As discussed in the articles, A Tour of the Abdomen (Part 1, January/February 2016, and Part 2, March/April 2016), ultrasound (US) examination of the urinary tract is typically completed in a counterclockwise fashion in the following order:

1. Left kidney
2. Urinary bladder
3. Proximal urethra
4. Right kidney.

**PREPARATION**
Prior to beginning the examination, clip the patient’s hair and apply ultrasonic gel to the skin.

The bladder is usually examined when it is distended with urine as an empty or minimally distended urinary bladder may appear to have thickened walls on ultrasonographic examination. Methods of distending the urinary bladder are described under Urinary Bladder on page 62.

**SCANNING TECHNIQUE**
A 5-, 7.5-, or 10-MHz convex, linear, or vector transducer is required to examine the distal ureters, urinary bladder, and proximal urethra, while a microconvex transducer with a small footprint allows the ultrasonographer to easily view the intrapelvic ureter.

**Urinary Bladder**
To evaluate the urinary bladder:
1. Keep the transducer positioned in long axis to the animal, and move it caudal to a level between the last 2 mammary chains.
2. Evaluate the urinary bladder in long axis and short axis.
3. Be sure to examine the trigone region carefully, particularly as it extends caudally into the urethra in cats and female dogs or the prostate gland in male dogs.

**Urethra**
To evaluate the proximal urethra or, in male dogs, the prostatic urethra:
1. Place the transducer in a long-axis sagittal position at the level of the urinary bladder.
2. Move the transducer caudally until the trigone region is identified.
3. When the transducer cannot move any farther caudally due to the presence of the pubic bone, angle the transducer footprint in a caudal direction.

**Measuring Urinary Bladder Wall Thickness in Dogs**
Urinary bladder wall thickness in dogs can be calculated based on the degree of bladder distension:

- If the bladder is minimally distended (0.5 mL/kg), bladder wall thickness is 2.3 ± 0.43 mm.
- If the bladder is mildly distended (2 mL/kg), bladder wall thickness is 1.6 ± 0.29 mm.
- If the bladder is moderately distended (4 mL/kg), bladder wall thickness is 1.4 ± 0.28 mm.

If urinary bladder wall thickness is suspected, differential diagnoses include cystitis and urinary bladder neoplasia.
NORMAL ULTRASONOGRAPHIC FEATURES

Urinary Bladder

Bladder Wall Thickness

Normal bladder wall thickness in dogs is 1 mm, with thickness increasing mildly as body weight increases (see Measuring Urinary Bladder Wall Thickness in Dogs, page 61). In cats, urinary bladder wall thickness ranges from 1.3 to 1.7 mm.

The urinary bladder has irregular folds, which can be mistaken for abnormally thickened bladder walls when the bladder is relatively empty. If an abnormality of the urinary bladder wall (e.g., cystitis) is suspected, wall thickness may be confirmed by:

- Re-examining the bladder at the end of the abdominal US examination
- Administering maintenance intravenous fluid or furosemide at low doses
- Placing a urinary catheter to fill the bladder with sterile isotonic saline as needed.

Evaluation of Bladder Structures

The urinary bladder should be evaluated in long axis and short axis, from the apex to the level of the urethra at the ureterovesicular junction (Figure 1). In male dogs, the prostate gland is immediately caudal to the urinary bladder. In females, the urethra should be followed for several centimeters beyond the urinary bladder to evaluate for any abnormal urethral thickening or mineralization.

The distal ureters (if seen) can be evaluated as they enter at the ureteral papillae, which are located along the dorsal urinary bladder wall adjacent to the cranial aspect of the trigone (Figure 2). Occasionally, echogenic ureteral jets may be seen entering the urinary bladder lumen at the level of the ureteral papillae secondary to ureteral peristalsis.\(^2,3\)

The histologic layers of the urinary bladder are difficult to define using US in a moderately distended urinary bladder. If the layers are evident, they will consist of the following (Figure 2):

- Outer serosal layer (hyperechoic)
- Three smooth muscle layers (hypoechoic)
- Lamina propria submucosal layer (hyperechoic), which parallels the inner mucosal layer (hypoechoic).

Evaluation of Adjacent Structures

The urinary bladder serves as a good acoustic window for adjacent structures, such as the colon, uterus (intact females), and iliac lymph nodes. Anatomically, the urinary bladder is the most ventral structure in the caudal abdomen, followed by the...
uterus (intact females), colon, and iliac lymph nodes dorsally (far field).

**Evaluation of Urine & Artifacts**

Urine in the urinary bladder is normally anechoic; however, echogenic urine is not specific for urinary tract disease.

Other US artifacts of the urinary bladder include side-lobe or grating-lobe artifacts. Side-lobe artifacts, or *pseudosludge*, are caused by mismapped reflections of the secondary US beam into anechoic regions, resulting in echogenic areas within the urinary bladder lumen that can be mistaken easily for sedimentation (Figure 3).

Angling the transducer can sometimes decrease the severity of the artifact and, thus, rule out sedimentation in the urinary bladder. Alternatively, the patient can be imaged in a standing position to assess for gravity dependence, which would be characteristic of true sludge.

**Urethra**

The proximal urethra (prostatic urethra in male dogs) can be visualized as a tubular hypoechoic structure continuing caudal to the trigone region of the urinary bladder and extending to the level of the pubic bone. The membranous urethra cannot be visualized due to its location within the pelvis.

Assessment of the penile urethra within the ventrally located urethral groove of the os penis may be performed in male dogs but is typically not included in a normal abdominal US examination. Indications for a penile urethral US examination include suspicion of a distal urethral obstruction.

**URINARY TRACT ABNORMALITIES**

**Congenital Abnormalities:**

**Urinary Bladder & Ureter**

*Ureterocele*

Ureterocele is a rare congenital ureteral malformation that can be associated with ectopic ureters. An intravesicular ureterocele is characterized by focal cystic dilation of the distal submucosal portion of the ureter that protrudes into the urinary bladder lumen. A thin-walled, round structure containing anechoic fluid can be seen within the neck of the urinary bladder (Figure 4).

*Urachal Remnants*

In the fetus, the urachus connects the apex of the urinary bladder with the allantoic sac through the umbilical cord. Before birth, this structure normally atrophies. Incomplete closure of the urachus may result in patent urachus, urachal diverticulum, or urachal cyst.

Patent urachus is uncommon in dogs and cats. Ultrasonographically, it is seen as a tubular structure extending from the apex of the urinary bladder to the umbilicus.

Urachal diverticulum results when the caudal segment of the urachus fails to close. It appears as a fluid-filled, rounded, thin-walled, well-defined structure extending from the urinary bladder lumen at any location (Figure 5, page 64). The urachal diverticulum disappears in an empty urinary bladder.

Urachal cysts form when secretions continue in an isolated section of urachal epithelium while the remainder of the urachus undergoes fibrosis. Ultrasonographically, a urachal cyst appears as a thin-walled, anechoic structure cranial to the urinary bladder.
Acquired Abnormalities: Bladder

Ruptured Urinary Bladder

In ruptured urinary bladder, small mural defects may not be seen and discontinuity of the wall may be falsely suspected due to echo dropout from a curved urinary bladder wall (Figure 6). A ruptured urinary bladder is best diagnosed using positive-contrast cystography and identifying contrast material within the peritoneum.5

Cystic Calculi

Cystic calculi appear as a variable-sized, spheric, and hyperechoic curvilinear interface with distal acoustic shadowing collecting in the dependent portion of the urinary bladder (Figure 7), but cystic calculi can adhere to a severely inflamed urinary bladder wall. If the gas in the adjacent descending colon makes the cystic calculi difficult to detect, the patient can be scanned while standing, using the benefits of gravity to mobilize the calculi away from the dorsal urinary bladder wall.

Blood Clots & Hematomas

Blood clots may form secondary to trauma, bleeding disorders, infection, or neoplasia. They are commonly hyperechoic without distal acoustic shadowing (Figure 8), irregularly shaped, and often gravity dependent.6,7

Cystitis

Chronic cystitis causes urinary bladder wall thickening and mucosal surface irregularity that is...
most pronounced cranioventrally (Figure 9). Severe cystitis can be generalized.⁸

**Polypoid Cystitis**
Polypoid cystitis appears ultrasonographically as wall thickening and multiple small masses (usually located cranioventrally) that project into the urinary bladder lumen (Figure 10). Large polyps can appear pedunculated at their attachment site.⁹,¹⁰

**Emphysematous Cystitis**
Gas-producing micro-organisms (e.g., *Escherichia coli*, *Aerobacter*, *Proteus*, *Clostridium*) accumulate within the urinary bladder wall, lumen, and ligaments. These micro-organisms ferment glucose, with gas as a by-product. As a result, in patients with glucosuria secondary to diabetes mellitus, gas can be present in the urinary bladder wall.

Ultrasonographically, the urinary bladder wall is irregularly marginated and hyperechoic, with acoustic shadowing and reverberation produced by the gas (Figure 11).¹¹,¹² The position of the gas in the wall can help differentiate emphysematous cystitis from a normal colon containing gas within its lumen; in emphysematous cystitis the position of the gas does not change with the position of the patient.

**Urinary Bladder Neoplasms**
Transitional cell carcinoma (TCC) is the most common neoplasm of the urinary bladder (Figure 12). It is typically an irregular urinary bladder wall mass with a broad-based attachment projecting into the urinary bladder lumen in the trigone region.

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**Footnotes**
⁸ Glucosuria secondary to diabetes mellitus
⁹,¹⁰ Polypoid cystitis appears ultrasonographically as wall thickening and multiple small masses (usually located cranioventrally) that project into the urinary bladder lumen.
¹¹,¹² The position of the gas in the wall can help differentiate emphysematous cystitis from a normal colon containing gas within its lumen; in emphysematous cystitis the position of the gas does not change with the position of the patient.
Abnormalities: Urethra

Urethral Calculi

Urethral Neoplasms

IN SUMMARY

Systematic examination of the urinary system is a routine part of a complete abdominal evaluation. A complete US examination of the urinary system is required as abnormalities of the kidneys and ureters are commonly seen in conjunction with urinary bladder lesions.

SCC = squamous cell carcinoma; TCC = transitional cell carcinoma; US = ultrasound

References


