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Visualization of the Adrenal Glands: Normal And on Pathological Conditions

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Abstract:
The presented review examines the normal anatomy of the adrenal glands and the features of modern methods their visualization, which is necessary for the assessment of both benign and malignant neoplasms.
In particular, some of the most common formations are considered, such as adenoma, pheochromocytoma, metastatic lesions and adrenocortical cancer. For this purpose, an analysis of relevant domestic and foreign literature sources dating from 1991 to January 2021.
In many cases, adrenal gland formations have distinctive features that allow characterization call them using non-invasive methods. In some cases, it is possible to suspect a malignant nature and promptly refer the patient for the necessary invasive studies. Computed tomography, especially with the use of intravenous contrast enhancement, is the main method of imaging, since in most cases suggests a nosological form of formation. Magnetic resonance imaging remains a highly sensitive method in terms of tumor detection and follow-up by size, however, the method is not very specific for determining the malignant potential of a formation. Positron emission computed tomography is also an additional method and is mainly used in the detection of malignant tumors, their differential diagnosis, detection of metastases. Ultrasound plays a limited role, however, it has great importance in diagnosis in children, especially newborns. Promising methods such as radiomics and dual-energy CT, allow for expanded imaging capabilities and improved diagnostic accuracy.
Because adrenal masses are often detected incidentally on imaging performed by other reasons, it is important to interpret them correctly. This review gives the reader a broad understanding of what personal imaging may be helpful in assessing adrenal pathology and what to look for attention to radiologists and clinicians.

Keywords: adrenal glands, CT, pheochromocytoma, benign and malignant neoplasms, adrenal glands, tumors of the adrenal gland, adrenal incidentalomas, visualization adrenal gland, ultrasound,MRI, PET-CT.

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Introduction

Incidentally detected adrenal tumors those more than 1 cm in diameter are usually called “incidentalomas" (from the English incident - "case", "side” “circumstance"). Widespread use of visualization, including ultrasound examination (ultrasound), computer tomography (CT), positron emission tomography combined with computed tomography (PET-CT), and magnetic resonance imaging (MRI), sharply increased the frequency of detection of tumors adrenal glands. If the patient has no history malignant neoplasms and endocrine violations, such formations in most cases benign and non-functioning common adenomas [1]. However, the differential diagnosis of benign and malignant the nature of adrenal gland damage can be complex new task of decisive importance, especially for cancer patients.

Frequency of detection of adrenal incidentalomas, diagnosed by CT is up to 7% [1–3]. This may be due to the high prevalence application of the method, as well as the possibility of visualization isolate the adrenal glands during chest examination and abdominal cavities. According to the results of the autopsy, adrenal gland formations are also one of them among the most common tumors,occurring in at least 3% of people over 50 years of age [4].

Imaging methods allow not only to identify formations, but also to characterize their morphological structure, if necessary, on time edit for invasive studies. Radiologists must remember the advantages and disadvantages of each

before using any visualization method, avoid incorrect interpretation, especially with differential diagnosis of benign and malignant formations.

The purpose of this work was to assess the features of the methods of visualization of adrenal neoplasms, necessary for accurate characterization of the most common of their defeats.

NORMAL ANATOMY OF THE ADRENAL GLAND

The adrenal glands are located in the retroperitoneal prowandering in the thickness of the perirenal fatty tissue, above the upper pole of the corresponding kidney. Adrenal glands consist of two morphofunctionally independent endocrine glands - medulla and cortex,having different embryonic origins.

During the period of intrauterine development of the fetus, adrenal glands develop rapidly during the first 3 months. From 12 to 18 weeks of development, the weight of the adrenal glands increases 7 times [5]. At birth their sizes are significant but more than in adults (about half up to a third of the size of the kidneys), and the weight averages 10 g.

By age 20, the mass of each adrenal gland increases 1.5 times relative to the mass of the neonatal adrenal gland expected and reaches its maximum size. According to ultrasound data, normal adrenal glands are usually but are clearly visible in newborns. This is a connection but not only with large adrenal glands compared to the kidneys, but also with a small number of peritoneal adipose tissue and a short distance from sensor [6]. When scanning in B-mode, the adrenal nicknames are visualized with clear, even contours, triangular and crescent-shaped, with differentiation into a homogeneous hyperechoic brain and homogeneous hypoechoic

cortical layers [7]. In teenagers and adults, adrenal glands are examined in several patient and sensor positions for optimal

mal visualization. However, the assessment may be difficult or impossible in case of fatty degeneration liver (a normal liver is a good acoustic window when assessing the right adrenal region), large amounts of gas in the intestines and stomach (left adrenal region) and obesity (poor ultrasonic wave patency) [6].

On axial sections of CT and MRI, each adrenal nick is the structure of a variable form (linear, triangular, Y- or V-shaped), length up to 4.5 cm, an average height of 2 cm and a thickness of about 1 cm [8] (Fig. 1). Using these methods of adrenal ki can be visualized even in children of the first years of life, since the thickness of the adrenal pedicles exceeds. This determines the thickness of the diaphragm legs.

IMAGING THE ADRENAL GLANDS

Ultrasonography Ultrasound is the method of choice when assessing the condition of renal glands in newborns and young children. Due to availability, relatively low cost and non-invasiveness, this method is also often used for evaluation of the adrenal glands in adolescents and adults. In addition, ultrasound is recommended for patients with arterial hypertension or adrenal insufficiency kov, as well as when monitoring adrenal tumors, having a benign nature according to CT data or MRI. Ultrasound using B-mode and elastography allows you to distinguish a solid tumor from adrenal cysts, in contrast to CT, in which it is possible to differentiate these formations are possible only with the use of contrust enhancement [6].

This method has a number of limitations. Visualization adrenal glands depends on factors such as width acoustic window, quality of equipment and experience of doctors. The difficulty of visualization may be due to the fact that that when assessing this area, a high level of the level of the natural echo signal, almost equal to the level surrounding fatty tissue [6]. Contrast-enhanced ultrasound improves visualization tion of vascular supply even with small tumors of the adrenal glands, but does not allow differentiation malignant and benign neoplasms adrenal glands [9]. Assessment of the nature of the contrasting in the group of benign lesions of the supra-adrenal glands showed the presence of differences between nodal hyperplasia and adenomas. For nodular hyperplasia contrasting begins at the periphery of the formation and in adenomas mixed or value predominates character [10].

When examining adults, the threshold average diameter of adrenal gland lesion accessible to visualization is 10 mm. However, in the literature It is noted that focal lesions with a diameter of 5 mm can be visualized through the abdominal approach, and it is time diameters of 2–3 mm - through endoscopic [11]. However, some tumors with a maximum diameter meter less than 20 mm in the left adrenal gland may be xo visualized by transabdominal ultrasound. This depends on their location in the adrenal gland, as well as from anatomical and physiological conditions. CT scan CT is one of the leading diagnostic methods adrenal neoplasms. CT is the most a common method for detecting incidentalomas of adrenal glands patients, which may be due to the inclusion of adrenal glands into the scanning area not only during research of the

abdominal organs, but also during the study. The use of this method allows not only diagnose adrenal gland formations, but in most cases assume morphological nature.

According to the updated version of the American recommendations, American Society of Radiology (ACR, American College of Radiology) from 2017 according to the management algorithm patients with adrenal incidentalomas, about malignant qualitative potential of the neoplasm is necessary/ Difficult to judge by the size of the lesion, the nature of growth during dynamic observation and oncological medical history. So, if incidentaloma has diagnostic signs of benign neoplasms formations, such as myelolipoma, cyst or hemorrhage (no accumulation of the contrast agent, the difference in density Pre- and post-contrast images up to 10 units Hounsfield (Hounsfield units, HU)), then further examination or follow-up is not required. Where in it was found that even adrenal incidentalomas with a density greater than +10 HU in patients without aggravation known oncological history in most cases are benign [13]. Formation larger than 4 cm, not good- qualitative signs must be correlated with cancer anamnesis and consider the issue of resection and PET-CT with 18F-fluorodeoxyglucose (18F-FDG). If, on a native CT scan, the formation adrenal glands in density more than +10 HU, advisable scans with intravenous bolus contrust enhancement and the use of special protocol. A protocol with reduced dose is recommended. Irradiation zone for further characterization of the formation of the adrenal glands, since it evaluates how density and contrast characteristics in one research. Positron emission computed tomography PET-CT is a combined method that can differentiate benign tumors removal of the adrenal glands from malignant ones and is necessary to detect relapse or metastases in cancer patients patients [20]. The results of the meta-analysis show that most adrenal tumors can be characterized using 18F-FDG PET-CT with high sensitivity (0.97), specificity (0.91) and accuracy (0.98) [21]. This method allows you to determine the exact new anatomical localization of areas of increased metabolic activity and measure them.

According to the updated version of the ACR recommendations from 2017, cancer patients in the presence of education enlargement of the adrenal gland more than 4 cm or an increase in size the source of the previously identified lesion should be sent on PET-CT, since there is a high probability of metastatic lesions [12]. Magnetic resonance imaging According to MRI data, normal adrenal glands are max T1 and T2 have a signal from low to medium in range wearing to signal the liver and skeletal muscles. In modes with signal suppression from fat, visualization is normal adrenal glands is the best, since their signal is hyper-more intense than from suppressed adipose tissue. So- this can be useful if the education contains fatty inclusions or hemorrhage. MRI Accuracy may be increased if gadolinium is used contrast agents. After administration of contrast substances of 90% of adenomas demonstrate homogeneous enhancement tion, while 60% of malignant tumors are

heterogeneous [22]. Adenomas are characterized by contrast intensification in the early period, but the intensity of the signal nala even after contrast enhancement in most cases is the same

for both adenomas and malignant formations, which is not an absolute diagnostic static criterion [22].

Diffusion-weighted imaging imaging, DWI) is an important additional information tool when assessing pathological conditions in the abdominal no cavity. However, with DWI and measured diffusion coefficient (DCI) cannot be distinguished benign lesions of the adrenal glands from malignant qualitative, as well as identify atypical adenomas [23]. Chemical shift MRI remains an important tool ment for additional assessment of formations above-kidneys identified using other methods imaging, especially for patients with allergies on an iodine-containing drug, as well as in children and pregnant women changeable women. The method consists in assessing the relative significant loss of signal from the adrenal gland in compared to the phase, which is sufficient for in order to suggest the nature of education. Today there are two ways to quantify assessment of signal intensity reduction [22].

The first method of quantitative assessment comes down to the ratio of the signal from the adrenal gland to the signal another organ, most often to the spleen signal. Given spleno-adrenal ratio (ASR, spleno-adrenal ratio) reflects the percentage of signal reduction from the formation of the adrenal gland compared to the spleen and may be calculated using the following formula:

(adrenal formation signal index out of phase/spleen signal index
in antiphase)/ (adrenal gland formation signal index in phase /
spleen signal index per phase) × 100%.

The second way to quantify the reduction in signal intensity consists in calculating the intensity index signal intensity (SII, signal intensity index), which calculated by the formula:

(adrenal formation signal index in phase – adrenal gland formation signal index out of phase) / formation signal index adrenal gland in phase × 100%.

Pheochromocytoma

Pheochromocytoma originates from the medulla adrenal glands and is manifested by excessive production catecholamines and associated clinical symptoms symptoms (headache, increased sweating, rapid heartbeat), with approximately 10% of feochromocytomas are asymptomatic [42]. More often feochromocytoma is benign, although 10% these lesions may be malignant [43].

The sizes of pheochromocytomas vary from 1.2 to 15 cm, the average size is 5.5 cm [44]. If pheochromocytoma is suspected, the first stage is a laboratory examination.

Diagnostics

Pheochromocytoma when visualizing hundred is a challenging task due to its diversity appearance (associated with necrosis, fibrosis, cyst, fatty degeneration and calcification), bone which can mimic other diseases. According to ultrasound data, pheochromocytomas are heterogeneous, in encapsulated, with hypervascularization in color Doppler study and early arterial pattern on contrast-enhanced ultrasound.According to CT data, large pheochromocytoma may have solid, cystic, calcified and/or necrotic components. Smaller tumors (less than 7 cm) often have a homogeneous structure. According to contrast-enhanced

CT absolutely oh and relate-the washout of the contrast agent is similar adenomas. Therefore, pheochromocytomas cannot be but can be reliably distinguished from adenomas using this method of choice for localizing pheochromocytomas is scintigraphy with metaiodobenzylguanidine.

According to MRI data, there may be a lumpy, lycyclic contour of the tumor with primary multiply natural damage to the adrenal gland, is often detected heterogeneity of the internal structure. In T2 mode in approximately 35% of cases, pheochromocytomas may have homogeneous isointense or minimally hyperintensive intense signal in relation to the spleen and in rare cases (11%) - isointense with respect to spin-brain fluid [44]. In T1 mode pheochromotsi-

volumes are usually isointense relative to muscles and hyintense relative to the liver. In the images with antiphase, loss of signal intensity does not marked (unlike a typical adenoma) [33]. However in some cases, pheochromocytomas may contain microscopic fat, which leads to signal loss on MRI with a chemical shift, simulating adenomas [43].

CONCLUSION Imaging (ultrasound, CT, PET-CT, MRI) plays a key role role in differential diagnosis by chance identified adrenal gland formations, with targeted corrected preoperative preparation of patients and choice of surgical tactics. So promising methods such as radiomics and DECT allow expanding imaging capabilities and improve diagnostic accuracy. In turn, the use of a machine algorithm training will help reduce the frequency of radiologists of adrenal incidentalomas, especially in the midst of a large flow of screening studies.

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