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Transcutaneous abdominal ultrasound of adult Greater cane rats (*Thyronomys swinderianus*)

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Abstract

Greater cane rats (GCR) are increasingly becoming an important micro-livestock in Nigeria. However, domestication is progressing slowly due to a dearth of information about their biology. This study evaluated the sonographic anatomy and morphometry of major GCR abdominal organs. Intraperitoneal injection of Ketamine hydrochloride (7.5kg) and Xylazine hydrochloride (2mg/kg) was used to anaesthetize eight adult GCR, after which a portable ultrasound machine was used to examine their abdominal cavity. The Liver Short Axis (LSA) and Long Axis (LLA), Long Axis of Gall Bladder (LAGB) and Short Axis of (SAGB) of the gall bladder, Longitudinal Axis of the right and left kidneys (LARK; LALK), Transverse Axis of right and left kidneys (TARK; TALK), Stomach Diameter (SD), and Caecal Diameter (CD) were determined sonographically. Analysis of Covariance was used to compare the sonographic measurements between sexes. The result revealed that the adrenal gland, pancreas, ovaries, uterine horn, and urinary bladder were not visualizable, while the liver, kidneys, stomach, caecum, and intestine were visualized. The gall bladder and hepatic arteries appeared anechoic, and the liver was moderately echogenic. The liver's LLA varied from 34.69 mm to 86.05 mm, while its LSA varied from 28.34 mm to 47.50 mm. The mean LLA and LSA were not significantly different ($P > 0.05$) between sexes. Female GCR had a greater LARK (72.27 ± 4.74 mm) compared to males (68.57 ± 4.88 mm). On the other hand, males' TARK was longer (35.17 ± 3.0 mm) than females' (28.96 ± 5.4 mm). For both sexes, the stomach diameter varied from 11.63 to 20.85 mm. The caecum diameter between the male (6.63 ± 0.30mm) and female (6.01 ± 0.22 mm) was not significantly different ($p > 0.05$). In conclusion, transcutaneous abdominal ultrasound provides useful ultrasonographic details of abdominal structures for clinical disease diagnosis and management in GCR.

Keywords: Abdominal, Cane rats, Transcutaneous, Ultrasound

Introduction

The shortfall of animal protein in resource-deficit nations can be alleviated by consolidating national wildlife conservation programs and promoting the domestication of rodents with high reproductive capacity and widespread public acceptance for food (Adewumi *et al.,* 2021). Due to their high growth rate and potential for reproduction, Greater cane rat (GCR) is one of the micro-livestock species with the potential to be domesticated. One of the GCR's health benefits is that its meat has a reduced cholesterol content (Kilwanila *et al.,* 2023).

Africa is home to a large population of the GCR (*Thryonomys swinderianus*; grasscutter) (Babarinde *et al.,* 2023). GCR are closely related to agouti, guinea pigs, and porcupines and are among the microlivestocks that are domesticated across the region for meat (Shoyombo-Amusa *et al.,* 2025). The GCR is found in most regions south of the Sahara, especially in West Africa, where natives hunt it for food (Adewumi *et al.,* 2021). Growing scientific and socioeconomic interest in this rat has prompted more research to better understand its biology (Mustapha *et al.,* 2020).

In rodents, ultrasound is the most often utilized imaging modality (Bazanto *et al.,* 2014). In this non-invasive imaging modality, ionizing radiation is not used, giving it an edge over other imaging methods. A thorough description of the use of ultrasound imaging in common exotic species is lacking in the scientific literature, despite its growing application in veterinary practice (Bazanto *et al.,* 2015). Meanwhile, abdominal ultrasonographic characteristics have been reported in rodents, such as guinea pigs (Sekulić *et al.,* 2009), domestic rats (Bazanto *et al.,* 2014), mice (Jaiswal *et al.,* 2009), common marmosets (Wagner & Kirberger, 2005), agouti (Sousa *et al.,* 2012), and African Giant rats (Akinloye *et al.,* 2018). Despite the GCR's possible economic significance, there is no documentation of the rat's abdominal ultrasonographic characteristics. This study detailed the morphometric measurements and sonographic anatomy of the GCRs' abdominal structures.

Materials and Methods

Animals

Eight captive-bred adult GCRs of both sexes with weight ranging from 2.8-3.1 kg and sourced from Favour Farm, Eleweran, Abeokuta, Ogun State, Nigeria, were used for the study. The rats were kept singly in metal cages in an enclosed area on the **farm** prior to and during the study. The health status of the rats was assessed based on general body evaluation. The rats were fed grasses and concentrates, *ad-libitum* water was also provided. Prior to commencement of the sonographic examination, the GCRs were adjudged to be apparently healthy based on the findings at physical examination. Ethical approval for the study was obtained from Federal University of Agriculture, Abeokuta, College of Veterinary Medicine, Research and Ethics Committee (CREC) as FUNAAB/COLVET/CREC/2022/07/03.

Ultrasonographic examination

Sonographic examinations were performed on each rat using a 6.5 MHz portable ultrasound machine (Leica, Medical England), as described by Akinloye *et al.* (2018). Sonographic preparation was done by clipping the rat's abdominal hair and acoustic gel was applied. The rats were restrained using intraperitoneal injection of Ketamine hydrochloride (7.5kg) and Xylazine Hydrochloride (2mg/kg). They were examined from both right and left lateral recumbency. The Liver Short Axis (LSA) and Long Axis (LLA), as well as Long Axis of Gall bladder (LAGB) and Short Axis of (SAGB) of the gall bladder were measured after freezing a well-focused and clear image. Similarly, the Longitudinal Axis of the right and left kidneys (LARK; LALK), as well as the Transverse axis of the right and left kidneys (TARK; TALK) were also measured. In addition, Stomach Diameter (SD) and Caecal Diameter (CD) were determined. The LSA was measured from the dorsal to the ventral margin of the liver in a longitudinal plane, while the LLA was measured from the cranial margin to the caudal margin of the liver in a longitudinal scan. The LARK and LALK measurements were obtained in the longitudinal plane, while the TARK and TALK were obtained from the parasagittal image. In a longitudinal scan, the SD was measured as the greatest separation between two opposing stomach walls, and in a sagittal scan, the CD was measured as the greatest distance between the caecum's walls.

Data analysis

The parameter measured was expressed in range, median, and mean values and presented in tables. Data generated was subjected to Analysis of Co-variance with fixed effect of gender (female versus male). All data analysis were performed with SAS 9.1 software (Central Tendency and Student T test) and values were considered significant at 95% confidence interval.

Results

This study revealed that the liver, kidneys, gall bladder, caecum as well as the stomach of the GCR were visualizable on transcutaneous abdominal ultrasound while the urinary bladder, adrenal gland, pancreas and reproductive tract were not visualized.

The liver echogenicity is relatively homogenous and is isoechoic to the renal cortex (Plate I). The anaechoic strands-like appearance of the hepatic vessels was seen traversing the liver. The GCRs LLA ranges between 34.69 mm and 86.05 mm, while the LSA ranges between 28.34 mm and 47.50 mm (Table 1). The gall bladder had an oval, slightly elongated shape, and is located somewhere around the liver's center with distal acoustic enhancement. The gall bladder wall has a hyperechoic appearance, while the lumen is somewhat anaechoic. The cane rats' LAGB ranges from 15.47 to 24.91 mm, while the SAGB ranges from 11.28 to 15.47 mm (Table 2).

The GCRs' kidneys have a relatively oval shape with its border marked by the hyperechoic renal capsule. The echogenicity of the medulla was hypoechoic while that of the cortex was hyperechoic (Plate II). The pelvis was marked by the hyperechoic peri-pelvic fats. The TARK measurement range from 22.99 mm to 36.63 mm, while the LARK range from 64.32 mm to

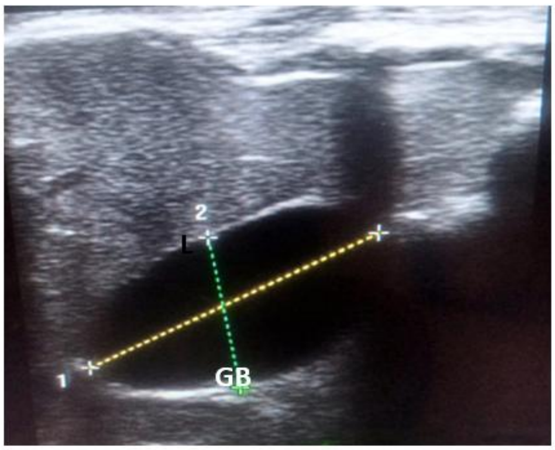

Plate I: Sonographic appearance of the liver parenchyma (L) and gall bladder (GB) in adult greater cane rats

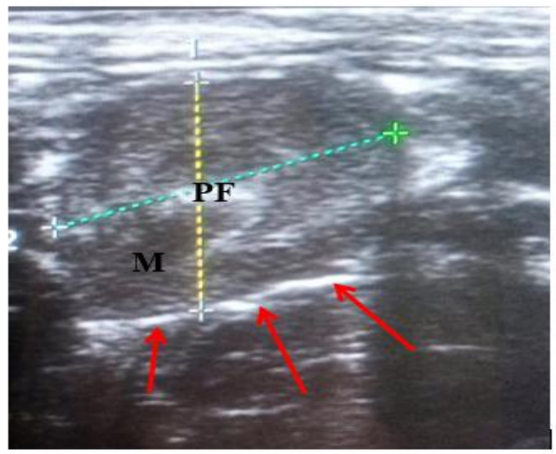

Plate II: Sonographic appearance of the kidney of adult greater cane rats showing the hyperechoic cortex (Red arrows), hypoechoic medulla (M) and the hyperechoic pelvic fat (PF)

Table 1: Sonographic measurements of the liver and gall bladder of adult greater cane rats

	Sonographic measurements (mm)			
GCRs	LSA	LLA	LAGB	SAGB
1	36.69	69.82	16.52	11.52
2	32.81	62.21	22.76	11.28
3	35.59	67.48	22.76	15.47
4	31.34	86.05	24.91	14.09
5	28.34	71.92	18.31	12.30
6	37.07	83.25	17.59	13.62
7	47.50	34.69	22.37	12.59
8	30.77	74.25	20.17	13.58
Range	28.34-47.50	34.69-86.05	15.47-24.91	11.28-15.4
Mean±SD	35.01±5.91	68.71±15.83	19.76±3.34	13.06±2.03

Key: LSA: Liver short axis, LLA: Liver long axis, LAGB: Long Axis of gall bladder, SAGB: Short axis of gall Bladder.

Table 2: Comparison of mean sonographic values of liver measurements between male and female greater cane rats

Sonographic measurements (mm)	Male (n=4)	Female (n=4)
LSA	34.11±2.46	35.92±4.63
LLA	71.39±10.38	66.03±21.46
LAGB	19.92±4.63	19.61±2.13
SAGB	13.09±2.03	13.02±0.63

Key: LSA: Liver short axis, LLA: Liver long axis, LAGB: Long Axis of gall bladder, SAGB: Short axis of gall Bladder. Non-significant difference at $p > 0.05$

77.50 mm. The range of the TALK is 26.66 mm to 37.71 mm, and the range of the LALK is 72.19 mm to 84.79 mm (Table 3). The TARK was significantly higher ($p<0.05$) in male (35.17 ± 3.00 mm) than in female (28.96 ± 5.04 mm). Also TALK was significantly higher ($p<0.05$) in male (35.55 ± 1.78 mm) than in female (27.52 ± 0.86 mm) (Table 4)

The stomach of the GCRs was visualized caudal to the liver. The gastric lumen is somewhat anaechoic, while the mucosa and serosa layers were hyperechoic have (Plate III). The SD ranges between 11.63 mm and 20.85 mm for both sexes (Table 5). The GCR's caecum was seen as an oval, elongated structure on the left half of the abdomen. The wall of the caecum appeared somewhat hyperechoic while the lumen was anaechoic (Plate IV). There was no significant difference between the stomach and caecum diameter in both male and female GCR (Table 6).

Table 3: Sonographic measurements of the right and left kidney of adult greater cane rats

	Sonographic measurements (mm)			
GCRs	LARK	TARK	LALK	TALK
1	66.02	36.62	79.12	37.71
2	68.52	35.91	76.32	35.58
3	64.32	34.36	72.19	35.52
4	75.42	33.77	77.75	33.38
5	72.17	29.95	72.89	28.59
6	66.25	22.99	84.79	26.66
7	72.83	35.73	79.97	27.82
8	77.81	27.17	76.78	27.02
Range	64.32-77.81	22.99-36.62	72.19-84.79	26.66-37.71
Mean±SD	70.42±4.87	32.06±4.90	77.48±4.02	31.54±4.48

Key: LARK: Longitudinal Axis of Right Kidney, TARK: Transverse Axis of Right Kidney, LALK: Longitudinal Axis of Left Kidney, TALK: Transverse Axis of Left Kidney.

Table 4: Comparison of mean sonographic values of kidney measurements between male and female greater cane rats

Sonographic measurements (mm)	Male	Female
LARK	68.57±4.88	72.27±4.74
TARK	35.17±3.00	28.96±5.04*
LALK	76.35±3.00	78.61±5.04
TALK	35.55±1.78	27.52±0.86*

Key: LARK: Longitudinal Axis of Right Kidney, TARK: Transverse Axis of Right Kidney, LALK: Longitudinal Axis of Left Kidney, TALK: Transverse Axis of Left Kidney. *Significant difference at $p > 0.05$

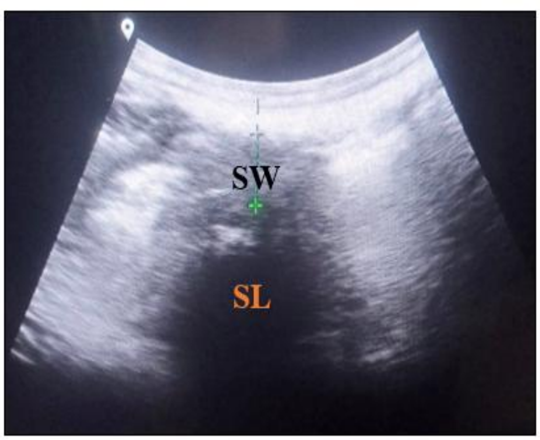

Plate III: Transcutaneous abdominal ultrasound of the stomach of adult greater cane rats showing the hypoechoic stomach wall (SW) and the anaechoic stomach lumen (SL)

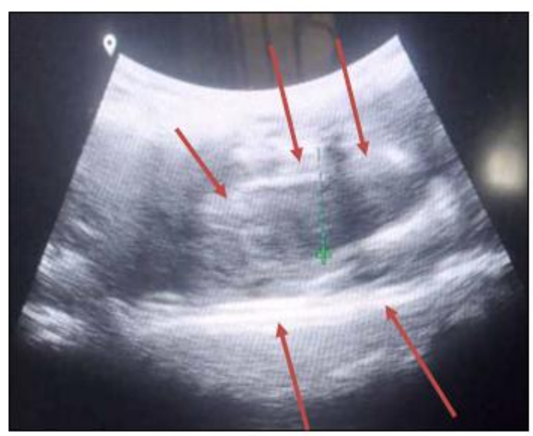

Plate IV: Transcutaneous abdominal ultrasound of the caecum of adult greater cane rats showing the hyperechoic caecal wall (Red arrows) and the anaechoic caecal lumen (CL)

Table 6: Comparison of mean sonographic values of stomach and caecum measurements between male and female adult greater cane rats

Sonographic measurements (mm)	Male (n=4)	Female (n=4)
Caecum Diameter	6.63±0.30	6.01±0.22
Stomach Diameter	15.07±3.92	15.31±2.91

Discussion

The abdominal structures of GCR are described sonographically in this study. Additionally, morphometric measures of specific GCR abdominal structures were determined. It was discovered that the liver, kidneys, and gastrointestinal tracts are among the abdominal tissues visible on transcutaneous abdominal ultrasonography while the reproductive tract, adrenal gland, pancreas, and spleen were not visible.

During a sonographic examination, the use of chemical restraints permits appropriate positioning and inhibits movement. GCR is tough to handle due to its wild nature, hence moderate anesthesia is required. Agents such as isoflurane (Ikeda *et al.,* 2022), halothane (Kapoor *et al.,* 2016), and ketamine-xylazine combination (Akinloye *et al.,* 2018) have allegedly been used to induce chemical anesthesia in rats during radiographic examination. It is crucial to consider the possible impact of chemical constraints on the overall evaluation of the animal's sonographic results, even though there are no reports that this could influence the outcome of the ultrasound examination.

According to Akpan *et al.* (2018), thick and spiky hairs covers the skin of GCR. Hair trimming and ultrasonic gel application are standard procedures for preparing the skin for an ultrasound examination. Moreover, the GCR hair follicle may be an effective sound reflector, which could result in artifact (reverberation). However, due to their thin skin, GCR's skin rips off readily, hence the application of chemical constraints was necessary for the skin preparation.

Rats' abdomen can be sonographically examined using a transducer probe with frequencies ranging from 10 mHz to 15 mHz (Ypsilantis *et al.,* 2009). Lower frequency transducers (6.5 MHz) were employed in this study to examine the cane rats' abdomens. This may account for the inability to see smaller organs such as the reproductive tracts, spleen, and adrenal glands. According to Pessoa *et al.* (2018), the utilization of higher frequency transducers may have made it possible to clearly visualize the lymph nodes, kidneys and adrenal glands more clearly.

The liver's echogenicity pattern in the GCR was comparable to those of laboratory rats and AGRs

(Chen *et al.,* 2012). The cane rat's liver parenchyma was homogeneous and moderately hypoechoic, with branching tubular anaechoic structures that were tracked to the hepatic vein or portal. The gall bladder had an anaechoic lumen and a hyperechoic wall. According to this study, the GCR's liver's sonographic dimension is noticeably larger than that of African giant rats (Akinloye *et al.,* 2018). The size difference between the GCR and the African giant rats (AGR) could be the reason of this. The livers of male and female GCRs in this study have the same sonographically determined morphometric measurement. This implies that the cane rats' livers do not exhibit sexual dimorphism. Nonetheless, there have been reports of sexual dimorphism in the GCR's gastrointestinal system (Obadiah *et al.,* 2015.).

The renal capsule, a thin, hyperechoic structure, lined the elongated, oval-shaped kidneys of the GCR. Sonographically, the kidney was separated into the hypoechoic medulla and the more echogenic cortex, creating a corticomedullary differentiation that can serve as a guide for diagnosing diseases. On sonography, the kidney of GCR resembles that of AGR, laboratory rats and rabbits (Azuma *et al.,* 2011; Bazanto *et al.,* 2015; Akinloye *et al.,* 2018). According to Pessoa *et al.* (2018), the GCR's kidneys' sonographic measurements were noticeably larger than those of the AGR and Agouti. Given their similar body proportions, the higher renal sonographic findings in GCR as opposed to Agouti seem incongruous. However, the observed differences can be connected to the measurement standards where this study identified the kidneys' longitudinal and transverse axes, while the study on Agouti only examined the kidneys' length and width (Pessoa *et al.,* 2018). Furthermore, the Agouti has a relatively short tail and is taller and slimmer than the GCR (Pessoa *et al.,* 2018). In this investigation, the male cane rats' short axis of the left and right kidneys was noticeably longer than the females'. This could indicate that the GCR kidney exhibits sexual dimorphism.

The GCR's stomach was multilayered, with a moderately hypoechoic wall and an anaechoic lumen. This trend is comparable to what has been seen for AGRs (Akinloye *et al.,* 2018). Three distinct ultrasonographic layers can be seen in the rabbits' layered stomach pattern (Bazanto *et al.,* 2015). Despite their larger size, GCRs' stomach diameter was less on sonography than that of AGRs, most likely due to the fact that they are hindgut fermenters (Obadiah *et al.,* 2015). In contrast, the caecum of the GCRs was seen as an oval, lengthy structure on the left side of the abdomen that extended from the stomach's caudal aspect to the pelvic brim. Sonographic measurements of the cane rats' stomach and caecum showed no significant differences. Although sexual dimorphism was observed in the length of the cane rats' gastrointestinal system, this finding is comparable to that reported for the species (Obadiah *et al.,* 2015).

This study has few limitations, which is important to mention. Initially, it was unknown whether the chemical restraints may affect the rats' sonographic appearance and measurements. According to Ajadi *et al.* (2006), chemical restraints including xylazine or acepromazine have been shown to affect renal opacification and fading during excretory urography in cats. Since it is nearly impossible to evaluate the rats without chemical restraints, it may be required to identify the anaesthetic agents that have the least impact on the renal functions of the cane rats.

In conclusion, transcutaneous abdominal ultrasound of the adult GCR showed that the liver, kidneys and gastrointestinal tracts were visualizable, while the spleen, adrenal glands, ovaries and uterus were not visualizable. This finding may be related to the type and frequency of the transducer used. The measurements in GCR were higher than those reported for rats and rabbits and may be associated with the size of the GCR. However, these measurements could serve as baseline data for future reference in transcutaneous abdominal ultrasound of GCR.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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