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Original Research Article

THE CORRELATION OF BODY LENGTH WITH SONOGRAPHIC MEASUREMENT OF BIPOLAR LENGTH OF KIDNEYS OF THE GUINEA PIG (*CAVIA PORCELLUS*)

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ABSTRACT

The study examined the effect of sex on the size of guinea pigs' kidneys and correlates ultrasonographically measured bipolar length of the animal with body weight and length. Ten healthy adult guinea pigs; 5 males and 5 females bought from Samaru market in Zaria, Kaduna State, Nigeria were used. Kidney bipolar lengths were obtained ultrasonographically on the sagittal plane by measuring the distance from the cranial to the caudal poles of the kidneys. The mean body weight and length of the guinea pigs were 388.20 ± 32.55g, 25.20 ± 0.58 cm respectively. The mean bipolar lengths of the left and right kidneys were 18.22 ± 0.73 mm and 18.11 ± 0.82 mm respectively. There was statistically significant difference ($P< 0.05$) in the length and volume of the left kidney length and right kidney volume of the male and female guinea pigs respectively. However, there was no statistically significant difference ($P > 0.05$) in the length and volume of the left kidney and right kidney of the male and female guinea pigs respectively, and a correlation of 0.517 which has a significance data of 0.126 ($P > 0.05$). The present study has elucidated that kidney length correlated with this body index (body weight) in guinea pigs and this may be of assistance for estimating kidney size during clinical assessment of patients, as this gives an early indication to the condition of the kidney.

Keywords: Body length; Body weight; Guinea pigs; Kidney bipolar length, Ultrasonography,

INTRODUCTION

Guinea pigs (*Cavia porcellus*) have long been recognized as representatives of laboratory animals (Harness & Wargner, 1993). Biological experimentation on guinea pigs has been carried out since the 17th century. The first experimental use of this species can be traced to Lavoisier, in 1790, in investigations of the effects of heating (Andrade *et al.*, 2006). Thereafter, these animals have been largely used as experimental models in several area of biology (Karol, 1994), resulting in the epithet "guinea pig" for a test subject. Even though guinea pigs have since been largely replaced by other rodents such as mice and rats, they are still used in research, primarily as models for human medical conditions such as juvenile diabetes, tuberculosis, scurvy, and pregnancy complications (Newsom & Wing, 2004).

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Thus, there is a need for detailed information on aspects related to diseases affecting the guinea pig and for veterinarians to deepen their knowledge of available diagnostic imaging aids. There is no doubt that the science-oriented studies of anatomy and physiology are the basis for the interpretation of imaging studies, as well as for the success of clinical and surgical procedures (Peixoto *et al*., 2010).

The main functions of the kidney include excretion of uraemic toxins and the regulation of several vital body systems such as intra and extracellular volume status, calcium and phosphorus metabolism and erythropoiesis (Gueutin *et al*., 2012).

Ultrasound is a widespread diagnostic imaging modality in Veterinary medicine that provides real time information about the architecture and ultrasonographic characteristics of organs, assisting in the identification of the physiological conditions and abnormalities in various organ and diseases (Peixoto *et al*., 2010). Furthermore, ultrasound is portable, does not emit radiation and usually does not require general anaesthesia, except in wildlife animals. It can be used in clinics, laboratories and field, but its use is still limited in wildlife animals, due to the limited knowledge of the topography and ultrasound anatomy of their organs (Peixoto *et al*., 2010).

According to Nyland *et al.* (2005) and Peixoto *et al.* (2010), it is essential that the sonographer has an extensive knowledge of anatomy, physiology and pathophysiology of the studied species. The knowledge of the topography and ultrasound anatomy of organs to be examined are prerequisite for an ultrasound, given that the accurate interpretation depends directly on the differentiation between normal and abnormal structures. The aim was to determine whether sex has effect on the size of kidney and to correlate the ultrasonographically measured bipolar length of the animal with body weight and length.

MATERIALS AND METHODS

STUDY AREA

The experiment was carried out in the Department of Radiology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria (11° 04/N, 7° 42/E), Kaduna State, located in the Northern Guinea Savannah zone of Nigeria. (Wiki, 2013). It is divided into Zaria and Sabon gari LGAs (Ministry of Economic Development, 1996). Zaria has an estimated land area of about 300 square kilometres and it is approximated that about 40-75 % of its working populating derive its means of livelihood from agriculture (ABU, 2000).

EXPERIMENTAL ANIMALS

Ten healthy adult Guinea pigs (*Cavia porcellus*) of both sexes (5 each) were bought from Samaru market in Zaria, Kaduna State, Nigeria. They were transferred into standard laboratory cages in the Department of Veterinary Anatomy, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria. The animals were given free access to water and feeds during the period. The animals were acclimatised for two weeks before the commencement of the experiment.

ETHICAL APPROVAL

The Ethical Committee of the Ahmadu Bello University Animal Care and Use Committee (ABUCAU//2017/032) reviewed all the experimental procedures and protocols. This was to ensure that animals were humanely handled (AVMA, 2013).

MORPHOMETRIC STUDIES

Each guinea pig was weighed to the nearest 0.1g with a dial spring table scale (Camry^{R}). The length of each guinea pig was measured to the nearest 0.1 cm using a string and a measuring tape (Butterfly^{R}). The total length of the guinea pig was measured starting from the nostril to the end of the coccygeal vertebrae.

GUINEA PIG AGE ESTIMATION

The gestational period of guinea pig is 59-72 days and their life spans is 4-8 years. The age of the guinea was estimated using their body mass or length as adult as described by Annon (2016): Body mass: 1.5 – 2.6 Ibs (Adult), Body length: 7.9 – 9.8 in (Adult)

RESTRAINT MODALITIES

One hand was placed around the chest with the thumb and fingers directly behind the front legs. The palm of the other hand was placed under the hind quarters when lifting to bear most of the animal's weight. The guinea pigs were wrapped in a towel and held against the restrainer's body before they were gently placed on the examination table.

SONOGRAPHIC EVALUATION

The hairs on the ventral abdominal, region, from the coastal arch to the inguinal region of the guinea pig were clipped. Then a heated acoustic gel was applied to the animal's skin to prevent hypothermia and assisted in acoustic contact between the transducer and the patient. Thereafter the animal was positioned in a supine position to perform the sonographic evaluation with the ultrasound. The kidneys were evaluated in the longitudinal, transverse and dorsal planes to determine the contour, margin, echo-texture and echogenicity following the methods of Vac (2004), measurements were taken on images obtained with the dorsal and transverse planes.

According to Nyland *et al.* (2005**)** from the:

i. Dorsal Plane: The measure of Length= Distance between the cranial and caudal pole
   Height = Distance between ventral and dorsal surface
ii. Transverse Plane: Kidney Width = Distance between the dorsal and ventral surfaces

Cortical thickness = Distance between the outer edge of the kidney and renal capsule

DATA ANALYSIS

All recorded values were expressed as means ± standard errors of mean. The data were subjected to Pearson's correlation analysis, one-way analysis of variance (ANOVA) and the student t test/pair test was used to check the association between the left kidney/right kidney and weight of the animal/length in male and female guinea pigs. The statistical package used was Statistical Package for Social Sciences (SPSS) version 11.5 Microsoft excel. The value of $P < 0.05$ was considered significant.

RESULTS

MORPHOMETRIC AND SONOGRAPHIC STUDIES

The result of the body length measurement showed the guinea pigs to have a mean body length of 25.20 ± 0.58 cm, with the mean kidney length being 18.22 ± 0.73 mm and 18.11 ± 0.82 mm for the left and right kidney respectively. The mean body weight of the guinea pig was 388.20 ± 32.55 g. The relationships between the morphometric and sonographic parameters are shown (Table I to Table IV).

TABLE I: MORPHOMETRIC PARAMETERS OF THE GUINEA PIG (N = 10)

Parameters	Mean ± SEM
Body Weight (g)	388.20 ± 32.55
Body Length (cm)	25.20 ± 0.58
Left Kidney Length (mm)	18.22 ± 0.73
Right Kidney Length (mm)	18.11 ± 0.82

TABLE II: SEXUAL DIMORPHISM IN KIDNEY LENGTH OF GUINEA PIG (MEAN ± SEM)

SEX	LEFT KIDNEY (MM)	RIGHT KIDNEY (MM)
Male (n=5)	19.7 ± 1.04^{a}	19.6 ± 1.29^{a}
Female (n=5)	16.7 ± 0.47^{b}	16.6 ± 0.45^{a}

^{a,b} = Values with different superscript letters within the same column are statistically significance (P < 0.05)

TABLE III: SEXUAL DIMORPHISM IN KIDNEY VOLUME OF GUINEA PIG (MEAN ± SEM)

SEX	LEFT KIDNEY (CM^3)	RIGHT KIDNEY (CM^3)
Male (n=5)	1.58 ± 0.15^{a}	1.67 ± 0.21^{a}
Female (n=5)	1.06 ± 0.17^{a}	1.02 ± 0.07^{b}

^{a,b} = Values with different superscript letters within the same column are statistically significance (P < 0.05)

TABLE IV: THE RELATIONSHIP BETWEEN BODY LENGTH, BODY WEIGHT AND KIDNEY LENGTH

CORRELATED PARAMETERS	CORRELATED COEFFICIENT	SIGNIFICANCE
Body length and Left Kidney length	0.385	P > 0.05
Body length and Right Kidney length	0.417	P > 0.05
Body weight and Left Kidney length	0.517	(P < 0.05)
Body weight and Right Kidney length	0.691	(P < 0.05)

DISCUSSION

To the best of our knowledge, there are few studies on the sonographic measurement of the kidney parameters of guinea pig (*Cavia porcellus*) in this part of the world.

The body length and length of the left kidney was analyzed and a correlation of 0.385 which has a significance data of 0.271 (P > 0.05). This implies that there is no strong significant correlation between the body length and length of the left kidney. T = 9.491 which has a significance of 0.000 (2-tailed test) and P < 0.05, this shows that there is relationship between the body length and length of the left kidney with poor correlation. The body length of the right kidney was analyzed and a correlation of 0.417, which has a significance data of 0.231 (P > 0.05). This implies that there is a better significant correlation between the body length and length of the right kidney than that of the left kidney.

The body weight and length of the left kidney was analyzed and a correlation of 0.517 which has a significance data of 0.126 (P > 0.05). This implies that there is a significant correlation between the body weight and length of the left kidney. T = 11.491 which has a significance of 0.000 (2-tailed test) and P < 0.05, this showed a strong correlation and relationship between the body weight and length of the left kidney. Furthermore, comparing the body weight and length of the left kidney also showed a significant correlation.

As kidney length correlated with body indices (length and weight), it is suggested that this body index (weight) is a useful and simple method of estimating kidney size as an adjunct to treatment decisions concerning renal diseases

(Edell *et al*., 1990). The results of this study is not similar to finding of Lawal *et al.* (2011) where the body index that correlated with kidney length is the length but in this study the weight is the body index that correlated with the length of the kidney.

The differences in right kidney volume are statistically significant ($P < 0.05$) in male and female guinea pigs. This finding agrees with Beregi *et al.* (2001), where he carried a preliminary study of the ultrasonographic determination of renal size in guinea pig (*Cavia porcellus*) and obtained a significant ($P < 0.01$) positive correlation between renal length and calculated volume compared to body weight ($r = 0.459$ to 0.535). The differences in left kidney volume are not statistically significant ($P > 0.05$) in male and female guinea pig.

A graphical representation of correlations between the length of left/right kidneys and length/weight of animal was also shown in male and female animal which estimate the kidney size using pooled and unspooled data. On each of the graphs, significant information can be drawn as shown on the graph.

CONCLUSION

The present study has elucidated that kidney length correlated with this body index (body weight) in guinea pigs may be of assistance for estimating kidney size during clinical assessment of patients, as this gives an early indication to the condition of the kidney. A significant ($P < 0.05$) positive correlation between renal length and calculated volume compared to body weight ($r = 0.517$ to 0.691) was obtained.

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