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Studies on Echostructural Pattern of Urinary System in Adult Female Goats

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ABSTRACT

Background: Ultrasonography is a second most commonly used diagnostic imaging technique in veterinary practice after radiography. The ultrasonographic examination of clinically healthy animals provides relevant information about anatomical location, echo texture, size and shape of organs. In the present study, the echo-structural pattern of urinary system of adult female goats were evaluated to find the normal structural pattern of various constituents of urinary system.

Methods: B-mode ultrasonographic study of urinary system was performed in 20 healthy adult female Jamunapari goats. Mean±S.E. values of body weight and age of selected animals were 27.49±0.79 kg and 2.77±0.10 years, respectively. All twenty animals were subjected to sonographic examination after clipping the hairs from desired sites to scan the various organs of urinary system in standing position under physical restraint without using any anesthetic agent. The values of various clinico-physiological parameters including rectal temperature, heart rate, respiration rate, colour of mucous membranes were recorded to examine the health status prior to sonography. The left and right kidneys were scanned from right dorsal flank by paravertebral approach using a transcutaneous micro-convex probe at 5 MHz and a convex probe at 2.8-6 MHz frequency. A dual frequency (5-9 MHz) micro-curved array cavity probe was used to scan bladder and urethra per rectally. The renal parenchyma in healthy goats was distinctly divided into hypoechoic outer cortex and anechoic inner medulla. The hyperechoic renal sinus complex was present in center of the kidney and renal pelvis was anechoic. The renal capsule was seen as hyperechoic fine line surrounding the renal parenchyma. Pulsed wave renal color doppler ultrasound was performed in 3 healthy goats with the aim to generate reference images of renal vasculature.

Result: The Mean±SE values of renal length, renal height, horizontal diameter of renal sinus, vertical diameter of renal sinus and diameter of renal pelvis for right kidney were 6.11±0.09, 3.26±0.08, 3.01±0.11, 1.32±0.03, 1.05±0.03, respectively while for left kidney these values were 6.02±0.09 and 3.35±0.07, 2.67±0.12, 1.14±0.06, 1.10±0.07 cm. The ureters could not be visualized in any of the goats. The distended bladder was seen as anechoic circular structure surrounded by a smooth echogenic wall with a mean thickness of 1.65±0.06 mm. No significant difference was observed in the measurements of both kidneys except in dimensions of renal sinus. Positive correlation was found between renal size and body weight of goats. It was concluded that ultrasound is an easy, rapid and non-invasive method to evaluate echotexture and morphometry of structures of urinary system.

Key words: Echo-structural pattern, Goats, Ultrasonography, Urinary system.

INTRODUCTION

Ultrasonography is an easy and rapid diagnostic method to image the urinary and reproductive tract assisted by superficial location of these organ systems (Stieger-Vanegas *et al*., 2020). The use of diagnostic ultrasonography in small ruminants was first mentioned in 1983 for diagnosis of pregnancy in both sheep and goats (Streeter and Step 2007). It has been used to diagnose uroliths, renal cysts, renal neoplasia, pyelonephritis, bladder neoplasms, hydronephrosis, ruptured bladder and other urinary tract disorders (Braun *et al*., 1992). The ultrasonographic examination of clinically healthy animals provides relevant information of anatomical location, echotexture, size and shape of organs. The data collected from healthy animals after ultrasonography is used to establish the reference ranges for various dimensions *i.e*., length, width, depth, diameter, of organ of interest. To evaluate abnormalities in any organ, knowledge of reference values for various dimensions is crucial as it shows variability in the values of normal size and shape (Abdelghafar and Almubarak, 2016). In the present study, the echo-structural pattern of urinary system of adult female goats were evaluated to find the normal structural pattern of various constituents of urinary system.

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MATERIALS AND METHODS

Animals

The present study was conducted in 20 clinically healthy adult female goats of Jamunapari breed, born and kept at the goat farm of the College of Veterinary Science and Animal Husbandry, DUVASU, Mathura from January to July 2022. The animals were fed roughage and concentrate with water and mineral block supplement. The mean body weight and age of selected 20 animals were 27.49+0.79 kg and 2.77+0.10 years, respectively. Clinical status of animals was examined prior to ultrasonography by recording rectal temperature (°F), heart rate (bpm), respiration rate (breaths per minute), colour of mucous membranes and size of pre scapular and pre femoral lymph nodes. Classification of echogenicity of different renal structures is shown in Table 1. Area of scanning was clipped and shaved carefully using a manual clipper. Animals were restrained in standing position without using any anesthetic agent. A liberal amount of ultrasonic gel / liquid paraffin was applied to the area prior to scanning. Different animals subjected to ultrasound at different sites as displayed in Table 2.

Anatomy

Kidneys are placed in the sub-lumbar region in goats and the right kidney is placed slightly anterior to the left kidney. The kidneys of the local goat are bean shaped and have smooth surface without any lobulations (Jabbar *et al*., 2018). Renal calices are absent in the kidneys of goats. Convex shaped renal crest was observed on mid line of renal pelvis on which several ducts opened. Mean length of right ureter was found significantly greater than left ureter (Venumadhav *et al*., 2019). Position of right kidney is fixed since it is in association with liver but left kidney is relatively mobile and its mobility depends on movement of rumen (Ragab *et al*., 2010).

In the present study, probe was placed on left and right dorsal flank below transverse processes of 1st, 2nd, 3rd and 4th lumbar vertebrae and in the last two intercostal spaces to scan the left and right kidneys. Attempts were made to scan ureters from left and right flank and inguinal region. Urinary bladder and urethra were scanned per rectally by using a cavity probe in standing position. The right kidney was scanned over the rib area while the left kidney was scanned more caudally just behind the last rib.

RESULTS AND DISCUSSION

The right kidney was scanned from 12th intercostal space in 14 animals and just behind last rib in 6 animals. The longitudinal axis of right kidney was found to be obliquely parallel to the ribs. The cranial pole of right kidney was associated with liver. Mean±SE values of measurements of left and right kidney is tabulated in Table 3. B-mode ultrasonographic image of renal height and diameter is displayed in Fig 1. The renal capsule was seen as a thin hyperechoic fine line surrounding the kidney. The renal parenchyma was distinctly seen as hypoechoic cortex and anechoic medulla. Renal sinus complex (fat, vessels, lymphatics and fibrous tissue) was seen in center of each kidney as a hyperechoic elliptical structure. Comparison of echogenicity of various renal structures is displayed in Fig 2. The renal pelvis was seen as a round to oval anechoic structure outlined by hypoechoic wall. B-mode ultrasonographic image of renal pelvis is displayed in Fig 3. The left kidney was imaged in sublumbar region from right dorsal flank. It was scanned below the transverse processes of 1st and 2nd lumbar vertebrae in 13 animals and below transverse processes of 3rd and 4th lumbar vertebrae in rest 7 animals. The longitudinal axis of left kidney was parallel to the vertebrae in all animals. The left kidney was situated more caudally than the right kidney. The left kidney was not fixed in position and its position was found to be changed

Table 1: Classification of renal parenchyma echogenicity.

Renal structures	Normal echogenicity
Renal cortex	Hypoechoic
Renal medulla	Anechoic
Renal pelvis	Anechoic
Renal sinus	Hyperechoic
Renal capsule	Hyperechoic

Table 2: Placement of the ultrasound probe for visualization of the kidney via ranscutaneous examination in 20 female Jamunapari goats (n= frequency of animals).

Location	Right kidney from right side (n)	Left kidney from right side (n)	Left kidney from left side (n)
12th ICS	14	0	0
Caudal to last rib	6	0	0
1st and 2nd lumbar vertebrae	0	13	0
3rd and 4th lumbar vertebrae	0	7	0

Table 3: Mean±S.E. values of measurements of right and left kidney in female Jamunapari goats (n= 20).

Parameters (cm)	Right kidney	Left kidney
Renal length	6.11±0.09 (5.43 - 7.04)	6.02±0.09 (5.25-6.66)
Renal height	3.26±0.08 (2.26 - 3.90)	3.35±0.07 (2.65-3.87)

depending on the degree of fullness of the rumen. All the attempts to scan left kidney from left dorsal flank failed.

The results of present study are similar to the study done by (Abdelghafar and Almubarak, 2016) the right kidney was scanned over the rib area while the left kidney was scanned more caudally from the right flank (caudal to the last two ribs). This was surprising because the left kidney was not seen from the left flank in any of the animal (Braun *et al.*, 1992). The position of the right kidney is in the dorsal abdomen at the level of transverse process of the vertebrae 13th thoracic to 3rd lumbar (T13 to L3) and the left kidney is located more caudally at the level of 4th and 5th lumbar vertebrae (Smith and Sherman, 2009). Values of vertical diameter and width of urinary bladder wall is shown in Table 4. Measurement of urinary bladder wall thickens is shown in Fig 4. Color doppler image of left kidney is displayed in Fig 5.

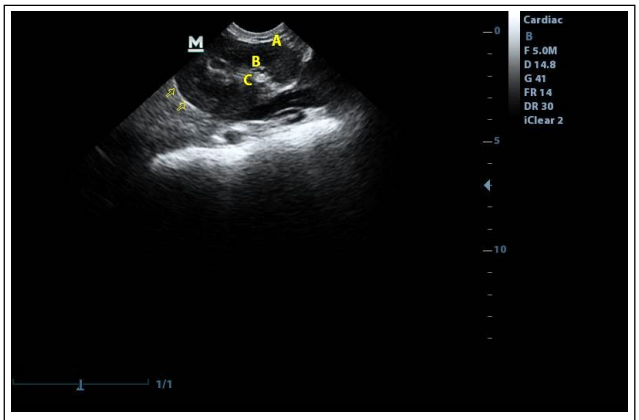
All the attempts made to scan ureters from right and left flank and inguinal region using a transabdominal probe were failed. Ureters were not seen in any of the animals.

Table 4: Mean±S.E. values of measurements of urinary bladder.

Parameters (mm)	Mean±S.E.	Range
Vertical diameter of bladder	32.44±1.17	25.67-41.86
Thickness of bladder wall	1.65±0.06	1.07-2.10

D1 (renal length), D2 (renal height).

Fig 1: B-mode ultrasonographic measurements of renal length and renal height.



A: abdominal wall, B: renal parenchyma, C: renal sinus, arrows indicating renal capsule.

Fig 2: Comparison of echogenicity of different renal structures.

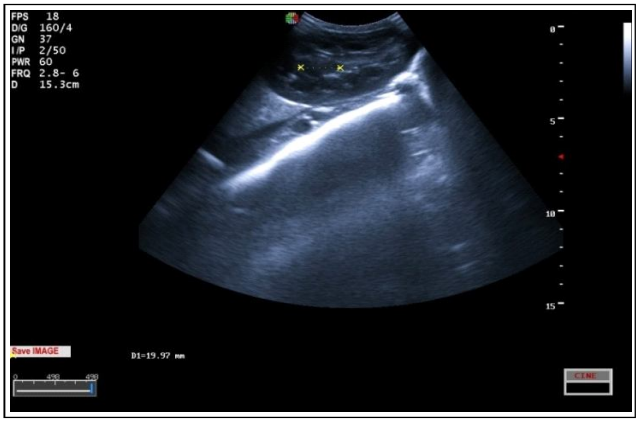


Fig 3: B-mode ultrasonographic measurement of diameter of renal pelvis.

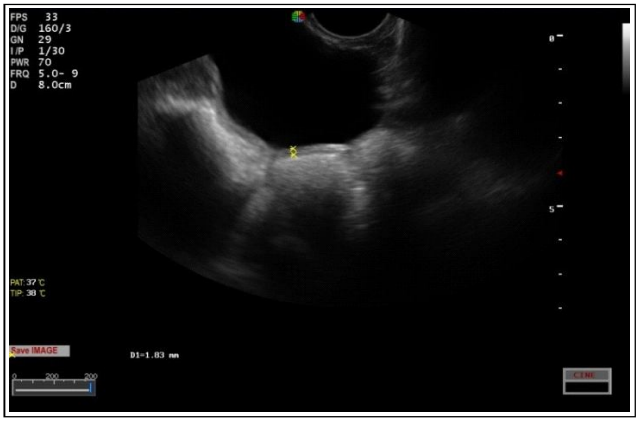
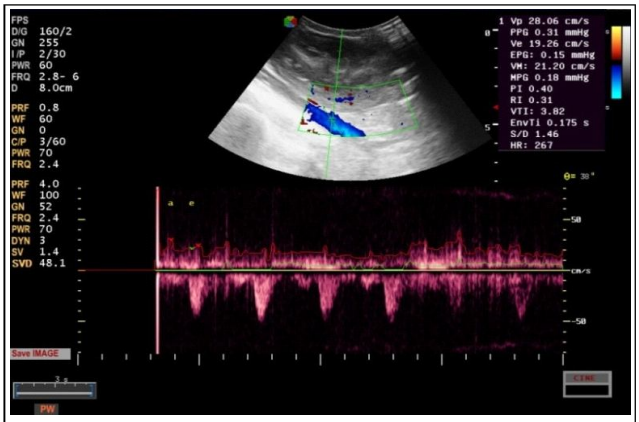


Fig 4: Measurement of thickness of bladder wall.



Spectral display showing Doppler scan of the left renal artery in healthy goat. The arterial flow towards the transducer *i.e.*, towards the kidney, confirms that it is the artery and not the renal vein.

Fig 5: Color doppler ultrasound of left kidney.

The junction of the ureters and bladder could also not be seen via transrectal ultrasonography (Braun *et al*., 2013).

CONCLUSION

Both right and left kidneys can be scanned from right dorsal flank in 12th intercostal space and area below 1st to 4th lumbar vertebrae using a micro-convex or convex probe at frequency 5 MHz and 2.8-6 MHz. In healthy goats urinary bladder and urethra can be imaged per-rectally using a cavity probe at dual frequency of 5-9 MHz. The right kidney was fixed in position and its cranial border was associated with liver while position of left kidney can be variable depending on degree of fullness of rumen. The renal parenchyma in healthy goats was distinctly divided into hypoechoic outer cortex and anechoic inner medulla. The hyperechoic renal sinus complex (fat, vessels, lymphatics and fibrous tissue) was present in center of the kidney and renal pelvis was anechoic. The renal capsule was hyperechoic fine line surrounding the renal parenchyma. The urinary bladder was anechoic surrounded by smooth and thin echogenic wall. The layers of the bladder wall (serosa, muscularis, submucosa and mucosa) could not be seen distinctly. It was not possible to scan the ureters from flank and inguinal region. No significant difference was observed in the measurements of both kidneys except in dimensions of renal sinus. Moderately positive correlation was found between renal size and body weight of animals. It was concluded that ultrasound is an easy, rapid and non-invasive method to evaluate echotexture and to measure the dimensions of organs of urinary system in healthy goats.

Conflict of interest

Authors declare no conflict of interest.

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