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Relationship between ultrasonographic kidney bipolar length and body weight in normal Nigerian Indigenous Dogs

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ABSTRACT

Introduction: Ultrasonographic kidney bipolar length is considered the most important kidney dimension which can be used in the diagnosis of kidney diseases. The aim was to determine healthy Nigerian indigenous dogs with normal kidneys, evaluate variation between right and left kidney bipolar length and correlate between ultrasonographic kidney bipolar length and body weight in normal Nigerian Indigenous Dogs.
Methods: One hundred and fifteen (115) apparently healthy Nigerian Indigenous Dogs owned by local hunters and households residing in Zaria, the weight and age range between 8 to 30 kg and 1 to 4.5 years respectively. Only dogs with normal serum biochemistry values (creatinine, blood urea nitrogen and total protein) were used for this study. Ultrasonographic kidney bipolar lengths were obtained on the sagittal plane by measuring the distance from the cranial to caudal poles of the kidneys.
Results: Haematological profile and serum biochemistry of the dogs used were within normal limits and values. Left kidney bipolar length was statistically larger than the right kidney bipolar length. Correlation between ultrasonographic kidney bipolar length and body weight revealed a significant positive linear relationship as 0.33 and 0.50 in right and left kidneys respectively.
Significance: The relationship between ultrasonographic kidney bipolar length and body weight can be a valuable parameter for the diagnosis of kidney disorders in Nigerian Indigenous Dogs.

Introduction

Ultrasonography has been used to study the disease conditions and dimensions of the canine kidney (Remichi *et al*., 2014), which is superior over radiography as there are no adverse effects of contrast agents and radiations (Nyland *et al*., 1995).
Many kidney disease conditions are consistent with an aberration in kidney dimensions (Sohn *et al*., 2016). Ultrasonographic kidney bipolar length is considered the most important kidney dimension used in determining kidney size (Konde *et al*., 1984), so changes in kidney bipolar length, as well as other kidney dimensions, indicate abnormal kidney function which is used in diagnosis of kidney diseases (Barr, 1990; Sohn *et al*., 2016). Ultrasonographic kidney dimensions have been correlated with body weight in dogs to evaluate its relationship in diagnosis of kidney diseases (Nyland *et al*., 1989; Barr *et al*., 1990; Felkai *et al*., 1992; Sampaio and Araujo, 2002). Body weight is the principal product of nutrition and metabolism of body to sustain life and to engage in physical activities (Hall *et al*., 2012). In humans, ultrasonographic kidney bipolar length has been established as an important dimension used in diagnosis of kidney diseases (Hekmatnia and Yaraghi, 2004) and its correlates positively with body weight (Raza *et al*., 2011; El-Reshaid and Abdul-Fattah, 2014).
There is a paucity of information on ultrasonographic kidney bipolar length and its relationship with body weight in Nigerian Indigenous Dogs, which has clinical importance in the diagnosis of kidney diseases. Therefore, there is a need to investigate the relationship between ultrasonographic kidney bipolar length and body weight in Nigerian Indigenous Dogs. The aim was to determine healthy Nigerian indigenous dogs with normal kidneys, evaluate variation between right and left kidney bipolar length and correlate between ultrasonographic kidney bipolar length and body weight in normal Nigerian Indigenous Dogs.

Materials and methods

Animal subjects
One hundred and fifteen (115) apparently healthy Nigerian Indigenous Dogs owned by local hunters and house-holds residing in Zaria and its environs, weight and age ranges between 8 to 30 kg and 1 to 4.5 years respectively were used for this study. Haematological profile and serum biochemistry were analysed, and only dogs with normal values were used in the study. All experimental procedures and protocol were reviewed and approved by the Ethical Committee of the Animal Bello University Animal Care and Use Committee (ABUCAUC/2017/008), and consent

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was obtained from all the dog owners, prior to the commencement of the study.

Ultrasonographic kidney bipolar length

The dogs were restrained physically on dorsal recumbency and the ventral abdominal area was shaved. Then acoustic gel was liberally applied to both the probe contact surface and skin at the cranial abdomen, caudal to the last rib cage. Scanning procedure was carried out with a portable digital B-mode scan machine Sonostar C5^{TM} (Sonostar T1echnologies Co., Guangzhou, Guangdong, China) using a 5.0 MHz, curvilinear electronic transducer. Sagittal plane scan of right and left kidneys was carried out to obtain the ultrasonographic kidney bipolar length. The left kidney was first located between L_1-L_3, while the right kidney was deeper and cranially in the para-costal region located between T_{12}-L_1. Movement of the transducer at these locations assisted on targeting the impulse from the transducer on the kidneys which appeared on the B-mode monitor. A clear image of the kidney on the monitor was frozen, and distance measurement mode was activated to measure the kidney bipolar length in centimetre (cm) for both right and left kidneys, which is the distance from the cranial pole to the caudal pole of the kidneys as shown in Figure 1 (bipolar length).

Haematological profile and serum biochemistry analyses

Five to seven mls of blood sample from the cephalic vein was collected from each dog. Blood samples for analysis of haematological profile were collected in EDTA sample bottles, while serum samples were extracted from the blood sample collected in plain sample bottles for creatinine, urea, and total protein analyses, to ensure the ultrasonographic kidney data were obtained from normal kidneys.

Data analysis

Data collected were subjected to statistical analysis using Graph Pad Prism® version 5.0 and mean ± SEM for each variable was calculated. The student-T test was used to analyse data between paired kidneys. Pearson's correlation coefficient test was used to relate between ultrasonographic kidney bipolar length and body weight. The value of $p < 0.05$ was considered significant.

Results

Haematological profile and serum biochemistry evaluations

The haematological profile are haemoglobin concentration (g/dl), packed cell volume (%), erythrocytes (10^{12}/L), leucocytes (10^9/L), neutrophils (10^9/L), lymphocytes (10^9/L), eosinophils (10^9/L), monocytes (10^9/L) and bands (10^9/L) with mean ± SEM of 13 ± 0.33, 40 ± 0.98, 6.7 ± 0.16, 11 ± 0.37, 6.4 ± 0.31, 3.4 ± 0.17, 0.13 ± 0.03, 11 ± 0.02 and 0.14 ± 0.03 respectively as shown in Table 1. The mean ± SEM values for the analyses of the serum biochemistry are creatinine (mg/dl), urea (mg/dl), and total protein (g/l) with mean ± SEM of 0.84 ± 0.03, 12.10 ± 0.31 and 67.06 ± 1.02 respectively as shown in Table 1. These conclude that the mean values of the serum creatinine, urea, and total protein of the Nigerian Indigenous Dogs used in this study are within normal range.

Kidney bipolar length

In male Nigerian Indigenous Dogs, right kidney bipolar length has a range of 3.86 – 7.40 cm with the mean ± SEM of 5.59 ± 0.08, while the left kidney bipolar length has a range of 4.40 – 7.57 cm with the mean ± SEM of 5.85 ± 0.08 as presented in Table 2. Similarly, in female Nigerian Indigenous Dogs, right and left kidney bipolar length were within the range of 4.01 – 6.90 cm and 4.12 – 6.92 cm, their mean ± SEM were 5.44 ± 0.11 and 5.74 ± 0.11 respectively as shown in Table 2. The lengths of the left kidneys were significantly larger than the right kidneys in both male ($p = 0.0008$) and female ($p = 0.0012$) Nigerian Indigenous Dogs.

The right kidney bipolar lengths (cm) were within the range of 3.86 - 7.40 cm with the mean ± SEM of 5.54 ± 0.67 cm, while the left kidney bipolar lengths ranged from 4.12 to 7.57 cm with the mean ± SEM of 5.81 ± 0.06 cm. This surmised that the average right and left kidney bipolar lengths in this study are 5.54 ± 0.67 cm and 5.81 ± 0.06 cm respectively in normal Nigerian Indigenous Dogs. The length of the left kidneys was significantly larger than the right kidneys ($p < 0.0001$) in Nigerian Indigenous Dogs as presented in Table 2.

Correlation between kidney bipolar length and body weight

The ranges and mean ± SEM of the body weight (kg) of the Nigerian Indigenous Dogs used were 8 to 30 and 16.74 ± 0.45 respectively. Correlation between ultrasonographic kidney bipolar length and body weight in males and females revealed significant positive relationship and insignificant positive relationship respectively.

Correlation between ultrasonographic kidney bipolar length and body weight in both males and females revealed a positive relationship with right kidney (0.33) and left kidney (0.50). The relationship was statistically significant in right kidney ($p = 0.0003$) and left kidney ($p < 0.0001$) as shown in Table 3 and graphically represented in Figure 1 and 2 respectively.

Table 1. Haematological profile and serum biochemistry evaluations of Nigerian Indigenous Dogs.

Variables	Mean ± SEM	References values
Haemoglobin (g/dl)	13.00 ± 0.33	8.60 – 17.00
Leucocytes (×10⁹/L)	11.00 ± 0.37	8.00 – 17.00
Neutrophil (×10⁹/L)	6.40 ± 0.31	3.52 – 14.45
Lymphocytes(×10⁹/L)	3.40 ± 0.17	0.23 – 4.87
Eosinophils (×10⁹/L)	0.10 ± 0.03	0.00 – 1.67
Monocytes (×10⁹/L)	0.10 ± 0.02	0.00 – 1.37
PCV (%)	40.00 ± 0.98	24.00 – 48.00
Erythrocytes (×10^{12}/L)	6.7 ± 0.10	3.10 – 6.80
Creatinine (mg/dl)	0.84 ± 0.03	0.40 – 1.80
Urea (mg/dl)	12.10 ± 0.31	10.00 – 20.00
Total protein (g/l)	67.06 ± 1.02	23.00 – 75.00

References values: Atata *et al*., 2018

Table 2. Ultrasonographic length of right and left kidneys of Nigerian Indigenous Dogs

Variables	Kidney dimensions n = 115				
	Right kidney bipolar length (cm)		Left kidney bipolar length (cm)		
	Range	Mean ± SEM	Range	Mean ± SEM	Variation (p values)
Males (M)	3.86 - 7.40	5.59 ± 0.08	4.40 - 7.57	5.85 ± 0.08	0.0008***
Females (F)	4.01 - 6.90	5.44 ± 0.11	4.12 - 6.92	5.74 ± 0.11	0.0012**
Both M & F	3.86 - 7.40	5.54 ± 0.67	4.12 - 7.57	5.81 ± 0.06	0.0001***

**: $p < 0.05$ (Significant variation)

Table 3. Correlation between body weight with right and left kidney bipolar length in Nigerian indigenous dogs

Parameters	Right kidney bipolar length correlation	Left kidney bipolar length correlation
Males (M)	0.39^{***}	0.60^{***}
Females (F)	0.10	0.21
Both M & F	0.33^{***}	0.50^{***}

***: $p < 0.0005$ (Significant correlation)

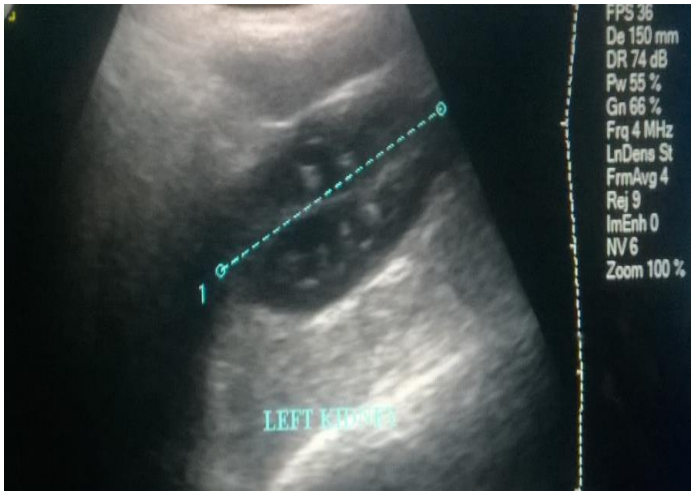

Figure 1. Sonographic measurement of kidney bipolar length. The dotted lines indicate the measurement of the length of the kidney.

Discussion

Haematological profile and serum analyses especially indicators for kidney disorders such as creatinine, urea, and total protein are within normal ranges. This entails that dogs used for this research were clinically healthy in respect of the subject, due to the fact that haematological profile and serum biochemistry are usually within normal limits in the normal state of health of an organism (Bush, 1993). The common specific indicators for kidney disorders such as creatinine, urea, and total protein were also within normal limits in the dogs used for this study, this can be related to the physical examination and consideration of body condition score of three (ideal) from a five point scale, these are evidences that the ultrasonographic kidney data obtained from the dogs in this research are clinically normal (Esievo, 2017). There were significant findings that revealed that the left kidney bipolar length was larger than the right kidney bipolar length in Nigerian Indigenous Dogs. Kolber and Borelli (2005), and Cunha *et al*. (2009) reported similar findings in German shepherd and Dachshund dogs respectively, while some studies reported that right kidney is larger than the left kidney (Mareschal *et al*., 2007), and others reported no differences between right and left kidneys (Sampaio and Araujo, 2002; Barella *et al*., 2012; Jeyaraja *et al*., 2015). In humans, the large left kidney bipolar length was suggested as the right kidneys are surrounded by liver tissues which restrict its development, unlike the left kidney (Karim *et al*., 2015). Another study suggested the short left renal artery as culprit, thereby allowing increased blood flow that may slightly increase the left kidney due to increased volume (Okur *et al*., 2014).

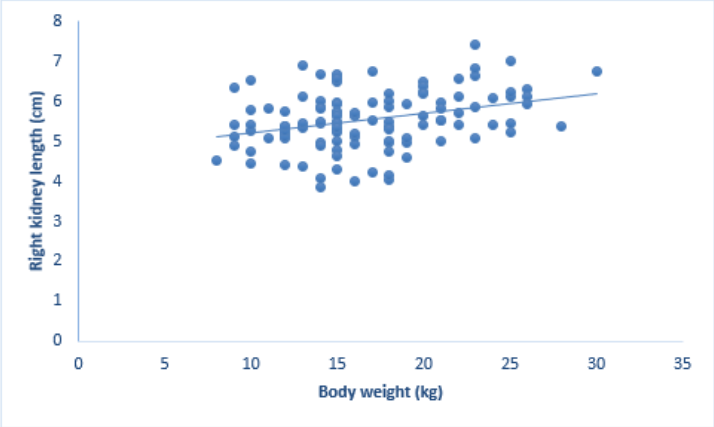

Figure 2. Positive linear relationship between right kidney bipolar length and body weight

There were significant but weak positive correlations between ultrasonographic kidney bipolar length bipolar and body weight in Nigerian Indigenous Dogs. However, some researchers reported positive relationship between kidney dimensions and body weight in dogs (Nyland *et al*., 1989; Barr, 1990; Felkai *et al*., 1992; Sampaio and Araujo, 2002). The positive linear relationship was observed between ultrasonographic kidney bipolar length and body weight in this study. Because it has been reported that the body weight has influence on kidney size (Sohn

et al., 2016), such that changes in body weight affects kidney size (Barr *et al*., 1990) as similarly explained by Olesen and Genster (1970). Body weight gain leads to obesity which was also reported as a risk factor for kidney diseases (Kramer *et al*., 2005; Ejerblad *et al*., 2006) that is usually characterized with changes in kidney size (Barrera *et al*., 2009). Such relationship has been known to be useful in diagnosis of nephropathies (Sampaio and Araujo, 2002).

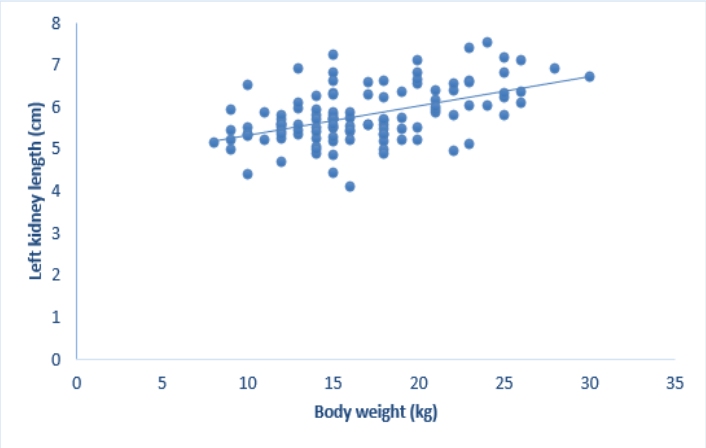

Figure 3. Positive linear relationship between left kidney length and body weight.

Limitation to this study was that ultrasonographic kidney volume was not determined, which can be compared with the ultrasonographic kidney bipolar length to evaluate the best ultrasonographic dimension that would best correlate with body weight which can be used in diagnosis of kidney diseases.

Conclusion

The relationship between ultrasonographic kidney bipolar length and body weight can be used for diagnosis of kidney disorders in Nigerian Indigenous Dogs.

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Conflict of interest

There is no conflict of interest regarding this research work.

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