Urogenital Imaging:
Can I Do a Contrast Procedure in Practice?

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Urinary tract infections are a very common cause for stranuria and hematuria seen in the general veterinary practice. Usually, a urinalysis is obtained and appropriate therapy is provided with limited imaging and the hope is that the patient's symptoms will resolve due to a self-limiting problem. This lecture will focus on all the modalities available to help the clinician assess the urinary tract with examples of specific diseases to help illustrate key points.

Radiographs are considered the first line of diagnostic imaging obtained in a urinary patient. This is to look for urinary calculi since struvite and calcium oxalate crystals are radiopaque. The problem is that soft tissue and fluid have the same opacity so cystitis and a thick wall of the urinary bladder. Ectopic ureters cannot be seen, hydronephrosis secondary to obstruction, pyelonephritis and even a renal mass or perinephric pseudocyst cannot be seen because of similar opacities. For this reason intravenous contrast medium can be used to create contrast between the urine and the soft tissues of the organs, bearing in mind that the contrast medium can damage the kidneys and cause renal failure.

Despite the inherent risk of contrast medium, the benefits of excretory urography (also called intravenous pyelogram or IVP) and the ease of the procedure still make it a viable modality in patients with urogenital disorders. The basic types of contrast medium procedures that will be discussed are retrograde urethrograms, positive contrast cystograms, double contrast cystograms and excretory urograms. Generally, procedures are performed in the order listed above of a complete evaluation of the urinary system.

The contrast medium of choice for all urinary procedures is iodinated contrast medium. Ionic (hypertonic) or nonionic (closer to isotonic) contrast medium is less important for urethrograms or cystograms, but the choice may come into play with intravenous administration. Ionic contrast medium, such as MD-76 and Conray, are very hypertonic and as such can cause a tachycardia and reflex bradycardia due to the increased blood volume by pulling fluid from the periphery into the vascular space, much like hypertonic saline. Non-ionic contrast medium, such as Omnipaque and Isovue, is generally closer to isotonic saline and so the vascular changes are minimal. The other complication with contrast medium is the simulation of the chemoreceptor trigger zone in the brain, which can cause vomiting. This is believed to be the direct result of the high level of iodine within the blood when contrast medium is administered. This response is avoided by administering the contrast as a slow bolus over 30 seconds to 1 minute or having the patient under general anesthesia. Due to the potential damage to the nephrons and the multiple images obtained for the contrast medium procedures, all animals should be heavily sedated or under general anesthesia and placed on at least twice maintenance intravenous fluids during the procedure. The risk of an anaphylaxis event is considered equally likely between ionic and non-ionic contrast medium.

Retrograde urethrograms can be performed in males by placing a catheter directly into the penile urethra and infusing contrast medium. Generally a small volume of contrast medium diluted with sterile saline is used. In the author's experience, 2 mL of contrast medium diluted with 8 mL of saline is sufficient to infuse the urethra with contrast medium. In females, a vaginourethrogram is usually performed using a Foley catheter within the vestibule and 30 mL of contrast medium and saline in a 1:5 dilution. A tissue clamp may be needed on the labia to keep the contrast medium within the vestibule. A lateral and ventrodorsal radiographic projection is then obtained at the end of the infusion of contrast medium so that the pressure of the contrast medium administration dilates the urethra.

Positive contrast cystograms are generally used to evaluate for urinary bladder ruptures whereas double contrast cystograms help evaluate the wall of the urinary bladder, evaluate for calculi and help identify ectopic ureters. A positive contrast cystogram is performed with a patient in left lateral recumbency and a foley catheter is placed in the urinary bladder. The catheter balloon can be filled with air or saline and the urine removed from the urinary bladder. Then approximately 60 mL contrast medium is infused into the urinary bladder diluted with saline in a 1:5 ratio. A lateral and ventrodorsal radiographic projection is obtained while infusing the contrast medium to look for leakage in the urinary bladder wall. If the urinary bladder is insufficiently dilated with 60 mL of dilute contrast medium, another 60 mL is administered and radiographs are repeated. Fluoroscopy, when available, will aid in evaluating the volume of contrast medium administered as well as watching the distention of the urinary bladder.

After the positive contrast cytogram is perform, the contrast medium and urine are removed and carbon dioxide or room air is administered into the urinary bladder. Carbon dioxide is recommended if available as the risk of air emboli, especially in cats, is greatly reduced since carbon dioxide is more soluble in blood compared to room air. If room air is used, maintaining the patient in left lateral recumbency and monitoring the heart for "gurgling" sounds is necessary. If air emboli occur, you should elevate the pelvis of the patient to allow the right ventricle to be higher than the pulmonary outflow tract. This will trap the gas in the right ventricle and allow time for it to dissolve before entering the pulmonary system as an emboli. It generally takes approximately 20 minutes for the air to dissolve; however, a radiograph of the thorax can be used to identify the air within the ventricle.

After infusion of the negative contrast medium (air or gas), a small volume of positive contrast medium is administered. Generally 1-3 mL is sufficient to create a small pool of contrast medium. Right and left lateral as well as ventrodorsal and dorsoventral radiographs are obtained to evaluate the urinary bladder wall.

Excretory urography is performed by administering 1 mL of contrast medium per pound of patient body weight intravenously up to 50 mL. The toxic dose of contrast medium is 4 mL per pound and the 50 mL cut off is more for convenience and cost rather than safety as most bottles of contrast medium are 50 mL. Generally the patient is in lateral recumbency for the injection in case vomiting occurs and then immediately placed in ventrodorsal recumbency to obtain the first radiograph. This will provide a vascular phase of the kidneys. After 3 min, repeat radiographs, both ventrodorsal and lateral radiographs are obtained to evaluate the kidneys, called the nephrogram phase. After 5 minutes, both ventrodorsal and lateral are obtained and contrast medium should be seen within the renal pelves (called the pyelogram phase) and within the ureters. Oblique radiographs and subsequent images can be obtained until you seen the ureters enter the urinary bladder. Having negative contrast (air or gas) within the urinary bladder will aid in this contrast and help to identify the ureteral papilla and any ectopic ureters that are present. During this procedure, if contrast medium is present within the urethra, an ectopic ureter is strongly suspected.

Contrast procedures of the urinary bladder can be labor intensive, but with digital radiographic equipment, it requires less technical skill than ultrasound and can provide a large amount of diagnostic information in a patient with a urinary tract disorder.