Ultrasonography of urinary system in normal Iraqi buffaloes (*Bubalus bubalis*)

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Summary

The objective of this study was to evaluate the usefulness of ultrasound in the examination of urinary system in buffaloes. Ultrasonography of the urinary system was done for 60 local buffaloes breed, 1-15 years old of both sexes in Mosul/Iraq, and they then were divided into two groups according to age, 25 calves less than 2 years and 35 adults 2-15 years. Kidney measurements are taken from three different sites (right lumbar, right sublumbar and right twelfth intercostal space. The right sublumbar region is the best area for getting good ultrasonographic images (in both adult and calves) followed by right lumbar region which gives clear images in adult buffaloes. Ultrasonographic examination for the left and right kidneys in adult buffalo and their calves showed no significant difference in kidney measurements from different sites (lumbar, sublumbar, twelve intercostal space). The results showed that the mean thickness of right kidney of buffaloes aged 2-15 years from right sublumbar region was (7.40±0.13) centimeters and in buffalo calves was (5.29±0.23) cm. The mean thickness of left kidney of buffaloes from right sublumbar region was (7.30±0.20) cm, and in buffalo calves was (5.06±0.59) cm. The urinary bladder is easily observed by ultrasonography per-rectum in adult and percutaneous in calves (right sublumbar region). The urinary bladder appears as circumscribed round to oval structure in the pelvic area. It usually contains anechoic to hypoechoic urine. The wall of urinary bladder is echogenic, smooth and its thickness varies with the amount of bladder distention. Positive correlation between right kidney thickness (cm) (from right sublumbar region) and the age (months) for buffaloes (0.627).

Keywords: Ultrasound, Urinary system, kidney, Buffaloes, Calves.

Introduction

In ruminants the two kidneys are located in a fat mass around the vertebral column on the dorsal abdominal wall in the lumber region, the right kidney pass cranially beneath the last ribs at the intrathorasic abdominal area. The right kidney located more cranially than the left one and fixed inside the fossa of the liver that prevents its mobility, while the left kidney has a more free area for mobility because it is not attached to the liver and suspended by mobile, long mesonephrons so that an increase in rumen size will push the left kidney towards the right abdominal area (1 and 2). It was reported that Iraqi buffaloes have paired of kidneys with an elongated characteristic, elliptical shape and a specific lobulated surface, they are red brown color. The left kidney has a large rounded caudal end and a pointed cranial end. Its size about 16 cm length and 12 cm width and 6 cm thickness, while the right kidney about 23 cm length and 14 cm width and 6 cm thickness (3). Ultrasound is of a very high frequency 1,000,000 Hz (1 megahertz, or MHz) to 25 MHz mechanical wave sound that need medium to move. It is generated in a transducer due to vibration of the crystals that have a piezoelectric characteristic that lead to a transformation of an electrical energy to a mechanical once and mechanical returns to electrical energy. Ultrasonography has the advantage of being relatively noninvasive and allows the imaging of both kidneys and the urinary bladder (4-6).

Sonographic examination of kidneys should be done if clinical signs or laboratory abnormalities suggest urinary tract disease, presence of palpable masses or abnormalities in the region of the kidneys on rectal palpation, to differentiate chronic from acute renal disease and differentiate diffuse from focal renal involvement, to identify sites for biopsy or aspiration of renal tissue, to monitor

the progression of renal disease in an individual animal, and give a prognosis. The most obvious indication for urinary bladder sonographic evaluation is the presence of clinical signs of cystitis or production of abnormal urine, suspicion of cystic calculi or tumors or masses associated with the bladder wall and bladder atony, as well, it is done to examine bladder wall integrity, evaluation of trauma or obstructive Urolithiasis. Ureters imaging is indicated when rectal palpation suggests obstruction or enlargement of the ureters (7 and 8).

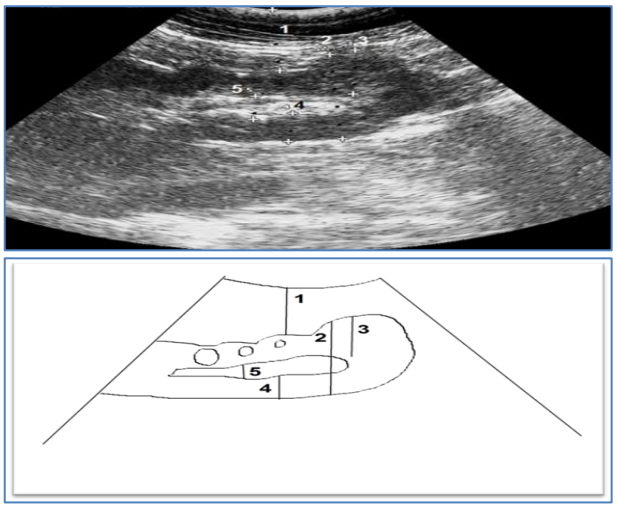
Materials and Methods

A total of 60 local buffaloes breed (1-15 years old) of both sexes in Mosul, Iraq clinically normal were divided into two groups according to age, 25 calves (less than 2 years) and 35 adults (2-15 years). 10 ml of blood was taken from jugular or milk vein, and 10 ml of midstream urine was taken by gentle message of perineum region or when animal urinates during examination according to (9), then imaging of the urinary system with ultrasonography in three sites percuteneously (Fig. 1) and per-rectum (10 and 11).

Figure, 1: Sites for ultrasonographic percutaneous examination of right and left kidneys in buffaloes, right sublumbar fossa (white arrow), right 12th intercostal space (red arrow), right lumbar region (black arrow).

Percutaneous examination of the kidneys: Ultrasonographic examinations were performed on the standing animal. Convex transducer 3.5-5.0 MHz was used. The areas at the sublumbar fossa, last intercostal space (cranial kidney pole, liver window) and lumbar region on the right side were clipped and shaved. Skin was degreased with alcohol then a transmission gel was applied. Examinations of the kidneys were done with transducer in 3 positions. First position, the transducer was placed on the sublumbar fossa and the beam directed medially, the transducer was then rotated about its longitudinal axis, from this position, the right kidney could be imaged and sometimes the left kidney could be found especially in thin cattle and calves. Second position, the transducer was placed on the dorsal area of the last intercostal spaces, with its beam directed towards the kidney. From this position, the right kidney was imaged through the so-called liver window. Third position, the lumbar regions between thoracic 13 vertebrae (T13) and lumbar 1 vertebrae (L1) and the regions between the lumbar 1 and 2 vertebrae at the right side were scanned to image the right kidney, scanner was held at a right angles to the midline so that the kidney was imaged transversely. Scan process was done as close as possible to the midline and progress laterally (8 and 10).

Measurements were made using the sagittal and transverse ultrasonograms from the sublumbar fossa, intercostal space and lumbar area. The distance between kidneys and body surface, thickness of kidneys, the thickness of the dorsal cortical-medulla, ventral cortical-medulla and sinus were determined. Ultrasonographic image is obtained when the animal was at maximal inspiration. The appropriate measurements were taken electronically by using cursors on the ultrasonogram (Fig. 2).



Figure, 2: Schematic represent the Ultrasonographic measurements of the right kidney of a buffalo imaged from the sublumbar fossa, 1=distance between body surface and kidney; 2=thickness of the kidney; 3=lateral cortex-medulla thickness; 4=medial cortex-medulla thickness; 5=sinus thickness.

Per-rectal examination of urinary bladder and left kidney: Transrectal sonographic evaluation was performed by using a 6.5 MHz linear transducer. All feces were removed from the rectum and air in the rectum was expelled. The scanner was covered with gel and put in a plastic rectal glove. The transducer was directed to the symphesis pubis. Urinary bladder was identified at the ventral aspect of the rectum. By directing the transducer caudally the urethra was observed during micturition, from the urinary bladder and continue caudally, according to (8 and 11). Then the transducer was placed in dorsal aspect of the rectum subllel to the backbone under the midline of the left kidney and advanced cranially to image the left kidney. The left kidney measurements were taken by directing the beam dorsally and held longtudinally bellow the kidney.

The thicknees of left kidney, dorsal and ventral cortical-medulla and sinus were made on the ultrasonograms by using cursores. The diameter of the urinary bladder and its wall thickness was made by ultrasonograms according to (10 and 11). Data were analaysed statisticaly for means and significant with T-test by using SPSS program (Microsoft, Ver. 11.5, USA), and for regressions and correlation by Minitab 14 (MINITAB® Release 14 Statistical Software 2003) (12).

Results and Discussion

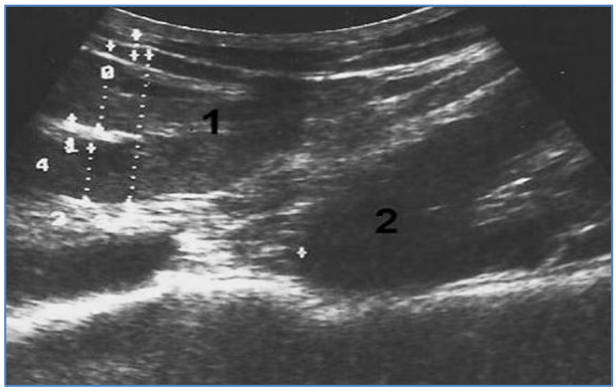
Three ultrasonographic examination sites were done for measurements of right kidney in normal buffaloes. The sublumbar region is the best area for getting good ultrasonographic imaging, followed by lumbar region which gives clear images than the 12th intercostal space (12 ICS) (Table, 1).

Table, 1: Right kidney ultrasonographic measurements (Mean±SD) in normal adult buffaloes

Sites of ultrasound examination	Kidney measurements mean ± SE					
	N	Distance from body surface to kidney/cm	Kidney thickness/ cm	Cortex- medulla dorsal thickness/cm	Cortex- medulla ventral thickness/cm	Sinus thickness/ cm
Right Lumbar region	25	2.828±0.156	6.256±0.221	2.264±0.082	2.364±0.371	1.952±0.053
Right Paralumbar region	30	1.826±0.069	7.403±0.133	2.583±0.075	2.603±0.059	2.063±0.075
12th intercostal space	18	2.122±0.094	7.127±0.265	2.500±0.144	2.072±0.168	2.055±0.048

The right kidney of buffaloes can be examined and imaged without difficulty through trans-abdominal approach by ultrasonography. Demonstrating the normal right kidney images provide information for diagnosis of urinary tract diseases in Iraqi buffaloes. Right sublumbar fossa region is considered to be the best area, this result was in agreement with (13), the Iraqi local buffaloes breed have well-developed muscles which prevent good imaging of the right kidney except from right sublumbar fossa region, moreover, the medullary pyramids, vasculature, collecting tubules, and the secondary branches of the ureter in the sinus are imaged clearly, also it is suitable for the collection of biopsy specimens because there is a small distance between body surface and kidney. Hilus could be visualized from the sublumbar fossa when the transducer is rotated about its longitudinal axis, both kidneies were imaged in some animals especially thin ones (Fig. 3). This result was disagreed with that of (10) because kidney measurements were made on light body weight cattle. Lumbar region is the second area for of the right kidney ultrasonographic examination in buffaloes. This was agreed with findings of others (10) lumbar region which depends on the animal body weight, in which well-developed lumber muscles preclude visualization of the ventral region of the kidney because of the limit penetration capabilities of the ultrasound beam (Fig. 4).

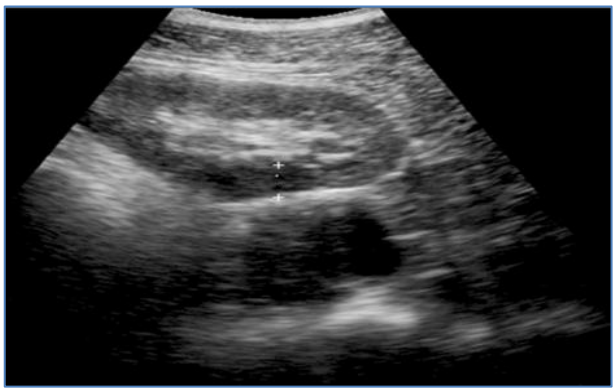
Ultrasonographic examination of right kidney from intercostal space through liver window provides well images. This result was observed in cows (10) because of the kidney cranial pole lies in the renal impression of the liver and therefore, it is close to the body surface. However the right kidney cannot be accessible per-rectal examination (7), although others reports opposite (14).



Figure, 3: Percutaneous ultrasonogram of both kidneys in right sublumbar fossa region of buffaloes. 3.5 MHz. 1=left kidney, 2= right kidney.

Ultrasonographic imaging of the right kidney shows visible lobulation of kidney with various renal structures and appear in various echogenicity, renal parenchyma is hypoechoic which is well differentiated from the hyperechogenic sinus. The cortex and medulla could not be easily differentiated. The variance in kidney thickness between different areas depends on whether dorsal, ventral, medial or lateral measurements are taken, the same results were found by (10). Two sites of ultrasonographic examination are used for measurements of the left kidney in normal adult buffaloes.

Of these, the per-rectal (transrectal) approach is the best method for getting good images in buffaloes. While the right sublumbar (transcutaneous) approach is inferior (Table, 2).



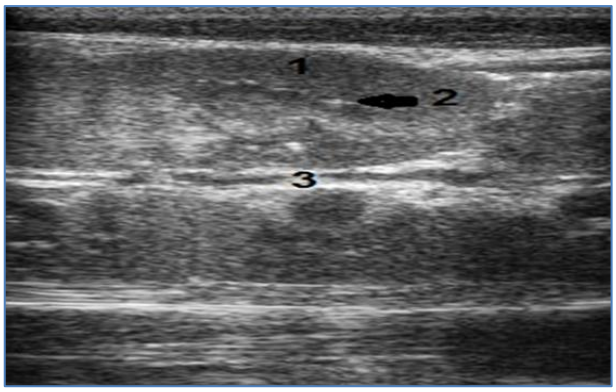
Figure, 4: Percutaneous ultrasonogram of right kidney from right lumbar region of buffalo. 3.5 MHz.

The left kidney can be examined by ultrasonography *via* both per-rectum, and right sublumbar fossa (35, 8 buffaloes respectively). The transrectal method is the best in small or light body weight animal, the left kidney can be examined through right caudal sublumbar fossa, but sometimes it is covered by gas-filled large bowel and only cranial pole may be visible.

Table, 2: Left kidney Ultrasonographic measurements (Mean±SD) of normal adult buffalos.

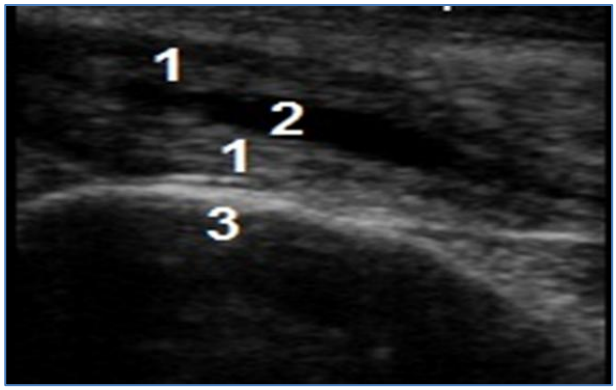
Sites of ultrasound examination	Kidney measurements					
	N.	Distance from body surface to kidney/cm	Kidney thickness/ cm	Cortex-medulla dorsal thickness/cm	Cortex-medulla ventral thickness/cm	Sinus thickness/ cm
Paralumbar region	8	4.311±0.43	7.300±0.20	3.255±0.02	2.233±0.23	1.600±0.14
Per-rectum	35	----	6.800±0.32	2.970±0.11	2.730±0.30	1.700±0.22

The image obtained from the left kidney scanned transrectally (Fig. 5) was superior to the transcutaneous method, because the kidney is closer to the focal zone of the transducer and a higher frequency transducer improves the resolution of the image, same results were found in cattle (8 and 11). The ultrasound images of left kidney transrectally in buffaloes reveals that characteristic fissured surface is clearly identified. Various renal structures have ultrasonograms with various echogenicities. The hyperechoic renal cortex easily differs from hypoechoic renal medullary pyramids, while hypoechogenic renal parenchyma contrasted sharply with the hyperechogenic renal sinus. Renal sinus has many centrally located renal echoes which reflect from the renal calyces, fat or connective tissue, and blood or lymph vessels.



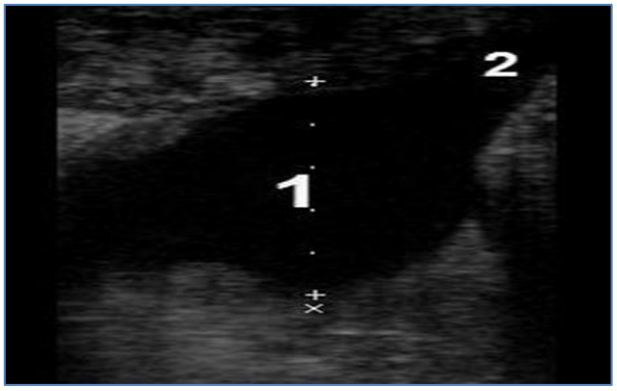
Figure, 5: Transrectal ultrasonogram of left kidney of buffalo 6.5 MHz. 1=cortex, 2=arcuate arteries, 3=sinus.

Similar results were mentioned by other researchers (8, 9, 11 and 15). The ultrasonography of urinary bladder is easily done per-rectum in adult and percutaneous in buffalo calves. Thickness of the wall varies according to urine amount. Urinary bladder appears as circumscribed round to oval structure in the pelvic area. It usually contains anechoic to hypoechoic urine. The wall of urinary bladder is echogenic, smooth and its thickness varies with the amount of bladder distention (Fig. 6-8), same results were recorded previously (8, 11 and 14).

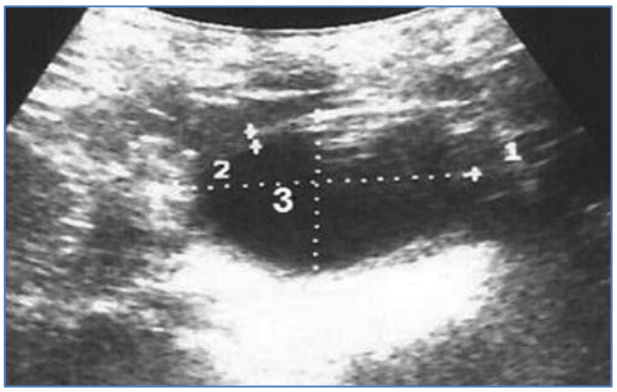


Figure, 6: Per-rectum ultrasonogram of urinary bladder of buffalo after urination. 6.5 MHz. 1=bladder wall, 2=hypoechoic urine, 3=pelvic bone. Cranial to the right.

From the results of ultrasonographic examination for the kidney in different sites (lumbar, sublumbar, 12th ICS), the sublumbar fossa region is the best site for making sonographic measurements in (24) buffalo calves (Table, 3) because of the short distance from skin surface to right kidney which allows best imaging from right sublumbar fossa region, moreover the small area inbetween transvers process or the 12 ICS make imaging of the kidneys from lumber region or 12 ICS in calves difficult. In contrast to other researches, about renal measurements in adult buffaloes (11 and 13), no reports had been published on renal measurements in buffalo calves; these results can be used for comparison of ultrasound images of both normal and diseased kidney in buffalo calves.



Figure, 7: Per-rectum ultrasonogram of normal size and position of buffalo urinary bladder filled with urine, 6.5MHz. 1=anechoic urine, 2= 2=caudal portion of UB.



Figure, 8: Percutaneous ultrasonograms of normal urinary bladder of calve from right paralumbar area, 3.5MHz. 1= horizontal diameter, 2=wall thickness, 3=vertical diameter.

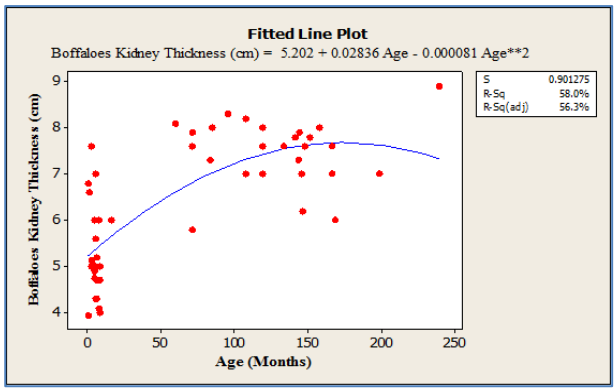
Table, 3: Right and left kidney ultrasonographic measurements (Mean±SD) of normal buffalo calves

kidney	Sites for ultrasound examination	N. calves	Distance from body surface to kidney/cm	Kidney diameter/ cm	Cortex-medulla dorsal thickness/cm	Cortex- medulla ventral thickness/cm	Sinus thickness/ cm
Right	Right lumbar	10	2.8±0.25	4.82±0.39	1.67±0.79	1.67±0.09	1.51±0.11
	Right paralumbar	24	1.01±0.05	5.29±0.23	1.61±0.84	1.63±0.067	1.76±0.17
	12th Intercostal space	14	1.47±014	6.21±0.38	1.79±0.13	1.72±0.08	2.00±0.21
Left	Right paralumbar	12	2.33±0.15	5.06±0.59	1.88±0.10	2.10±0.15	1.55±0.19

A positive correlation (0.627) of right kidney thickness (cm) with animal age (months) were found in both calves and adult buffaloes (Table, 4). From regression analysis between age and right kidney thickness, the results reveal an estimated relationship which can be used to predict right kidney thickness from the age of local buffalo breed (Fig. 9). The right kidney becomes thicker with age in buffaloes, this results were reported previously (16-18).

Table, 4: Correlation of right kidney thickness (cm) (Mean±SD) with animal age months).

Buffaloes	Age (months)	Right paralumbar	Correlation
		Right kidney thickness /cm	
Calves	12-24	5.293±0.238	0.627
Adult	36-180	7.403±0.133	



Figure, 9: Scatterplot describing the relationship between buffaloes right kidney thickness and the age. The solid line is the calculated linear regression line.

Ultrasonographic evaluation of the urinary system provide an accurate practical, rapid and noninvasive, diagnosis for animal status and can be performed on standing, non-sedated buffaloes. Moreover it also needs an expert sonologist as well. Per-cutaneous ultrasonographic examination is easier than per-rectum ultrasonographic examination in buffaloes and provides good images quality of right kidney. The sublumbar region is the best area for getting good ultrasonographic imaging, followed by lumbar region which gives clear images in buffaloes and the 12th ICS which gives good images in cattle. In calves urinary bladder is easily examined per-cutaneous from the right sublumbar region. An estimated relationship by regression analysis which can be used to predict right kidney thickness from the age of buffaloes, which provides an easily rapid equation for veterinary sonologist to confirm normal kidney thickness. Ultrasonographic examination and images of urinary system in clinically healthy buffaloes are easy and provide basic references for diagnosing urinary tract diseases.

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الفحص بالأمواج فوق الصوتية للجهاز البولي في الجاموس العراقي (*Bubalus bubalis*)

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الخلاصة

أجريت هذه الدراسة لتقييم كفاءة استعمال الأمواج فوق الصوتية في فحص الجهاز البولي للجاموس العراقي. شملت الدراسة فحص الجهاز البولي في 60 رأس من الجاموس المحلي تراوحت أعمارها بين 1-15 سنه ومن كلا الجنسين، قسمت حيوانات الدراسة إلى مجموعتين وحسب العمر إلى 25 عجل أقل من 2 سنه و 35 جاموس بالغ بعمر 2-15 سنه. أخذت قياسات الكليتين بالفحص عبر الجلد من ثلاث مناطق مختلفة من جسم الحيوان (القطنية اليمنى، تحت القطنية اليمنى، المسافة 12 ما بين الاضلاع اليمنى). بينت النتائج أنّ منطقة تحت القطنية اليمنى هي الأفضل للحصول على أنسب صور بالأمواج فوق الصوتية (في كل من العجول والجاموس) تتبعها منطقة القطنية اليمنى إذ أمكن فيها الحصول على صور واضحة للجاموس البالغ. اظهرت نتائج الفحص بالأمواج فوق الصوتية لكل من الكلية اليسرى واليمنى في الجاموس البالغ والعجول عدم وجود فروق معنوية في قياسات الكلية من المناطق المختلفة (القطنية، تحت القطنية، المسافة الثانية عشر ما بين الاضلاع). بينت الدراسة أن متوسط سمك الكلية اليمنى في الجاموس من المنطقة تحت القطنية اليمنى (0.13±7.40) سم وفي عجول الجاموس (0.23±5.29) سم، في حين أنّ متوسط سمك الكلية اليسرى في الجاموس من المنطقة تحت القطنية اليمنى (0.20±7.30) سم, وفي عجول الجاموس (0.59±5.06) سم. كشفت الدراسة عن سهوله إجراء فحص المثانة البولية بالأمواج فوق الصوتية عبر المستقيم في الحيوانات البالغة وعبر الجلد في العجول (المنطقة تحت القطنية اليمنى)، وقد ظهر جدار المثانة البولية بسمك مختلف حسب كمية البول الموجود داخل المثانة وظهرت المثانة البولية بشكل دائري إلى بيضوي داخل التجويف الحوضي وتحتوي بالغالب على بول عديم الصدى إلى قليل الصدى بينما كان جدار المثانة رقيق ذو صدى وبسمك مختلف بالاعتماد على مدى توسع المثانة.أثبتت النتائج وجود علاقة ترابط موجبة بين سمك الكلية اليمنى (سم) (من المنطقة تحت القطنية اليمنى) وعمر الجاموس (بالأشهر) وكانت (0.627).

الكلمات المفتاحية: الامواج فوق الصوتية، الجهاز البولي، الكلية، الجاموس، العجول.