

COMPARISON OF ADRENAL GLANDS ULTRASONOGRAPHIC CHARACTERISTICS AND MEASUREMENTS IN HEALTHY PUPPIES AND KITTENS

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ABSTRACT

The aim of the study was to analyze and compare the ultrasound characteristics of adrenal glands between healthy puppies and kittens by establishing standards of normality and references. Fifteen healthy crossbred puppies with mean weight of 3 kg and fifteen healthy crossbred kittens with mean weight of 2 kg, aged between five and six months, participated in the study. The animals were submitted to ultrasound exam of adrenal glands for visualization of their internal characteristics. The frequency of visualization of adrenal glands was 100% in kittens. In puppies the frequency was 75% for the right gland and 100% for the left gland. The puppy's adrenal

gland, both right and left, were bigger in length (1.08 ± 0.01 cm, 1.11 ± 0.01 cm) and width (0.42 ± 0.02 cm, 0.45 ± 0.01 cm) in relation to kittens' adrenal gland length (0.64 ± 0.01 cm, 0.63 ± 0.01 cm) and width (0.30 ± 0.02 cm, 0.34 ± 0.01 cm). The adrenal gland of puppies and kittens was hypoechogenic to the surrounded fat, delimited by a hyperechogenic line and without distinction of the cortical and medullar region. The ultrasound dimensions of length and width of the adrenal glands, both right and left, were the same in puppies and kittens. The right and left puppies' adrenal glands were longer and wider than the kittens' glands.

KEYWORDS: Abdomen; adrenal gland; small animals; ultrasound.

COMPARAÇÃO DAS CARACTERÍSTICAS E MEDIDAS ULTRASSONOGRÁFICAS DAS GLÂNDULAS ADRENAIS DE CÃES E GATOS FILHOTES SAUDÁVEIS

RESUMO

O estudo teve como objetivo analisar e comparar as características e dimensões ultrassonográficas das glândulas adrenais entre cães e gatos filhotes hígidos, estabelecendo padrões de normalidade e de referência. Participaram do estudo 15 cães e 15 gatos filhotes com idade entre cinco e seis meses, de raça mista, peso médio de 3 kg e 2 kg, respectivamente. Os animais foram submetidos ao exame ultrassonográfico das glândulas

adrenais, para visualização das características internas do órgão. A frequência de visualização das glândulas adrenais foi de 100% nos gatos filhotes, enquanto nos cães filhotes a frequência foi de 75% para a glândula direita e 100% para a esquerda. O comprimento e a largura das glândulas adrenais revelaram diferenças significativas ($P = 0,01$) entre os cães e gatos filhotes, sendo que as glândulas adrenais dos cães filhotes, direita e esquerda,

foram maiores em comprimento ($1,08 \pm 0,01$ cm e $1,11 \pm 0,01$ cm) e largura ($0,42 \pm 0,02$ cm e $0,45 \pm 0,01$ cm) em relação ao comprimento ($0,64 \pm 0,01$ cm e $0,63 \pm 0,01$ cm) e largura ($0,30 \pm 0,02$ cm e $0,34 \pm 0,01$ cm) dos gatos filhotes. Em ambos os grupos, as glândulas adrenais apresentaram-se hipocogênicas em relação à gordura adjacente, sendo delimitadas por uma linha

hiperecogênica, e não se observou distinção entre as regiões cortical e medular. As dimensões ultrassonográficas de comprimento e largura das glândulas adrenais, direita e esquerda, foram as mesmas em cães e gatos filhotes. A glândula adrenal direita e esquerda dos cães filhotes foram maiores, em comprimento e largura, que as glândulas dos gatos filhotes.

PALAVRAS-CHAVE: Abdômen; glândula adrenal; pequenos animais; ultrassonografia.

INTRODCTION

Ultrasonography is a standard procedure for visualizing the adrenal glands, because they are usually not visible radiographically (WIDMER et al. 2004; KEALY et al., 2012). It is also an important tool for identifying neoplastic masses in the adrenal glands (HOERAUF & REUSCH, 1999). The main peculiarity of ultrasonography is the possibility of obtaining sectional images in real time, in different spatial orientations, allowing the study of the movement of body structures (CERRI & ROCHA, 1993). Furthermore there are other advantages such as accessibility, low cost and rare need for anesthetizing the animal for the exam (DEBRUYN et al., 2011). Finally, disadvantages such as formation of artifacts and blurring of texture and echogenicity alterations in certain pathophysiological causes (ALVES et al., 2007) can be overcome with technique expertise combined with detailed anatomical knowledge of the region to be analyzed.

Sonographic features of the adrenal glands in humans were described by YEH (1988), and the exam is considered useful in patients likely to present adrenal disease. Due to the absence of radiation emission, ultrasonography has been the initial diagnosis examination chosen for the evaluation of abdominal masses and research of congenital diseases, such as congenital adrenal hyperplasia in children (ALLOLIO et al., 2004; MEYER-BAHLBURG et al., 2006).

KANTROWITZ et al. (1986) described the clinical use of the ultrasonographic exam in cases of adrenal disease in small animals. From these reports, the ultrasonographic exam became an important diagnostic imaging procedure for visualizing the adrenal glands in small animals, with possible observation of the glands and structural abnormalities, such as alterations in size, shape and echogenicity (BARTHEZ et al., 1998).

The right intercostal window is used to research the increase in the size of the right adrenal gland and the alterations in its internal architecture, and it can be evaluated at sagittal and

transverse cuts (LAMB, 1990). The right adrenal gland is more difficult to be observed than the left one due to the cranial position of the kidney and the proximity to the pylorus and duodenum (BRINKMAN et al., 2007; BARBRET et al., 2008).

In adult dogs and cats, the medullary cortical region can be distinguished (BESSO et al., 1997); however, contrary to dogs, in cats, the medullary region is hyperechogenic and the cortical region is hypoechogenic (GRAHAM, 2008).

Although ultrasonographic exam is a routine complementary diagnostic method in small animals, publications about the ultrasonographic characteristics of the adrenal glands of healthy puppies and kittens are scarce; thus, establishing ultrasonographic normality patterns is necessary in order to use the ultrasonographic features and dimensions in the identification of adrenal glands diseases in this animal group. Therefore, the objective of this study was to analyze and compare the ultrasonographic features and dimensions of the adrenal glands of healthy puppies and kittens, establishing normality patterns and reference values.

MATERIAL AND METHODS

The study was approved by the Ethics Committee in the Use of Animals in Experiments of the Faculty of Veterinary Medicine and Animal Science CEUA/ FMVZ, Universidade Estadual Paulista "Júlio de Mesquita Filho" - UNESP, Botucatu, SP, under the protocol number 081/2009.

Thirty healthy, crossbred, intact males, with average age of five months (5 months-6 months) were included in the study. The animals came from the kennel and cattery of FMVZ/UNESP, Botucatu, SP. The animals were divided into two groups, the first one had 15 puppies with mean weight of 3 kg (3 kg – 4 kg) and the second group had 15 kittens, with mean

weigh of 2 kg (1 kg – 3 kg).

The animal's health was assessed by physical exam, red blood count, white blood count, platelets count, serum biochemistry (alanine aminotransferase – ALT, urea and creatinine) and urinalysis. Urinalysis was carried out in the urine collected by cystocentesis and centrifuged for five minutes. The supernatant was separated from the sediment and then used for the urine physical exam (specific density) and chemical exam (proteins, bilirubin, glucose and urine pH), with refractometer and dipstick (reagent strip), respectively. The absence of abdominal abnormalities was verified by ultrasonographic exam.

The animals were submitted to a four-hour fast, but received water *ad libitum*. Before the ultrasonographic exam, dimethicholine (9.7 mg/kg/PO) was administered every eight hours. A wide shaving of the abdomen, from the seventh intercostal space until pubic bone and laterally to the proximal region of vertebrae transverse processes, was carried out. The kittens were placed on a foam rail to facilitate the exam. Isopropyl alcohol and acoustic gel were used to avoid the presence of air between the skin and the transducer, increasing the contact between them.

The ultrasonographic exams were carried out in right and left lateral recumbency, with a high definition device (GE-Logic 3) equipped with linear 80-mm long transducer (< 1.1 mm axial resolution, < 0.9 mm lateral resolution, 2 cm depth), 6 MHz - 10 MHz frequency, in B mode. The 10 MHz frequency was used in cases where there was doubt regarding structures differentiation. During the exams, two assistants carried out physical containment.

The anatomical reference used for the observation of the left adrenal gland was the cranial-medial edge of the left kidney, at the level of the second lumbar vertebrae, while for the right

adrenal gland was the cranial portion of the right renal hilum, at the level of the third thoracic vertebrae. During the ultrasonographic exam, a Doppler was used to assess aorta blood flow of the cranial mesenteric arteries, caudal vena cava, renal vein and artery, which were also used as reference points.

Sagittal and transverse cuts were performed for the identification of features and dimensions of the glands. With both groups of animals in left lateral recumbency, the right adrenal gland was visualized with the transducer positioned between the eleventh and the twelfth intercostal space. After locating the right kidney, the transducer was moved to the region between the cranial edge of the kidney and the caudal vena cava to visualize the right adrenal gland, which was observed laterally to the caudal vena cava and cranially to the right artery and renal vein. The left adrenal gland was visualized with the animals in right lateral recumbency. The transducer was positioned near the caudal region of the spleen and the cranial edge of the left kidney and the left renal artery were used as reference points. The left adrenal gland was adjacent to the lateral margin of the aorta, immediately cranial to the origin of the left abdominal phrenic artery.

The ultrasonographic structural features were analyzed and compared between both species in a descriptive way by three experts, by means of recording the images obtained on the day of the exam.

Regarding the dimensions, the adrenal length was determined as the distance between the cranial and the caudal edge, and the width as the distance between the dorsal and the wider ventral edge (Figures 1-A and 1-B). The measurements were statistically compared using the program SPSS, with analysis of variance (ANOVA), followed by Tukey test ($P < 0.05$).

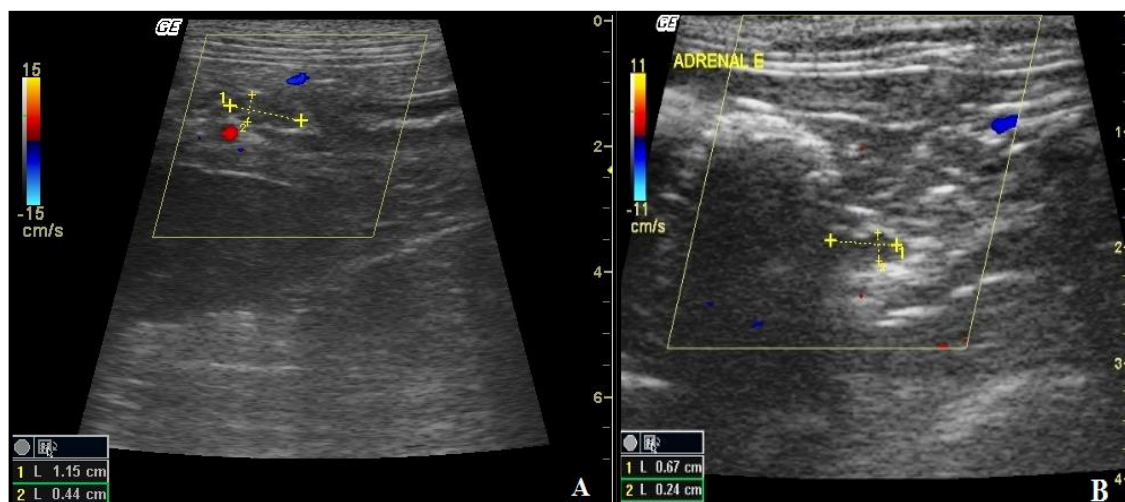


Figure 1: Sagittal sonogram (7.5 MHz, B mode) of the left adrenal gland of puppy (A) and kitten (B), illustrating length (1) and width (2) measurement.

RESULTS AND DISCUSSION

Incidental findings of adrenal masses during ultrasonographic exams of the abdominal region, performed for different purposes, have increased the incidence and prevalence of adrenocortical tumors in humans, mainly children (ABECASSIS et al., 1985). The prevalence varies from 0.6% to 2%. A bimodal distribution has been showed as the first incidence peak before five years of age and a second peak between 40 and 50 years of age (LATRONICO & CHROUSOS, 1997). The incidence of these masses in children from the Southern Region of Brazil is 10 to 15 times higher than the world incidence (WIENEKE et al., 2003). As this incidence is high in children, such adrenal masses are broadly studied in medicine. In veterinary medicine, however, reports on puppies and kittens are rare because ultrasonographic exams are not regularly performed. Therefore, the ultrasound operator must know how to recognize the ultrasonographic normality patterns and the dimensions of the adrenal glands in puppies and kittens to use them in the identification of abnormalities of the adrenal glands.

In all groups, the adrenal glands were visualized by the use of a linear transducer at a 7.5 MHz frequency, in B mode, in sagittal and transverse cuts, according to the literature (DOUGLAS et al., 1997; BESSO et al., 1997; KEALY et al., 2012). The use of a transducer in such frequency allowed a better resolution and anatomical detail of the adrenal glands of the studied animals. According to KEALY et al. (2012), the frequency can vary between 5 MHz and 7.5 MHz, depending on the age and thorax

conformation of the animal.

According to KEALY et al. (2012), both adrenal glands in adult dogs and cats are better visualized if the animals are in dorsal recumbency, due to the presence of gas in the intestines. Nevertheless, in the current study, the animals were placed in left and right lateral recumbency, and the previous preparation with fast and anti-flatulence drugs produced low quantity of gas in the region and improved visualization of the glands.

The use of the methodology for analysis and description of ultrasonographic structural features between species by three experts was useful to pattern them by consensus. On the other hand, when this methodology is used in measurements, significant variability may occur intra and between observers.

The agreement index intra and between observers constitutes a measure used to analyze the agreement between two observation intervals (intra-observers) and between observers (LUDBROOK, 2002). A study carried out by BARBERET et al. (2010) concluded that measurements of the height and thickness of caudal and cranial edges of both adrenal glands of adult Beagle dogs demonstrated low variability intra and between observers, while length measurements showed high variability intra and between observers. On the other hand, MOGICATO et al. (2011) concluded that variability intra and between observers was low in adrenal glands measurements in adult Beagle dogs, but there were statistically significant differences for the right adrenal gland, contrary to the left adrenal gland.

Anatomical reference points used in this

study were similar to those used in the literature (BESSO et al., 1997; KEALY et al., 2012), and the left adrenal gland was identified in a cranial-medial position to the left kidney, at the level of the second lumbar vertebrae, caudal to the cranial mesenteric artery and cranial to the renal vein and artery (BESSO et al., 1997). On the other hand, the right adrenal gland was located close to cranial edge of the right kidney, varying in the medial position between the eleventh and thirteenth thoracic vertebrae, consistent with the literature (SPAULDING, 1997; BESSO et al., 1997).

The identification of the right and left adrenal glands in both groups was facilitated by the right intercostal acoustic window and by the spleen, respectively, similar to what is cited in the literature (BRINKMAN et al., 2007; KEALY et al., 2012) about adult cats and dogs and giant breed dogs (SPAULDING, 1997). During visualization of the left adrenal gland we could not observe the left kidney and the left renal artery, due to the slight pressure that applied to the transducer to improve visualization of the gland, according to what was mentioned by KEALY et al. (2012).

According to GROOTERS et al. (1994) and BARTHEZ et al. (1995), it is more difficult to visualize the right adrenal gland than the left one. The frequency of visualization of the adrenal glands in the current study was 100% for both glands in the group of kittens and 75% for the right gland and 100% for left gland in the group of puppies, confirming the reports by GROOTERS et al. (1995) about adult dogs. The lower percentage of visualization of the right adrenal gland in puppies may be related to the deeper location of this gland compared to the contralateral one, greater presence of fat in puppies than in kittens, greater thorax depth, more cranial topographic position of the right kidney in relation to the left one, and its proximity with the pylorus, duodenum and ascending colon region, according to the literature on adult dogs (BARBERET et., 2008).

The frequency of visualization of the right and left adrenal glands in puppies was higher than in the study carried out by VOORHOUT (1990), involving ultrasonographic exam of the adrenal glands of healthy adult dogs and the observation of only seven left adrenal glands (75%) and five right adrenal glands (50%). The following factors contributed to this percentage: low resolution

equipment, percentage of abdominal fat, thorax conformation and presence of internal gas.

In puppies and kittens, the adrenal glands observed were bilobed with regular outlines, similar to adult dogs and cats (BESSO et al., 1997; KEALY et al., 2012).

In puppies, the right adrenal gland observed had oval or boomerang shape and the contralateral one had triangular or peanut shape, coherent with the literature about adult dogs (DOUGLAS et al., 1997; KEALY et al., 2012). On the other hand, in kittens, both adrenal glands observed presented oval or boomerang shape, similarly to what was observed by BESSO et al. (1997) and KEALY et al. (2012) in adult cats. For KEALY et al. (2012), the shape of the adrenal glands in adult cats and dogs may vary according to the age or breed. In a study carried out by DOUGLAS et al. (1997) on adult dogs of different breed and body weight varying between 2 kg and 75 kg, the adrenal glands presented elongated shape and an irregular outline, being such variations related to age and body weight. MOGICATO et al. (2011) concluded that the body weight of Beagle dogs affected significantly the length of both adrenal glands, being the body weight directly proportional to the length of the glands.

The adrenal glands in both groups (Figures 2-A and 2-B) were hypoechogenic in relation to lateral fat, with presence of a hyperechogenic line on the outline, as cited in the literature on adult dogs and cats (KEALY et al., 2012) and without distinction of the cortical and medullary region. The absence of differentiation between cortical and medullary region may be related to the difficulty of visualization of the abdominal phrenic artery and vein in puppies and kittens, which pass through the dorsal and ventral region of the adrenal gland, respectively. The frequency used in the current study represents another factor which might have contributed to the absence of distinction between these two regions. However, in this case, a 10 MHz frequency was used to avoid the effect of frequency in the exams. BESSO et al. (1997) and GRAHAM (2008) reported that, in adult dogs and cats, occasionally, cortical and medullary regions can be differentiated, and in adult dogs the medullary region is hypoechogenic and the cortical region is hyperechogenic, while in adult cats the medullary region is hyperechogenic and the cortical region is hypoechogenic.

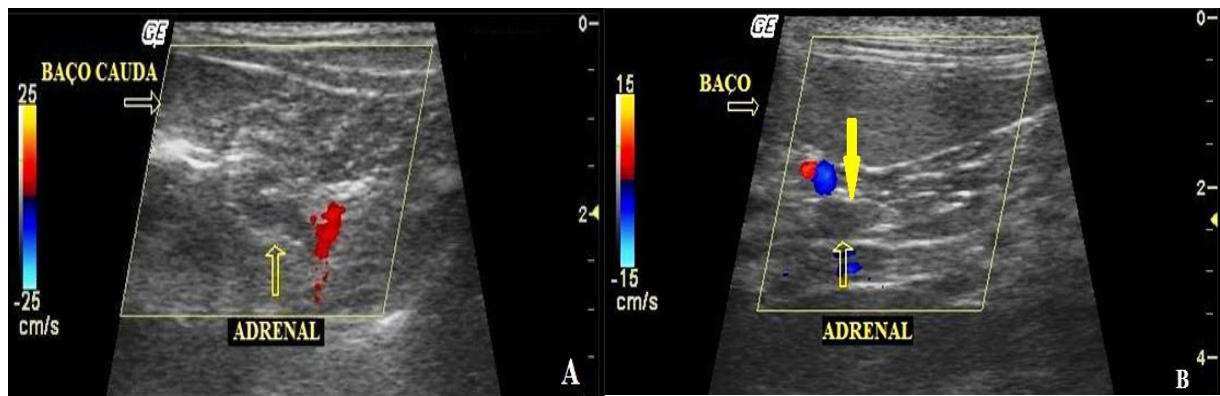


Figure 2: Sagittal sonogram (7.5 MHz, B mode) of the left adrenal gland showing the hypoechogenic gland in relation to the spleen, hyperechogenic line of the gland (yellow arrow), without distinction of the cortical and medullary regions. A - Adrenal gland with triangular shape in dog at five months of age and mean body weight of 3 kg; B - adrenal gland with oval shape in cat at five months of age and mean body weight of 2 kg.

Table 1: Ultrasonographic measurements (cm) of the right and left adrenal glands, in sagittal cut, of puppies and kittens (Mean \pm Standard deviation), Botucatu, SP, 2010

	Puppies		Kittens	
	Length	Width	Length	Width
Right adrenal gland	1.08 \pm 0.01 ^a	0.42 \pm 0.02 ^a	0.64 \pm 0.01 ^a	0.30 \pm 0.02 ^a
Left adrenal gland	1.11 \pm 0.01 ^a	0.45 \pm 0.01 ^a	0.63 \pm 0.01 ^a	0.34 \pm 0.01 ^a

Means followed by the same letter in the same column do not differ between each other by Tukey test ($p > 0.05$) and establish the comparison between groups ($n = 15$).

The ultrasonographic measures of the adrenal glands of puppies and kittens are summarized in Table 1. The measurements of the length and width of the adrenal gland revealed significant differences ($P = 0.01$) between puppies and kittens. Both adrenal glands of puppies were 1.7 cm and 1.4 cm bigger in length and width, respectively, compared to the glands of kittens. In puppies, the left adrenal gland was bigger than its contralateral, coherent with the literature on adult dogs (ELSAYES, 2006).

According to MOGICATO et al. (2011), body weight and age of adult Beagle dogs affected significantly the length and thickness of the glands, being both directly proportional to the length and width of the gland, as well as sex had a significant effect only on the right adrenal gland, being thicker in males and longer in females. On the other hand, the healthy condition of the dogs affected statistically the length and thickness of both adrenal glands.

According to the measurements of the current study, puppies, presenting heavier body than kittens, showed longer adrenal glands. The mean

dimensions of length of the right (2.3 cm) and left (2.7 cm) adrenal gland and the width of both glands (0.7 cm) in adult dogs (PANAGIOTIS et al., 2003) were higher in relation to the puppies and kittens in the current study, thus we can conclude that body weight and age are directly proportional to the size of the adrenal glands, while the body surface is inversely proportional to their size (DOUGLAS et al., 1997).

The left adrenal gland tends to be bigger than its contralateral in puppies, contrarily to kittens, confirming the literature on adult dogs (DOUGLAS et al., 1997; PANAGIOTIS et al., 2003).

CONCLUSIONS

In puppies and kittens, both adrenal glands are hypoechogenic in relation to the adjacent fat, and the left adrenal gland is hypoechogenic to the spleen. The glands are limited by a hyperechogenic line and there is no distinction between cortical and medullary regions. Both adrenal glands of puppies and kittens had similar shape and outline to the glands of adult dogs and cats. The ultrasonographic

dimensions of length and width of the right and left adrenal glands are the same in puppies and kittens. The right and left the right and left adrenal glands in puppies are bigger in length and width than both glands in kittens.

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