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Comparative evaluation of renal size on radiography and ultrasonography in rabbits

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토끼의 방사선 촬영상과 초음파 촬영상에 나타난 신장 크기의 비교평가

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초 록 : 토끼에서 신장의 크기(길이, 폭 및 높이)를 측정하고 이에 대한 기본자료로 삼고자 53마리의 토끼(Newzealand White)의 신장을 방사선 촬영과 초음파 신장촬영 그리고 신장을 적출하여 실제 길이를 재고 이들간의 측정치를 비교하였다. 방사선 촬영에서는 우측신장은 T13-L2에서 관찰되었고 좌측신장은 L2-L4에서 관찰되었다. 초음파 신장촬영상에서는 신장 피질은 작고 균등하며 주변조직에 비하여 저에코상을 보였고 신장의 신우는 무에코 내지는 약간의 저에코상을 보였다. 토끼의 좌측신장에서 길이, 폭 및 높이는 각각 35.84±3.12(mean±SD), 23.52±3.21 및 15.11±2.58cm 였으며 우측신장에서는 36.02±3.42, 23.69±3.50 및 14.13±3.55cm 이었다. 방사선 사진상에서 양쪽 신장의 길이와 폭은 실제 크기에 비하여 약간 확대되었으며(102~104%), 초음파신장 촬영상에서 양쪽 신장의 길이, 폭 및 높이는 실제 크기에 비하여 적게 축소된 상을 보였다(70~96%). 복배상 방사선 사진에서 신장의 길이와 폭의 제2요추 길이의 대비에서 1.85와 1.25배로 나타났다. 체중과 신장의 각 측정치와의 상관관계에서는 서로간에 유의치 있는 상관관계가 있었다.

Key words : rabbit, renal measurement, radiographs, nephrosonograms.

Introduction

Survey and contrast radiography are frequently utilized for diagnostic evaluation of the urinary system in animals. The external boundary of kidney can usually be identified on survey radiographs. This identification permits assessment of the size, shape, and radiographic opacity of the kidneys, which can aid in the diagnosis of disease processes[9].

The advent of ultrasonography in clinics can enhance its

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value as an additional diagnostic procedure in urinary tract diseases. With this, not only the renal cortex, medulla, diverticula and vessels, pelvis, but also differentiation of solid and cystic masses in animal can be identified[4].

The rabbits as laboratory animal are widely used for many medical and biochemical studies, but the paucity of data on normal renal radiography and sonography serves as the impetus for this paper.

The purpose of this study was 1) to measure length and width of normal kidneys of the rabbit *in situ* with radiography and sonography, and 2) to compare these data with those data of actual renal size.

Materials and Methods

Fifty three rabbits(New Zealand White, female) used for this study were operated for oocytes pick-up. After oocytes pick-up, all rabbits were euthanized for the measurement of radiographic, ultrasonographic and actual size of normal kidney.

The weight of rabbits ranged from 2.3kg to 4.3kg(Average 3.4kg), and aged from 4 months to 6 months. The ventrodorsal abdominal radiographs(FFD=36 inches, 60KVp, 5mAs) and nephrosonograms were obtained. An ultrasonography(Shimadzu Corporation. Japan, model: SDL-32) with a linear 3.5MHz transducer was used for nephrosonography.

The sagittal and transverse images were obtained by scanning the kidney. After radiographs and nephrosonograms, both kidneys were removed. The maximum renal length, width and height of each kidney were measured. Also, the renal length and width on radiographs were measured.

Results

On radiographs, right kidney was observed at the level of T13-L2 vertebrae and left kidney was at the level of L2-L4 vertebrae. Because of large cecum, the outlines of both kidneys were not clearly seen(Fig 1, left). The left kidney was

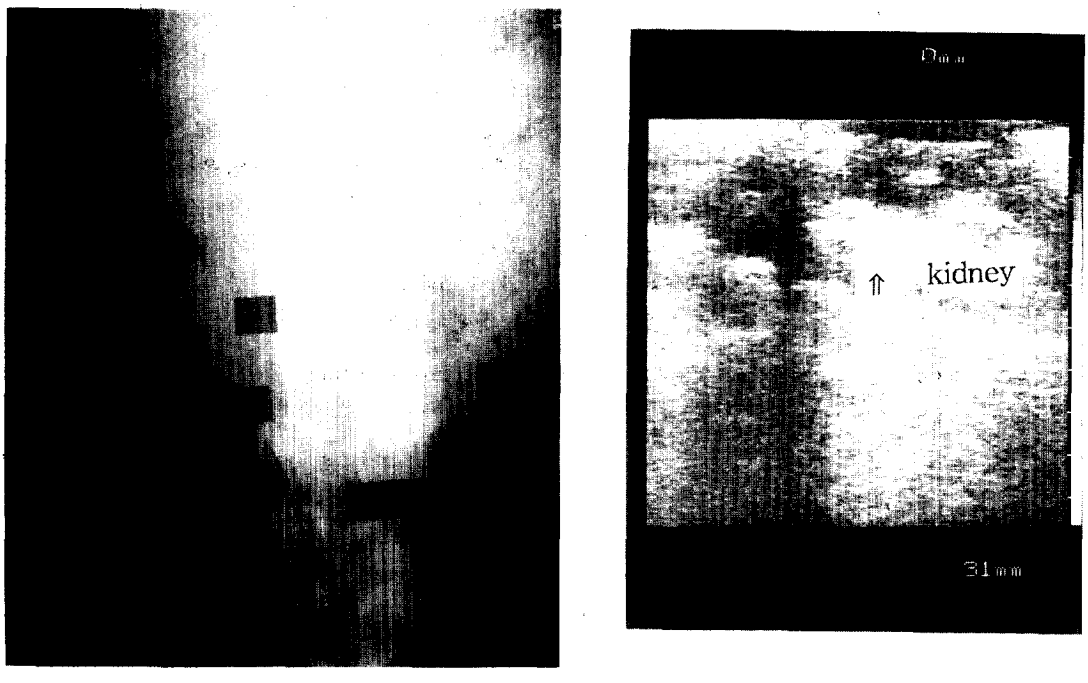

Fig 1. Radiograph(left) and nephrosonogram(right) of rabbit kidney.

less firmly attached to the dorsal wall than the right and hence is more variable in position. The right kidney lied more cranially than the left and was in contact with the renal fossa of the caudate lobe of the liver. As its cranial pole is within the rib cage about the level of the 13th thoracic vertebra, oblique sagittal scanning was sometimes made to outline the right kidney. On nephrosonograms, the renal cortex was visible as small, homogenous echoes that were hypoechoic relative to the surrounding tissues. The renal cortical echo pattern was consistenet on all sagittal sections. The renal medulla comprised most of the central region of the kidney and was anechoic to slightly hypoechoic(Fig 1, right).

After radiographs and nephrosonograms, both kidneys were removed and their length, width and height were measured (Table 1). The actual length, width and height of the left kidney were 35.84±3.12, 23.52±3.21, 15.11±2.58cm, respectively, whereas those of the right kidney were 36.02±3.42, 23.69±3.50 and 14.13±3.55cm, respectively.

On radiographs, the length and width of left kidney were 36.67±4.02, 24.73±3.20cm, right kidney was 37.00±4.01, 24.82±2.78cm. Compare to the actual size, all were a little magnified(102~104%, Table 2). On nephrosonograms, the length, width and height of left kidney were 29.13±5.26, 22.22±2.29 and 11.30±2.40cm, respectively, whereas those of right kidney were 29.18±4.40, 21.41±2.91 and 10.84±2.08cm, respectively. Compare to the actual size, all were lessened(70~96%, Table 2).

The length and width of kidney were 1.85 and 1.25 times the length of the second lumbar vertebrae on the ventrodorsal view of radiographs(Table 3).

In correlation and correlation coefficient of body weight with the renal measurements, the body weight and renal measurments were significantly correlated with each other($p<0.01$) and r(correlation coefficienct) of body weight and left, right and both kidneys were 0.748, 0.794 and 0.859, respectively(Tabel 4).

Table 1. Renal measurements on radiographs, nephrosonograms and in actual size(mean±S.D.cm)

Kidney		Actual size	Radiographic size	Sonographic size
Left	Length	35.84±3.12	36.67±4.02	29.13±5.26
	Width	23.52±3.21	24.73±3.20	22.22±2.29
	Height	15.11±2.58	-	11.30±2.40
Right	Length	36.02±3.42	37.00±4.01	29.18±4.40
	Width	23.69±3.50	24.82±2.78	21.41±2.91
	Height	14.13±3.55	-	10.84±2.08

Table 2. Comparison of radiographic, sonographic measurements with actual size

Kidney	Radiographic size/actual size	Sonographic size/actual size	Left
Length	1.02±0.12	0.81±0.12	Width
	1.02±0.12	0.96±0.13	Height
	-	0.70±0.14	Right
Length	1.02±0.09	0.82±0.11	Width
	1.04±0.13	0.92±0.16	Height
	-	0.82±0.11	

Table 3. Comparison of renal length, width with the length of 2nd lumbar vertebrae on radiogrphs

Kidney		Rate
Left	Length/ 2nd L-2	1.84±0.22
	Width / 2nd L-2	1.24±0.17
Right	Length/ 2nd L-2	1.86±0.23
	Width/ 2nd L-2	1.25±0.16

Table 4. Correlation and correlation coefficient of body weight with the renal measurements

Correlation	Equation	R
Body weight and right renal measurements	Y = 0.129 + 0.200 LL + 0.843 LW + 0.038 LH	0.748**
Body weight and right renal measurements	Y = -0.258 + 0.014 RL + 0.134 RW - 0.048 RH	0.794**
Body weight and both renal measurements	Y = -0.690-0.065LL +0.882 LW +0.202 LH+0.050 RL+ 0.108RW - 0. 026 RH	0.859**

Y=body weight, LL=length of left kidney, LW= width of left kidney, LH=height of left kidney, RL=length of right kidney, RW= width of right kidney, RH=height of right kidney, R=correlation coefficient
** = $p<0.01$

Discussion

On radiographs, due to the large intestines both kidneys were sometimes obscured. So some techniques are needed to discern the both kidneys. In the rabbits, right kidney is located more cranially than the left and its cranial pole is within the T-13 vertebra cage like dogs[3]. In the scanning of the right kidney with the transducer by placing the transducer parallel to the costal arch at an oblique cephad angle. The echo pattern of renal cortex was hypoechoic relative to the surrounding tissues, and renal medullar was visible as an anechoic region. The renal pelvic diverticula and interlobar vessels were linear echodensities. These echo patterns were same with those of dogs[6,10].

Renal anatomy that can be discriminated on an ultrasound scan include: cortex, medulla, pelvis, pelvic diverticula, interlobar vessels, perivelvic fat and renal capsule[6]. In this experiment with a 3.5MHz transducer, we can observe renal cortex, medulla and diverticula and interlobar vessels, but the clear outlines were not obtained. This is due to the resolution capability of the transducer. Nyland and Mattoon[7] suggest that 7.5 or 10MHz transducers is good for small dog (high resolution transducers(7.5MHz or more) are needed.

It is widely accepted that nephrosonography is a highly sensitive and noninvasive method used to differentiate solid and cystic masses in animal. In addition to evaluating nonfunctioning kidneys and differentiating solid from cystic lesions, indications for nephrosonography include percutaneous renal biopsy, percutaneous nephropyelocentesis, metastatic examination of the opposite kidney in an animal with renal neoplasia, renal calculi and known sensitivity to iodinated contrast medium[2,4]. Also ultrasonography appeared to be more sensitive than radiography in differentiating the internal characteristics of renal lesions[5]. But in renal measurements, we have found that radiography is more accurate than ultrasonography.

Renal measurements on nephrograms were smaller than actual size, whereas on radiogrphs these were a little larger than actual size. This was becuase of the difficulty in obtaining true sagittal or transverse sections due to the mobility of the kidney during sonogrphic procedure and magnification during radiographic procedure.

A "rule of thumb" for the normal kidney size is : in the dog, a normal kidney should measure 2.5 to 3.5 times the length of L2[3,8,9]. In the cat, a normal kidney should measure

2.4 to 3 times the length of L2[8]. In our experiments, the normal kidney size of the rabbit was 1.6 to 2.1(mean=1.85) times the length of L2, and 1.1 to 1.4(mean=1.25) times the width of the L2. We think this index can be useful for detection of enlargement due to many diseases.

In the renal sonographic measurements in the dog Boag, Atilola and Rennock[1] found that left anf right renal volume were significantly correlated with body weight(r= 0.73 and 0. 64, respectively). In this experiment, we have also found that the body weight and renal measurements(actual size) are correlated with each other. In growing period of the rabbit, all organs except gonads, thyroid gland and adrenal gland have maximum growth at 90 days after birth and these growth continue until 240-360 after birth[11]. So in this growing period, the correlation and correlation coefficient of body weight and renal measurements will be also useful for growth index for the rabbits.

Summary

Renal size(length, width and height) of rabbits was measured by radiographs and nephrosonograms and compared with actual size. After measuring on the radiographs and nephrograms, both kidneys were removed from the body and actual size was also measured.

On radiographs, right kidney was observed at the T13-L2 vertebrae and left kidney was at L2-L4 vertebrae. On nephrosonograms, the renal cortex was visible as small, homogenous echoes that were hypoechoic relative to the surrounding tissues, whereas the renal medulla was anechoic to slightly hypoechoic.

The actual length, width and height of the left kidney were 35.84±3.12(mean±SD), 23.52±3.21, 15.11±2.58cm, respectively, whereas those of the right kidney were 36.02± 3.42, 23.69±3.50 and 14.13±3.55cm, respectively.

On radiographs, the length and width of both kidneys were a little magnified(102-104%) when compared to actual size. On nephrosonograms, the length, width and height of bothkidneys were lessened(70-96 %) when compared to actual size.

The length and width of kidney were 1.85 and 1.25 times the length of the second lumbar vertebrae on the ventrodorsal view. In correlation and correlation coefficient of body weight with the renal size, the body weight and renal size were significantly correlated with each other other($p<0.01$) and the correlation coefficents of body weight with left, right and both Kindneys were 0.748, 0.794 and 0.859, respectively.

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