Indian Journal of Veterinary Anatomy 38 (01):46-50, June 2026

Ultrasonographic Assessment of Kidneys in Dog Cadaver

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Received: 24.04.2026; Accepted: 29.05.2026

ABSTRACT

The present study was conducted on eight non-descript adult male dog cadavers to evaluate the ultrasonographic features of kidneys. Ultrasonographic assessment was performed using a B-mode ultrasound machine equipped with a 3–9 MHz sector/curvilinear transducer following standard scanning protocols. Both kidneys were successfully visualized and assessed for their echotexture and structural characteristics. Both kidneys appeared as bean-shaped structures with smooth and well-defined margins. The renal cortex appeared homogeneous and hypoechoic relative to the spleen and slightly hypoechoic relative to the liver whereas the renal medulla appeared hypoechoic relative to both spleen and liver. A clear corticomedullary distinction was evident in all specimens. The renal sinus appeared prominently hyperechoic due to the presence of fat whereas the renal pelvis was not distinctly visualized.

Keywords: Ultrasonography, Kidney, Dog

INTRODUCTION

The imaging technique has become an essential tool in veterinary medicine, playing an important role in diagnosing, treating and managing animal health. The choice of imaging technique depends on the information needed, offering valuable insights into organ function and anatomy, which are critical for diagnosing and planning effective treatments. Among the available diagnostic methods, ultrasonography is a simple, non-invasive, economical and highly sensitive imaging diagnostic technique to assess the various pathological conditions affects the kidneys (Ramesh *et al.*, 2021). Ultrasonography is a cornerstone imaging modality in veterinary diagnostics due to its non-invasive nature, real-time imaging capability, and wide clinical applicability. It utilizes high-frequency sound waves to produce detailed images of internal organs, enabling accurate assessment of organ architecture and pathology. In small animal practice, ultra sonography is particularly valuable for evaluating renal parameters such as echogenicity, size, and shape. In pathological conditions of the urinary tract, renal parameters are highly useful diagnostic indicators in animals. Early detection through imaging is key to managing pathological conditions of kidneys effectively. Moreover, in the context of veterinary education, the application of ultrasonography on embalmed cadavers provides a valuable platform for students to develop practical imaging skills and understand organ physiology through simulation of real-time clinical scenarios, thereby improving their preparedness for clinical practice. Many research workers gave greater emphasis on the long-term preservation and multiple uses of canine cadavers, while minimizing the number of animals euthanized in the educational process (Oh *et al.,* 2025). The use of embalmed cadavers has significantly enhanced the scope of ultrasonographic studies in veterinary education and research. Unlike conventional embalming techniques, thiel embalming preserves soft tissue texture, elasticity, and echogenic properties, thereby allowing high-quality ultrasonographic imaging that closely resembles in vivo conditions (Macfarlane and Brooks, 2007). Oh *et al.* (2025) stated that thiel solution is considered the most suitable embalming solution for medical imaging acquisition and is usable over time in all imaging modalities regarding image quality and ease of application. Ultrasound researchers could use Thiel cadavers to conduct

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their initial abdominal imaging studies with lower cost and regulatory requirements than in-vivo trials (Lawley, 2025).

In recent years, advanced imaging techniques have been successfully performed in animals. However, meagre information is available on ultra sonographic assessment of the normal kidneys in embalmed dog cadavers. Hence, the present study was carried out with the aim of establishing the baseline ultrasonographic imaging characteristics of kidneys in thiel embalmed male cadavers.

MATERIALS AND METHODS

In the present study, ultrasonographic assessment of the kidneys was performed on eight non-descript adult male embalmed dog cadavers. The dog cadavers were procured from the animal hospital of the Bombay Society for the Prevention of Cruelty to Animals (BSPCA), Parel, Mumbai. The clinical history of these dogs was collected from BSPCA hospital to ensure that the dogs had no kidney pathology at the time of their death. The non-descript dogs cadaver were considered to be clinically healthy if there was no history of signs consistent with renal diseases in these dogs. The cadavers were embalmed using thiel embalming solution at the department of Veterinary Anatomy, Mumbai Veterinary College, Parel, Mumbai. The ultrasonographic examination of kidneys of dog cadaver was carried out within a week after embalming of dog cadavers at the department of Animal Reproduction, Gynaecology and Obstetrics, Mumbai Veterinary College, Parel, Mumbai. Prior to scanning, the abdominal region of each cadaver was prepared by shaving the area extending from the last rib to the pelvic brim, including the lateral abdominal walls. The skin surface was cleaned using surgical spirit to minimize air interference. A sufficient quantity of ultrasound coupling gel was applied over the prepared area as well as on the transducer head to ensure optimal acoustic contact. Ultrasonographic examination was conducted using a B-mode ultrasound machine (Sonoscape S2V) equipped with a 3– 9 MHz sector or curvilinear transducer, as recommended for small animal abdominal imaging (Nyland *et al.,* 2002). Machine parameters such as gain, depth, and focal zones were adjusted appropriately to obtain clear and diagnostically acceptable images. In the present study, the overall gain was adjusted until the renal medulla was daker and renal cortex was mid gray. The machines focus setting was adjusted to place the focus zone marker at the level of kidneys. The scanning depth for the kidneys of dog cadaver was between 4-8 cm. The cadavers were positioned in dorsal or lateral recumbency during the procedure (Fig.1). Ultrasonographic examination of both kidneys was performed by single operator and images were reviewed blinded. The right kidney was examined with the cadaver in left lateral or dorsal recumbency, while the left kidney was examined with the cadaver in right lateral or dorsal recumbency. For sagittal imaging, the transducer was placed parallel to the long axis of the body along the dorsal abdominal wall, just caudal to the last rib, with the transducer marker directed cranially. The probe was gently moved cranially and caudally to visualize the entire kidney from cranial to caudal pole. The probe was positioned perpendicular to the body wall over the renal region and moved in a fanning motion to obtain cross-sectional images at different levels. During ultrasonographic examination, parameters such as renal shape, contour, echogenicity of the cortex and medulla, corticomedullary differentiation, renal pelvis, and overall architecture were systematically assessed. Representative ultrasonographic images were recorded for documentation and further analysis.

RESULTS AND DISCUSSION

The present study documented the ultra sonographic appearance of right and left kidney in non-descript adult male dog cadaver. The present ultrasonographic study allowed visualization of organ position, shape, internal architecture and the relationships of the kidneys with adjacent abdominal and pelvic structures. Systematic assessment of kidneys in dog cadaver enabled clear identification of organ boundaries, parenchymal echotexture,surface characteristics and anatomical landmarks. In the sagittal plane, the cranial structures were visualized to the left of the screen and the caudal structures were visualized to the right side of the screen. Both kidneys were successfully visualized and evaluated using ultrasonography for their echotexture and structural architecture. The cranial end of right kidney was placed closed to caudate lobe of liver whereas left kidney was observed caudal to the gastric fundus and medial to the spleen. Right kidney was found more cranial and deeper than the left kidney in dog cadavers. This observation in the present study is in accordance with the findings reported by Jang *et al.*(2025) in clinically healthy korean raccon dogs. The right kidney appeared as a bean-shaped structure with smooth and well-defined margins during ultrasonographic examination (Fig. 2). The renal parenchyma showed a characteristic heterogeneous echotexture consisting of cortical, medullary and sinus regions. The renal cortex appeared relatively homogeneous forming the outer region of the kidney. The renal medulla was arranged as triangular or pyramidal areas between the cortex and the renal sinus.

In the present study, the corticomedullary junction was clearly distinguishable. The renal sinus appeared highly comparatively hyperechoic, which was attributed to the presence of sinus fat, connective tissue and renal vascular structures. Similar ultrasonographic architecture of the kidney has been reported by Bhadwal and Mirakhur (1999) in dogs, who described the kidney as having a complex echogenic pattern consisting of hyperechoic, hypoechoic and anechoic regions. The renal pelvis was not distinctly visualized in the right kidney. Similar observation was reported by Singh and Kumar (2021) in canine kidneys. Mantis (2008) reported that the renal pelvis was generally not visible in normal animals. The left kidney was also clearly visualized during ultrasonographic examination and exhibited similar ultraso nographic characteristics (Fig. 3). The renal cortex appeared homogeneous and hypoechoic relative to the spleen and slightly hypoechoic relative to the liver whereas the renal medulla appeared hypoechoic relative to both spleen and liver allowing clear differentiation of the corticomedullary junction. Similar observation were reported by Drost *et al.* (2000) and Griffin (2020) and in the normal kidneys of cat. Drost *et al.* (2000) reported that kidneys have increased accumulations of fat vacuoles within the cytoplasm of the proximal tubular epithelium, compared with other species. Qualitatively, this fat accumulation causes variation in the cortical echogenicity, as compared with the echogenicity of the renal medulla, in cadaveric kidneys. Griffin (2020) further stated that an increase in echogenicity of the renal cortices of healthy cats is a common occurrence and is due to hormonally dependent intra - cellular fat deposition within the epithelium of the convoluted renal tubules of the cortex, leading to increased corticomedullary definition. The renal sinus appeared as a comparatively hyperechoic in central region, which corresponded to the sinus fat and renal vasculature. Singh and Kumar (2021) also reported isoechoic or hypoechoic renal cortex relative to the liver in dog when imaged with a 5-mHz transducer. Huynh and Berry (2017) noted that the renal sinus, medulla, and cortex can be identified when viewing the kidneys in sagittal orientation. They reported that the renal medulla was the least echogenic region, followed by the renal cortex, and then the renal sinus with hyperechoic fat. Mantis (2008) observed hypoechoic to almost anechoic renal medulla interrupted by the diverticulli in dog and cat .He reported that in some dogs and cats, hyperechoic line could be seen just within the renal medulla running parallel to the corticomedullary junction representing the medullary rim sign which was usually non-specific finding in both dogs and cats.

During the assessment of kidneys in dog cadaver, visualization of the left kidney was easier and clearer than the right kidney. These observations are in agreement with the findings of Barrera *et al.* (2009) who reported that right kidney ultrasound measurements were usually more difficult to obtain than those of the left kidney because of gas bowel and the cranial location of the right kidney under the rib cage in dog cadavers. They further concluded that linear kidney ultra sound measurements “in vivo” appeared to be sufficiently accurate for clinical use. Bhadwal and Mirakhur (1999) also reported that the right kidney is often more difficult to image due to interference caused by intestinal gas ventral to the kidney, which acts as a barrier to sound transmission. Furthermore, Triolo and Miles (1995) suggested that the relatively shorter distance between the transducer and the left kidney results in improved image quality compared to the right kidney. Triolo and Miles (1995) reported that the echogenicity of the renal cortex may vary depending on the ultrasound frequency, with higher frequency probes producing a relatively hyperechoic echotexture of renal cortex. Oh *et al.* (2025) observed both poles of kidneys along the long axis having smooth margination and corticomedullary junction in kidneys of dog cadavers. They further noted reduced ultrasound image quality of kidneys over time in thiel embalming dog cadavers which was different from a previous study that showed improvements in the quality of ultrasound images from post-embalming cadavers by replacing the gas generated during decomposition with an infusion of preservative fluid (Benkhadra *et al.*, 2009). In the present study, ultrasonography was found to be an effective imaging modality for assessing the morphology of normal kidneys in dog cadavers as this study established baseline ultrasonographic imaging characteristics of kidneys in embalmed dog cadavers.

The present ultrasonographic study on kidneys of dog cadavers has some limitations. While this study included eight embalmed male nondescript dog cadavers, the relatively small sample size may limit the generalizability of the findings. Further studies with larger populations are warranted to validate these results. Although this study included ultrasonographic assessment of kidneys in dog cadavers, additional objectives such as quantitative measurements like renal dimensions and cortical thickness were not performed. This limitation should be considered when interpreting the results and future studies incorporating more comprehensive assessment of kidneys may provide a clearer understanding.

ACKNOWLEDGEMENT

The authors are grateful to the Associate Dean, Mumbai Veterinary College for providing necessary infrastructural facilities and financial grants to carry out the research work.

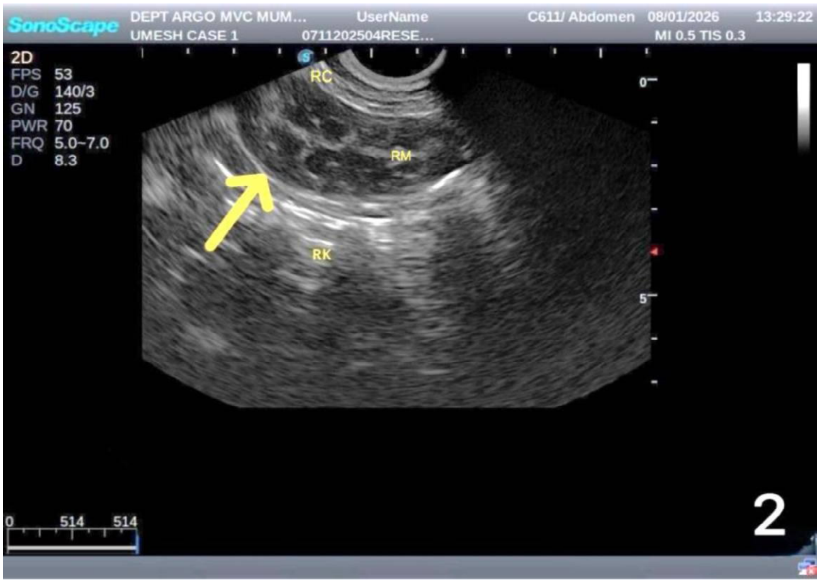

Fig.1: Photomacrograph showing ultrasonography machine (Sonoscape S2V) along with the dog cadaver undergoing ultrasonographic (Dog cadaver placed in dorsal recumbency), **Fig. 2:** Ultrasonographic image of right kidney of dog cadaver (Sagittal scanning plane in dorsal recumbency, RK- Right Kidney,RC- Renal Cortex, RM- Renal Medulla, Arrow- Renal capsule).

Fig. 3: Ultrasonographic image of left kidney of dog cadaver (Sagittal scanning plane in dorsal recumbency, LK- Left Kidney, RC-Renal Cortex, RM-Renal Medulla, Arrow- Renal capsule).

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