic lymph nodes with typical microcalcifications and partly cystic components (**Fig. 34**).

/ **CT/MRI:** in locally advanced disease for staging and to exclude distant metastases (**Fig. 35**).

/ **PETCT:** not routinely recommended for the initial staging of DTC. Its role is primarily limited to postoperative follow-up in selected cases and in suspected dedifferentiation.

FIGURE 34

Profoundly hypoechoic mass in the right thyroid lobe with microcalcifications confirmed to be papillary carcinoma at histology.
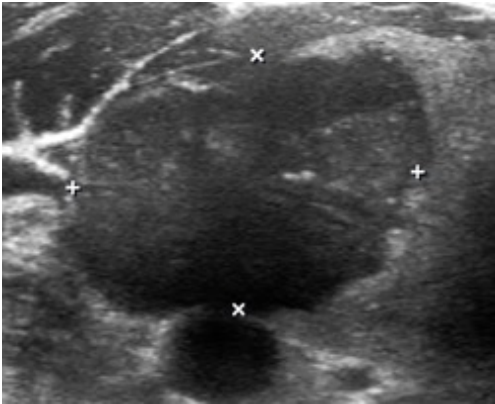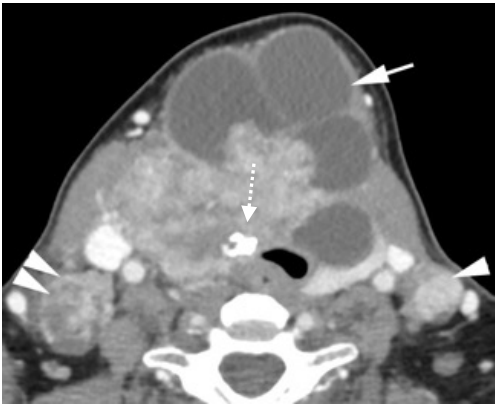

FIGURE 35

Massive goitre (arrow) with extensive cystic changes, coarse calcifications (dashed arrow) and severe tracheal compression, accompanied by bilateral metastatic cervical lymph nodes (single and double arrowheads). This was a histologically proven papillary thyroid cancer.

/ **Endocrine** System

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/ 甲状腺乳头状癌 (PTC)

甲状腺乳头状癌 (PTC) 占所有甲状腺癌的 85%，占所有恶性肿瘤的 1%。PTC 也是甲状腺分化型癌 (DTC) 中最常见的类型。

PTC 通常呈散发性，但也可与辐射暴露增加相关。女性发病率是男性的 3 倍。

PTC 可摄取碘，并在 TSH 刺激下分泌甲状腺球蛋白。甲状腺球蛋白水平可用于接受手术及放射性碘治疗患者的随访监测。

其 10 年生存率为 96%。仅少数 PTC 具有侵袭性。

淋巴结转移常见，远处转移发生率为 5%-10%。约 10-20% 的 PTC 为多灶性，70% 为实性。

影像学表现：

/ **US：** 是首选影像学检查方法，可显示典型特征，包括低回声、边缘不规则、内部微钙化 +/- 转移性淋巴结伴典型微钙化和部分囊性成分（**图 34**）。

/ **CT/MRI：** 用于局部晚期疾病的分期和除外远处转移（**图 35**）。

/ **PETCT：** 不推荐常规用于 DTC 的初始分期。其作用主要限于特定病例及疑似去分化癌的术后随访。

图 34

甲状腺右侧叶内一明显低回声肿块伴微钙化，经组织学证实为乳头状癌。

图 35

巨大甲状腺肿（箭头）伴广泛囊性改变、粗大钙化（虚线箭头）和严重气管受压，并双侧颈部转移性淋巴结（单箭头和双箭头）。经组织学证实为甲状腺乳头状癌。

/ Follicular Carcinoma

Follicular carcinoma (FC) accounts for 1 in 10 thyroid malignancies. It is a differentiated thyroid cancer (DTC) with an overall 20-year survival rate of 81%. It has a predilection for haematogenous spread to the lungs, bones and central nervous system. It takes up iodine and produces thyroglobulin in response to TSH stimulation.

On US, it usually has characteristic malignant features (**Figs. 36-37**). It is distinguished from benign follicular adenoma by microscopic vascular invasion and full thickness capsular invasion into adjacent thyroid tissue.

<!> ATTENTION

Minimally invasive follicular cancer may mimic a benign nodule on US! Its appearance can also be that of a heterogenous and locally invasive mass. US is the examination of choice for lesion characterisation and to guide FNA.

Oncocytic carcinoma (formerly called Hürtle cell carcinoma) is a more aggressive cancer with an intermediate prognosis and a 65% 20-year survival.

The role of **CT** is limited for advanced stage cancers and for surveillance. This should be performed without IV contrast as the latter delays Iodine-131 therapy by up to 6 months.

Surveillance imaging should include:

/ I-131 scan ± US

/ PET/CT if increased serum thyroglobulin levels but negative I-131 scan

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FIGURE 36

Profoundly hypoechoic mass in the right thyroid lobe (asterisk), taller than wide confirmed to be follicular carcinoma on histology. T = trachea.
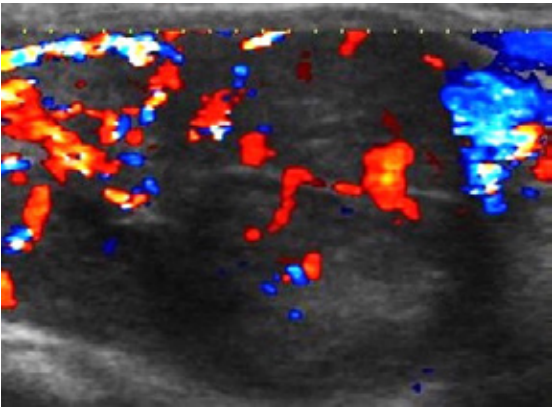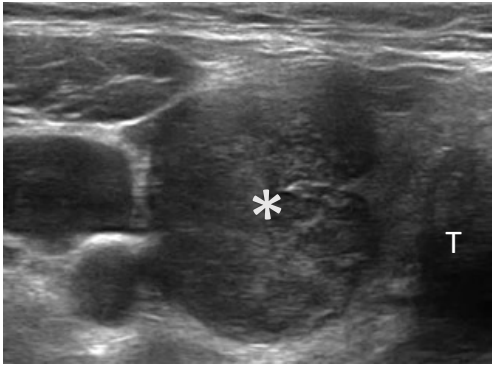

FIGURE 37

Same lesion exhibits disorganised, predominantly central Doppler flow.

/ Endocrine System

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/ 滤泡状癌

滤泡状癌 (FC) 占甲状腺恶性肿瘤的 1/10。它是一种甲状腺分化型癌 (DTC)，20 年总生存率为 81%。易通过血行转移至肺、骨及中枢神经系统。可摄取碘，并在 TSH 刺激下分泌甲状腺球蛋白。

US 检查中通常具有典型恶性特征（**图36-37**）。与良性滤泡性腺瘤的鉴别要点为显微镜下可见血管侵犯及穿透包膜侵及邻近甲状腺组织。

<!> 注意

微小浸润性滤泡状癌在 US 中可能类似良性结节！其表现也可能为不均质、局部浸润性肿块。US 是病灶定性及引导 FNA 的首选检查。

嗜酸细胞癌（曾称为 Hürtle 细胞癌）是一种侵袭性更强的癌症，预后中等，20 年生存率为 65%。

CT 对晚期癌症及随访监测价值有限。该检查应避免使用静脉注射对比剂，因为后者会延迟碘-131 治疗长达 6 个月。

影像学监测应包括：

/ I-131 扫描 ± US

/ 如果血清甲状腺球蛋白水平升高但 I-131 扫描呈阴性，则进行 PET/CT 检查

图 36

甲状腺右侧叶内一明显低回声肿块（星号），纵径大于横径，经组织学证实为滤泡状癌。T = 气管。

图 37

同一病灶显示紊乱的、以中央分布为主的多普勒血流。

/ Medullary Thyroid Carcinoma

Medullary thyroid cancer (MTC) is a rare neuroendocrine malignancy. It arises from the calcitonin producing parafollicular C cells. Most cases are sporadic, however, 15-25% are inherited and occur in the context of **multiple endocrine neoplasia (MEN) syndromes** due to a mutation in the RET (Retinoblastoma) protooncogene. These syndromes include MEN 2a (MTC, phaeochromocytoma, parathyroid hyperplasia), MEN 2b (MTC, phaeochromocytoma, multiple mucosal neurinomas), familial medullary thyroid cancer. MTC accounts for 10% of paediatric thyroid malignancies. The 20-year survival following adequate treatment of MTC is about 65%.

MTC has a predilection for both lymphatic and haematogenous spread.

Patients require pre-operative biochemical screening for parathyroid and adrenal tumours with phaeochromocytomas needing to be removed prior to thyroidectomy. Genetic screening is offered to family members in the inherited form.

Intravenous iodine-based contrast agents are not contraindicated.

Imaging:

/ **US:** first choice modality. The lesion is typically hypoechoic with ill-defined margins and calcifications (**Fig. 38**)

/ **CT:** to assess the degree of local invasion and metastases (**Fig. 39**)

/ **Ga-68 DOTATATE PET:** for metastatic disease

/ **I-131 MIBG** or **octreotide** scintigraphy: for metastases

FIGURE 38

US shows a strongly hypoechoic mass with irregular margins , internal calcifications (arrow in A) and sparse vascularity (arrow in B), histologically proven medullary carcinoma.
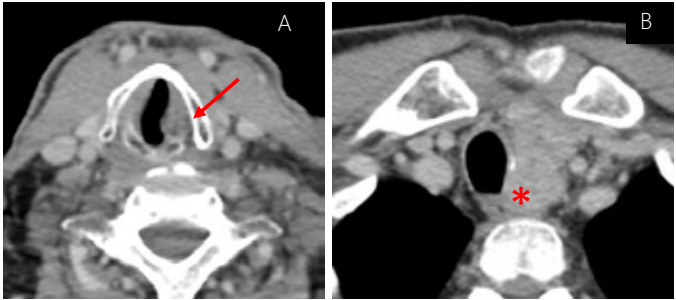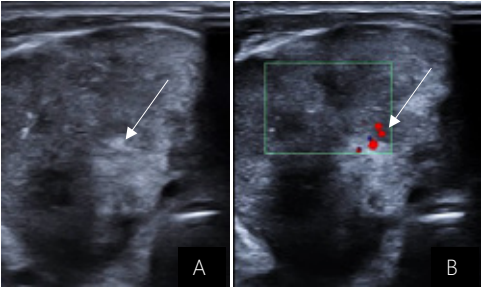

FIGURE 39

Contrast enhanced CT in a patient presenting with hoarseness shows a fixed and adducted left vocal (red arrow) due to an infiltrative mass extending into the left tracheo-oesophageal groove (asterix), confirmed medullary thyroid carcinoma.

<∞> **REFERENCE**

Kim SH, Kim BS, Jung SL, Lee JW, Yang PS, Kang BJ, Lim HW, Kim JY, Whang IY, Kwon HS, Jung CK. Ultrasonographic findings of medullary thyroid carcinoma: a comparison with papillary thyroid carcinoma. Korean J Radiol. 2009 Mar-Apr;10(2):101-5.

/ Endocrine System

/ 内分泌系统

/ 甲状腺髓样癌

甲状腺髓样癌 (MTC) 是一种罕见的神经内分泌恶性肿瘤，起源于分泌降钙素的滤泡旁 C 细胞。大多数病例为散发性，但 15%-25% 为遗传性，与由 RET（视网膜母细胞瘤）原癌基因突变引起的**多发性内分泌腺瘤病 (MEN) 综合征**有关。这些综合征包括 MEN2a (MTC、嗜铬细胞瘤、甲状旁腺增生)、MEN2b (MTC、嗜铬细胞瘤、多发性黏膜神经鞘瘤)、家族性甲状腺髓样癌。MTC 占儿童甲状腺恶性肿瘤的 10%。经充分治疗后，MTC 的 20 年生存率约为 65%。

MTC 易通过淋巴及血行转移。

患者需接受甲状旁腺和肾上腺肿瘤的术前生化筛查，若存在嗜铬细胞瘤则需在甲状腺切除术前先行切除。遗传性病例则需对家族成员进行基因筛查。

静脉注射碘对比剂无禁忌。

影像学表现：

/ **US：** 首选检查方法。病灶通常表现为低回声、边缘不清伴钙化（图 38）

/ **CT：** 评估局部侵犯程度及转移（图 39）

/ **Ga-68 DOTATATE PET：** 用于转移性疾病

/ **I-131 MIBG** 或奥曲肽闪烁扫描：用于转移瘤

图 38

US 显示一明显低回声肿块，边缘不规则，内部钙化（A 中箭头），血流稀疏（B 中箭头），经组织学证实为髓样癌。

图 39

一例声音嘶哑患者的对比增强 CT 显示，由于浸润性肿块延伸至左侧气管食管沟（星号），左侧声带内移（红色箭头），确诊为甲状腺髓样癌。

<∞> 参考文献

Kim SH, Kim BS, Jung SL, Lee JW, Yang PS, Kang BJ, Lim HW, Kim JY, Whang IY, Kwon HS, Jung CK. Ultrasonographic findings of medullary thyroid carcinoma: a comparison with papillary thyroid carcinoma. Korean J Radiol. 2009 Mar-Apr;10(2):101-5.

/ Anaplastic Thyroid Carcinoma (ATC)

Anaplastic thyroid carcinoma (ATC) is a rare and very aggressive form of thyroid neoplasms, accounting for 1-2% of thyroid cancers & 39% of thyroid deaths.

In most cases, it presents in patients > 60 years as a rapidly growing, large, painful neck mass, partially necrotic (75%) and calcified (60%).

Patients tend to have advanced disease at initial presentation, often with extra-thyroid extension, nodal and distant metastases (**Fig. 40**).

ATC often arises in elderly patients with multinodular goitre and is thought to develop from pre-existing differentiated thyroid cancer (papillary/follicular carcinoma).

The lack of response to radioactive iodine therapy is associated with rapid progression and poor prognosis (average survival: 6 months).

The diagnosis should ideally be made with core biopsy rather than FNA.

Imaging:

/ **US:** mostly used to guide core biopsy

/ **CT/MRI:** for staging, to delineate the extent of trans-spatial invasion; PETCT: tumours are highly FDG avid

/ **Iodine scintigraphy** is not used in the evaluation or treatment of anaplastic carcinoma
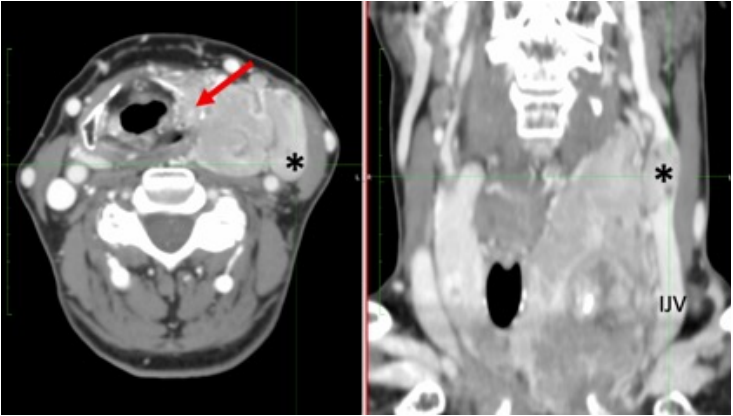
FIGURE 40

Contrast-enhanced CT scan showing an invasive cervical mass developped from the left thyroid lobe. The lesion invades thyroid cartilage (arrow) and left larynx and extends into the ipsilateral jugular vein. Intravenous tumour thronbus (asterisks). IJV = internal jugular vein.

>▪< FURTHER KNOWLEDGE

IV iodine contrast agents can be used

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/ 甲状腺未分化癌 (ATC)

甲状腺未分化癌 (ATC) 是一种罕见且侵袭性极强的甲状腺肿瘤，占甲状腺癌的 1%-2%，占甲状腺癌死亡病例的 39%。

在大多数病例中，它在 60 岁以上患者中表现为生长迅速的、巨大的、疼痛性颈部肿块，伴有部分坏死（75%）和钙化（60%）。

患者初诊时多为晚期，常伴甲状腺外侵犯、淋巴结及远处转移（图 40）。

ATC 多发生于合并多结节性甲状腺肿的老年患者，它可能是由已存在的甲状腺分化型癌（乳头状/滤泡状癌）发展而来。

由于对放射性碘治疗缺乏反应，肿瘤进展迅速，预后极差（平均生存期：6 个月）。

诊断最好采用核心组织活检而非 FNA。

影像学表现：

/ **US：** 主要用于引导核心组织活检

/ **CT/MRI：** 用于分期及评估跨间隙侵犯范围；PETCT：肿瘤对 FDG 高摄取

/ 碘闪烁扫描不用于未分化癌的评估或治疗

图 40

对比增强 CT 扫描显示甲状腺左侧叶来源的颈部浸润性肿块。病变侵犯甲状软骨（箭头）、左侧喉部并延伸至同侧颈静脉。静脉内瘤栓（星号）。IJV = 颈内静脉。
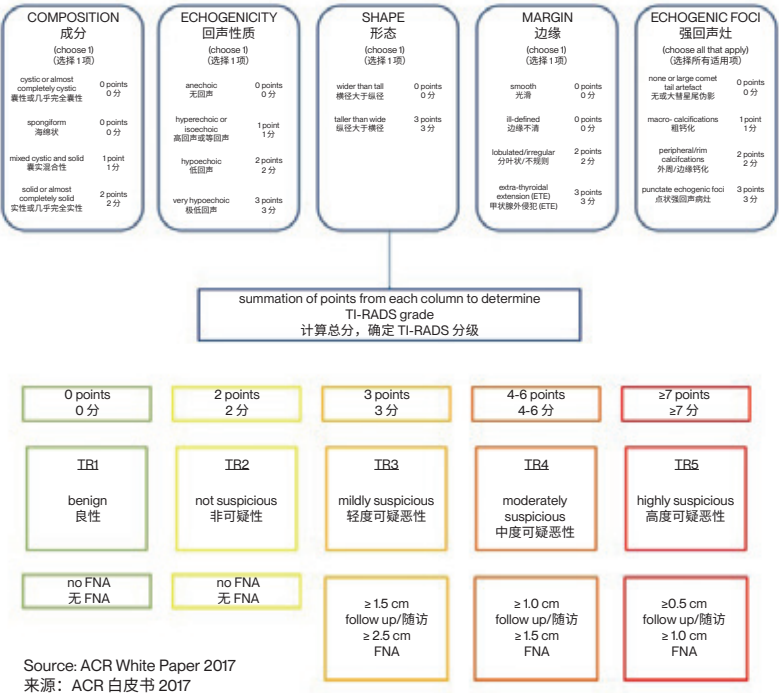
>▪< 进阶知识

可静脉注射碘对比剂

/ ACR-TIRADS

The ACR Thyroid Imaging Reporting System (TIRADS) provides a structured approach to assess the risk of malignancy of a thyroid nodule based on the size of the nodule and on the following US features:

/ Composition
/ Echogenicity
/ Shape
/ Margin
/ Echogenic foci

This classification uses a standardised scoring system and the sum of the different scores determines the TIRADS level or grade (range 1 – 5).

It also provides guidelines indicating which nodules warrant FNA cytology, e.g., TIRADS 1 corresponds to a benign lesion & no cytology is required, whereas TIRADS 5 is a highly suspicious lesion requiring cytology if nodule size ≥ 1 cm.

COMPOSITION 成分 (choose 1) (选择 1项)	ECHOGENICITY 回声性质 (choose 1) (选择 1项)	SHAPE 形态 (choose 1) (选择 1项)	MARGIN 边缘 (choose 1) (选择 1项)	ECHOGENIC FOCI 强回声灶 (choose all that apply) (选择所有适用项)
cystic or almost completely cystic 囊性或几乎完全囊性 0 points 0 分	anechoic 无回声 0 points 0 分	wider than tall 横径大于纵径 0 points 0 分	smooth 光滑 0 points 0 分	none or large comet tail artefact 无或大彗星尾伪影 0 points 0 分
spongiform 海绵状 0 points 0 分	hyperechoic or isoechoic 高回声或等回声 1 point 1 分	taller than wide 纵径大于横径 3 points 3 分	ill-defined 边缘不清 0 points 0 分	macro- calcifications 粗钙化 1 point 1 分
mixed cystic and solid 囊实混合性 1 point 1 分	hypoechoic 低回声 2 points 2 分		lobulated/irregular 分叶状/不规则 2 points 2 分	peripheral/rim calcifications 外围/边缘钙化 2 points 2 分
solid or almost completely solid 实性或几乎完全实性 2 points 2 分	very hypoechoic 极低回声 3 points 3 分		extra-thyroidal extension (ETE) 甲状腺外侵犯 (ETE) 3 points 3 分	punctate echogenic foci 点状强回声病灶 3 points 3 分

summation of points from each column to determine TI-RADS grade
计算总分，确定 TI-RADS 分级

0 points 0 分	2 points 2 分	3 points 3 分	4-6 points 4-6 分	≥7 points ≥7 分
TR1 benign 良性	TR2 not suspicious 非可疑性	TR3 mildly suspicious 轻度可疑恶性	TR4 moderately suspicious 中度可疑恶性	TR5 highly suspicious 高度可疑恶性
no FNA 无 FNA	no FNA 无 FNA	≥ 1.5 cm follow up/随访 ≥ 2.5 cm FNA	≥ 1.0 cm follow up/随访 ≥ 1.5 cm FNA	≥0.5 cm follow up/随访 ≥ 1.0 cm FNA

Source: ACR White Paper 2017
来源：ACR 白皮书 2017

/ ACR-TIRADS

美国放射学会（American College of Radiology，ACR）甲状腺影像报告和数据系统（Thyroid Imaging Reporting System，TIRADS）提供了一种结构化方法，根据结节大小和以下超声特征来评估甲状腺结节的恶性风险：

/ 成分
/ 回声性质
/ 形态
/ 边缘
/ 强回声灶

该分类采用标准化评分系统，各项评分总和确定 TIRADS 水平或等级（1-5 级）。

同时，该系统还明确了不同等级结节是否需要 FNA 细胞学检查的指导原则。例如，TIRADS 1 级表示良性病变，不需要进行细胞学检查，而 TIRADS 5 级是一种高度可疑病变，若结节 ≥1 cm，则需要进行细胞学检查。

/ ACR-TIRADS 1 and 2

These two categories are used to describe benign nodules (**Fig. 41**):

/ TIRADS 1 corresponds to a homogenous thyroid gland / absence of nodule.

/ TIRADS 2 includes pure anechoic cysts, "colloid cysts" and "spongiform nodules", which are composed of tiny cystic spaces involving the entire nodule, separated by isoechoic linear septa.

<!> **ATTENTION**

FNA cytology is not indicated unless for comfort treatment such as emptying a cyst in case of compression symptoms.

FIGURE 41

US of different thyroid glands with nodules classified as TIRADS 2. On images A and B colloid cysts are shown with arrows pointing at the typical "comet tail artifact". On images B and C, stars indicate large spongiform nodules.
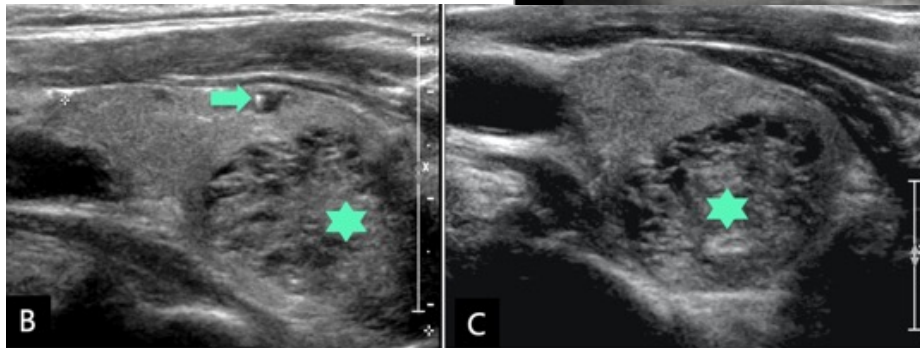
/ Endocrine System

/ 内分泌系统

/ ACR-TIRADS 1 级和 2 级

这两类用于描述良性结节（图 41）：

/ TIRADS 1 级表现为甲状腺腺体均匀/无结节。

/ TIRADS 2 级包括单纯无回声囊肿、"胶质囊肿"及"海绵状结节"（整个结节内遍布微小囊腔，由线性等回声分隔）。

<!> 注意

除非用于缓解症状（例如因压迫症状需抽吸囊液），否则无需行 FNA 细胞学检查。

图 41

不同甲状腺中被归类为 TIRADS 2 级结节的 US 图像。图像 A 和 B 中箭头指向胶质囊肿典型的"彗星尾征"。图像 B 和 C 中星号表示大海绵状结节。

/ ACR-TIRADS 3 and 4

TIRADS 3 and 4 correspond to low and intermediate-risk categories (Fig. 42).

They are used to describe nodules with oval shape and smooth margins and without any feature of high risk.

The main difference between these 2 categories is the relative echogenicity of the nodule compared to the adjacent gland parenchyma.

<!> ATTENTION

> Iso or hyperechoic: TIRADS 3 (risk of malignancy < 5%)

> Mildly hyperechoic: TIRADS 4 (risk of malignancy: 6-17%)
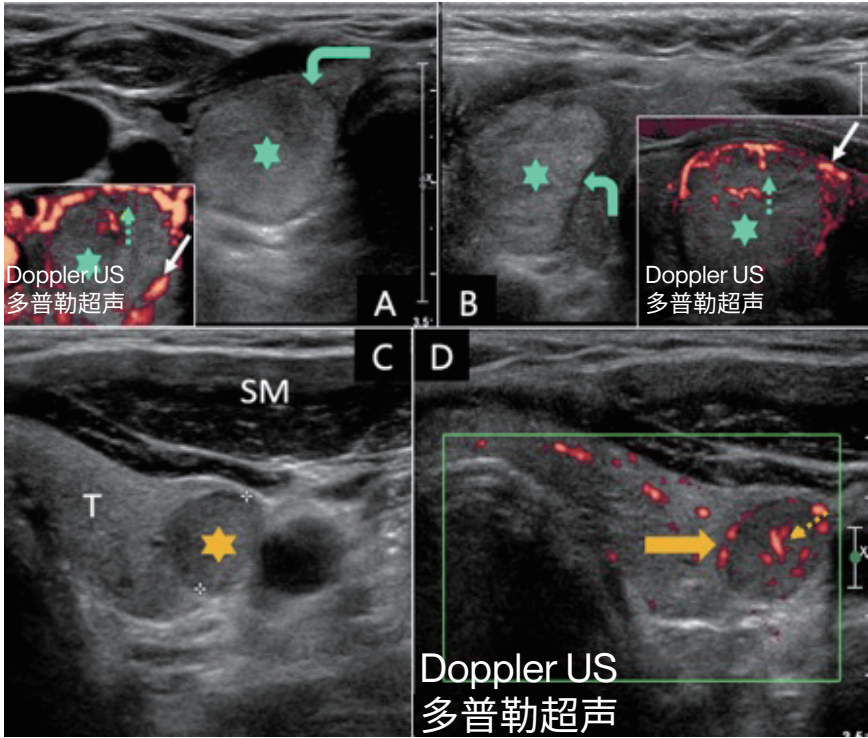
FIGURE 42

Images A and B show a homogenous isoechoic nodule (TIRADS 3) with a typical vascular ring (white arrows). The nodule (star) has an oval shape and well-defined margins (curved green arrows, dashed green arrows show increased peripheral vascularisation)
Images C and D show a slightly hypoechoic nodule (TIRADS 4, star) with peripheral and central (yellow dashed arrow) vascularisation.

/ Endocrine System

/ 内分泌系统

/ ACR-TIRADS 3 级和 4 级

TIRADS 3 级和 4 级分别对应低风险与中风险结节（图 42）。

该级别用于描述形态呈椭圆形、边缘光滑且无任何高危特征的结节。

这两种分类的主要区别在于结节相对于邻近腺体实质的回声强度。

<!> 注意

> 等回声或高回声：TIRADS 3 级（恶性风险 < 5%）

> 轻度高回声：TIRADS 4 级（恶性肿瘤风险：6%-17%）

图 42

图像 A 和 B 显示一均匀等回声结节（TIRADS 3 级），可见典型血管环（白色箭头）。结节（星号）呈椭圆形，边缘清晰（绿色弧形箭头），周边血流增多（绿色虚线箭头）。图像 C 和 D 显示一轻度低回声结节（TIRADS 4 级，星号），可见周边及中央血流信号（黄色虚线箭头）。

/ ACR-TIRADS 5

TIRADS-5 corresponds to the high-risk category with a risk of malignancy estimated between 26% and 87% (**Fig. 43**).

<!> **ATTENTION**

High-risk features include:

/ Taller than wide
/ Irregular margins
/ Microcalcifications
/ Marked hypoechoicity
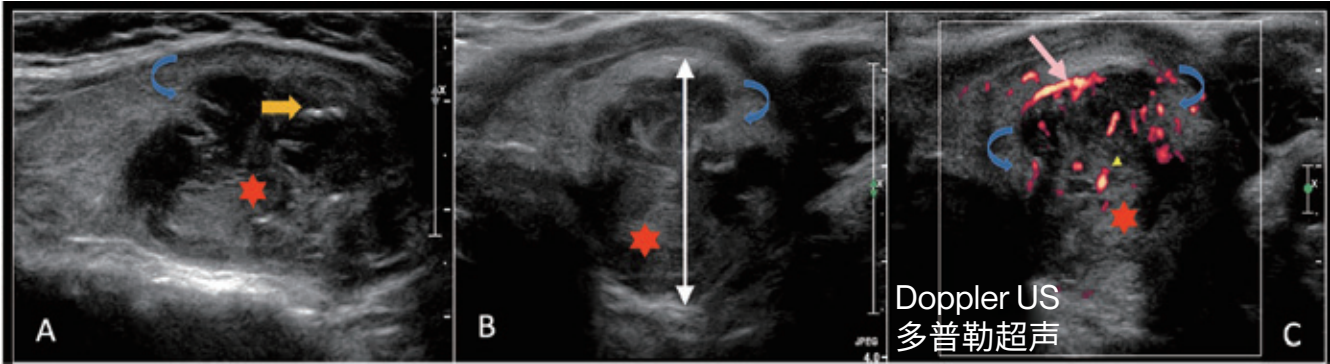
FIGURE 43

US showing a TIRDAS 5 strongly hypoechoic nodule with microcalcifications (yellow arrow in A), a taller than wide shape on the transverse image (B). Doppler US demonstrates an anarchic vascularisation with peripheral (large pink arrow) and central (yellow arrowhead) vessels. Note poorly defined margins (curved blue arrows on all images).

/ Endocrine System

/ 内分泌系统

/ ACR-TIRADS 5 级

TIRADS 5 级对应高风险结节，恶性风险估计在 26%-87% 之间的高风险结节（图 43）。

<!> 注意

高风险特征包括：

/ 纵径大于横径
/ 边缘不规则
/ 微钙化
/ 明显低回声

图 43

TIRDAS 5 级结节的 US 检查显示明显低回声伴微钙化（A 中黄色箭头），横断面上纵径大于横径（B）。彩色多普勒显示血流紊乱，可见周边（大粉色箭头）及中央（黄色箭头）血管分布。所有图像中均可见边缘不清（蓝色弧形箭头）。

/ Hyperparathyroidism

/ Definition and Epidemiology

Hyperparathyroidism is a pathological condition in which one or multiple parathyroid glands produce an excess amount of parathyroid hormone (PTH), leading to hypercalcemia and reduced bone density.

There are three types of hyperparathyroidism: primary, secondary and tertiary.

- / **Primary hyperparathyroidism** is the most common type and is usually caused by a single hyperfunctioning adenoma
- / **Secondary hyperparathyroidism** is caused by chronic kidney disease or vitamin D deficiency
- / **Tertiary hyperparathyroidism** occurs after longstanding secondary hyperparathyroidism in which hypercalcaemia has resulted

Symptoms of hyperparathyroidism can include fatigue, weakness, bone fragility, kidney stones and gastrointestinal symptoms. However, many patients are asymptomatic and the condition is discovered incidentally during routine blood tests.

Severe osteoporosis is the most feared complication of hyperparathyroidism. Acute hypercalcemia can lead to cardiac complications, however it is rarely observed in hyperparathyroidism.

Surgical resection is the only curative treatment. Minimally invasive parathyroidectomy is the technique of choice, which requires precise preoperative imaging studies to locate the hyper-functional glands.
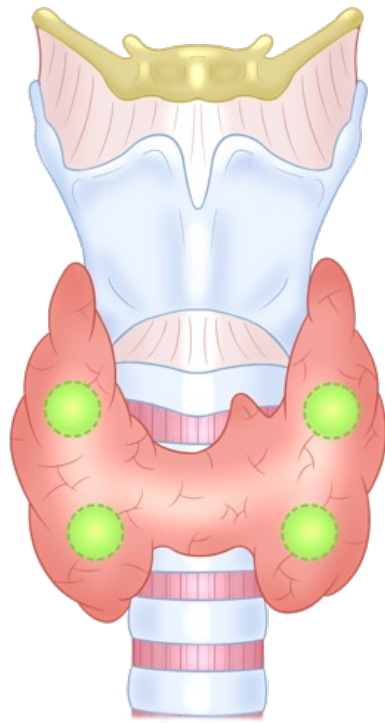
FIGURE 44

Schematic drawing of the thyroid and parathyroid glands (green dots). However, many parathyroid glands have an ectopic location in the neck and in the thoracic cavity.

/ Endocrine System

/ 内分泌系统

/ 甲状旁腺功能亢进症

/ 定义和流行病学

甲状旁腺功能亢进症是一种因一个或多个甲状旁腺分泌过量甲状旁腺激素 (PTH)，导致高钙血症及骨密度降低的病理状态。

甲状旁腺功能亢进症分三种类型：原发性、继发性和三发性。

- / 原发性甲状旁腺功能亢进症是最常见的类型，通常由单发的功能亢进性腺瘤引起
- / 继发性甲状旁腺功能亢进症因慢性肾病或维生素 D 缺乏症引起
- / 三发性甲状旁腺功能亢进症在长期继发性甲状旁腺功能亢进导致高钙血症后发生

甲状旁腺功能亢进症的症状可包括疲劳、乏力、骨脆性增加、肾结石及胃肠道症状。然而，许多患者并没有症状，而在常规血液检查时偶然发现。

严重骨质疏松症是甲状旁腺功能亢进症最严重的并发症。急性高钙血症可能导致心脏并发症，然而在甲状旁腺功能亢进症中极少见。

手术切除是唯一根治性治疗方式。微创甲状旁腺切除术为首选术式，需依赖精准的术前影像学检查定位功能亢进的甲状旁腺。

图 44

甲状腺和甲状旁腺（绿点）示意图。然而，许多甲状旁腺可异位于颈部或胸腔内。

/ Primary Hyperparathyroidism: Adenoma

As shown in the chart on the left (Fig. 45), adenomas and diffuse parathyroid hyperplasia represent the main aetiologies of primary hyperparathyroidism.

Radiological exploration plays an important role to determine the number and size of pathological glands. Facilitated by a precise imaging localisation (Fig. 46) surgeons can operate using microincision, thus avoiding bilateral neck exploration and limiting the risk of recurrent laryngeal nerve damage.
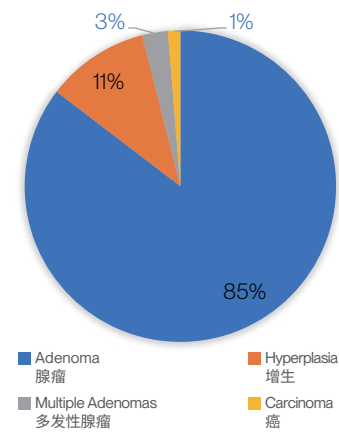

- Adenoma 腺瘤
- Hyperplasia 增生
- Multiple Adenomas 多发性腺瘤
- Carcinoma 癌

FIGURE 45

Main aetiologies in primary hyperparathyroidism.
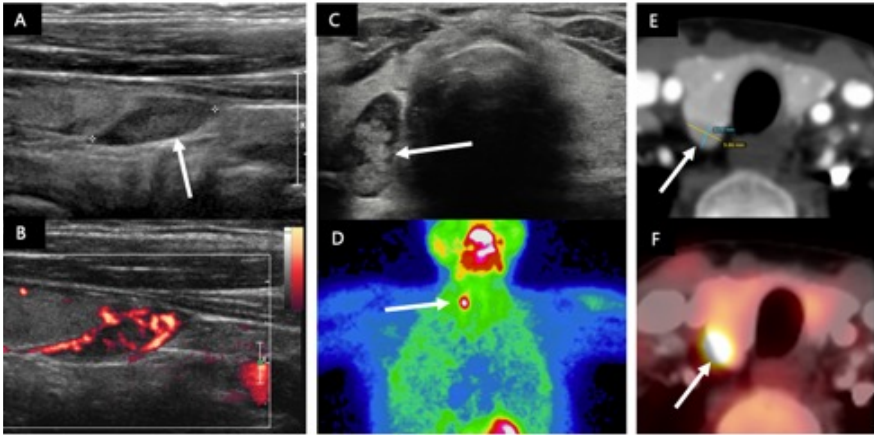
FIGURE 46

Three different patients with surgically proven parathyroid adenomas. Patient 1: Longitudinal US image (A) shows a hypoechoic nodule (arrow) below the right thyroid lobe with increased vascularisation on the power Doppler image (B). Patient 2: large parathyroid adenoma on US (C) and corresponding MIBIscintigraphy (D). Patient 3: 18F choline PET/CT (E and F) shows focal uptake of an enlarged parathyroid gland (arrows) corresponding to an adenoma.

/ Endocrine System

/ 内分泌系统

/ 原发性甲状旁腺功能亢进症：腺瘤

如左侧图表所示（图 45），腺瘤和弥漫性甲状旁腺增生是原发性甲状旁腺功能亢进症的主要病因。

放射检查在确定病变腺体的数量和大小方面发挥重要作用。通过精准的影像学定位（图 46），外科医生可采用微小切口手术，从而避免双侧颈部探查，并降低喉返神经损伤风险。

图 45

原发性甲状旁腺功能亢进症的主要病因。

图 46

3 例经手术证实的甲状旁腺腺瘤患者。患者 1：纵向 US 图像 (A) 显示甲状腺右侧叶下方低回声结节（箭头），能量多普勒图像 (B) 显示血供丰富。患者 2：US 检查显示巨大甲状旁腺腺瘤 (C) 和相应的 MIBI 闪烁扫描 (D)。患者 3：18F-胆碱 PET/CT（E 和 F）显示增大的甲状旁腺（箭头）局灶性摄取，符合腺瘤表现。

/ Renal and Skeletal Involvement

To regulate calcium blood levels, para-thormone influences bone and kidney homeostasis.

Regarding the kidneys, it increases tubular reabsorption of calcium, it inhibits tubular reabsorption of phosphate and stimu-lates calcitriol (active form of vitamin D) synthesis.

Chronic hypercalciuria predisposes to stone formation, renal colic being one of the more frequent symptoms associated with hyperparathyroidism.

Primary hyperparathyroidism induces both bone resorption and formation. Conse-quently, it causes excessive and constant bone remodelling, which affects bone mineralisation.

As illustrated in **Fig. 47**, different types of skeletal lesions can be observed on conventional X-ray images including osteo-penia (**Fig. 27A**), brown tumours (**Fig. 27B**) and acro-osteolysis (**Fig. 27C**).

<!> ATTENTION

For skeletal manifestations of hyperparathyroidism, see also the eBook chapter on Musculoskeletal Imaging!
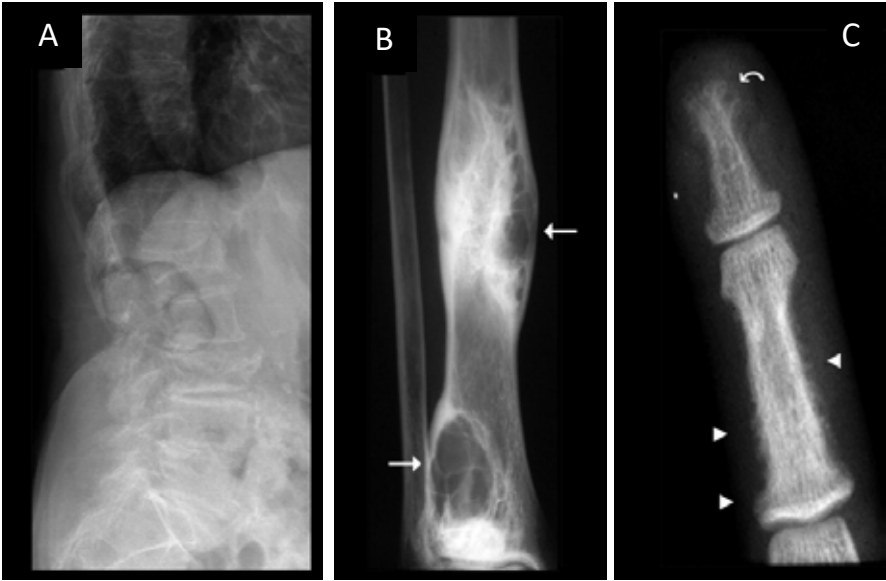
FIGURE 47

Lateral X-Ray (**A**) showing multiple vertebral compression fractures due to severe osteoporosis. Tibial radiograph (**B**) showing well-defined lytic lesions, corresponding to brown tumours (white arrows), which manifest as expansile lesions causing cortical thinning. Image **C** showing subperiosteal resorption of the middle phalanx of the second finger (arrowheads) and terminal tuft resorption acro-osteolysis (curved arrows).

/ **Endocrine** System

/ 内分泌 系统

/ 肾脏和骨骼受累

甲状旁腺激素通过调节血钙水平影响骨骼与肾脏的稳态。

对肾脏的作用表现为：增加肾小管对钙的重吸收，抑制肾小管对磷的重吸收，并促进骨化三醇（维生素 D 的活性形式）合成。

慢性高钙尿症易诱发结石形成，肾绞痛是甲状旁腺功能亢进症最常见的症状之一。

原发性甲状旁腺功能亢进症可同时引起骨吸收与骨形成，因此导致过度且持续的骨重塑，进而影响骨矿化。

如图 47 所示，常规 X 线图像可观察到多种骨骼病变，包括骨质疏松（图 27A）、棕色瘤（图 27B）和肢端骨质溶解（图 27C）。

<!> 注意

关于甲状旁腺功能亢进症的骨骼表现，另请参阅《骨骼肌肉影像学》电子书章节！

图 47

侧位 X 线检查（A）显示严重骨质疏松导致的多发椎体压缩性骨折。胫骨 X 线检查（B）显示边界清晰的溶骨性病变，对应棕色瘤（白色箭头），表现为膨胀性病变伴皮质变薄。图像 C 显示食指中节指骨骨膜下吸收（三角箭头）和指骨末端簇状骨质吸收溶解（弯箭头）。

/ Para-ganglioma (PGL)

/ 副神经节瘤 (PGL)

/ Endocrine System

/ 内分泌 系统

/ Epidemiology and Risk Factors

Paragangliomas (PGL) are rare tumours arising from the paraganglia cells of neural crest origin.

These tumours can develop in various parts of the body along the parasympathetic chain of the head and neck (Fig. 48) and along the sympathetic chain in the chest and abdomen (Fig. 49).

Above the aortic arch, the carotid bifurcation is the most common location of PGL, followed by the jugular fossa, tympanic cavity and along the vagus nerve. In the abdomen, the main sites are the adrenal glands and the retroperitoneal "organ of Zuckerkandl".

Adrenal paragangliomas are usually called "pheochromo-cytomas".

Hereditary cases represent 33% - 50% of all PGL and -as specific genetic alterations increase the malignancy risk- genotyping is always recommended.
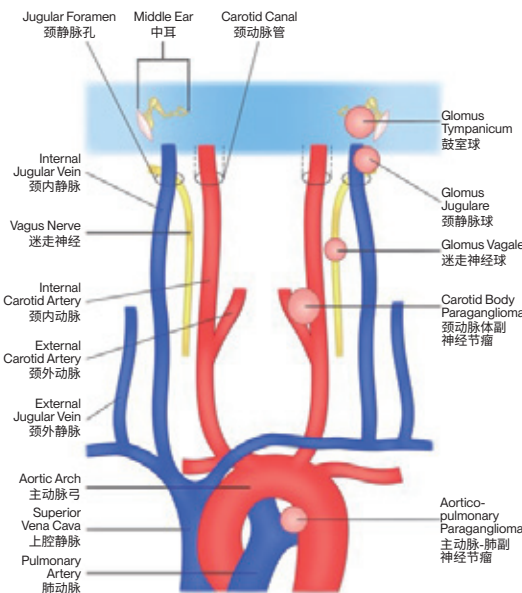
FIGURE 48

Diagram representing the main PGL locations in the head and neck along the parasympathetic chain.
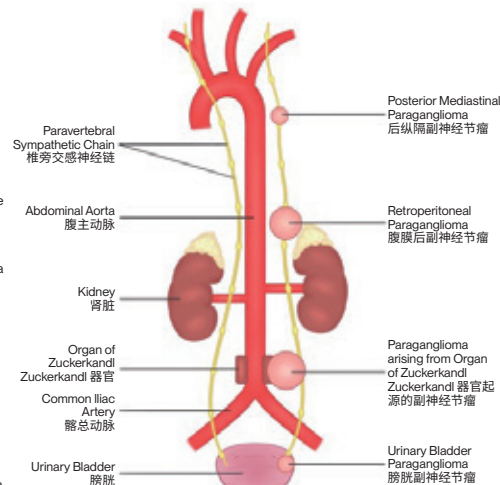
FIGURE 49

Schematic diagram of the sympathetic chain from the aortic arch to the bladder.

/ Endocrine System

/ 内分泌 系统

/ 流行病学和危险因素

副神经节瘤 (PGL) 是起源于神经嵴来源副神经节细胞的罕见肿瘤。

这些肿瘤可发生于沿头颈部副交感神经链（图 48）及胸腹部交感神经链（图 49）的多个部位。

主动脉弓上方，颈动脉分叉是 PGL 最常见的发病部位，其次为颈静脉窝、鼓室及迷走神经走行区。腹部主要累及肾上腺及腹膜后"Zuckerkandl 器"。

肾上腺副神经节瘤通常被称为"嗜铬细胞瘤"。

遗传性病例占所有 PGL 的 33% - 50%，由于特定基因变异会增加恶性肿瘤的风险，因此始终建议进行基因分型。

图 48

头颈部沿副交感神经链的 PGL 主要分布示意图。

图 49

从主动脉弓到膀胱的交感神经链示意图。

/ Carotid Body Paraganglioma

Paragangliomas (PGL) located in the carotid bifurcation are commonly called "carotid body PGL". They are slow-growing tumours and rarely functional. Symptoms are generally due to mass effect. Alternatively, they can present as pulsatile cervical masses, causing submucosal oropharyngeal swelling or they represent an incidental imaging finding. PGL can be familial and multicentric (bilateral in 5 to 10 % of cases).

Imaging features on contrast-enhanced CT/MRI (**Figs. 50 and 51**) include:

/ Well-defined mass with a heterogenous central portion in larger lesions

/ Typical splaying of the internal and external carotid arteries ("lyre sign")

/ Rapid enhancement due to increased vascularisation

/ « Salt and pepper » appearance on MRI due to flow voids and/or haemorrhage
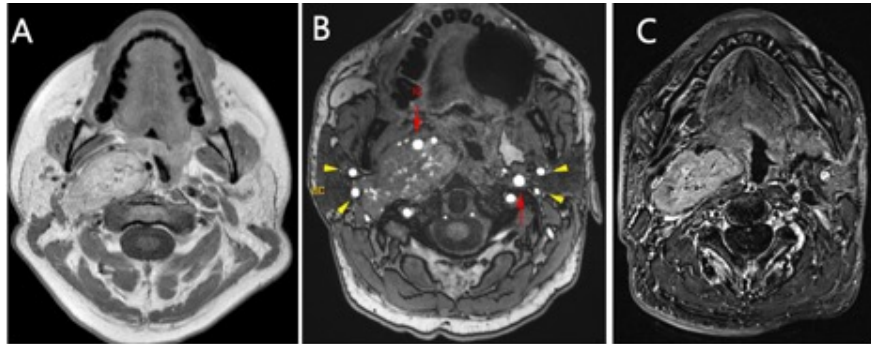
> **<!> ATTENTION**
>
> > See also eBook chapter on Head and Neck Imaging!
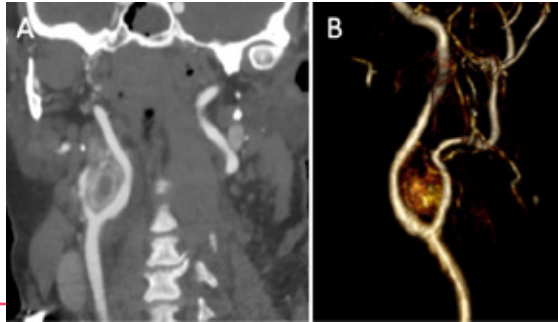
FIGURE 50

A. Coronal reconstruction of an arterial phase CT showing a carotid body tumour on the right. **B**. 3D Volume rendering reconstruction of the same tumour.

FIGURE 51

Axial MRI demonstrates a right cervical lesion with mass effect on the oropharynx. On the contrast-enhanced T1W image (A), the lesion appears hyperintense with « flow voids » corresponding to a « salt and pepper aspect ». The contrast-free angiography (Time-of-flight, B) image demonstrates increased distance between the internal (IC) and external (EC) carotid arteries compared to the contralateral side. Numerous arterial vessels in the tumour. Marked and global enhancement after gadolinium is visible on the subtraction T1W image (C).

/ Endocrine System

/ 内分泌 系统

/ 颈动脉体副神经节瘤

发生于颈动脉分叉的副神经节瘤 (PGL) 通常被称为"**颈动脉体 PGL**"。这些肿瘤生长缓慢，很少有功能。症状多由占位效应引起，或表现为搏动性颈部肿块、口咽部黏膜下肿胀，亦可为影像学偶然发现。PGL 可为家族性或多中心性（5%-10% 为双侧发病）。

对比增强 CT/MRI 的影像学特征（**图50 和 51**）包括：

/ 较大病灶可见边界清晰的肿块，中心部分不均匀

/ 典型的颈内动脉和颈外动脉向外延伸（"竖琴征"）

/ 因血供丰富而快速强化

/ MRI 因流空信号及/或出血呈"椒盐征"

> **<!> 注意**
>
> > 另请参阅《头颈部影像学》电子书章节！

图 50

A. 动脉期冠状位重建 CT 显示右侧颈动脉体瘤。B. 同一肿瘤的 3D 容积重建图像。

图 51

轴位 MRI 显示右侧颈部病变，对口咽部存在占位效应。在对比增强 T1W 图像 (A) 中，病灶呈高信号，伴"流空"信号，符合"椒盐征"。无增强血管成像（时间飞跃法，B）图像显示患侧颈内动脉 (IC) 与颈外动脉 (EC) 间距较对侧增大，肿瘤内可见丰富动脉血管。钆剂增强后减影 T1W 图像 (C) 显示显著整体强化。

/ Jugulo-Tympanic Paraganglioma

Paraganglia of the temporal bone are located along Arnold's and Jacobson's nerve.

Jacobson's nerve is a branch of the glossopharyngeal nerve, passing in the tympanic cavity along the cochlear promontory where tympanic paragangliomas are most frequently found. In this location, patients present with a retrotympanic mass which can cause pulsatile tinnitus (**Figs. 52 and 53**).

Arnold's nerve is an auricular branch of the vagus nerve which runs posteriorly in the jugular foramen. An expanding paraganglioma may progressively compress surrounding nerves (IX, X and XI) causing symptoms.

In large tumours involving both the cochlear promontory and the jugular fossa, lesion origin cannot always be established. These tumours are called **"jugulo-tympanic"**.
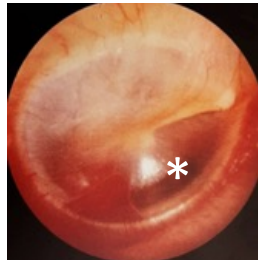
FIGURE 52

Otoscopic view showing a red retrotympanic mass (asterisk).

Case courtesy: Pascal Senn, University Hospitals Geneva.
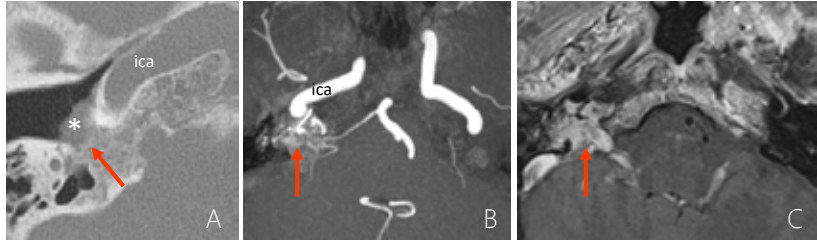
FIGURE 53

Axial CBCT image shows a hypotympanic lesion (asterisk) along the promontory associated with petrous bone erosion (arrow). Axial MR angiography sequence (TOF, B) and T1W contrast-enhanced image (C) show a strongly enhancing mass with important neovascularisation (arrows) partly arising from the internal carotid artery (ica).
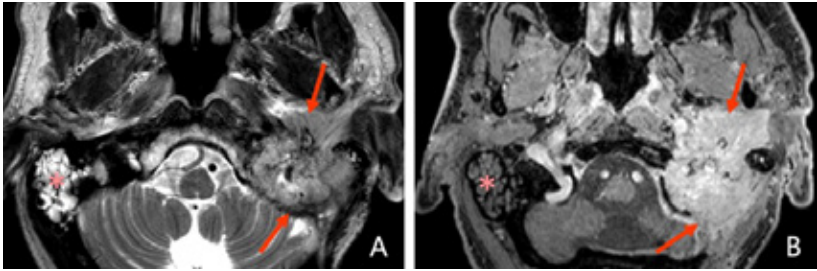
FIGURE 54

Axial T2W image (A) shows a heterogenous mass (arrows) arising from the left jugular foramen with strong enhancement on the axial T1W image post gadolinium (B). The mass invades the left skull base, the left parotid gland and extends intracranially into the posterior fossa. Fluid in the right mastoid cells (asterisks)

/ 颈静脉鼓室副神经节瘤

颞骨副神经节沿阿诺德神经与雅各布森神经分布。

雅各布森神经为舌咽神经分支，沿耳蜗岬走行于鼓室，此处最常发现鼓室副神经节瘤。在该部位，患者表现为鼓室后区肿块，可伴搏动性耳鸣（**图52 和 53**）。

阿诺德神经为迷走神经耳支，向后走行于颈静脉孔。不断增大的副神经节瘤可能会进行性压迫周围神经（第 IX、X 和 XI），从而引发症状。

累及耳蜗岬与颈静脉窝的大肿瘤，其起源有时难以明确，这些肿瘤被称为"**颈静脉鼓室副神经节瘤**"。

图 52

耳内镜显示鼓室后区红色肿块（星号）。

病例提供：Pascal Senn，日内瓦大学医院。

图 53

轴位 CBCT 图像显示鼓室岬存在鼓室下病变（星号），伴岩骨侵蚀（箭头）。轴位 MR 血管成像序列（TOF，B）和 T1W 对比增强图像 (C) 显示明显增强肿块伴重要新生血管形成（箭头），部分源自颈内动脉 (ica)。

图 54

轴位 T2W 图像 (A) 显示左侧颈静脉孔起源的不均质肿块（箭头），钆增强后轴位 T1W 图像显示显著强化 (B)。肿块侵犯左侧颅底、左侧腮腺并向颅内延伸至后颅窝。右侧乳突气房积液（星号）

Pituitary Gland Lesions

垂体病变

/ Endocrine System

/ 内分泌系统

/ Pituitary Gland Adenoma

Adenomas are the most common tumours of the sella turcica in the adult population. They are benign lesions arising from the adenohypophysis. Due to the increased amount of brain imaging, completely asymptomatic adenomas are commonly diagnosed.

Parallel to these "incidentalomas", two main types of symptomatic adenomas can be distinguished:

/ secreting microadenomas (**Fig. 55. A and B**) with endocrine dysfunction allowing early diagnosis, and

/ non-secreting macroadenomas causing compression of adjacent neural structures (**Fig. 55. C and D**).

Typically, a macroadenoma will induce hypopituitarism due to compression of the stalk or of the pituitary gland, superior extension will cause hemianopia due to optic chiasm compression, while lateral extension to the cavernous sinus is rarely symptomatic but can compromise surgical resection if surrounding the internal carotid artery.
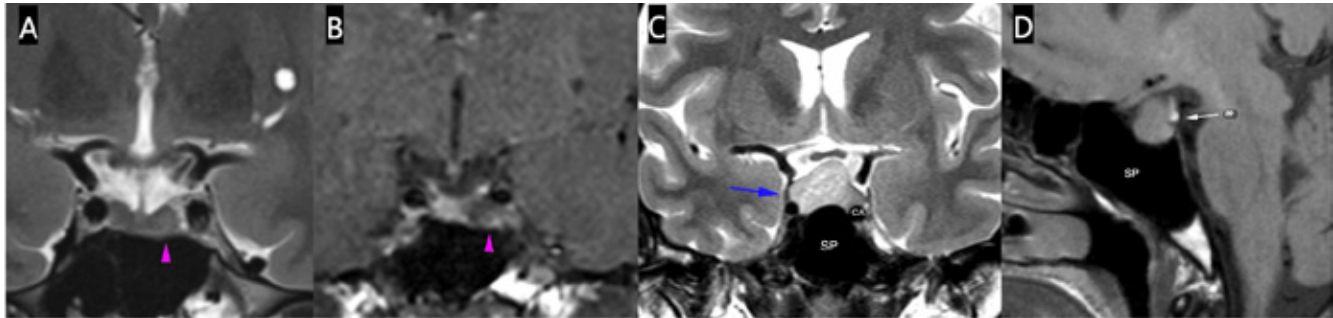
FIGURE 55

Coronal and sagittal MR images of two different patients. Images A and B show a pituitary micro-adenoma (purple arrowheads) seen as a slightly hyperintense image on the T2W sequence (A) and as a focal hypo-enhancing region on the fat suppressed T1W image (B). Macro-adenoma appearing as a hyperintense mass on the coronal T2W (C) with extension to the right cavernous sinus (blue arrow) and surrounding the internal carotid artery. The lesion is isointense on the sagittal T1W image (D). On D, the tumour has a mass effect on the neurohypophysis that appears as a bright spot on the non-contrast T1W image (white arrow). SP = sphenoid sinus. CA = Internal carotid artery.

/ Endocrine System

/ 内分泌系统

/ 垂体腺瘤

腺瘤是成人蝶鞍区最常见的肿瘤，它们是起源于腺垂体的良性病变。随着脑部影像学检查的普及，完全无症状的腺瘤也常被检出。

与这些"偶发瘤"相对应，症状性腺瘤可分为两种主要类型：

/ 分泌性微腺瘤（图 55.A 和 B）：因内分泌功能异常可早期确诊；

/ 非分泌性大腺瘤：压迫邻近神经结构（图 55.C 和 D）。

通常，大腺瘤可因垂体柄或垂体受压导致垂体功能减退；向上延伸可压迫视交叉引起偏盲；向侧方延伸至海绵窦时虽罕见症状，但若包绕颈内动脉则可能增加手术切除难度。

图 55

两例不同患者的冠状位和矢状位 MR 图像。图像 A 和 B 显示垂体微腺瘤（紫色箭头），在 T2W 序列图像上呈稍高信号 (A)，在脂肪抑制 T1W 图像上表现为局灶性低增强区域 (B)。大腺瘤在冠状位 T2W 上呈高信号肿块，延伸至右侧海绵窦（蓝色箭头）并包绕颈内动脉。在矢状位 T1W 图像上呈等信号 (D)。如 D 图所示，肿瘤对神经垂体产生占位效应，非增强 T1W 图像中神经垂体呈亮点（白色箭头）。SP = 蝶窦。CA = 颈内动脉。

/ Craniopharyngioma

Craniopharyngioma is a benign epithelial tumour derived from Rathke's pouch epithelium. Frequent in the paediatric population, it represents >50 % of all paediatric sellar tumours. The lesions tend to be partially cystic and to grow intracranially along the pituitary stalk. Large tumours may reach the hypothalamus and are associated with a high risk of injury in case of surgical resection.

There are two histologic subtypes, namely adamantinomatous and papillary craniopharyngioma. They can be differentiated based on molecular testing, age of predilection and imaging/histologic findings. In the paediatric population, adamantinomatous craniopharyngioma is the most common subtype (Fig. 56).

<!> ATTENTION

>■< FURTHER KNOWLEDGE

Rathke's cleft cyst shares a common origin with craniopharyngioma, and it can occasionally be difficult to differentiate one from the other.

Calcifications and thick parietal enhancement favour the diagnosis of craniopharyngioma.
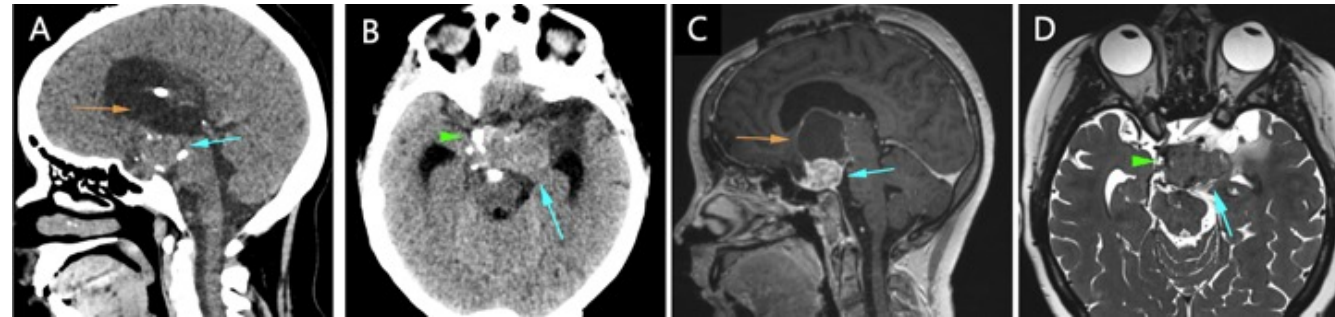
FIGURE 56

Adamantinomatous craniopharyngioma in a 9-year-old girl with headache and vision loss. Sagittal and axial CT images (A and B) show a heterogenous partially solid mass (blue arrows) with calcifications (green arrowhead) and cystic parts (brown arrow). Corresponding MR images show mixed solid and cystic components. The solid parts display heterogenous enhancement (blue arrow) on the contrast-enhanced T1W image (C) and isointensity to brain parenchyma on the T2W sequence (D). The pituitary stalk is inside the mass and cannot be identified. Brown arrow in C points at the cystic component.

<∞> REFERENCE

Tsukamoto T, Miki Y. Imaging of pituitary tumors: an update with the 5th WHO Classifications-part 1. Pituitary neuroendocrine tumor (PitNET)/pituitary adenoma. Jpn J Radiol. 2023 Feb 24. doi: 10.1007/s11604-023-01400-7. Epub ahead of print. Erratum in: Jpn J Radiol. 2023 Mar 24;: PMID: 36826759.

/ **Endocrine** System

CHAPTER OUTLINE:

Anatomy and Function

Choice of Imaging Techniques

Thyroid & Parathyroid Pathology

Paraganglioma

Pituitary Gland Lesions

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章节大纲:

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垂体病变

/ 颅咽管瘤

肾上腺病理学

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/ 颅咽管瘤

颅咽管瘤是一种起源于 Rathke 囊袋上皮的良性上皮肿瘤。多见于儿童群体，占儿童蝶鞍区肿瘤的 50% 以上。病灶多为部分囊性，常沿垂体柄向颅内生长。巨大肿瘤可累及下丘脑，手术切除时损伤风险较高。

颅咽管瘤分为两种组织学亚型：造釉细胞型与乳头型，可通过分子检测、好发年龄及影像学/组织学表现鉴别。儿童群体中以造釉细胞型最常见（图 56）。

图 56

1 例头痛伴视力下降 9 岁女孩的造釉细胞型颅咽管瘤。矢状位及轴位 CT 图像（A 和 B）示部分实性不均匀肿块（蓝色箭头），伴钙化（绿色箭头）及囊性部分（棕色箭头）。对应 MR 图像显示实性及囊性成分并存。实性部分在对比增强 T1W 图像上显示不均匀强化（蓝色箭头，C），在 T2W 序列上显示与脑实质等信号（D）。垂体柄在肿块内，无法辨认。C 中棕色箭头指向囊性成分。

<!> 注意

>■< 进阶知识

Rathke 裂囊肿与颅咽管瘤起源于同一组织，有时很难区分两者。

钙化及厚壁层强化支持颅咽管瘤的诊断。

<∞> 参考文献

Tsukamoto T, Miki Y. Imaging of pituitary tumors: an update with the 5th WHO Classifications-part 1. Pituitary neuroendocrine tumor (PitNET)/pituitary adenoma. Jpn J Radiol. 2023 Feb 24. doi: 10.1007/s11604-023-01400-7. 网络预先发表。勘误：Jpn J Radiol. 2023 Mar 24;: PMID: 36826759.

/ Other Pathologies

Besides tumours, the pituitary gland can be the target of congenital or inflammatory disorders, as well as cystic lesions and infectious diseases.
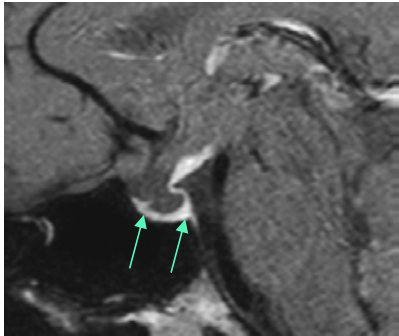
Asymptomatic 38-year old woman, sagittal post-contrast T1W image shows a partially empty sella, filled with cerebrospinal fluid. The pituitary gland is small and located in the floor of the pituitary fossa (arrows).

◄∞► **REFERENCE**

https://doi.org/10.1007/s11604-023-01407-0

Syndromes
/ Stalk interruption
/ Empty stella

Cystic lesions
/ Arachnoid
/ Rathke cleft

Sagittal T1W post contrast shows an enlarged pituitary gland and stalk (arrow) with homogenous contrast enhancement due to hypophysitis.

Abcess
Hypophysitis
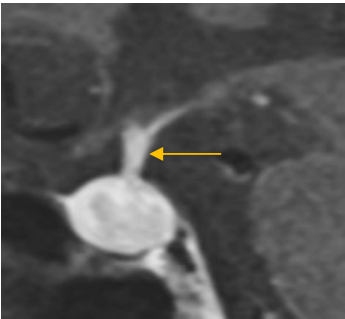
Rathke cleft cyst (orange arrows) seen as midline strongly hyperintense on T2W (A) and isointense on sagittal T1W image (B), with mass effect on the neurohypophysis and in contact with the optic chiasm (pink star). Some cysts may appear as hyperintense on T1W and low on T2W images, due to proteinaceous or haemorrhagic content. The location between anterior and posterior pituitary is typical.

/ Endocrine System

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除肿瘤外，垂体还可成为先天性或炎症性疾病、囊性病变和感染性疾病的靶点。

综合征
/ 垂体柄中断
/ 空蝶鞍

图 57

38 岁无症状女性，矢状位增强后 T1W 图像显示部分空蝶鞍，充满脑脊液。垂体很小，位于垂体窝底部（箭头）。

图 59

Rathke 裂囊肿（橙色箭头）在 T2W 图像上表现为中线区显著高信号 (A)，在矢状位 T1W 图像上表现为等信号 (B)，对神经垂体产生占位效应，并与视交叉接触（粉色星号）。部分囊肿因含蛋白性或出血性内容物，在 T1W 图像上呈高信号，在 T2W 图像上呈低信号。病灶通常位于垂体前叶与后叶之间。

脓肿
垂体炎

图 58

垂体炎患者矢状位 T1W 增强后图像显示垂体及垂体柄增大（箭头），均匀强化。

囊性病变
/ 蛛网膜
/ Rathke 裂

◄∞► 参考文献

https://doi.org/10.1007/s11604-023-01407-0

Adrenal Gland Pathology

肾上腺病理学
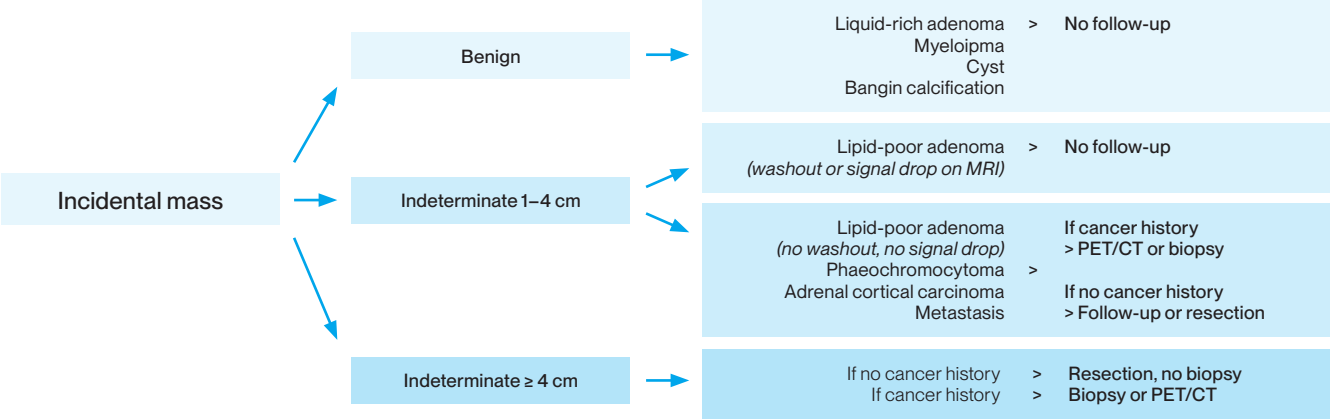
Endocrine System

内分泌系统

/ Adrenal Incidentaloma, Epidemiology and Diagnostic Algorithm

Adrenal incidentalomas are frequently encountered following the use of high resolution cross sectional imaging.

The majority of these lesions are benign and do not require further investigation or follow-up.

The role of the radiologist is to primarily identify signs of potential malignancy and recognise which patients would benefit from further investigation.

For the purpose of standardised practice the following algorithm (**Fig. 59**) is used.

Benign	Liquid-rich adenoma	> No follow-up
	Myeloipma	
	Cyst	
	Bangin calcification	
Indeterminate 1–4 cm	Lipid-poor adenoma *(washout or signal drop on MRI)*	> No follow-up
	Lipid-poor adenoma *(no washout, no signal drop)* Phaeochromocytoma Adrenal cortical carcinoma Metastasis	> If cancer history > PET/CT or biopsy If no cancer history > Follow-up or resection
Indeterminate ≥ 4 cm	If no cancer history	> Resection, no biopsy
	If cancer history	> Biopsy or PET/CT

Incidental mass

FIGURE 60

Schematic algorithm for adrenal incidentaloma characterisation and management.

/ Endocrine System

/ 内分泌系统

/ 肾上腺偶发瘤的流行病学和诊断流程

高分辨率断层成像技术应用后，临床上经常发现**肾上腺偶发瘤**。

这些病变大多为良性，无需进一步检查或随访。

放射科医生的作用主要是识别潜在恶性征象，并判断哪些患者需接受进一步评估。

为规范诊疗实践，现采用以下诊断流程（**图 59**）。

良性	富脂腺瘤 髓样脂肪瘤 囊肿 Bangin 钙化	> 无需随访
性质待定 (1-4 cm)	乏脂腺瘤 *（MRI 上廓清或信号丢失）*	> 无需随访
	乏脂腺瘤 *（无廓清、无信号衰减）* 嗜铬细胞瘤 肾上腺皮质癌 转移瘤	如有癌症病史 > PET/CT 或活检 如无癌症病史 > 随访或切除
性质待定 (≥ 4 cm)	如无癌症病史	> 切除，无需活检
	如有癌症病史	> 活检或 PET/CT

偶发肿块
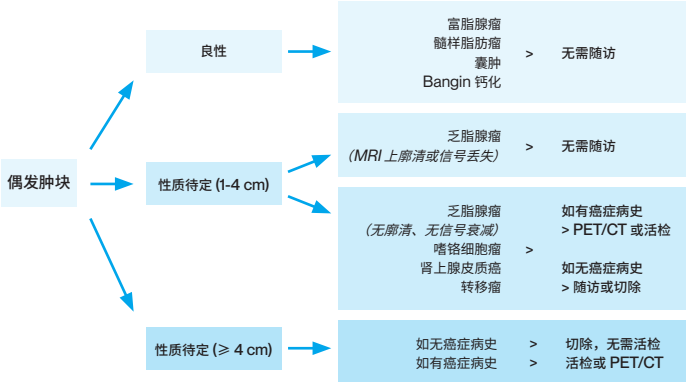
肾上腺偶发瘤的特性描述和分层管理流程图。

/ Adenoma

Depending on hormonal secretion, there are two types of adenomas:

/ "Functional adenomas", which produce either cortico-steroids causing Cushing syndrome or aldosterone (discovered because of uncontrollable hypertension)

/ "Non-functional adenomas", which are more frequent and most of the time incidentally discovered.

The majority of **non secreting** tumours are **lipid rich adenomas** which display typical features at imaging: small (< 4cm), round or oval shaped, well delineated, homogenous lesions with attenuation values <10 Hounsfield Units (HU) at CT (**Fig. 60**).

However, in 30% of adenomas with lower lipid content, the attenuation value is above 10 HU. In this situation, an additional delayed contrast-enhanced CT or MRI should be performed. The CT protocol includes delayed phase acquisitions obtained 15 min after contrast injection to calculate the absolute washout that should be ≥ 60%. MRI can also be used as an alternative to CT and shows ≥ 20% drop in signal on opposed- phase MRI (**Fig. 61**).

FIGURE 61

Unenhanced CT with right adrenal incidentaloma, mean attenuation = 5.2 HU, in keeping with a lipid-rich adenoma

Len/长度	19.2 mm
Area/面积	29.4 mm2
Min/最小	-20.0
Max/最大	39.0
Mean/平均值	52
Sdev/标准差	13.5
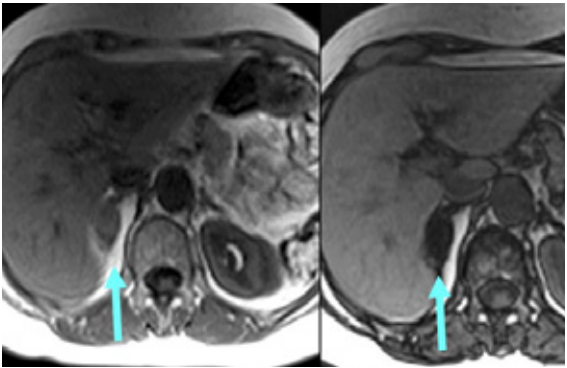
FIGURE 62

MRI chemical-shift sequence demonstrating homogenous signal drop in the right adrenal lesion on the opposed-phase compared to the in-phase (blue arrows)

<■∞> REFERENCE

/ **Endocrine** System

/ 内分泌 系统

/ 腺瘤

根据激素分泌情况，腺瘤分为两种类型：

/ "功能性腺瘤"，分泌皮质醇（导致库欣综合征）或醛固酮（因难以控制的高血压被发现）

/ "非功能性腺瘤"，更常见，且多为偶然发现。

大多数非分泌性肿瘤为**富脂腺瘤**，在影像学检查中显示典型特征：体积小（< 4 cm）、圆形或椭圆形、轮廓清晰、均匀病变，CT 衰减值 < 10 亨氏单位（HU）（**图 60**）。

然而，在 30% 的较低脂质含量腺瘤中，衰减值高于 10 HU。此时需行延迟对比增强 CT 或 MRI 进一步验证。CT 方案包括注射对比剂后 15 min 获得的延迟期采集，以计算绝对廓清率（应 ≥ 60%）。MRI 也可用作 CT 的替代方案，在反相位 MRI 上显示信号衰减 ≥ 20%（**图 61**）。

图 61

非增强 CT 示右肾上腺偶发瘤，平均衰减 = 5.2 HU，符合富脂腺瘤表现

图 62

MRI 化学位移序列显示与同相位（蓝色箭头）相比，反相位上右肾上腺病变表现为均匀信号衰减

<∞> 参考文献

/ Pheochromocytoma

Pheochromocytoma is a rare neuroendocrine tumour that originates in the adrenal medulla. The tumour is usually benign and can secrete adrenaline and noradrenaline. When the tumour is secreting, high blood pressure, rapid heartbeat, sweating, headaches, anxiety, and weight loss are the result. Non-secreting tumours are usually asymptomatic and detected later. These are often larger in size at the time of diagnosis.

Several genes have been identified that are associated with the development of pheochromocytoma, including the RET, VHL, NF1, SDHA, SDHB, SDHC, and SDHD genes.

Metaiodobenzylguanidine (MIBG) is a radioactive substance taken up by the adrenal glands. MIBG scintigraphy is commonly used to diagnose pheochromocytoma or to determine tumour extent.

PETCT can also be used (**Fig. 62. A-B**) but has a low specificy. PET/CT is useful in the context of a known cancer to look for metastatic disease.

Dynamic contrast enhanced MRI can also help to better characterise these lesions (**Fig. 62.C-D**).

◄!► ATTENTION

The 10% rule:
/ 10% bilateral
/ 10% non-secreting
/ 10% malignant
/ 10% genetic (NEM, von Hippel Lindau, ...)
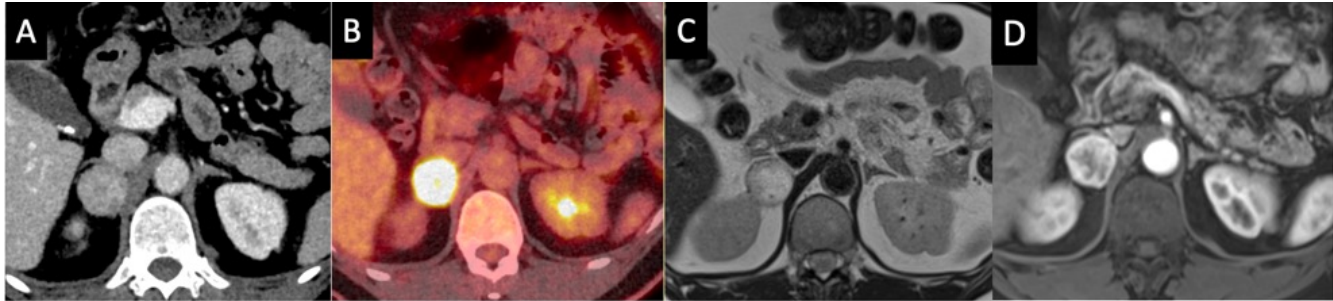
FIGURE 63

Contrast-enhanced CT (A) and PET 18FDG fusion demonstrating intense tracer uptake in the heterogenous right adrenal mass. On MRI, the lesion has a high signal on T2W (C) and cystic unenhanced portions on T1W post Gadolinium (D) sequences.

/ Endocrine System

/ 内分泌 系统

/ 嗜铬细胞瘤

嗜铬细胞瘤是一种起源于肾上腺髓质的罕见神经内分泌肿瘤。肿瘤通常为良性，可分泌肾上腺素和去甲肾上腺素。分泌活跃时表现为高血压、心跳加快、多汗、头痛、焦虑及体重下降。非分泌性肿瘤通常无症状，发现较晚。确诊时体积通常较大。

目前已发现了几种与嗜铬细胞瘤发生相关的基因，包括 RET、VHL、NF1、SDHA、SDHB、SDHC 和 SDHD 基因。

间碘苄胍 (MIBG) 是一种由肾上腺摄取的放射性物质。MIBG 闪烁扫描常用于诊断嗜铬细胞瘤或确定肿瘤范围。

也可使用 PETCT（图 62.A-B），但特异性较低。PET/CT 对已知恶性肿瘤患者的转移灶筛查有价值。

动态对比增强 MRI 也有助于这些病变的进一步定性（图 62.C-D）。

◄!► 注意

10% 法则：
/ 10% 为双侧病变
/ 10% 为非分泌性肿瘤
/ 10% 为恶性肿瘤
/ 10% 为遗传性（NEM，von Hippel Lindau 等）

图 63

对比增强 CT (A) 和 PET 18FDG 融合扫描显示右侧肾上腺不均质肿块内显著的示踪剂摄取。在 MRI 中，该病灶在 T2W 序列上呈高信号 (C)，在钆对比增强后 T1W 序列上呈囊性未强化区域 (D)。

/ Other lesions

While adenomas are the most frequent adrenal tumours, other adrenal lesions can also occur including cysts, haematomas, myelolipomas or metastases.

Benign

Myelolipoma present as solid tumours with macroscopic fat representing > 50% of the tumour volume (**Fig. 63**).
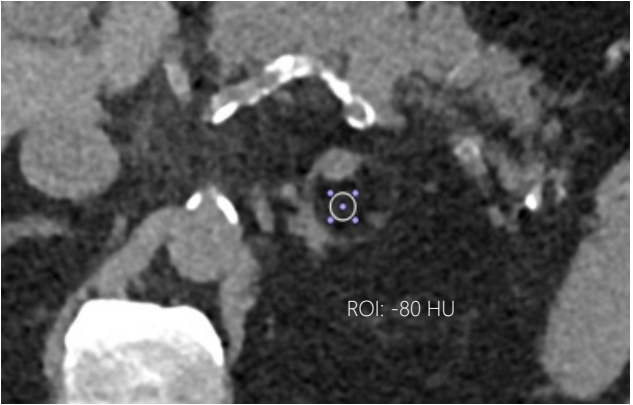

ROI: -80 HU

FIGURE 64

Axial abdominal unenhanced CT showing a tumour with macroscopic fat (Region of Interest attenuation measurement = -80 HU) suggesting a myelolipoma.

Malignant

Some criteria, e.g., actual or previous cancer history, large size (> 4cm) or heterogenous mass are red flags for malignancy (**Fig. 64**).

FIGURE 65

Axial contrast-enhanced CT showing a large and heterogenous mass of the left adrenal gland (red arrow), in a patient treated for lung cancer

◄∞► **REFERENCE**

https://doi.org/10.7861/clinmed.2023-0042.

/ **Endocrine** System

/ 内分泌 系统

/ 其他病变

虽然腺瘤是最常见的肾上腺肿瘤，但也可能发生其他肾上腺病变，包括囊肿、血肿、髓样脂肪瘤或转移瘤。

良性

髓样脂肪瘤为实体瘤，肉眼可见脂肪在肿瘤体积中占比 > 50%（图 63）。

恶性肿瘤

部分标准（如现有或既往癌症病史、体积大 [> 4 cm] 或不均质肿块）是恶性肿瘤的危险信号（图 64）。

图 64

腹部轴位非增强 CT 显示一肿瘤伴肉眼可见脂肪（感兴趣区衰减测量 = -80 HU），提示髓样脂肪瘤。

图 65

轴位对比增强 CT 显示 1 例接受肺癌治疗的患者左侧肾上腺存在巨大不均匀肿块（红色箭头）

◄∞► 参考文献

https://doi.org/10.7861/clinmed.2023-0042.

/ Take-Home Messages

/ The endocrine system is a complex network of glands with intricate hormonal interactions responsible for almost every organ and function in the body. It is because of its complexity that a thorough knowledge of the radiological anatomy is crucial to understand underlying pathology and corresponding symptoms.

/ The choice of the most appropriate imaging technique depends on the involved organ and on patient symptoms. Knowledge and familiarity with all imaging modalities and their respective roles depending on the clinical situation are, therefore, crucial.

/ Both radiological and biological tests must be correctly utilised and closely integrated with each other, thereby allowing accurate clinical interpretation.

/ The radiologist plays an important role in identifying signs of potential malignancy and in recommending which patients would benefit from further investigations.

/ To improve practices for lesion characterisation, standardised radiological algorithms and classifications have been developed and are routinely used in every-day practice.

/ **Endocrine** System

/ 内分泌 系统

/ 核心要点

/ 内分泌系统是由复杂腺体网络构成的精密调控体系，其激素相互作用几乎影响全身所有器官功能。因此，深入掌握影像解剖学知识对理解病变本质及症状至关重要。

/ 选择最合适的影像学检查方法需结合受累器官及患者症状，了解并熟悉所有影像学检查方法及其临床适用场景是关键。

/ 影像学与实验室检查需有机结合、综合分析，方能实现精准临床解读。

/ 放射科医生在识别潜在恶性征象、制定个体化随访/检查方案中发挥核心作用。

/ 为优化病变定性流程，标准化影像诊断算法与分类已被纳入日常诊疗实践。

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Test Your Knowledge

/ Endocrine System

/ 内分泌系统

CHAPTER OUTLINE:

章节大纲：

/ 知识测试

/ Test Your Knowledge

<?> QUESTION

1 Which of the following statements is correct?

☐ The thyroid gland is located in the carotid space

☐ Ultrasonography is the imaging modality of choice for assessing thyroid pathology

☐ The thyroid gland often has an ectopic location

☐ ACR-TIRADS grades are used to classify thyroid cancer grades

/ Endocrine System

/ 内分泌 系统

/ 知识测试

<?> 问题

1 以下说法正确的是?

☐ 甲状腺位于颈动脉间隙

☐ 超声是评估甲状腺病变的首选影像学检查方法

☐ 甲状腺通常存在异位

☐ ACR-TIRADS 分级用于甲状腺癌的分级

/ Test Your Knowledge

/ 知识测试

◄?► ANSWER

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/ Test Your Knowledge

/ 知识测试

<?> QUESTION

2 On US, the thyroid gland has the following appearance:

☐ Isoechogenic to the overlying strap muscles

☐ Hypoechoic compared to the overlying strap muscles

☐ Isoechogenic to the subcutaneous tissues

☐ Hypervascularised at Doppler studies

<?> 问题

2 以下哪项为 US 中甲状腺的表现：

☐ 与上方带状肌等回声

☐ 较上方带状肌低回声

☐ 与皮下组织等回声

☐ 多普勒检查显示血供丰富

/ Test Your Knowledge

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☐ 与皮下组织等回声

☐ 多普勒检查显示血供丰富

/ Test Your Knowledge

/ 知识测试

<?> QUESTION

3 Regarding the parathyroid glands, which of the following statements is correct?

☐ Ectopic parathyroid glands are rare

☐ They are usually located on the anterior surface of the thyroid gland

☐ A typical ectopic location is in the retroesophageal region

☐ Are commonly located within the thyroid gland

<?> 问题

3 关于甲状旁腺，以下说法正确的是?

☐ 异位甲状旁腺很少见

☐ 通常位于甲状腺前表面

☐ 典型异位位置为食管后区域

☐ 常位于甲状腺内

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/ 知识测试

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☐ 常位于甲状腺内

/ Test Your Knowledge

/ 知识测试

<?> QUESTION

4 Regarding the adrenal glands, which statement is correct?

☐ In adults US is better suited for assessing the adrenal glands

☐ The adrenal glands do not enhance after contrast administration on CT

☐ In children, adrenal glands are readily visible on ultrasound

☐ Phaeochromoctyomas are indistinguishable from adrenal adenomas on imaging

<?> 问题

4 关于肾上腺，以下哪种说法正确？

☐ 成人肾上腺评估更适合使用 US 检查

☐ 注射对比剂后 CT 图像显示肾上腺无强化

☐ 儿童肾上腺在超声下易见

☐ 嗜铬细胞瘤与肾上腺腺瘤在影像学上难以区分

/ Test Your Knowledge

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/ Test Your Knowledge

/ 知识测试

<?> QUESTION

5 Regarding imaging of the thyroid gland, which statement is correct?

☐ Iodine based contrast agents are not contraindicated in the work-up of thyroid cancer

☐ MRI has a superior spatial resolution compared to US

☐ PET CT is routinely used as part of the preoperative management of thyroid cancer

☐ One of the disadvantages of nuclear medicine studies is lower spatial resolution

<?> 问题

5 关于甲状腺影像学检查，以下哪种说法正确？

☐ 在甲状腺癌的检查中，碘对比剂无禁忌

☐ MRI 的空间分辨率高于 US

☐ PET-CT 常规用于甲状腺癌术前管理

☐ 核医学检查的缺点之一是空间分辨率较低

/ Test Your Knowledge

/ 知识测试

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☐ PET-CT 常规用于甲状腺癌术前管理

■ 核医学检查的缺点之一是空间分辨率较低

/ Test Your Knowledge

6 Regarding imaging of the parathyroid glands, which statement is correct?

☐ US always requires correlation with 4DCT in the standard work-up of patients with hyperparathyroidism

☐ Parathyroid lesions can be of mixed cystic and solid composition and very large

☐ Parathyroid lesions ectopically located within the thyroid gland are easily distinguished from nodules of thyroid origin

☐ MRI is recommended to distinguish parathyroid adenomas from lymph nodes

/ Endocrine System

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/ 知识测试

6 关于甲状旁腺影像学检查，以下哪种说法正确？

☐ 在甲状旁腺功能亢进症患者的标准检查中，超声检查始终需要联合 4DCT

☐ 甲状旁腺病变可为囊实混合性成分且体积巨大

☐ 异位至甲状腺内的甲状旁腺病变易与甲状腺结节鉴别

☐ 推荐行 MRI 鉴别甲状旁腺腺瘤与淋巴结

/ Test Your Knowledge

<?> ANSWER

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<?> 回答

6 关于甲状旁腺影像学检查，以下哪种说法正确？

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☑ 甲状旁腺病变可为囊实混合性成分且体积巨大

☐ 异位至甲状腺内的甲状旁腺病变易与甲状腺结节鉴别

☐ 推荐行 MRI 鉴别甲状旁腺腺瘤与淋巴结

/ Test Your Knowledge

/ 知识测试

<?> QUESTION

7

Which of the following statements regarding thyroid cancer is correct?

- ☐ It is the least common endocrine malignancy
- ☐ Medullary carcinoma occurs more frequently than follicular carcinoma
- ☐ Hashimoto's thyroiditis has an increased risk for thyroid malignancy
- ☐ Papillary carcinoma is a type of dedifferentiated thyroid cancer

<?> 问题

7

关于甲状腺癌，以下说法正确的是:

- ☐ 它是最不常见的内分泌恶性肿瘤
- ☐ 髓样癌发生率高于滤泡状癌
- ☐ 桥本氏甲状腺炎患者发生甲状腺恶性肿瘤的风险增加
- ☐ 乳头状癌是一种去分化甲状腺癌

/ Test Your Knowledge

/ 知识测试

‹?› ANSWER

7 Which of the following statements regarding thyroid cancer is correct?

☐ It is the least common endocrine malignancy

☐ Medullary carcinoma occurs more frequently than follicular carcinoma

▪ Hashimoto's thyroiditis has an increased risk for thyroid malignancy

☐ Papillary carcinoma is a type of dedifferentiated thyroid cancer

‹?› 回答

7 关于甲状腺癌，以下说法正确的是：

☐ 它是最不常见的内分泌恶性肿瘤

☐ 髓样癌发生率高于滤泡状癌

▪ 桥本氏甲状腺炎患者发生甲状腺恶性肿瘤的风险增加

☐ 乳头状癌是一种去分化甲状腺癌

/ Test Your Knowledge

<?> **QUESTION**

8 ## Which of the following statements regarding paragangliomas is correct?

☐ They occasionally occur along the sympathetic chain of the head and neck

☐ They rarely occur in the context of hereditary disorders

☐ The jugular fossa is the most common location above the aortic arch

☐ They are rare neuroendocrine tumours

/ **Endocrine** System

/ **内分泌** 系统

/ 知识测试

<?> 问题

8 ## 关于副神经节瘤，以下说法正确的是：

☐ 偶见于头颈部交感神经链

☐ 罕见于遗传性疾病

☐ 颈静脉窝是主动脉弓以上最常见的部位

☐ 是罕见的神经内分泌肿瘤

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CHAPTER OUTLINE:

Anatomy and Function

Choice of Imaging Techniques

Thyroid & Parathyroid Pathology

Paraganglioma

Pituitary Gland Lesions

Adrenal Gland Pathology

Take-Home Messages

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甲状腺和甲状旁腺病理学

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<?> QUESTION

9 Regarding imaging in paragangliomas, which statement is correct?

☐ Tympanic paraganglioma is often found along the cochlear promontory

☐ Jacobson's nerve is an auricular branch from the vagus nerve

☐ Carotid body tumours have a characteristic salt and pepper appearance on contrast enhanced CT

☐ In jugular paraganglioma, splaying of the internal and external carotid arteries is common

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9 关于副神经节瘤影像学检查，以下哪种说法正确？

☐ 鼓室副神经节瘤常位于耳蜗岬

☐ 雅各布森神经是迷走神经耳支

☐ 对比增强 CT 显示颈动脉体瘤有特征性"椒盐征"

☐ 颈静脉副神经节瘤常伴颈内动脉与颈外动脉向外衍生

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<?> QUESTION

10 Regarding pituitary lesions, which of the following statements is correct?

☐ Adenomas are the commonest tumours of the sella turcica in the paediatric population

☐ They most often arise from the neurohypophysis

☐ They are often asymptomatic and rarely cause mass effect on the adjacent structures

☐ Craniopharyngiomas frequently occur in the paediatric population

<?> 问题

10 关于垂体病变，以下说法正确的是?

☐ 腺瘤是儿童蝶鞍区最常见的肿瘤

☐ 最常起源于神经垂体

☐ 通常无症状，很少对邻近结构产生占位效应

☐ 颅咽管瘤常见于儿童

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