Evaluating the Feline Urinary Tract: Radiography, Special Procedures and Ultrasonography

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Clinical signs of stranguria, dysuria, pollakiuria and periuria in cats can result from a variety of urinary tract disorders, including urinary tract infections, cystic calculi, neoplasia and idiopathic cystitis. Urolithiasis is common in cats, and can account for up to 28% of cats with lower urinary tract signs. Diagnostic imaging plays an important role in diagnosis of urinary tract disease. Radiography, contrast radiography and ultrasound are useful in locating uroliths when present; evaluating for changes in size and shape of the urinary bladder and kidneys; and identifying masses in the urinary tract. This lecture will review the utility of these techniques with illustrations using case examples.

Objectives

1. Review findings associated with urinary tract obstruction
2. Review the findings associated with urolithiasis and other causes of urinary tract obstruction in cats using radiography, contrast radiography and ultrasonography
3. Review findings associated with bladder wall thickening, renal irregularities on diagnostic imaging studies

Key points

1. Different imaging tests may be of use in the workup of a cat with urinary tract signs
2. The diagnosis of urinary tract obstruction may require more than plain radiographs
3. The utility of contrast radiography is often overlooked, and can be a useful tool in the diagnosis of urinary tract disease in cats

Radiography

Plain radiographs are a very useful tool in the diagnosis of urinary tract disease. As always, the fundamentals of radiographic interpretation should be observed. This requires that images of diagnostic quality are obtained. A complete abdominal radiographic examination consists of at least 2 orthogonal projections collimated on the abdomen. Additional images collimated on the caudal abdomen may also be obtained to more accurately assess the pelvic/penile urethra. While a systematic review process is required for abdominal radiographic interpretation, the primary focus of this lecture is on the urinary tract.

A standard Roentgen approach to interpretation should be used. Evaluation of abnormalities based on their location, size, shape, contour, number and opacity is the start of this approach. Documentation of renal size, irregularity and changes in opacity are an aid in diagnosis of possible renal diseases. Urinary bladder size and/or regional changes in opacity may indicate the presence of uroliths with possible obstruction. Ureters, while not normally seen radiographically, may contain ureteroliths, which might be seen radiographically.

Special procedures

The addition of positive and negative contrast media can be helpful in identifying abnormalities of the urinary tract.

Excretory urography

Excretory urography (also known as intravenous pyelography, intravenous urography), requires the intravenous administration of positive contrast media to better image the kidneys, crudely estimate renal function, evaluate renal shape, size and masses, and look for evidence of urinary obstruction. It is also useful in evaluating anatomy, including the presence of ectopic ureters.

Intravenous contrast is administered in the form of organic iodine, which comes in ionic and non-ionic forms. Ionic forms of organic contrast are less expensive, but come with greater risk as they dissociate into their respective cation and anion, which increases their toxicity and their osmolarity. The non-ionic forms are safer, as they have no cation or anion, and are typically less hyperosmolar than their ionic counterparts.

Risks of intravenous contrast administration include contrast induced renal failure, acute anaphylaxis-type reactions, and renal injury. Dehydration is the primary contraindication for intravenous contrast administration; however, some evidence exists to suggest that administration of contrast to animals with severe renal compromise is also contraindicated.

Iodine is excreted primarily through the kidneys, and causes progressive opacification of the renal parenchyma. This opacification can be separated into 2 distinct phases, the nephrogram and the pyelogram. The first, the nephrogram, can be further divided into the vascular phase and the tubular phase, and is characterized by increased cortical opacification. This phase lasts only seconds to a minute, and is quickly followed by the pyelogram. The pyelogram is characterized by the visualization of concentrated positive contrast in the renal diverticuli, renal pelvis and the ureters. Orthogonal images are obtained as survey images, and post-contrast images obtained immediately, 5 minutes, 10 minutes, 20 minutes and 40 minutes following contrast administration. Observation of

progressive opacification in the initial stages of the excretory urogram, followed by progressive loss of opacity in the later stages signifies relatively normal renal function in the cat. Failure of the kidneys to become less opaque during the later stages of the study indicates renal dysfunction.

Cystography/Cystourethrography

Evaluation of the lower urinary tract is also useful for the evaluation of urinary bladder disease and urethra, including bladder wall thickening, masses, cystoliths, and urethral obstruction. Heavy sedation or anesthesia is required for proper examination. A urinary catheter must be placed. The urinary bladder is emptied of urine, and for a positive contrast study, non-ionic contrast media is administered at a dose of 5 cc/lb. Typically, at the University of Florida, we use positive contrast media with a concentration of 300 mgI/ml. This is typically diluted 1:1 with 0.9% sterile saline prior to administration. It is important to palpate the urinary bladder during filling to avoid rupture, as diseased bladders may be friable. Significantly less contrast may be necessary in diseased bladders. Positive contrast cystography is useful for evaluation of the urinary bladder wall, but may obscure small stones or other luminal contents. Alternatively, a double contrast cystogram can be performed. This requires the administration of negative contrast (air, CO_2) until full, then adding approximately 2 cc of non-ionic iodinated contrast material.

For each of these, it is important to take at least 4 projections: left lateral, right lateral, ventrodorsal and dorsoventral. The ventrodorsal and dorsoventral projections may be obliqued to allow visualization of areas obscured by the vertebrae.

Urethrography may be performed normograde or retrograde. Both may be necessary for complete evaluation of the urethra. As these studies require intervention of a technician or veterinarian during the exposure, it is important to pay careful attention to radiation safety. NEVER be in the primary beam, and always wear appropriate lead shielding and monitoring devices. Remember the ALARA principle (As Low As Reasonably Achievable), which means you must minimize Time of your exposure to x-rays, Distance from the radiation source and wear proper Shielding. A urinary catheter is placed in the urethra, and positive contrast is administered under pressure to distend the urethra. A radiograph is made during the administration. Fluoroscopic evaluation, if available, is also extremely useful, as it allows real-time interrogation of the urethra during voiding or retrograde administration of positive contrast media. The retrograde study allows evaluation of the mucosal border of the urethra, and can test for the presence of luminal abnormalities.

Ultrasonography

Ultrasonography is a commonly used method for the evaluation of renal parenchyma, the urinary bladder, and occasionally the ureters and portions of the proximal urethra. Ultrasound, however, is highly operator dependent, so it is important to consider one's comfort level with this modality prior to choosing this test for your patient.

Ultrasonographic evaluation of the kidneys yields significant information regarding the distinction between cortex and medulla, changes in shape, size, and the presence of nephroliths, especially those that are small and composed of urate or cysteine crystals. Nephroliths generally reflect incident ultrasound waves due to their high acoustic impedance, resulting in shadowing and/or reverberation artifacts. Normal ureters are not generally seen; however, those that are dilated due to partial or complete obstruction may be detected as fluid filled tubes in the retroperitoneal space. In addition, the shadowing and reverberation artifact that is characteristic of stones can be identified when ureteroliths are present. Focal and diffuse urinary bladder wall thickening can also be evaluated, though the degree of urinary bladder distention will alter wall thickness, and must be considered in your evaluation. Additionally, mucosal irregularities characteristic of cystitis can also be seen. Finally, while a large portion of the urethra lies within the pelvis, a difficult area for sonographic interrogation, there is a small portion of the proximal urethra that can be imaged. Contrast urethrography still remains superior to US in evaluation of the urethra.

Conclusions

In the context of feline urinary tract diseases, diagnostic imaging can be a useful tool in the diagnosis and management. Choosing the appropriate test is based on clinical suspicions. Special procedures in diagnostic imaging are under-utilized in general practice, and can be useful when performed properly. Always remember radiation safety when performing special procedures. Finally, while ultrasonography provides parenchymal information not realized with radiography, this test is highly dependent on the experience of the sonographer and comfort level with interpretive principles.