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UPDATE

# Ultrasonographic examination of the feline adrenal glands: A review☆

## Échographie des glandes surrénales de chat : une revue de la littérature

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**Summary** Ultrasonographic examination of the adrenal gland became a routine procedure in veterinary medicine. The improvement of the operator experience, anatomy knowledge and ultrasound equipment allowed a more systematic examination of the adrenal glands in dogs but also in cats. Compared with cross-sectional imaging modalities, such as computed tomography or magnetic resonance imaging, ultrasonography is more accessible, less expensive, does not require general anesthesia and allows real-time procedures to be performed. A few studies describe the normal ultrasonographic appearance of the feline adrenal glands. Pathological conditions of the adrenal glands, such as hyperaldosteronism and hyperadrenocorticism, are relatively rare in cats but do occur (Feldman and Nelson, 2004 [6]). Ultrasonographic findings in these diseases are sparsely described in multiple case reports. Detection of ultrasonographic abnormality in the adrenal gland can orientate the selection of endocrine blood testing or confirm a clinical or biological suspicion of adrenal disease. Ultrasonography of the adrenal glands is interesting for detection of adrenal asymmetry caused by a unilateral adrenal mass. Moreover, it allows detection of local invasion and abdominal metastases. However, it is limited in case of bilateral adrenal hyperplasia that is not always associated with detectable ultrasonographic changes. The aim of this review is to summarize the anatomy and the ultrasonographic technique of normal feline adrenal examination, and the changes associated with adrenal diseases reported in the current literature. It provides to general practitioners a framework for the ultrasonographic approach to feline adrenal disorders.


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Hyperaldostéronisme

**Résumé** L'échographie des glandes surrénales est une pratique courante en médicine vétérinaire. Chez le chien comme chez le chat, l'examen de routine des glandes surrénales s'est répandu grâce une meilleure connaissance des repères anatomiques, une expérience accrue des échographistes et un équipement de haute qualité. Contrairement à l'imagerie en coupe, l'échographie est plus accessible, moins chère, ne nécessite pas d'anesthésie générale et permet un examen en temps réel. L'aspect échographique normal des glandes surrénales du chat est décrit dans quelques rares publications. Les maladies concernant les glandes surrénales sont relativement rare chez le chat. L'hypercorticisme ou l'hyperaldostéronisme peuvent cependant être rencontrés dans la pratique courante. L'aspect échographique de ces maladies est rapporté dans des cas cliniques épars. La découverte fortuite d'anomalies échographiques des glandes surrénales peut orienter le choix d'un test biologique endocrinien ou confirmer une suspicion clinique et biologique de maladie endocrinienne. L'échographie des glandes surrénales est particulièrement intéressante dans le cas d'une asymétrie surrénalienne due à une masse surrénalienne unilatérale. L'examen échographique de l'abdomen permet également de détecter une invasion vasculaire locale ou des métastases à distance. L'échographie surrénalienne reste cependant limitée en cas d'hyperplasie surrénalienne bilatérale, qui n'entraîne pas systématiquement d'anomalie échographique des glandes. L'objectif de cette revue est de résumer les données décrivant la technique d'examen échographique des glandes surrénales, leur anatomie normale ainsi que les lésions échographiques associées aux maladies endocriniennes surrénaliennes rapportées dans la littérature scientifique à ce jour. Cette revue constitue, pour le vétérinaire praticien, une base dans l'approche échographique des maladies surrénaliennes chez le chat.


## Anatomy and physiology of the feline adrenal glands

The adrenal glands are paired, flattened, ovoid organs located in the retroperitoneal space, medial and cranial to each kidney. The left adrenal gland lies ventrolateral to the aorta, close to the cranial mesenteric artery. The right adrenal gland lies more cranial than the left one, located dorsolateral to the caudal vena cava and caudal to the right diaphragmatic crus. The phrenico-abdominal artery and vein course on the dorsal and ventral surfaces of the glands respectively [1,2]. The blood supply of the adrenal gland is provided by multiple sources: the caudal phrenic artery, the renal artery, the first or second lumbar artery, the celiac artery, the cranial abdominal artery, the cranial mesenteric artery and the aorta. The adrenal glands are drained by the suprarenal veins, which join the neighbouring veins [3].

Histologically, a thin capsule consisting of dense connective tissue and smooth muscle fibres surrounds the gland and gives rise to trabeculae that variably penetrate the adrenal parenchyma.

The adrenal gland is composed of two different tissues: an outer cortex and an inner medulla, of different embryologic origins. The adrenal cortex has a mesenchymal origin. It has the potential for secreting a variety of steroid substances (progesterone, testosterone, cortisol, aldosterone, oestradiol) depending on the enzymes available in the different cortical layers (Fig. 1). It is organized in three layers: glomerulosa (secreting mineralocorticoids like aldosterone), fasciculata (secreting glucocorticoids) and reticularis (secreting glucocorticoids and sex hormones). Aldosterone promotes potassium excretion and stimulates conservation of sodium and secondarily of water. It raises blood volume and increases blood pressure [4]. Cortisol affects almost every tissue: gluconeogenesis and glycogenesis by liver and muscle, suppression of peripheral glucose uptake in cells, enhanced protein and fat catabolism, stimulation of erythrocytosis, suppression of inflammatory responses and lymphoid tissue, maintenance of normal blood pressure and counteraction of the effects of stress [4]. Progesterone is a precursor of other sex hormones, such as oestrogens and androgens [5]. In addition to its effect on the reproductive function, progesterone may simulate the actions of cortisol by competitively binding to the cortisol-binding proteins in the circulation and then releasing circulating, active, unbound cortisol despite normal total serum cortisol [6]. Some progestins also have intrinsic glucocorticoid effect [5]. Adrenocortical secretions are regulated by adrenocorticotropic hormone (ACTH), produced by the pituitary gland. Its stimulatory properties are more important on glucocorticoid secretion than on mineralocorticoid or androgenic steroid secretions. ACTH secretion is controlled by the hypothalamus and central nervous system with corticotropin-releasing hormone (CRH), arginine vasopressine and other neurotransmitters. Cortisol also has a negative feedback control on ACTH secretion at both the hypothalamic and pituitary levels [6].

The adrenal medulla arises from neural crest cells and it consists in axonless postganglionic sympathetic neurons. Adrenal medullary production of catecholamines is mediated by acetylcholine released from stimulated preganglionic sympathetic nerve fibres [1]. Catecholamines induce sympathetic effects such as mydriasis, decreased glandular secretion, vasoconstriction, tachycardia, inotropism, bronchodilation, decreased gastro-intestinal activity, decreased urine output, urine retention, increased blood glucose,