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Ultrasound of the adrenal glands

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Content

Topographic Remarks

The right kidney and the inferior vena cava are landmarks for the examination of adrenal glands on the right side. On the left side the aorta, the lower pole of the spleen and the upper pole of the kidney are points of orientation. The most favorable planes for ultrasound scanning of the right adrenal gland are a right transcostal scan or an subcostal flank scan or oblique subcostal scan. On the left side it is better to use an intercostal flank scan through the spleen.

The adrenal glands are located within the retroperitoneum. The right adrenal gland faces supramedial the right kidney and posterolateral to the inferior vena cava. These are the principal landmarks on the right side. Typically the right adrenal gland is visualized behind the right lobe of the liver and anterior to the inferior (lumbar) crus of the diaphragm.

The left adrenal gland is inherently more difficult to scan than the right because it lacks the acoustic window of the liver and is obscured by air in the stomach. It is imaged with an intercostal flank scan directed through the spleen. The key landmarks are the aorta medially, the left inferior crus of the diaphragm (Crus diaphragmaticum sinister and the lower pole of the spleen or upper renal pole laterally. Not infrequently, the adrenal glands extend down to the level of the renal hilum [(1;2)]. Besides the kidneys, they are bordered by the liver and inferior vena cava on the right side and by the aorta and tail of the pancreas on the left side. Enlarged adrenal glands (wings of glands > 2 – 5 cm long and 6 – 10 mm thick) are detectable in a high percentage of cases, the normal sized adrenal glands are visible with trained examination techniques and by using high resolution technology (right > left). The adrenal region on each side appears as a triangular echogenic area bordered by the landmarks noted above [Figure 1 and 2].

Figure 1   Diagram of the adrenal glands showing their relations to neighboring organs.
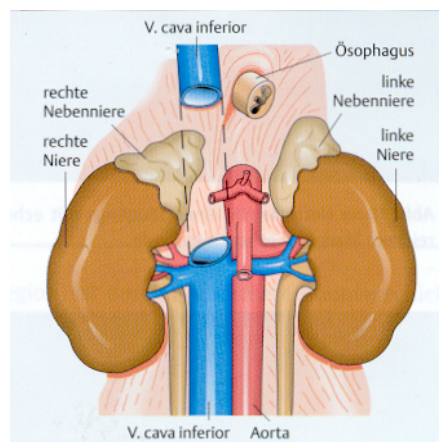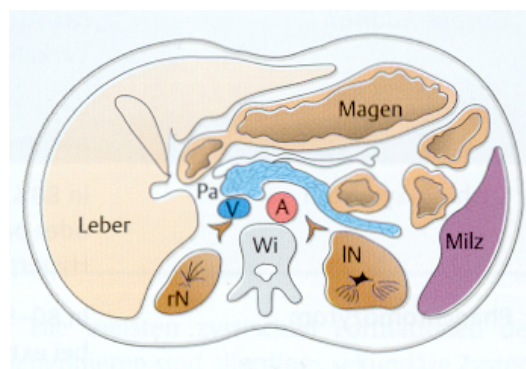

Figure 2   Cross-sectional diagram at the level of the adrenal glands. The adrenal glands are the Y-shaped structures lying anteromedial to the kidneys. Pa = pancreas; rK = right kidney; lK = left kidney; A = aorta; V = inferior vena cava; SC = spinal column.

Anatomy

The adrenal glands are small, caplike glandular organs situated in close proximity to the kidneys. Often these "suprarenal" glands are incorrectly looked for above the kidneys, but the term "adrenal" correctly implies that each gland is predominantly medial to the upper pole of the associated kidney. The right adrenal gland has a linear or V shape, while the left adrenal gland is more V- or Y-shaped. The wings of each gland are 2 – 5 cm long and 6 – 10 mm thick [(2;3)]. Their physiological function is hormone production. The adrenal cortex secretes cortisol, aldosterone, and sex hormones, while the adrenal medulla secretes epinephrine and norepinephrine.

The normal adrenal glands are difficult to visualize with ultrasound. This requires good scanning conditions, a high-resolution transducer, and a meticulous examination by a knowledgeable sonographer. It is more accurate, then, to speak of evaluating the "adrenal region" rather than the glands themselves. CT can consistently define the normal-sized adrenal glands, giving this study a priority role in the primary imaging of these structures.

The EUS of the upper gastointestinal tract shows the adrenal gland in the best picture quality [Figure 3], but this is possible only on the left side, the right adrenal gland in EUS is detectable only in 30-40 % of examinations [(4) (5)]. The attending vessels (left Aa. and Vv. suprarenales) are visible only with the endosonographical technique. In primary diagnostics the indicated EUS is not favored. [(1;6-9)]

Figure 3   Sonoanatomy of the left adrenal gland - image by high resolution endosonography. The proximal and the caudal limbs are visible in high resolution quality and the adrenal gland-marrow is more echorich.

Echogenicity

When the normal adrenal glands are seen using ultrasound, they have a long and hyperechoic, narrow shape, typically with 5 layers of stratification with a hypoechoic cortex and medulla.

The adrenal glands can almost always be visualized in newborns [(10-12)]. The physiological hypertrophy at this stage of life results in relatively large glands that can easily be identified using ultrasound and show clear corticomedullary differentiation Erledigt ! [Figure 4].

Figure 4   Normal adrenal gland of an infant, consisting of a hyperechoic medulla and hypoechoic cortex.
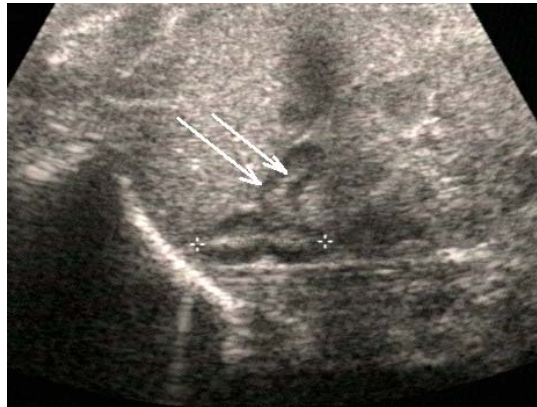
Examination technique

The normal position for examination is the dorsal decubitus position. On the right side of the body one would optimally use a subcostal flank scan or oblique subcostal scan. On the left side it is better to use an intercostal flank scan through the spleen. Often better scanning is possible in a lateral decubitus position (on the left side looking through the liver or (in right lying position scanning through the spleen), or in prone position. Rarely it is useful to examine (the patient) in a lying position over a roll (so-called gabled position) [(13)] especially in the prone position. In case of intercostal scanning, slow and deep breathing of the patient move those part of the organ from its place, lying originally under the ribs. Thus, the visible region increasing. The guide-lines or landmarks have already been explained. Normally used transducer is a convex probe with high resolution in depth and in tissue-harmonic-functions.

Acoustic obstacles of adrenal gland examination are usually air in the intestine which can be reduced when we prepare the patient. However, the adrenal gland has a good position so it is usually accessible even at the patient who is not well prepared.

The basic need for the examination is examination by convex abdominal transducer (3-6 MHz in B mode). A Tissue Harmonic Imaging can help for better tissue differentiation. Vascularisation can be evaluated by Power Doppler, microvascularisation can be examined also by CEUS. There are also interventional methods that can improve the differentiation. Those methods enable the transducer to get close to the targetted tissue. EUS –Endoscopical ultrasonography can be used especially for imaging of left adrenal gland. [(14;15)]

Normal adrenal gland

On the right side the normal adrenal gland regulary is visible using optimized examinating techniques (approximately 1 x 4 cm) [Figure 5]. The left adrenal gland is in generally only visible in about 40-50 % of all cases. [(7)]

Figure 5   The normal adrenal gland on right side is visible dorsal of right liver lobe as a narrow layered organ with two shanks.
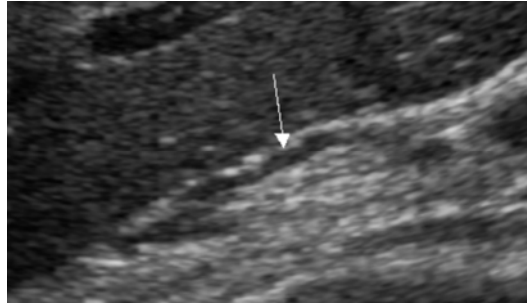
Enlarged adrenal gland

In adults, however, the adrenal glands are usually only visible when they are enlarged. Some types of enlargement have pathological significance. Diseases of the adrenal glands may or may not be associated with endocrine symptoms [Table 3]. Examination of the adrenal region is indicated for the staging of oncological diseases (M-staging) and in endocrinological investigations. Adrenal abnormalities are, however, often detected coincedentially. In the absence of an underlying disease, an incidentally detected solid adrenal mass is called an incidentaloma [Figure 10].

Differential diagnosis (differentiation from other structures in the surrounding area)

Enlarged or tumorous adrenal gland require distinguishment from other possibly tumourous structures in the surrounding area of the adrenal gland. In differentiating one has to consider tumours of the kidney, pancreas [Figure 6] and spleen (especially accessory spleen) or vascular abnormalities and lymphoma. In the differential diagnosis it must taken into account, that adrenal gland tumours always dislocate the surrounding structures. When the adrenal gland tumour is extremely large, it may be difficult to find the neighbouring organs.

Figure 6   Transsplenic scan of a large, hypovascular malignant tumour of the pancreas tail

Adrenal gland hyperplasia

Hyperplastic adrenal glands are usually hypoechoic, especially in the cortical zone. They appear plump and elongated, may show low-level nodular echoes and the borderline between cortex and marrow disappears. The adrenal gland here are larger than 10 mm, usually are only moderately enlarged (to 2 cm) [Figure 7]. Adrenal hyperplasia can occur, for example, as an adaptive response in ACTH-dependent Cushing syndrome. It may have a paraneoplastic cause, or it may occur in hyperaldosteronism. The hyperplasia is even bilateral in most cases. For the advanced examiner the adrenal glands are poorly demarcated from their surroundings. Again, CT provides a better view of the hyperplastic adrenal glands, which usually cannot be detected with ultrasound. Also the EUS on the left side shows the hyperplastic adrenal gland better than transcutaneous ultrasound. Differentiation to adenoma normally is only possible by histology or cytology (s.o. FNB).

Figure 7   EUS shows on left side an enlarged proximal shank of adrenal gland, which occurs in nodular hyperplasia.

Adrenal Cyst

A cyst of the adrenal region is anechoic, has smooth margins, and shows distal acoustic enhancement. Its extent is variable. True cysts have regular walls and are filled with serous material [Figure 8].

Figure 8   Round, sharply circumscribed, echo-free mass located dorsal to the right liver and cranial to the right kidney: adrenal cyst.

Most cystic masses in the adrenal region are secondary cysts that develop following pancreatitis, hemorrhage, or inflammation. Seldom cystic tumours like pheochromocytoma or lymphangioma are observed. The greater mobility of adrenal cysts serves to differentiate them from hepatic cysts in the right adrenal region. Lack of contact with the renal parenchyma distinguishes them from a cyst of the upper renal pole.

In the neighbourhood the followings are delineated for differentiation:

Renal cysts. Parietal cysts located in the upper pole of the kidney are particularly apt to be mistaken for adrenal cysts. They are distinguished by defining the relation of the cyst to the renal parenchyma.

Pancreatic pseudocysts and cystic pancreatic tumours. Pancreatic pseudocysts often form in the retroperitoneum following acute pancreatitis. The contents of the cysts may be completely anechoic, and the wall is usually irregular. Fine-needle aspiration (FNB) and laboratory analysis demonstrate high levels of pancreatic enzymes. Cystadenocarcinoma of the pancreas can also be a source of confusion.

Splenic and collateral vessels. Tortuous and ectatic splenic vessels can mimic a cystic mass in the adrenal region. Shunt vessels in portal hypertension, e.g. secondary to splenic vein thrombosis, can also assume bizarre shapes.

Intra-adrenal Hemorrhage (Hematoma)

Bleeding into an adrenal gland is anechoic in its early stage. It can occur in newborns due to obstetric trauma, hypoxia, or coagulation disorders. Intra-adrenal hemorrhage may correlate clinically with adrenal insufficiency. A large central hemorrhage (adrenal apoplexy) consistently leads to the marked enlargement of the gland [Figure 9]. An older hemorrhage becomes increasingly echogenic over time and may eventually be completely absorbed. Differentiation is required from partially cystic neuroblastomas in small children.

Up to 25% of patients who sustain blunt abdominal trauma are discovered to have hematomas in the adrenal region. They also occur in patients on anticoagulant medication and can lead to hypocortisolism (Addison disease).[(16)]

Figure 9   Echo -free intra-adrenal hemorrhage in a newborn with high resolution ultrasound

Adrenal Abscess

An abscess of the adrenal glands is rarely anechoic. It is usually hypoechoic or has a complex echo structure. When the contents are anechoic, the clinical and laboratory findings can differentiate the lesion from an ordinary cyst. The wall is irregular, and distal acoustic enhancement may be present

Cystic Tumour

A cystic tumour may be anechoic in rare cases, but usually it is hypoechoic. The walls are irregular in thickness and outline (some solid elements).

Differentiation of benign and malignant lesions

Benign adrenal gland tumours

Adenoma

Adenomas are uniformly hypoechoic with smooth margins and a round to oval shape, although some lesions have scalloped borders (polycyclic) [Figure 10-12]. Adenomas occasionally have an inhomogeneous appearance. Autopsy statistics indicate that they are quite common (10–20%), but most adenomas (90%) produce no endocrine symptoms, they are „silent" and too small to be seen with ultrasound. The average size of adenomas in one study was 1.5 cm, although they may exceed 5 cm in diameter. In a small percentage of patients adenomas are bilateral. Functioning and nonfunctioning adenomas are indistinguishable by their sonographic features [(17-21)].

Figure 10 Medial to the upper pole of the right kidney is a sharply circumscribed, hypoechoic mass: typical adrenal adenoma.
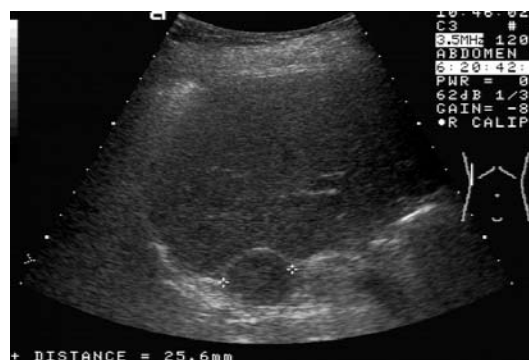
Figure 11   Hypoechoic, sharply circumscribed adenoma of the right adrenal gland discovered at routine ultrasound (confirmed by ultrasound-guided fine-needle aspiration).

Figure 12   Approximately 5 cm hypoechoic inhomogenous mass above the right kidney: adenoma (incidentaloma) without associated symptoms, detected at routine upper abdominal ultrasound. Histology identified as an adrenal adenoma (most common incidentaloma).

Lipoma, Myelolipoma

Lipoma. A pure lipoma of the adrenal glands has smooth margins and high, homogeneous echogenicity. In contrast to the mixed tissues of myolipoma, posterior acoustic shadowing does not occur. Lipoma is rare and shows no proliferative tendency.

Myelolipoma. Adrenal myelolipoma has smooth margins and a homogeneous hyperechoic structure [Figure 13]. It resembles a renal angiomyolipoma in its sonographic features. Posterior acoustic shadowing is often present. Malignant transformation is not known to occur. The tumour consists histologically of fat and bone marrow tissue (hematopoietic cells and reticular cells). Intratumoral hemorrhage and calcifications may be seen. [(22-25)]

Figure 13 Homogeneous, sharply circumscribed, hyperechoic tumour adjacent to the right kidney. Classic adrenal myelolipoma.

Calcification

Complete or partial calcification of the adrenal glands is characterized by a typical echo complex with a posterior acoustic shadow. Calcifications can result from a retained intra-adrenal hemorrhage or a prior inflammatory process (e.g., tuberculosis) [Figure 14]. Patients occasionally show the clinical manifestations of Addison disease. However, calcifications can also develop in tumours (carcinoma, metastases, pheochromocytoma, adenoma) [Figure 15].

Figure 14 In the proximal left kidney in the adrenal gland region we found a classical calcification with dorsal acoustic shadow.

Figure 15 Small calcifications also occur in tumours of adrenal gland, most often observed in pheochromocytoma

Malignant adrenal gland tumours

Metastases

With their rich blood supply, the adrenal glands are the fourth most frequent site for hematogenous metastasis. Metastases to the adrenal glands account for the majority of solid adrenal tumours after the adenomas.

In contrast to adenomas these lesions are less homogeneous and often have irregular margins [Figure 16-18]. The most common primaries are bronchial carcinoma (25–30 %), breast carcinoma and malignant melanoma (in Europe). Other possible sources are gastrointestinal (esp. in Asia), urological and gynecological tumours (renal carcinoma, gastric carcinoma, pancreatic carcinoma and others). Adrenal metastases are bilateral in up to 30% of cases, and this can produce the clinical manifestations of Addison disease. Bronchial carcinoma is virtually the only tumour that is associated with isolated adrenal metastases (in ca. 15-20 %) [(26-28)].

Figure 16 Large metastasis from bronchial carcinoma on the right side, with a very inhomogeneous internal structure. Solid components are seen along with central liquid areas

Figure 17 Transverse scan shows a metastasis with a complex echo structure "wedged" between right lobe of the liver, inferior vena cava, the kidney and spinal column.

Figure 18 Transverse scan of a metastasis of the right adrenal gland with complex structure beside a primary tumour of lung cancer.

Pheochromocytoma

Pheochromocytoma is a tumour of the adrenal medulla that is generally detected sonographically (80–90% of cases) following the appearance of clinical symptoms (hypertension and tachycardia caused by increased catecholamine secretion).

Most pheochromocytomas are already several centimeters in diameter when diagnosed. They have smooth margins, a round shape, and a nonhomogeneous or complex echo structure.

Hypoechoic liquid components are also observed. A spectrum of appearances may be seen [Figure 19 and 20]. Pheochromocytomas are bilateral in approximately 10% of cases and extra-adrenal in 10–20%.

The "Zuckerkandl organ" should be looked for at the level of the origin of the inferior mesenteric artery, anterior to the aorta.

Other extra-adrenal sites are the renal hilum, bladder wall, and thorax. Pheochromocytoma is occasionally seen posterior to the renal vein in transverse scans. Rarely, pheochromocytoma is diagnosed in the setting of multiple endocrine neoplasia (MEN). From 2% to 5% of pheochromocytomas are malignant. Owing to the risk of inciting a hypertensive crisis, fine-needle aspiration biopsy causes discrepant discussions about FNB [(29-44)].

Figure 19 Nonhomogeneous tumour with a hyperechoic center (positive endocrine test, increased catecholamine secretion) – phaechromocytoma.

Figure 20 Large, functionally active pheochromocytoma (7 cm in diameter). The scan shows that most of tumour is hypoechoic with some hyperechoic regions.

Lymphoma

The adrenal region is a rare extranodal site of occurrence for lymphoma. Foci of lymphomatous infiltration have smooth borders and are hypoechoic [Figure 21].

Differentiation is required from lymphomas in the renal or splenic hilum. If invasion by lymphoma is suspected, other nodal stations should be scanned and commonly infiltrated organs (spleen, liver) should be closely scrutinized.[(45-50)]

Figure 21 Perisplenic lymphoma in the left adrenal region of a patient with B-cell lymphoma. Colour Doppler shows hypervascularisation of the lymphatic tissue.

Adrenal Carcinoma

Adrenal carcinoma is usually inhomogeneous hypoechoic or echocomplex with irregular margins. It frequently infiltrates its surroundings and metastases can be demonstrated in the adrenal region and in other organs (e.g. the liver) [Figure 22]. The adrenal carcinoma is a very rare (1 : 1,7 million inhabitants), highly malignant tumour with a poor prognosis. Adrenal carcinoma is indistinguishable sonographically from a metastasis, although the visualization of additional tumours can advance the differential diagnosis. Most adrenal carcinomas are hormone-producing. Sometimes one can get evidence from detection of other tumour sign. The tumour is usually detected only after it has reached considerable size (often >8 cm). Intratumoural hemorrhage, necrotic foci, and calcifications may occur, adding to the variegated appearance. [(51)].

Figure 22 Adrenal carcinoma may be hypoechoic or may have a complex echo structure. Usually it was relatively large when diagnosed (in this case 8 cm × 9 cm) and had irregular margins.
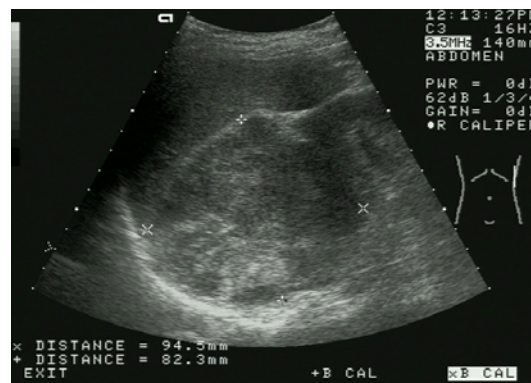
Rare entities

Neuroblastoma

Neuroblastoma, like pheochromocytoma, develops from cells of the adrenal medulla. Besides the Wilms tumour, it is the most common malignant abdominal tumour in children. Approximately 70% of neuroblastomas are located in the adrenal glands, the rest occurring at other sites in the sympathetic chain. Most neuroblastomas are very large and predominantly hyperechoic. Some may have cystic elements (due to hemorrhage) and calcifications. Laboratory tests usually show an increase in catecholamine secretion
Considerably less common are benign neural tumours such as ganglioneuromas. They have been described only sporadically in the adrenal glands, occurring more commonly in the posterior mediastinum and at paravertebral sites.

Other tumours

Incidentaloma

An incidentaloma is an adrenal tumour that is detected incidentally in an asymptomatic patient. Incidentalomas are found in 1% of CT examinations. They are much less common in ultrasound examinations, because of the difficulty in defining small lesions (< 2 cm) [Table 1 and 2; Figure 23 and 24]. The predominantly hypoechoic tumours listed in Table 1-2 account for the great majority of incidentalomas. Figure 25 [Figure 25] shows the algorithm used in the investigation of incidentalomas. Approximately 10% to 15% of these tumours are hormonally active. The recommended endocrine work-up is detailed in Table 3 [Table 3] [(52)]. In some cases, ultrasound-guided fine-needle aspiration can also aid in the evaluation of incidentalomas [Figure 26], but only ca. 1% to 2% of these tumours are malignant [(53-63)].

Figure 23 Abdominal ultrasound examination incitentally found most hypoechoic lesions smaller 2 cm without clinical symptoms – which is typical for incidentalomas

Figure 24 Adenomas occur most often among the incidentaloma of adrenal gland. They are smooth bordered and commonly homogeneous structured.

Table 1   Prevalence of adrenal gland-tumours in autopsy studies and CT-studies (after Reinke)[(61)]

Author	Year	Study	N	adrenal gland-Tumour %
Russi [(21)]	1944	autopsy, retrospective	9000	1.45
Commons [(17)]	1948	autopsy, retrospective	7437	2.86
Shamma [(64)]	1958	autopsy, retrospective	220	1.8
Kokko [(65)]	1967	autopsy, retrospective	1495	1.41
Hedeland [(66)]	1968	autopsy, prospective	739	8.7
Reinhard [(67)]	1994	autopsy, prospective	498	5.0
Total			19389	2.38
Glazer [(68)]	1982	CT, retrospective	2200	0.6
Garz [(68)]	1982	CT, retrospective	12000	0.5
Kley [(69)]	1990	CT, prospective	2568	4.4
Stark [(70)]	1994	CT, prospective	13818	0.8
Total			30586	1.0

Table 2   Pathological classification and prevalence of incidentalomas

Diagnosis	Imaging + OP Reinke 1995 [(61)]	Imaging + OP Allolio 2001 [(53)]	OP Mantero 2000 [(71)]
[]Summery	n = 172	n = 267	n = 380
Adrenal adenoma	134 (78 %)	230 (86 %)	198 (52 %)
Nonfunctioning adrenal adenoma	119 (69 %)	206 (77 %)	137 (36 %)

Adrenal carcinoma	1	1 (0.3%)	47 (12 %)
Adrenal-hyperplasia	-	3	-
Pheochromocytoma	5 (3 %)	7 (2.6 %)	42 (11 %)
Ganglioneuroma	2	3 (1 %)	15 (4 %)
Myelolipoma	6 (3,5 %)	9 (3 %)	30 (8 %)
Adrenal cyst	5 (3 %)	6	20 (5 %)
Metastasis	1	3	7 (2 %)
other	2	5	21 (6 %)

Table 3   **Endocrine laboratory work-up of adrenal incidentaloma (modif. after Reinke) [(61)]**

Initial work-up	
Mandatory	▶ Free catecholamines in 24 h urine ▶ Serum cortisol in dexamethasone suppression test (1 mg)
Optional	▶ Plasma renin activity after 30 min rest period ▶ Potassium excretion in 24 h urine
Extended work-up if initial findings are abnormal	
Preclinical Cushing syndrome	▶ High-dose dexamethasone suppression test (8 mg) ▶ CRH stimulation test
Conn syndrome	▶ Aldosterone-18-glucuronide in 24 h urine ▶ Plasma renin activity and aldosterone at rest and orthostasis ▶ Selective renal vein catheterization with bilateral blood sampling for aldosterone and cortisol in adrenal venous blood

Figure 25 Algorithm for investigating an adrenal incidentaloma. Recommendations of the NIH state-of-the-science conference 2002. [(72)]
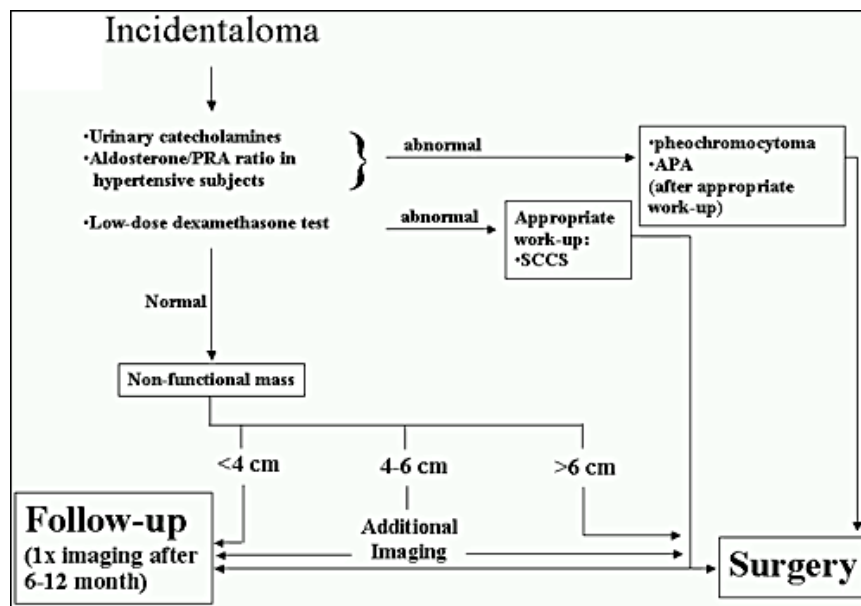
Ultrasound-guided Fine-needle Aspiration of an Adrenal Lesion

Given the frequency of incidentally detected adrenal tumours, every patient should undergo an initial endocrine work-up [Table 3]. If the tumour cannot be positively identified by laboratory tests and imaging (ultrasound, EUS, CT), ultrasound-guided fine-needle aspiration (UFNA) can supply a diagnosis in cases requiring treatment. The sensitivity of adrenal UFNA is between 90% and 95% [Table 4]. UFNA can provide material for cytological or histological analysis with a relatively low risk of complications. The procedure is performed in a lateral position. Access is easier in a right-sided lesion than in a left-sided one, also the complication rate is (somewhat) higher on the left side. UFNA is particularly indicated for the oncological investigation of tumours larger than 3 cm [Figure 26] [(9;73-94)].

Table 4   uFNB in adrenal glands tumours

Author	Year	N	Sensitivity	Specifity	Accurracy
Tikkakoski [(95)]	1991 c	56	91,3 %	97,0 %	85,7 %
Dock [(75)]	1992 c+h	47			85,1 %
Görg [(78)]	1992 h	37	95,2 %	100 %	97,0 %
Kojima [(96)]	1994 h	12	91,0 %		100 %
Fröhlich [(77)]	1995 c+h	33	88,2 %	92,9 %	90,3 %
Nürnberg [(97)]	1995 c+h	22	95,4 %	100 %	95,4 %
Lumachi [(98)]	2001 h	70	93,3 %	100 %	98,6 %
Liao [(99)]	2001 c+h	116	93,6 %		
Saeger [(100)]	2003 h	220	94,6 %	95,3 %	90,0 %
Kocijanicic [(101)]	2004 c	64	90,0 %	100 %	91,0 %

c=Cytology; h=Histology
Sensitivity: RP x 100/ RP+FN %
Spezifity: RN x 100/ RN+FP %
Accurracy: (RP+RN) x 100 / (RP + FP+RN+FN) %

Figure 26 Algorithm for "sonographic" adrenal tumours and the use of ultrasound-guided fine-needle aspiration (uFNA) (after Froehlich) [(77;102)]
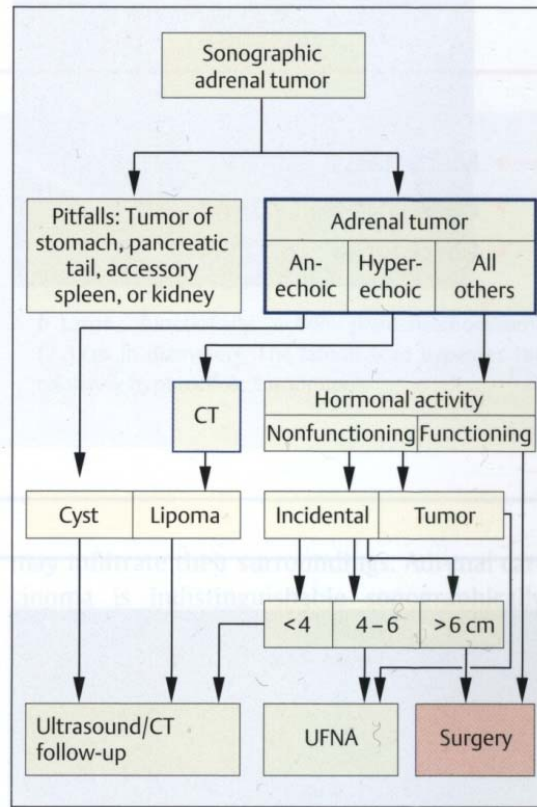
Special ultrasound techniques in differentiation of adrenal gland tumours

Colour Doppler imaging

Cysts do not show CD-signals, only in border areas, which also applies to hematoma or abcesses. Among tumours often lymphoma and endocrine tumours (pheochromozytoma) are hypervascularized [Figure 27]. Metastasis and carcinoma are regularly hypovascularized.

Figure 27 Some tumours show hypervasculrization in CD, between them e.g. pheochromcytoma and lymphoma. Metastasis most are hypovascularized.

CEUS (Contrast enhanced ultrasound)

With help of CEUS cysts, abscesses and hematoma are to identify as avascular processes. Lipoma and myelolipoma regularly do not show a wash out effect [Figure 28]. Malignant tumours does not show a characteristic phenomenon, both wash out and late contrast accumulation occur [Figure 29]. The contrast media performance is inhomogeneous, e.g. also adenomas show a wash out phenomenon. Today, even after numerous studies it is not possible to exactly distinguish between benign (adenoma) and malignant tumours (metastasis) without histology or cytology.

Laparoscopic ultrasonography is used for better orientation in surgical area during laparoscopic surgeries because the most of surgeries of adrenal gland are performed by laparoscopic access [(103-112)].

Figure 28 In CEUS a myelolipoma shows a nearly constant contrast enhancement without wash out.
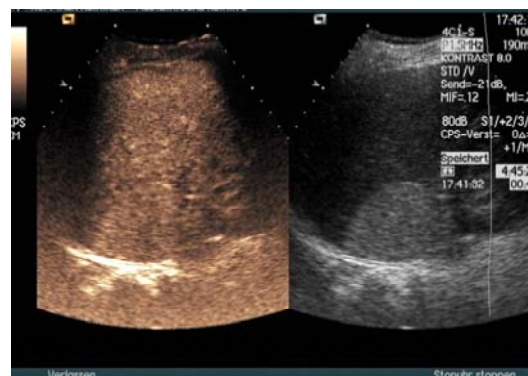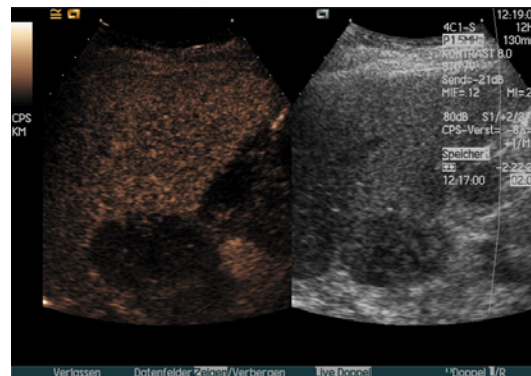
Figure 29   Partial metastases esp. of lung cancer, show a wash out of contrast media in late phase.

Clinical importance of adrenal glands ultrasound in daily routine

Sonography of the adrenal glands

- is able to show the normal adrenal gland (ri > le)
- is very sensitive in detection of enlarged adrenal gland and especially adrenal gland tumours
- is very sufficient in differentiation between cystic adrenal gland lesions and solid tumours
- is limited in differentiation of solid tumours
- is very useful in guidance for FNB (u/eusFNB)
- often detects incidentaloma
- is very helpful in the follow up of enlarged adrenal gland
- EUS is the best imaging method for the examination of the left adrenal gland (as in FNB)
- CEUS shows diversified results

(see also Table 5 [Table 5].)

Indication for examination:
Ultrasonography of adrenal region should be a standard part of abdominal ultrasonography because a big part of pathologic changes is without any symptoms and early detection of them (especially of adrenal tumor) gives us better chance for therapy.

The number of patients with a so called Incidentalom of adrenal gland (lesion up to 20mm) raises with increasing number of ultrasonographic examinations. The most of those lesions are benign and watchfull waiting (using ultrasound examinations) in cooperation with endocrinologists is usually sufficient.

Table 5   Sonographic features of adrenal diseases with or without endocrine symptoms (after Allolio et al.) [(53)]

	Sonographic appearance
Diseases with endocrine symptoms	
Addison disease	Adrenal atrophy not detectable with ultrasound; possible calcifications as evidence of prior tuberculosis
Conn disease	Unilateral adenomas, usually 2 cm, not detectable

	with ultrasound
Cushing syndrome	In 80% of cases, bilateral hyperplasia due to pituitary (75%) or paraneoplastic (5%) ACTH overproduction; hyperplasia is usually not detectable with ultrasound
Pheochromocytoma	Can be localized with ultrasound in 80–90% of cases; extra-adrenal location is difficult, usually prevents identification
Diseases without endocrine symptoms	
Adrenal adenoma	Most common solid mass
Adrenal carcinoma	Often quite large (several centimeters) despite absence of symptoms; sometimes detected incidentally at ultrasound
Adrenal metastases	Common with bronchial carcinoma, malignant lymphoma, breast cancer, renal cancer, pancreatic cancer, and melanoma
Adrenal tumours and cysts	Detectable at 1–1.5 cm on the right side, at 1.5–2 cm on the left side

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