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Three-dimensional Volumetric Ultrasonography of Enlarged Adrenal Gland in Dog

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Abstract

Objective: Detection and evaluation of adrenal glands are complex problems in conventional ultrasonography in dogs. Using three-dimensional (3D) ultrasonography (US) in adrenal gland volume evaluation can add new potential for further adrenal studies.
Design: Descriptive study
Animals: a total of 10 mix breed dogs
Procedures: The dogs underwent two dimensional (2D) and 3D US of the adrenal glands before and after 10 days of tetracosactide administration.
Results: The adrenal glands increased progressively in size and volume over time which was quite significant in compare with the imitate measurements and it was detectable more in 3D US than 2D.
Conclusion and Clinical Relevance: The differential diagnosis of adrenal enlargement should include PDH and adrenal tumors which apparently cannot be diagnosed by 2D nor 3D US but in detection of mild enlargements, 3D US volumetric evaluation can make a better and more accurate role than 2D.
Keywords: Adrenal gland, dog, three dimensional, ultrasonography

Introduction

Detection and evaluation of adrenal glands are complex problems in conventional ultrasonography.[1,12,13,14] Especially the suspicion of adrenal enlargement by two-dimensional

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(2D) ultrasonography (US), since there is an overlap in size between normal dogs and those with adrenal abnormalities.[1,2] A diagnosis of adrenal gland diseases is usually performed by clinical assessment, laboratory tests, and diagnostic imaging techniques. Diagnosis should not be invasive and be accurate enough especially in some particular times such as pregnancy.[6] In principle, ultrasonography is the main imaging technique. Thus far, US have a limited role in differentiation of adrenal enlargement. However, US can be a most suitable modality for monitoring adrenal size in small animal.[4,5] Novel presentation of using 3D US in adrenal gland volume evaluation can add new potential for further adrenal studies. To the authors' knowledge, this is the first study and report of evaluation adrenal gland enlargement with 3D US in animals.

Materials and Methods

A total of 10 (5 males and 5 females) mix breed, 2 +/- 1.3 years old dog, weighing 16 +/- 3.3 kg were selected. They were fed by standard dry food and had free access to water and housed in optimum condition. They were all healthy in physical examination, complete blood tests, and routine abdominal ultrasonography and radiography. Three screening tests were used for evaluation of hypothalamus-pituitary-adrenal axis which were:

1. Corticotropin (ACTH) stimulation test: serum cortisol concentrations were determined 1 hour before and after the intravenous injection of tetracosactide (syntethic ACTH) at a dose of 5 mg/kg. In normal dogs this injection produces a rise in serum cortisol to values usually greater than 10mg/dl, in contrast dogs with hyperadrenocorticism tend to have rising greater than 20 mg/dl.
2. Low-dose dexamethasone suppression test: serum cortisol concentrations were determined 1 hour before, 4 and 8 hours after intravenous injection of 0.01 mg/kg dexamethasone sodium phosphate. In normal dogs serum cortisol concentrations is less than 1.4 mg/dl at 4 and 8 hours after injection.
3. Uurinary cortisol: creatinine ratio: morning urine samples were collected and urine cortisol and creatinine concentrations were determined by the laboratory. In normal dogs cortisol to creatinine ratio is less than 15-20.

So, the dogs had normal hypothalamus-pituitary-adrenal axis based on screening tests result prior to study.

After clipping abdominal hair and application of US gel, the dogs were positioned in the right recumbancy for the left adrenal and left recumbency for the right adrenal gland restraining manually. Two dimensional and 3D US of the adrenal glands performed using a 2D 6-12 linear and a 3D 6-12 linear transducer, respectively by a 3D US system (Voluson 730-Pro, Kretztechnik, Austria). Cranial and caudal pole diameters of both adrenal glands in sagittal view as well as adrenals volume were measured by 2D and 3D ultrasonography, respectively. (Table1). Then, the cases received tetracosactide at a dose of 1 mg/body once a day intramuscularly for 10 days. They were monitored clinically every day and underwent 2D and 3D US every other day by two independent observers who were unaware of the treatment. Adrenal glands 2D diameters (fig.1) and 3D volumes in grey-scale imaging were obtained (table 1). Grey-scale imaging was acquired with sweeping angle 15 degree and the image quality setting was adjusted to high (slow sweeping). Three Dimensional data acquisition time was 5 seconds for each adrenal. Three Dimensional volumes were achieved by VOCAL® mode introduced in 4D view 5.1 software. Multiplanar reformation (fig.2), of the adrenals was obtained. Cortisol in serum was also measured with Cayman's Elisa Kit, before, after 10 days

of the administration and 10 day after stopping treatment. Statistical analysis was based on ANOVA method using SPSS statistical soft ware.

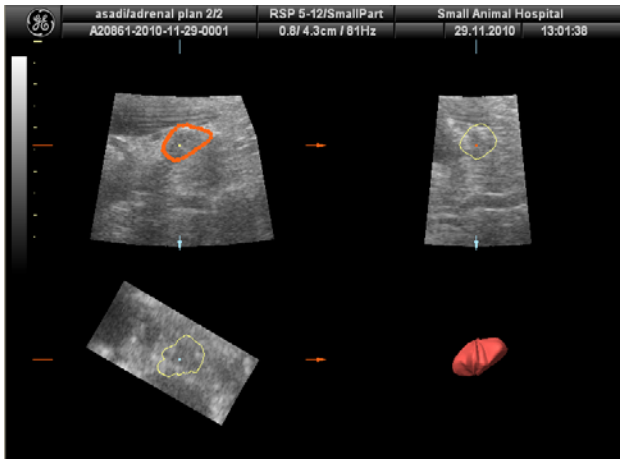

Figure 2. 3D multiplanar reformation image for evaluating adrenal glands from different plans.

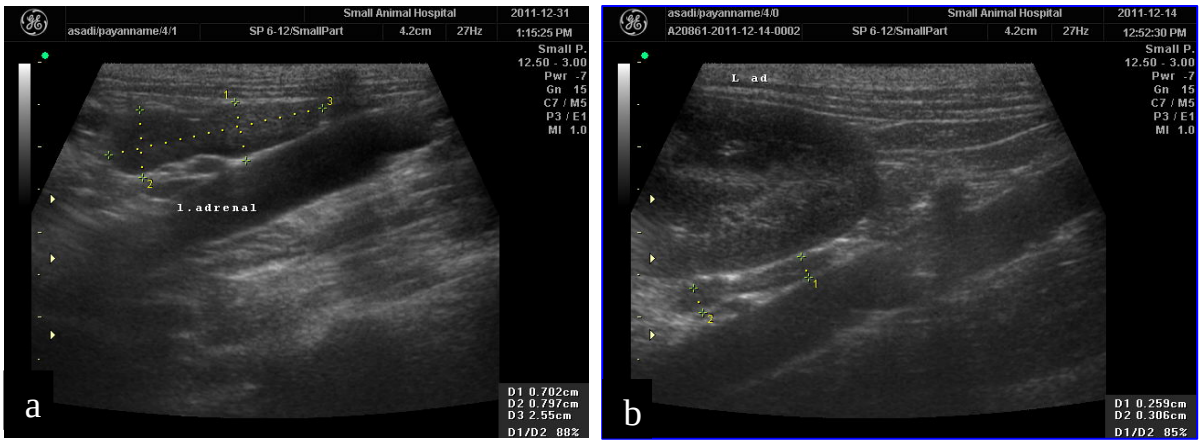

Figure2. 2D images of left adrenal gland in a dog befor (b) and after (a) ACTH adminstration

Results

All dogs developed polyuria and polydipsia within 10 days but there was no sign for any abdominal distension, skin lesions or muscle atrophy. There were mild amount of free fluid detectable in the abdominal cavity ultrasonography. The body weights remained constant during the study.

Mean urine specific gravity was 1/25 at the end of study just like at the initiation of treatment. The size of the adrenals was within normal limits at the beginning of study and there was not any significant difference in the height of the cranial and caudal adrenal poles in left and right adrenal glands. ($p<0.001$) (table1). The adrenal glands increased progressively in size and volume over time which was quite significant in compare with the imitate measurements ($p<0.001$) which were both detectable with 3D and 2D US. The measurements of the present adrenal hypertrophy in the dogs receiving tetracosactide is reported in table 1.

Three Dimensional US data collection and evaluation of each adrenal gland takes almost 15 min in general which was 5 minutes more than 2D study.

Table 1. Left and Right adrenal glands measurements before, after 10 days of study, and 10 days after stopping drug administration in 10 dogs.

		Before study Mean ± SE	After 10 days Mean ± SE	After Treatment Mean ± SE
Right Adrenal poles diameter (cm) by 2D	Cranial pole	0.46 ± 0.06	0.72 ± 0.08	0.45 ± 0.02
	Caudal pole	0.47 ± 0.05	0.74 ± 0.04	0.48 ± 0.05
Left Adrenal poles diameter (cm) by 2D	Cranial pole	0.42 ± 0.06	0.70 ± 0.05	0.41 ± 0.05
	Caudal pole	0.40 ± 0.08	0.71 ± 0.06	0.42 ± 0.05
3D Volume measurement of left adrenal gland by VOCAL® mode (cm^3)		0.439 ± 0.054	0.640 ± 0.027	0.415 ± 0.097
3D Volume measurement of right adrenal gland by VOCAL® mode (cm^3)		0.486 ± 0.066	0.664 ± 0.087	0.495 ± 0.076

Discussion

Tetracozactide* is a synthetic analogue of the naturally occurring adrenocorticotropic hormone (ACTH) which is normally released from the pituitary gland at the base of the brain and acts on the adrenal glands to stimulate the production of steroid hormones. This medication is mostly used for diagnostic purposes.[3]The present study showed that excessive usage of the drug probably can make adrenal enlargement in dog by induction hypertrophy of the zonaefaciculata and reticularis.[11]

Ultrasonography is the diagnostic modality of choice for adrenal diseases. Conventional 2D US can offer only a planar image and cannot effectively delineate the overall adrenal configuration. Three-dimensional US is a newly developed imaging technology, and its clinical application field is expanding.[14]

Three-dimensional US enables unique evaluation of the morphology and volume of the adrenal gland. Volume measuring can be more precise than diameter detection especially when the adrenal enlarges longitudinally. Although data collection and evaluation in 3D US is more time consuming than 2D method, complete volume data from desired region and then multidirectional analysis of the region of interest, does worth! Other advantages of 3D US in compere with the conventional one seems to be a better following up modality, capability of showing a regional enlargement in the gland (tumors. etc.) and making a better view out of the surrounding structure; however, 3D US has also some disadvantages like vital needs for more expensive US machines, heavy transducer, and huge amount of data capacity.

All in all, the differential diagnosis of adrenal enlargement should include Pituitary Dependent Hyperadenocortisism and adrenal tumors which apparently cannot be diagnosed by 2D nor 3D US however in detection of mild and elongated enlargement of the adrenal glands, 3D US may make a better and more accurate role than 2D.

*synacran(tetracosactide LA) manufactured by Iran hormone Tehran-Iran

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چکیده

اولتراسونوگرافی حجمی سه بعدی آدرنال بزرگ شده در سگ

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هدف: پیدا کردن و تشخیص عوارض غده آدرنال در سگ همواره به عنوان یک چالش در اولتراسونوگرافی دو بعدی مطرح بوده است. استفاده از اولتراسونوگرافی سه بعدی و اندازه گیری حجمی غده آدرنال می تواند راه گشای ارزیابی عوارض غده آدرنال در آینده باشد.

طرح: مطالعه توصیفی

حیوانات: ده قلاده سگ نژاد مخلوط

روش: غدد آدرنال سگ های مذکور قبل و بعد از تزریق داروی تتراکوزکتاید مورد مطالعه اولتراسونوگرافی دو بعدی و سه بعدی قرار گرفت.

نتایج: داروی تتراکوزکتاید منجر به افزایش اندازه و حجم غدد آدرنال گردید که این تفاوت توسط اولتراسونوگرافی سه بعدی به کاملا قابل تشخیص بود

نتیجه‌گیری: تشخیص تفریقی در بزرگ شدگی های غده آدرنال می تواند بیماری هیپرآدنوکورتیسیزم و یا تومور های بدخیم آدرنال باشد که نه با اولتراسونوگرافی دو بعدی قابل تفریق است نه با سه بعدی. در عین حال تشخیص بزرگ شدگی های ملایم ادرنال با اولتراسونوگرافی سه بعدی راحت تر و دقیق تر خواهد بود.

کلید واژگان: غده آدرنال، سگ، سه بعدی، اولتراسونوگرافی