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Comparison of Ultrasound Histogram in Liver, Kidney and Spleen in Beagle Dogs

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Abstract: For the assessment of the clinical application of histogram on internal parenchymal organs, ultrasonography with a multi-frequency transducer was taken. We scanned in the region of right cranial abdomen for both liver and right kidney, and left cranial abdomen for liver, spleen and left kidney in 9 normal Beagle dogs. The data from histogram examined in a region of interest centered on each picture element of B-mode images at the same depth were compared among liver, renal cortex, spleen, cortex and medulla of each kidney. The right renal cortex showed significantly lower echogenicity than parenchyma of liver by 15%. Spleen was more echogenic than the cortex of the left kidney by 23%, and liver was more echogenic than the left renal cortex by 30%. Renal cortex was more echogenic than medulla by 47% and 65% on the right and left side, respectively ($p<0.05$). The mean (±SD) values calculated echogenicity were 46.2±12.3 (95% confidential interval (CI), 41.0 to 55.0) and 53.4±12.1 (95% CI, 47.0 to 55.1) in in the right renal cortex and liver parenchyma, 65.0±11.8 (95% CI, 57.9 to 71.0) and 51.0±16.9 (95% CI, 42.8 to 54.1) in splenic parenchyma and renal cortex. And the mean values calculated echogenicity were 65.0±10.15 (95% CI, 60.1 to 71.5) and 52.0±9.4 (95% CI, 43.8 to 60.3) in liver parenchyma and the left renal cortex, 54.5±18.3 (95% CI, 40.1 to 62.8) and 35.0±16.2 (95% CI, 24.2 to 43.6) in the left renal cortex and medulla. And the mean values calculated echogenicity were 55.0±14.4 (95% CI, 47.3 to 61.7) and 40.0±13.2 (95% CI, 34.3 to 46.7) in the right renal cortex and medulla, respectively. In addition, the echogenicity ratios were 0.86±0.11 between the right renal cortex and liver parenchyma, 1.37±0.47 between spleenic parenchyma and the left renal cortex, 1.30±0.19 between liver parenchyma and the left renal cortex. All the values measured showed significant different ($p<0.05$). Ultrasound histogram is simple, useful and feasible to evaluate the sonographic architecture of the internal organs such as liver, spleen and kidney, quantitatively.

Key words : ultrasound histogram, dogs, liver, renal cortex, renal medulla, spleen.

Introduction

Ultrasonography (US) is commonly performed to assess the alleged hepatic, splenic or renal disease in dogs and cats. Qualitative ultrasonographic abnormalities are recognized as changes in shape, size, echogenicity, and alterations in the anatomic and echogenic relationship of organs and tissues[10,13]. Diffuse hepatic, splenic or renal diseases often alter echogenicity and sometimes shape, one has to compare nearby structures to the organ of interest to verify whether the echogenicity is changed. Therefore, the relationship of hepatic, renal and splenic echogenicity is important for recognizing major abnormalities in the internal organs. Since subjective criteria have been used qualitatively for evaluation of abdominal organs from routine ultrasonographic examination, quantitative analysis by histogram for the measurement of histologic state on the sonographic image is required to aid diagnosis. Quantitative sonography derives numeric values from echogenicity data that are connected to the mechanical properties of the tissue being estimated[10]. These numeric values augment the accuracy and abnormal ultrasonograpahic appearances[10]. Several methods have been applied for quantifying ultrasonographic data achieved from parenchymal organs[5,10,13]. Histogram technique for appraising hepatic and renal brightness is precise, easy, noninvasive method for the diagnosis of diffuse hepatic fatty infiltration in human[2,11]. Use of a quantitiative method for determining hepatic, splenic, and renal echogenicity could decrease the number of hepatic biopsy specimens needed to evaluate the progression of disorders. In the veterinary medicine, however, the exact knowledge and criteria of histogram for dogs have not been reported yet.

The purpose of this study was to quantitatively determine the echogenicity of the liver, spleen, and kidney in clinically normal Beagle dogs, using histogram analysis. Values from this study may serve as a basis for determining diffuse abnormalities from normal appearance with these organs.

Materials and Method

Animals

Nine clinically normal adult Beagle dogs were examined. Each dog weighed between 7-9.5 kg, and all dogs were sexually intact. CBC, serum biochemical analysis, and urine analysis were taken to the health of each dog. The Animal Care and Use Committee at Seoul National University approved this study.

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Ultrasonography

Hepatic, splenic and renal ultrasonography (US) was performed using a Medison 9900 ultrasonographic machine (Medison, Korea) with a multi-frequency probe (3-7 MHz). all the experimental dogs were clipped adjacent to the liver and kidneys and followed application of acoustic coupling gel in each dog fasted for 12 hrs before examination. Only dogs with ultrasonographically normal liver, spleen and kidneys were in this study.

With each dog in dorsal recumbency position, images of the liver and the cranial pole of the right and left kidneys (Fig 1,2) and then an image of spleen and the left kidney (Fig 3) were obtained.

The sonographic recording was made with a standardized device setting that fixed the image focus between close and medium ranges of depth, with optimized brightness and contrast (fixed gain and TGC-curve). This standardized setting was kept constant during the scanning.

Ultrasound histogram

A same sized (3×3 or 4×4 mm) region of interest (ROI) was drawn on each picture element of B-mode image at the same depth. Data were calculated automatically by the ultrasound machine and compared within, renal cortex, spleen, and cortex medulla of each kidney.

Statistical analysis

Computer-based software (SigmaStat 2.0, SPSS Science, Chicago, SAS for Windows, version 11.0, SAS Institute, Cary, NC) was used for statistical analysis. Mann-Whitney test for the significance and correlation was performed to detect difference between ROI measurements for liver, spleen and kidney. P values < 0.05 were considered significant.

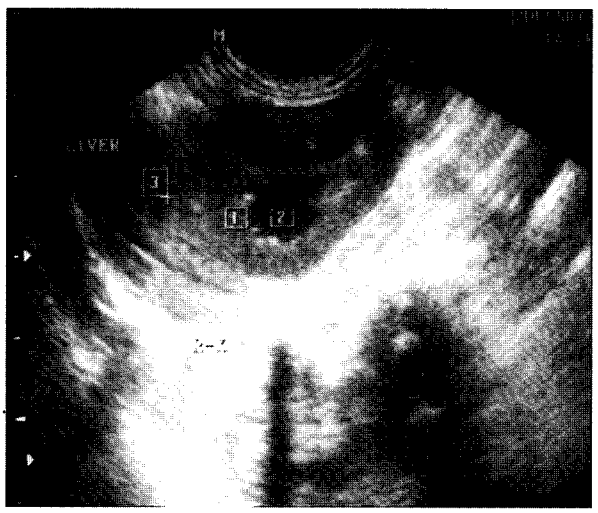

Fig 1. Transverse ultrasonographic image of the liver and cranial pole of the right kidney of a dog in dorsal recumbency. The image was made with at 6 MHz of multifrequency probe (3-7 MHz). Region of interest (ROIs) was drawn with 33 mm sized square on liver and renal cortex and medulla.

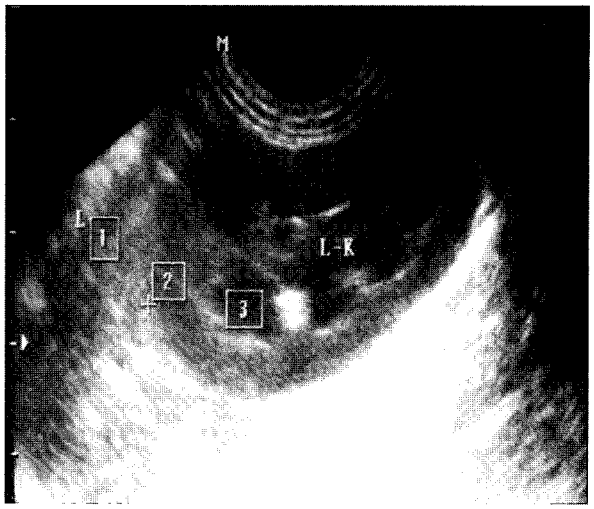

Fig 2. Longitudinal ultrasonographic image of the liver and the left kidney of a dog in dorsal recumbency. The image was made with at 6 MHz of multifrequency probe (3-7 MHz). Region of interests (ROIs) were drawn with 44 mm sized square on liver and renal cortex and medulla.

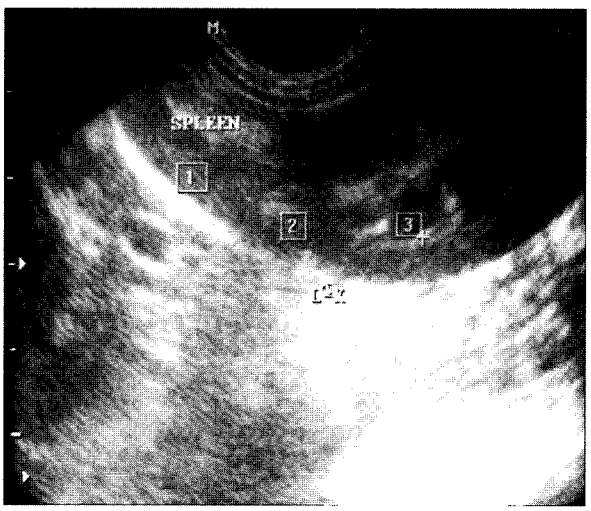

Fig 3. Oblique ultrasonographic image of the spleen and the left kidney of a dog in dorsal recumbency. The image was made with at 6 MHz of multifrequency probe (3-7 MHz). Region of interests (ROIs) were drawn with 33 mm sized square on liver and renal cortex and medulla.

Results

Differences among histographic values had a moderate-to high degree of correlation, with a small but significant difference for means between the paired samples. Data from paired samples are described (Table 1).

Table 1. Correlation and difference of histographic values among hepatic, spleen and renal cortex echogenicity data

	Histographic values		Correlation*	P value†
	Measurement	Ratio		
RK : Li	47.8±12.3 : 55.4±12.3	0.86±0.11	0.326	0.018
S : LK	65.0±11.8 : 51.0±16.9	1.37±0.47	0.471	0.002
Li : LK	65.0±10.15 : 52.0±9.4	1.30±0.19	0.657	0.003
LC : LM	54.5±18 : 35.0±16.2	1.65±0.72	0.799	P<0.0001
RC : RM	55.0±14.4: 40.0±13.	1.47±0.43	0.736	P<0.0001

*p<0.05. † RK: Right renal cortex, Li: Liver, S: spleen, LK: Left renal cortex, LC : left renal cortex, LM: left renal medulla, RC : right renal cortex, RM: right renal medulla.
The data are expressed as Mean ± SD

Discussion

Subjective evaluation of internal organs is prone to error because of the variability of ultrasound equipment, experience of the operator, intraobserver and interobserver variability[8]. Quantitative methods for measuring liver echogenicity in humans have been investigated with use of a simple histogram analysis[2,3,11]. Mailloux *et al.*[4] used a minicomputer based system to digitize B-mode images and to develop a method to measure their textural information. The method was illustrated on the thyroid gland and the application of this method to the study of other organs was proposed.

It was also reported that gray scale histogram analysis showed more sensitivity than endoscopic ultrasound image[1,7] and that the quantification of hepatic and renal cortical echogenicity was useful in cats. Furthermore, digital analysis of liver image is useful in steroid-induced hepatopathy in dogs[12].

In this study, we have used the grey-scale histogram analysis for a quantitative measurement of hepatic, splenic, and renal echogenicity in normal dogs. By this procedure, relationship among the internal organs could be described as numeric values. Spleen is more echogenic (37%) than the cortex of left kidney as well known[9]. And liver was more echogenic by 30% and 15% than the cortex of left and right kidney, respectively. It has been known that the echogenicity of the hepatic parenchyma is normally slightly higher or equal to that of the cortex of the right kidney[8].

Each ultrasound machine and measurements method are likely to result in slightly different values[3]. Currently, neither qualitative nor quantitative ultrasonography will replace histopathologic evaluation of tissue, but it may provide additional characterization of the imaged tissues. Histogram analysis of ultrasonographic images may be suitable and safer for monitoring of the progress of disease or effectiveness of treatment.

In conclusion, though extensive investigation may be required to authenticate the normal numeric sonographic histogram among various breed and age in clinically normal dogs, quantitative measurement using ultrasound histogram is very simple, useful and practicable to evaluate the sonographic architecture appearance on the internal organs such as liver, kidney, and spleen.

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비글견에 있어서 간, 신장 및 비장의 초음파 히스토그램 비교

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요 약 : 초음파 히스토그램의 내부 장기에 대한 임상적용을 알아보기 위하여 다주파수 탐촉자의 초음파기기를 이용하여 실험하였다. 9마리의 정상 비글견을 이용하여 우측전복부의 간과 우측신장, 좌측전복부의 간,비장과 신장를 검사하였다. 같은 깊이의 B-모드 영상으로 간,신장의 피질,비장, 그리고 각 신장의 피질과 수질의 수치를 비교하였다. 우측신장피질의 메아리발생치는 간에 비하여 유의적으로 15% 낮았다. 비장의 메아리발생치는 좌측신장피질보다 23% 높았으며, 간은 좌측 신장피질보다 30% 높았다. 각 신장의 피질과 수질의 비교에서는 피질이 우측과 좌측에서 각각 47%와 65% 높게 나타났다($P<0.05$). 우측신장피질과 간실질간의 메아리발생치 비율은 0.86±0.11, 비장과 좌측신장간에는 1.37±0.47, 간실질과 좌측신장피질간에는 1.30±0.19이었으며, 이들 모두다 유의적인 차이가 있었다($P<0.05$). 초음파 히스토그램은 간, 비장, 신장 같은 내장장기의 구조물의 초음파적 평가에서 정량적으로 평가하기에 단순하고 유용하고 실질적이다.

주요어: 초음파 히스토그램, 개, 간, 신장피질, 신장수질, 비장