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Original Article

Ultrasonographic Evaluation of the Urinary System in New Zealand White Rabbit and Tolai Hare

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Abstract

Ultrasonographic examination of urinary system (kidney and urinary bladder) was conducted in New Zealand white rabbit [NZwr] and Tolai hare (*Lepus tolai*). Ultrasound images of the kidney and urinary bladder were evaluated on fifteen healthy rabbits of New Zealand white rabbit and another fifteen Tolai hares. The healthy rabbits were 8-12 months old (mean = 9.3 months), of both sexes and weighed between 1.1-1.7 kg (mean = 1.250 kg). All examinations were performed while the rabbits were in dorsal recumbancy. The kidneys were examined from fossa by the use of an 8 MHz linear real-time scanner. This study revealed the following measurements normal rabbit kidneys: 27.80-35.70 mm and 16.90-22.40 mm in length and width in New Zealand white rabbit, respectively. The length and width were 26.67-34.50 and 15.82-20.60 mm, in Tolai hare, respectively. Bladder wall thickness varies from 1.70-2.50 mm (in New Zealand white rabbit) to 1.80-2.60 mm (in Tolai hare). Statistical analysis showed that the gender did not have effect on length, width and weight ($P > 0.05$), but the type of the animal, had significant effect on the cortex and surface ($P < 0.05$). In the present study, the renal cortex was uniform in echogenicity, hyperechoic to the renal medulla, hypoechoic to the spleen, and isoechoic to the hepatic parenchyma.

Key words: Ultrasonography, Rabbit, Kidney, Urinary bladder

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Introduction

Survey and contrast radiography are frequently utilized for diagnostic evaluation of the urinary system in animals in particular in dogs and cats. Radiography may allow assessment of a relationship existing between the urinary tract diseases and clinical signs. The kidneys are usually visible on survey radiographs, but the ureters are not.[1-5] Survey radiography provides information regarding to renal size, location, number, and density. However, survey radiographs may not provide adequate morphologic information when the patient is emaciated or has retroperitoneal fluid.[1, 3, 6, 7] Excretory urography (EU) is a radiographic contrast-enhanced procedure used to enhance visualization of the renal parenchyma and provide visualization of the structures not normally identified on survey radiographs, i.e., pelvic recesses, renal pelvis, and ureters.[1, 3, 5- 8] Renal ultrasonography, as a step in the evaluation of animals with clinical signs of renal disease, is generally performed after physical examination and the acquisition of laboratory results.[4, 9, - 11] Ultrasonographic examination and anatomy of the kidneys have been described for horses,[7] cattle,[16] dogs [12-14] and cats.[4,17] Ultrasonography has been used to diagnose renal calculi and cysts, renal neoplasia, hydronephrosis, cystitis, bladder diverticula, and obstruction of the lower urinary tract.[9,11] Diagnostic imaging techniques for the urinary system are included radiology (excretory urography, cystography, double-contrast cystography, positive-contrast cystography, and retrograde urethrography), abdominal ultrasonography, Doppler ultrasound, CT, MRI and scintigraphy.[10] Diseases of the urinary tract can be differentiated into those affecting the upper urinary tract (kidneys and ureters) and those affecting the lower urinary tract (bladder and urethra). Some urinary diseases affecting the kidneys are caused by a disease of the lower urinary tract.[15,18] Abdominal ultrasound of the urinary tract is very helpful in diagnosis of renal disease. However, many cases require biopsy or fine needle aspiration to achieve a final diagnosis. Renal ultrasonography requires additional diagnostic imaging techniques in some cases.[6] An 8 MHz transducer is optimal for ultrasonography of the kidney in cats[6]. Ultrasonographic evaluation of the urinary bladder can be performed in dorsal recumbency. The left kidney is scanned left of midline, caudal to the rib cage, with the spleen providing an acoustic window. The right kidney is more difficult to be completely visualized because of its position within the rib cage. A complete scan of both kidneys should be performed in transverse and longitudinal planes before making a diagnosis[6]. The normal renal cortex is finely granulated, homogenous and more hypoechoic than the parenchyma of the adjacent liver and spleen.[5,6] Liver and spleen echogenicity is so advantageous due to evaluate the ultrasonographic scans of kidneys and allow us to detect kidneys so easily in abdominal cavity. The renal cortex is the least echogenic, while the spleen has the highest echogenicity. The renal medulla is hypoechoic. Position of the animal allows optimal visualization of the urinary bladder. The bladder should be moderately distended with urine and the patient should have access to water without limits before examination[6].

The objective of this study was to determine the normal sonographic appearance of kidneys and urinary bladder in the healthy adult NZwr and Tolai hare

Materials and Methods

Fifteen healthy rabbits of New Zealand white rabbit and another fifteen Tolai hares were used. The rabbits did not have any apparent urinary tract infection. The healthy rabbits were 8-12 months old (mean = 9.3 month), and weighed between

1.1-1.7 kg (mean = 1.25 kg). Ultrasound images were obtained by real-time ultrasonographic equipment using 8 MHz linear real-time scanner. Sonographic images were printed using a video printer.

All ultrasonograms with the rabbits were done in dorsal recumbency. The rabbits were prepared for examination by clipping hair of the scanning site, cleaning of the skin with surgical spirit to remove debris and by application of sufficient amounts of coupling gel**.**

Ultrasonographic examination. The kidneys were examined from the paralumbar fossa by use of an 8 MHz linear real-time scanner (Sirphonix, Canada). The area over the paralumbar fossa had been already clipped on the right and left sides. Numerous ultrasonograms of the kidneys in both transverse and longitudinal section were conducted until the entire structure of the kidney had been covered. The echogenicities of the renal cortex, medullary pyramids were assessed and compared. Transverse ultrasonographic visualization of both kidneys was performed by placing the transducer at right angles to the longitudinal axis of each kidney.

Ultrasonographic measurements included the length of each kidney (the distance between the cranial and caudal renal poles, measured in the longitudinal plane); the depth of the kidney (the distance between the ventral and the dorsal surfaces, measured in the transverse plane); the width of the kidney (the distance between the lateral and the medial margin of the kidney, measured in the transverse plane). Ultrasound examination of the bladder was also performed in dorsal recumbency. The bladder was examined in a mid-sagittal plane. Bladder wall thickness was measured on static images. Before examination of every rabbits, transmission gel was applied and examined the kidneys.

Statistical Analysis. Statistical analysis and comparisons were done using Two-Way analysis of variance. Mean and standard deviation of kidney and bladder wall thickness were calculated for all rabbits from the collected data. The P values less than 0.05 were considered statistically significant.

Results

Ultrasonographic findings in 30 healthy animals (New Zealand white rabbit and Tolai hare) indicated that both kidneys could be visualized easily. The surfaces of the kidneys were smooth. The ultrasonographic images of the kidneys of all healthy rabbits appeared the same as those described for healthy dogs and cats (Fig. 1-4). Figures 1-6 are showing ultrasonograms of the kidneys in New Zealand white rabbit and Tolai hare. The means, standard deviations, and normal ranges of the measurements were calculated in all rabbits. This study revealed the following measurements for the normal rabbit kidneys: 27.80-35.70 mm and 16.90-22.40 mm in length and width in New Zealand white rabbit, respectively. The length and width were 26.67-34.50 and 15.82-20.60 mm, in Tolai hare, respectively. Bladder wall thickness varied from 1.70-2.50 mm (in New Zealand white rabbit) and 1.80-2.60 mm (in Tolai hare) (Table 1, 2). In this study, renal cortex was finely granular, uniform in echogenicity, hyperechoic to the renal medulla, hypoechoic than the spleen, and commonly hypoechoic or isoechoic to the hepatic parenchyma. The centrally located, hyperechogenic renal sinus was easily distinguished from the surrounding hypoechogenic renal cortex and medulla. Ultrasonographically, the renal medulla consisted of anechoic, circular, medullary pyramids. The renal cortex appeared uniformly gray and was less echogenic than the renal sinus. There was very little difference between the variables measured for the right kidney and those for the left. The course of the ureters could not be visualized ultrasonographically in any of the rabbits. The bladder could be ultrasonographically visualized in all rabbits (Fig. 5-6). The contents of the bladder were hypoechogenic and the bladder wall was uniform in thickness and smoothly demarcated inside and out. The mean diameters of the bladder were 19.23 ± 0.53 (in New Zealand white rabbit) and 18.42 ± 0.61 (in Tolai hare).

Fig 1. Ultrasonogram of a longitudinal left kidney (Tolai hare)

Fig 2. Ultrasonogram of a longitudinal left kidney (New Zealand white rabbit)

Fig 3. Ultrasonogram of a transverse right kidney (Tolai hare)

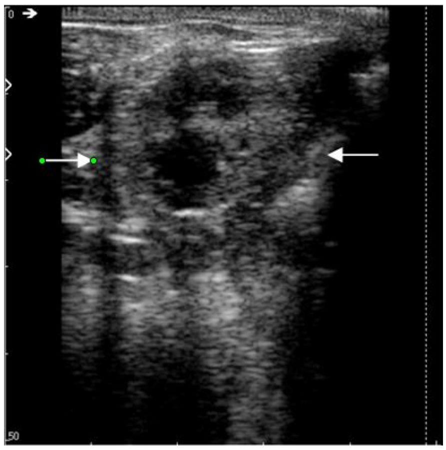

Fig 4. Ultrasonogram of a transverse right kidney (New Zealand white rabbit)

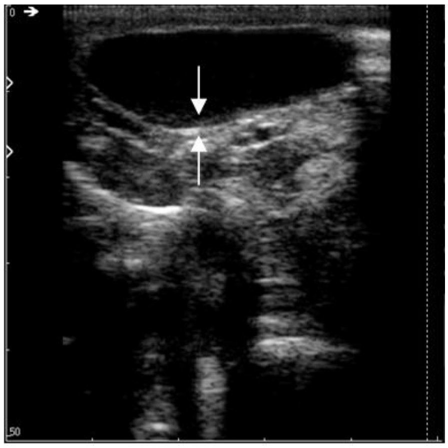

Fig 5. Ultrasonogram of the urinary bladder (Tolai hare)

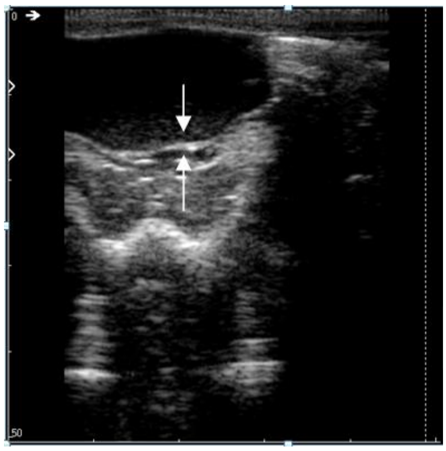

Fig 6. Ultrasonogram of the urinary bladder (New Zealand white rabbit)

Table 1. Measured parameters in the New Zealand white rabbits

	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation
Length(mm)	7.90	27.80	35.70	31.3733	0.54802	2.12249
width(mm)	5.50	16.90	22.40	19.9400	0.41631	1.61236
surface(mm)	2.00	6.20	8.20	7.2333	0.12749	0.49377
Diameter of cortex(mm)	2.30	3.80	6.10	4.9133	0.16729	0.64793
Diameter of medulla(mm)	1.30	3.70	5.00	4.2400	0.10365	0.40143
weight(mm)	0.55	1.10	1.65	1.3927	0.04420	0.17119
Urinary bladder	0.80	1.70	2.50	2.0600	0.06157	0.23845
depth(mm)	5.80	17.50	20.10	19.2312	0.52632	1.83214

Table 2. Measured parameters in Tolai hares

	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation
Length (mm)	7.43	26.67	34.50	30.3700	0.53711	2.12249
width(mm)	5.60	15.82	20.60	18.7600	0.50521	1.50110
surface(mm)	2.00	6.80	7.20	8.3231	0.13631	.58660
Diameter of cortex(mm)	3.10	4.70	5.50	5.6460	0.28910	.75665
Diameter of medulla(mm)	2.40	3.60	6.00	3.4300	0.20252	.51230
weight(mm)	0.65	1.20	1.70	1.4730	0.05530	.18055
Urinary bladder	0.90	1.80	2.60	2.3300	0.07063	.25620
depth(mm)	5.60	18.30	21.30	18.4235	0.61320	1.74055

Discussion

The purpose of the present study was to describe the ultrasonographic appearance of the rabbit urinary tract. The results indicated that the kidneys and bladder can be visualized by transcutaneous ultrasonography. To the best of the author’s knowledge, this study is the first to describe the urinary bladder of rabbits by means of ultrasonography. In the cat, kidney's length has also been reported to range from 3.8 to 4.4 cm, kidney's width from 2.7 to 3.1 cm, and kidney's depth from 2 to 2.5 cm by direct anatomic measurements.[6] In this survey, renal cortex

was finely granular, uniform in echogenicity, hyperechoic to the renal medulla, hypoechoic to the spleen, and commonly hypoechoic or isoechoic to the hepatic parenchyma. Our results suggested that the normal rabbit kidneys should be measured between length: 31.4 ± 2.1 (in New Zealand white rabbit) and 30.4 ± 2.1mm (in Tolai hare), width: 19.9 ± 1.6mm (in New Zealand white rabbit) and 18.7 ± 1.5mm (in Tolai hare), depth: 19.2 ± 1.8mm (in New Zealand white rabbit) and

18.4 ± 1.7mm (in Tolai hare). Diameter of the cortex and medulla were 4.9±0.64mm and 4.2±0.40mm (in New Zealand white rabbit) and 5.6 ± 0.75 mm and 3.4 ± 0.51 mm (in Tolai hare), respectively.

The renal medulla had the least echogenicity, followed by the renal cortex. Echogenicity of the renal cortex was similar to or slightly less than that of normal liver parenchyma. Thus the normal relationship of the echogenicity of the kidney to that of the liver and spleen was important for recognizing major abnormalities.

Linear kidney measurements in the cat are more useful because there is less variation in body size.[21, 23, 24] One investigation of to young cats (5 male, 5 female) reported that kidneys' length was 3.66 ± 0.46cm, width was 2.53 ± 0.30 cm, and depth was 2.21 ± 0.28 cm.[22]

The results of the present study indicated that ultrasonography is suitable in diagnosis of upper urinary diseases of rabbits, but were incapable in qualitative evaluation of renal functions and in examination of the ureters.

The bladder is readily examined when it is distended with urine and can be served as a useful acoustic window for detecting and visualizing adjacent structures such as the colon and uterus. In ultrasound, bladder wall thickness, mass lesions, foreign bodies and calculi are easily evaluated.[15] Bladder wall thickness varies with the degree of bladder distention. Mean bladder wall thickness was 2.3 mm in minimally distended canine bladders. It measures approximately 1.4 mm in moderately distended bladder. In addition, bladder wall thickness increases with body weight. The heaviest dogs have approximately 1 mm thicker wall than the lightest dogs.[20] Bladder wall thickness varies from 1.3 to 1.7 mm in cats.[19] In a study on dogs, it was shown that width and length of normal kidney were 5.5-9.1mm.[25] In our survey, the bladder wall thickness varied from 1.7-2.5 mm to 1.8 - 2.6 mm in NZwr and Tolai hare.

Knowledge of bladder volume is required in order to interpret the results of bladder scanning.[6] In species such as humans and dogs,[13] where B-mode ultrasonography is used and the bladder imaged in its entirety, longitudinal and transverse images of the urinary bladder are measured two-dimensionally and the four values then used to calculate the bladder volume. [13, 18]

Some descriptions of ultrasound examination of the canine bladder wall recommended complete bladder distention for evaluation of mucosal detail and wall thickness. However, complete bladder distention is deleterious to the bladder wall, potentially causing ischemia, hemorrhage, cystitis, and rupture. [20]

In humans it was however assumed that the bladder wall is uniformly thick regardless of the measurement locations,[26] and differing wall thicknesses at different locations reflect a measurement resulting from a higher or lower ultrasound resolution at the different locations [11]. Sediment can be visualized by transrectal scanning but, equally well transcutaneously which is a less laborious procedure and already used in pig production for reproductive purposes.[3]

Animals with urinary tract infection (UTI) have more often high and moderate amounts of sediment in urine than those without UTI. [23] Even though sediment was not described by microscopic examination in their research, the finding supports the concept that urine crystals predispose to bacterial infection.[23] In a full urinary bladder the wall thickness should not exceed 2mm while in an empty bladder the wall thickness may normally measure up to 5 mm in the dog. Bladder wall thickness varies from 1.3 - 1.7 mm in normal cats[19]. Although not commonly seen, sometimes a hypoechoic mucosa, a hyperechoic submucosa, a hypoechoic/ mixed muscular layer and a hyperechoic serosal surface may be visible. Diffuse or focal bladder wall thickening can be identified. Commonly in cases of cystitis the thickening is mainly seen at the cranioventral bladder wall while in cases of neoplasia the thickened irregular wall is seen at the level of the bladder neck.[25]

In conclusion, the renal cortex was finely granular, uniform in echogenicity, hyperechoic to the renal medulla, hypoechoic to the spleen, and isoechoic to the hepatic parenchyma.

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