

Clinical experience of MRI in two dogs with muscle-invasive transitional cell carcinoma of the urinary bladder

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ABSTRACT. This study described high-field magnetic resonance imaging (MRI) and computed tomography (CT) characteristics of muscle-invasive bladder transitional cell carcinoma (TCC) in two dogs. Ultrasonography revealed a urinary bladder mass with ambiguous result about invasion to the muscular layer. Contrast-enhanced CT showed that the bladder wall in which the mass was attached was more intensely enhanced than the normal bladder walls, supporting invasion to the muscular layer. The mass revealed an intermediate signal intensity with interruption of the hypointense muscular layer on T2-weighted MRI and showed greater enhancement compared with the normal bladder wall on postcontrast T1-weighted images. T2-weighted MRI, postcontrast T1-weighted MRI and contrast-enhanced dual-phasic CT were useful for evaluating muscle-invasive bladder TCC in dogs.

KEY WORDS: canine, computed tomography, magnetic resonance imaging, muscle-invasive, transitional cell carcinoma

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Transitional cell carcinoma (TCC), the most common malignancy of the urinary bladder in dogs, is challenging to diagnose and treat effectively [8]. Canine TCC is generally aggressive with invasion to the bladder muscular layer and metastasis to the lung, regional lymph nodes or liver [7, 8]. According to the human study, it is important to know whether patients have invasive or superficial tumors because of treatment option and prognosis [1].

Ultrasonography is commonly used as an initial imaging modality, because this technique is non-invasive, widely available and does not require anesthesia [5]. However, the use of ultrasonography is often limited by the expertise of the sonographer and critically by the equipment used [4]. Previous studies in humans demonstrated that high-field magnetic resonance imaging (MRI) and computed tomography (CT) are superior to ultrasonography for the evaluation of invasive bladder tumors [1, 9]. On the basis of human studies, the use of high-field MRI or CT for diagnosing bladder tumor is expected to have advantages in veterinary practice. However, no previous study in veterinary medicine has diagnosed bladder tumor by using high-field MRI or CT. The purpose of this study was to describe high-field MRI and CT characteristics of bladder TCC in two dogs.

A 12.5-year-old, male neutered Shih-tzu (Dog 1) and a 9.5-year-old, female Shih-tzu (Dog 2) were presented with hematuria for 2 weeks and 4 weeks, respectively. There was no significant finding on physical examination in both dogs.

Results of hematology and serum biochemistry were within normal reference ranges in Dogs 1 and 2. Two patients underwent thoracic and abdominal radiography, transabdominal ultrasonography, thoracic and abdominal CT, high-field MRI and cytology. The thoracic and abdominal radiographs were normal in the two dogs.

For ultrasonography, the patients were manually restrained in dorsal or lateral recumbency and were scanned with a B-mode ultrasound scanner (Acuson X300 PE, Siemens, Erlangen, Germany) by using a multi-frequency linear array transducer of 5 to 13 MHz (VF13-5, Siemens). Transabdominal ultrasonography revealed an irregular and broad-based hyperechoic mass in the trigone of the urinary bladder in Dog 1. In Dog 2, a reverse C-shaped hyperechoic mass occupied the urinary bladder and attached to the dorsal and ventral bladder walls (Fig. 1). Evaluation of invasion to the bladder muscular layer by ultrasonography produced ambiguous results in the two patients. The regional lymph nodes and the other abdominal organs were sonographically normal.

For CT and MRI scan, anesthesia was induced using propofol (2 mg/kg intravenously) and maintained with 2% isoflurane. CT scanning of the abdomen and thorax was performed by using a multi-detector-row CT scanner (Somatom Emotion, Siemens). Contrast studies were performed after intravenous administration of 600 mg iodine/kg iohexol (Omnipaque, Nycomed Imaging, Oslo, Norway) injected using an autoinjector and contrast-enhanced CT images obtained at the arterial and delayed phases. Contrast material was administered for 20 sec, and each CT scan duration was around 10 sec in the two dogs. CT scan for arterial phase was initiated 20 sec after injection of the contrast material, and CT scan for delayed phase was initiated at 60 sec. Subsequently, a MRI scan of the caudal abdomen, including the urinary bladder, was performed by using a 1.5-Tesla magnet

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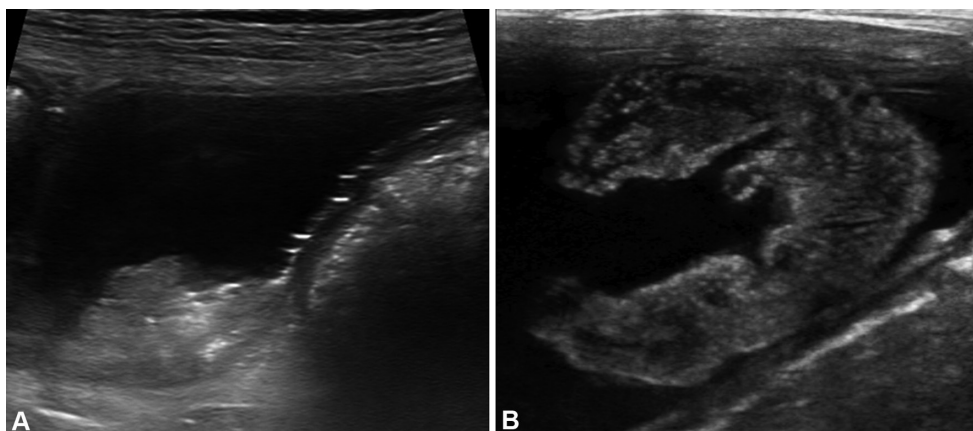


Fig. 1. Ultrasonographic images of the urinary bladder in Dog 1 (A) and Dog 2 (B) show an irregular mass with a heterogeneous echo pattern in the urinary bladder. Invasion to the muscular layer is difficult to evaluate by ultrasonography.

(Magnetom Essenza, Siemens, Munich, Germany). T2-weighted (T2W) spin-echo, precontrast T1-weighted (T1W) spin-echo and postcontrast (0.1 mmol of gadodiamide/kg, Omniscan, Nycomed Imaging) T1W images with transverse and sagittal images were obtained. In Dog 1, postcontrast T1W images were obtained with chemical shift selective saturation (CHESS) fat suppression to account for the possibility that a contrast enhancing tumor may be hidden by the surrounding fat.

Noncontrast CT showed that the urinary bladder masses were irregular and isodense to the muscle layer in the two dogs (Figs. 2A and 3A). The wall in which the mass was attached was more intensely enhanced than the remainder of the bladder walls on the arterial phase, supporting increase in arterial blood flow to the lesion in the two dogs (Figs. 2B and 3B). Although focal contrast-enhanced lesion in the mass was detected in Dog 1, the entire bladder wall showed mild contrast enhancement on the delayed phase in the two dogs (Figs. 2C and 3C). The broad-based mass was attached to the dorsal bladder wall on CT images in Dog 1. In Dog 2, contrast-enhanced CT revealed that the mass was attached to the ventral bladder wall, whereas ultrasonography had produced ambiguous results. There was no evidence of metastasis in the lung, regional lymph nodes or abdominal organs on CT in the two dogs.

In the two dogs, the mass showed an intermediate signal intensity that was higher than that of the bladder muscular layer, with interruption of the low signal intensity of the muscular layer by the tumor, on T2W images (Figs. 2D and 3D). The bladder masses had intermediate signal intensity, equal to that of muscle, on T1W images in the two dogs (Figs. 2E and 3E). In Dog 1, the strong hyperintense area on the bladder wall in contact with the mass on the T1W image was considered an artifact. On postcontrast T1W images, the bladder mass showed greater enhancement compared with the normal bladder wall (Figs. 2F and 3F). The final diagnosis of TCC was based on cytologic findings and hematuria resolved by 4 weeks after medical therapy in Dog 1.

Muscular invasive TCC was histopathologically confirmed after partial cystectomy in Dog 2.

A previous study reported that involvement of the bladder muscular layer can be assessed by ultrasonography in most cases [5]. In this study, however, muscular layer involvement was difficult to identify by ultrasonography in both cases. A possible explanation for this phenomenon in Dog 1 is that the artifacts were caused by the calcified lesions within the mass or were enhancement artifacts. In addition, the mass was located on the dorsal bladder wall, far from the body surface which may have led to decreased resolution. In Dog 2, it may have been difficult to evaluate the bladder wall, because of the thin bladder wall with a dilated urinary bladder due to a large-sized mass. Another possibility was the posture during ultrasound or residual urine volume in the urinary bladder at time of ultrasound.

A previous study in humans showed that the normal bladder wall enhances very slightly, whereas TCC tends to enhance earlier and more intensely than the normal bladder wall on dynamic CT [6]. In addition, a bladder tumor tends to show peak enhancement with the 60 sec scanning delay [6], which corresponds to the arterial phase in human. The CT findings on arterial phase in the two dogs in this study were consistent with the results on previous dynamic CT [6]. However, in this study, CT scanning for arterial phase was performed with a 20 sec scanning delay, which was satisfactory to assess invasion to the bladder wall. This may be due to the difference in injection duration and scan time, injection site of the contrast material, volume of the contrast material and patient's anesthetic condition. Although contrast-enhanced CT images obtained with only two scanning delays in this study, dual-phasic CT was useful for evaluating invasion to the bladder muscular layer, which was not identified on noncontrast CT images in the two patients.

MRI is widely used in human medicine in the assessment of bladder tumor, and bladder tumor is usually more conspicuous on T2W images [2, 4]. In the patient with muscle invasion of bladder tumor, the low signal intensity of the

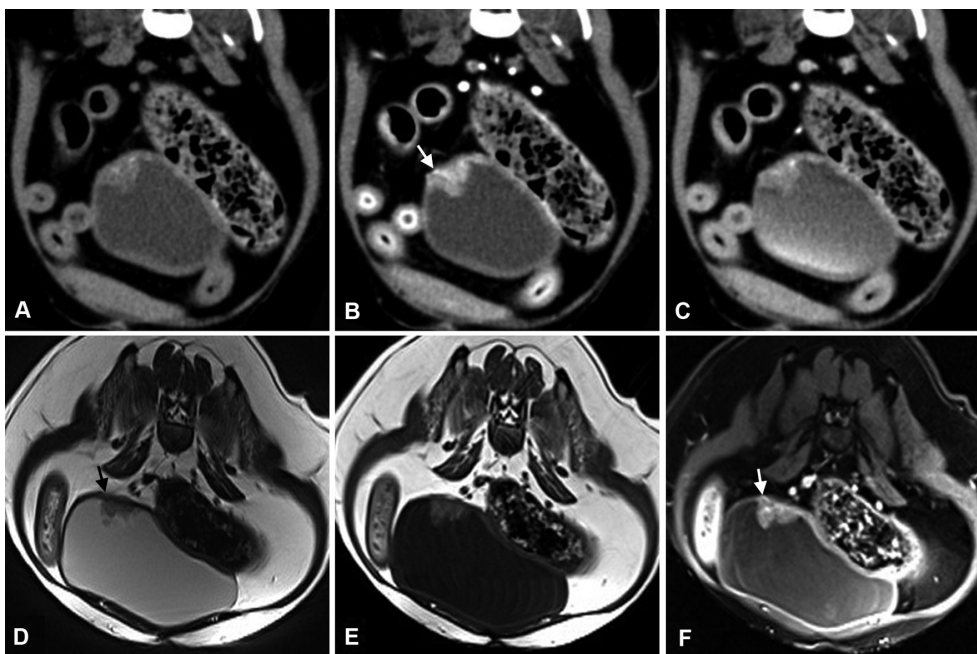


Fig. 2. Transverse CT (A–C) and MRI (D–F) in Dog 1. The urinary bladder mass is irregular and isoattenuating to the muscular layer in noncontrast CT (A). The mass is enhanced more intensely than the remainder of the bladder wall on arterial phase (B, arrow). Although focal contrast-enhanced lesion in the mass is detected, the entire bladder wall shows mild contrast enhancement on the delayed phase (C). On T2W image, the low signal intensity of the muscular layer is interrupted by the tumor (D, arrow). The mass has an intermediate signal intensity, equal to that of muscle on precontrast T1W image (E) and shows greater enhancement than the normal bladder wall on postcontrast T1W image (F, arrow).

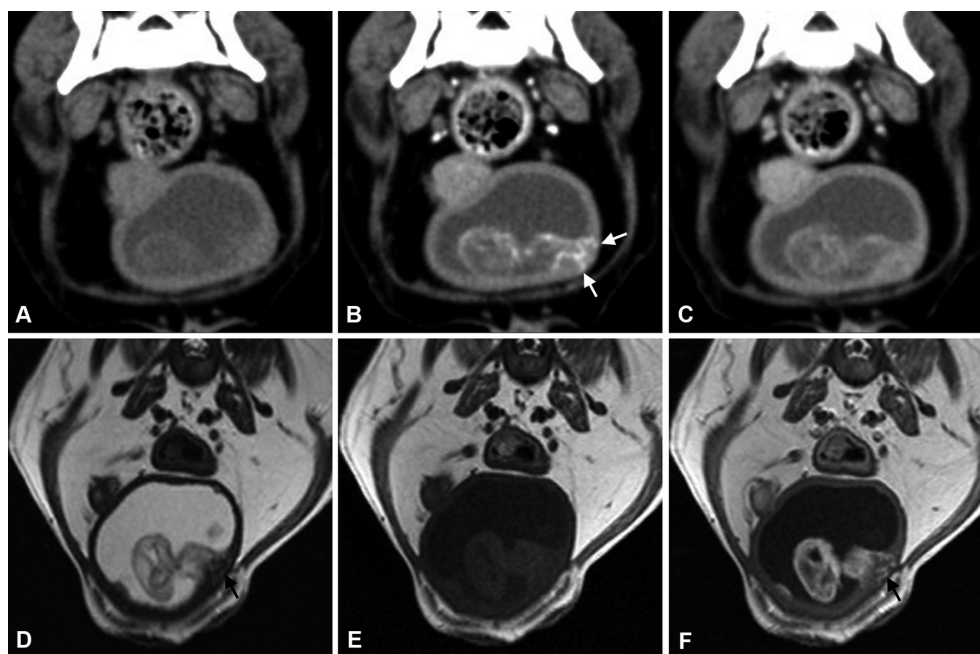


Fig. 3. Transverse CT (A–C) and MRI (D–F) in Dog 2. The urinary bladder mass is irregular and isoattenuating to the muscular layer in noncontrast CT (A). The mass is attached to the ventral bladder wall (B and C) and enhanced more intensely than the remainder of the bladder wall on arterial phase (B, arrows). On T2W image, the low signal intensity of the muscular layer is interrupted by the tumor (D, arrow). The mass has an intermediate signal intensity on precontrast T1W image (E) and shows greater enhancement than the normal bladder wall on postcontrast T1W image (F, arrow).

muscular layer is interrupted by the tumor on T2W images [3]. Invasion to the bladder muscular layer was detected on T2W images in both patients in the present study. These results support the idea that MRI could be useful for determining the presence of muscle invasion even in patients in whom administration of contrast medium should be avoided. In addition, a bladder tumor tends to enhance more intensely than the remainder of the bladder wall on postcontrast MRI as well as on contrast-enhanced CT [3]. However, in this study, postcontrast MRI was superior to contrast-enhanced CT in terms of excellent soft tissue resolution of the bladder wall.

In conclusion, detection of bladder tumor was possible by ultrasonography, CT and MRI. T2W images, postcontrast T1W MRI and contrast-enhanced dual-phasic CT were useful for evaluating invasion to the bladder muscular layer. This report demonstrated that MRI and contrast-enhanced CT could be valuable for evaluation of bladder wall involvement in canine TCC.

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