JOURNAL OF VETERINARY AND APPLIED SCIENCES
2020 VOL. 10 (2): 25 - 32
Manuscript No. JVAS/2019/068; Received: 05/10/2019; Accepted: 20/08/2020
Published by: Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria

EVALUATION OF SEX VARIATIONS IN ULTRASONOGRAPHIC KIDNEY VOLUME OF APPARENTLY HEALTHY NIGERIAN INDIGENOUS DOGS

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ABSTRACT

Ultrasonographic kidney volume has been clinically implicated in the diagnosis of canine kidney diseases. The aim of this research was to evaluate variation in the ultrasonographic kidney volume between male and female apparently healthy Nigerian indigenous dogs. One hundred and fifteen apparently healthy Nigerian indigenous dogs aged 1 to 4.5 years were selected on the basis of physical examination and normal value of haematological profile and serum creatinine levels in Zaria and its environs for this study. In-vivo ultrasonographic kidney dimensions were obtained by standard scanning procedure for measuring the kidney length (cm), width (cm) and height (cm) to compute the kidney volume (cm^3) using prolate ellipsoid formula (L xW x H x 0.523). In males, right kidney volume had a range of 10.74 – 63.20 cm^3 with a mean ± SEM of 27.47±1.22 cm^3, while the left kidney volume ranged from 13.66 to 70.21 cm^3 with a mean ± SEM of 32.67±1.35 cm^3. In the females, the range of the right and left kidney volume were 9.22 – 45.22 cm^3 and 15.56 – 51.80 cm^3 while the means ± SEM were 24.02±1.35 $cm^3$and 31.73±1.57 cm^3 respectively. There was no significant variation between right (0.0834) and left (0.6727) kidney volumes in the male and female Nigerian indigenous dogs in Zaria. This study provides preliminary information on the ultrasonographic kidney volume of apparently healthy Nigerian indigenous dogs and be useful in the diagnosis and monitoring of kidney diseases in these dogs.

Keywords: Ultrasonography, Kidney, volume, Nigerian, indigenous, dogs.

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ISSN: 2315 – 6856; e-ISSN: 2636 – 5553; *Website: www.jvasonline.com*

INTRODUCTION

Accurate diagnosis of kidney disorders in dogs has clinical relevance as many deaths are associated with kidney defects [1]. Several diagnostic modalities for kidney investigations include ultrasonography, computed tomography scan, radiography, magnetic resonance imaging and scintigraphy. Ultrasonography is, however, considered to be the best modality for examining abdominal structures including thise locations and dimensions of kidneys [2]. Ultrasound has been employed in assessing canine kidney dimensions such as kidney volume [3,4], kidney size [5] and kidney length [6].

Ultrasonographic kidney volume has been clinically implicated in the diagnosis of canine kidney diseases [7,8]. The knowledge on its normal values is very important in clinics as changes will aid in diagnosis and monitoring of canine kidney diseases [9,10,11,12,13]. Kidney volume has also been considered a reliable dimension for kidney disease diagnosis [4]. On the other hand, another kidney dimension like the kidney size decreases in value with increase in age while kidney volume remains relatively constant in humans [14]. Therefore, kidney volume is reported to be precise in clinical use regarding kidney diseases of dogs [8].

The normal range for canine kidney dimensions have been attempted [15], but some researchers are of the opinion that normal range for canine kidney dimensions should be based on individual breed because of body size disparity among numerous breeds of dog [16,17]. Presently, information on ultrasonographic kidney volume of Nigerian indigenous dogs is scarce and this may be of clinical importance in the diagnosis and monitoring of canine kidney diseases. The aim of this study was to provide preliminary data on the ultrasonographic kidney volume in apparently healthy male and female Nigerian indigenous dogs.

MATERIALS AND METHODS

Animal Subjects

One hundred and fifteen (115) apparently healthy Nigerian indigenous dogs aged 1 - 4.5 years and sourced within Zaria and its environs were used for this study. The dogs were considered apparently healthy on the basis of physical examination and normal haemogram and serum creatinine levels. Ethical clearance for the study was obtained from the Committee on Animal Use and Care of the Ahmadu Bello University with approval number: ABUCAUC/2017/008. Ethical protocols and standard scanning procedure were strictly observed in the study.

Hematological and biochemical evaluations

Blood samples (5 ml) were collected from the cephalic vein of each dog, Out of the 5 ml of blood collected, 1 ml was used for haemogram studies while the remaining 4 ml was used in extracting serum for creatinine assay.

Evaluation of ultrasonographic kidney dimensions

Restraint and site preparation

The dogs were physically restrained on dorsal recumbence and shaved from the xiphoid process which runs around the caudal border of the last rib that extends longitudinally downward at about 20 cm caudal to the umbilical scar and then also shaved laterally from side to side at about 10 cm to the left and right each from the midline.

Ultrasonographic scanning procedure

After shaving on dorsal recumbence, aquostic gel (Nacal® medical ultrasound gel, England) was liberally applied to the transducer and surface of the skin, caudal to the rib cage. Scanning procedure was carried out on B-mode laptop ultrasound scanner Sonostar C5® (Sonostar Technologies Co., Guangzhou, Guangdong, China) using a 5.0 MHz curvilinear transducer. Sagittal and transverse planes of right and left kidneys were scanned, where the left and right kidneys were located as described by Nyland and

Matton [18]. Kidney length (Fig. 1), was measured from the cranial to caudal poles of the kidney on sagittal plane [19]. Kidney width (Fig. 2) was measured by dragging the pointer from the medial limit to the lateral limit along the hilus of the kidney. Kidney height (Fig. 3) was obtained by measuring the distance from the dorsal limit to the ventral limit of the kidney; both on transverse plane [8]. The renal volume (V cm^3) was estimated using the formula for the volume of an ellipsoid where V = kidney length (L cm) x kidney width (W cm) x kidney height (H cm) x 0.523 [8].

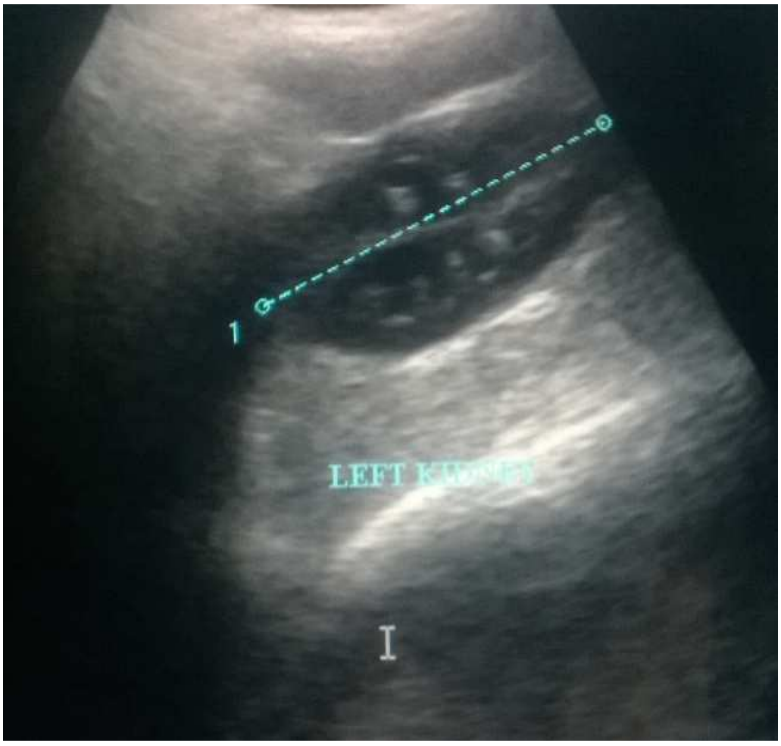

Figure 1: Sonographic measurement of kidney length. The diagonal broken lines indicate the oblique measurement to obtain the length of the kidney.

Data Analysis

Data collected were subjected to statistical analysis using GraphPad Prism® version 5.0 and mean ± SD of the value for each subject was calculated. Student T-test was used to compare kidney volumes between sexes with values of $P \leq 0.05$ considered significant.

RESULTS

Haematological and biochemical evaluations

Ranges and means ± SEM values of the hematological profile and serum creatinine values of the Nigerian indigenous dogs are shown in Table 1. This conjectured that the mean values of hematological parameters are within normal limits.

Evaluation of ultrasonographic kidney dimensions

Values of ultrasonographic kidney dimensions such as kidney length, width and height obtained for the Nigerian indigenous dogs are presented in Table 2. In male dogs, the range of right kidney volume was 10.74 – 63.20 cm^3 with a mean of 27.47±1.22 cm^3, while the range of left kidney volume was 13.66 – 70.21 cm^3 with a mean of 32.67±1.35 cm^3. Similarly, in females, right and left kidney volume were within the range of 9.22 – 45.22 cm^3 and 15.56 – 51.80 cm^3 while the means were 24.02±1.35 cm^3 and

31.73±1.57 cm^3 respectively. There was no significant (p>0.05) variation between right (0.0834) and left (0.6727) kidney volumes in male and female Nigerian indigenous dogs. Therefore, the average right and left kidney volume should be 26.33±0.94 cm^3 and 32.36±1.04 cm^3 respectively in apparently healthy Nigerian indigenous dog.

Figure 2: Sonographic measurement of kidney width. The horizontal broken lines indicate the oblique measurement to obtain the width of the kidney.

Figure 3. Sonographic measurement of kidney height. The vertical broken lines indicate the oblique measurement to obtain the height of the kidney.

Table 1. Mean ± SEM values of the hematological profile and serum creatinine of 115 apparently healthy Nigerian indigenous dogs.

Variables	Mean ± SEM `	Reference values*
Haemoglobin (g/dl)	13 ± 0.33	12.0 - 18.0
Packed cell volume (%)	40 ± 0.98	37 - 55
Erythrocytes ($x10^{12}$)	6.7 ± 0.16	5.5 - 8.0
Leucocytes ($x10^{9}$)	11 ± 0.37	6.0 - 17.0
Neutrophil ($x10^{9}$)	6.4 ± 0.31	3.0 - 11.5
Lymphocytes ($x10^{9}$)	3.4 ± 0.17	1.0 - 4.8
Eosinophils ($x10^{9}$)	0.13 ± 0.032	0.1 - 1.25
Monocytes ($x10^{9}$)	0.11 ± 0.016	0.11 - 0.7
Bands ($x10^{9}$)	0.14 ± 0.025	0 - 3.0
Creatinine (µmol/l)	74.13 ± 2.27	40.0 – 130.0

*Hematological reference values for Nigerian indigenous dogs used in Ahmadu Bello University Veterinary Teaching Hospital.

Table 2. Mean right and left ultrasonographic kidney dimensions and variations in apparently healthy male and female Nigerian indigenous dogs examined at Zaria, Nigeria.

Variables	Males (n= 77)				Females (n= 38)				*P* Values	
	Right Kidney		Left Kidney		Right Kidney		Left Kidney		RK	LK
	Range	Mean±SEM	Range	Mean±SEM	Range	Mean±SEM	Range	Mean±SEM	M x F	M x F
Kidney length (cm)	3.86-7.40	5.588 ± 0.083	4.40-7.57	5.848 ± 0.077	4.01-6.90	5.44 ± 0.110	4.12-6.92	5.743 ± 0.105	0.3001	0.4274
Kidney width (cm)	2.09-5.0	3.178 ± 0.070	2.04-5.42	3.345 ± 0.061	1.86-4.50	3.106 ± 0.093	2.40-4.59	3.385 ± 0.083	0.5465	0.7045
Kidney height (cm)	1.77-4.40	2.861 ± 0.058	1.84-4.64	3.115 ± 0.061	1.98-4.01	2.651 ± 0.066	2.01-4.03	3.063 ± 0.081	0.2940	0.6421
Kidney volume(cm^3)	10.74-63.20	27.47±1.218	13.7 - 70.2	32.7±1.35	9.2 - 45.2	24.02±1.346	15.6- 51.8	31.73±1.568	0.0834	0.6727

Key: RK= Right kidney, LK= Right kidney, M= Males and F= Females.

DISCUSSION

Hematological profile and serum creatinine analyses appeared to be within normal limits. This implies that the dogs used are apparently healthy since healthy state of organism is usually accompanied with normal hemogram and leukogram [20,21]. Therefore, the range limits obtained from the *in-vivo* ultrasound measurement of the kidney dimensions in these subjects may be considered normal for Nigerian indigenous dogs.

The results of this study suggested that there were no significant sex variations in kidney dimensions of Nigerian indigenous dogs. Similar findings were reported in Brazilian dogs [22]. On the other hand, studies in German shepherd [23] and Dachshund [24] breeds of dog showed that males had larger kidney dimension than females while a contrary finding was reported in cats [24],. On the other hand, some studies in humans reported no significant variations between male and female kidney dimensions [25,26,27,28]. Other studies reported significant sex variations in kidney dimensions with males having greater values than females [29,30]. This finding was suggested to be influenced by the anabolic activity of androgens that cause hypertrophy of proximal tubule, so that the length differences were restricted in the renal cortex [31,32]. Another most likely explanation could be due to larger body size in male which reqiures a large quantity of nephron for its metabolic activities [33].

The values obtained for kidney volume in this study may be considered as a reference value for the Nigerian indigenous dog breed, as the suggestion would derive fact from the point that various breeds of dogs would have different kidney dimensions due to body size disparity [17]. However, there is another volume method of prolate ellipsoid used for single plane area-length models (A^2 x 0.85/L) [3,34], which may produce slightly different values as 47.39±4.3 cm^3 and 44.53 ±3.49 cm^3 for the right and left kidneys respectively [34], The prolate ellipsoid for the biplane length-diameter models (L x W x H x 0.523) used in this study for the Nigerian indigenous dog, appears to be a better method when considering prolate ellipsoid organs such as kidneys [10,9]. This method has also been advocated in the ultrasonographical determination of kidney volume in humans [35,36].

Kidney volume has been considered as an accurate and reproducible kidney dimension that better explains the functionality of a kidney [37,3,9] in which changes occur in the presence of kidney disorders [4,34] as well as early detection of nephropathies even before clinical symptoms become evident [38]. In conclusion, therefore, this study was able to establish the normal reference range values of kidney volume of the Nigerian indigenous dog. This finding may be of clinical significance in kidney disease diagnosis and monitoring especially as it relates to morphological changes of the organ.

ACKNOWLEDGEMENTS

Authors are grateful to Ahmadu Bello University Veterinary Teaching Hospital, Zaria, for their use of ultrasound equipment.

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