SURGERY OF THE FELINE URETER
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Key points
- The most common indications for ureteral surgery in cats are ureteral obstruction secondary to urolithiasis and trauma
- Appropriate magnification is necessary to prevent complications, including stricture and urine leakage
- The location of the pathology will often dictate the surgical technique that is performed

The most common indications for ureteral surgery in cats include ureteral obstruction secondary to ureteral calculi and ureteral trauma. Although uncommon, fibrosis, congenital stenosis, stricture, neoplasia, and solidified blood calculi have all been associated with ureteral obstruction in cats and may be an indication for surgery.

Urolithiasis in cats
Calcium oxalate (CaOx) containing uroliths are the predominant stone type identified in the ureter of cats. Unfortunately, medical dissolution of CaOx uroliths is not available and so surgical removal or the placement of a ureteral stent is often recommended if the stones are causing clinical disease. If intervention is necessary, it is not always clear how long one should wait to address ureteral uroliths. Surgery is indicated in cases of worsening ureteral obstruction, known impairment of normal renal function, or the presence of a secondary infection that doesn’t respond to medical therapy. Factors that also need to be considered with regards to prognosis include the function of the contralateral kidney and the overall health of the patient. The ability of the feline kidney to recover from partial or complete outflow obstruction is unknown. Recovery of renal function generally depends on the severity and duration of the obstruction and the presence of pre-existing renal disease. Unfortunately, in cases of unilateral ureteral obstruction, a diagnosis may go undetected if function in the opposite kidney is normal.

Cats with uroliths affecting the ureter can present asymptomatic or with non-specific clinical signs including lethargy, weight loss, anorexia, vomiting, fever and polydipsia and polyuria. Hematuria may or may not be present. Patients may also present with abdominal pain and splinting or renomegaly. A complete physical examination is performed, as many affected cats are older and may have concurrent disease(s). A urinalysis, complete blood count, biochemical profile, and plain abdominal radiographs are usually recommended as initial investigative steps. Uroliths are often visualized on plain radiographs, although small ureteroliths, radiolucent ureteroliths, or those overlying colonic contents are occasionally missed. Further imaging studies including ultrasonography, excretory urography, antegrade pyelography and computed tomography are often helpful in identifying small ureteroliths, the presence of hydronephrosis and hydroureter, as well as delineating the level of a ureteral obstruction. It is important to note that ureteral dilation identified using one of these modalities does not always extend to the level of the obstruction.

Ureteral surgery in cats generally requires substantial magnification. The author recommends 8 to 10 times magnification provided by an operating microscope. Stones in the proximal ureter are removed by ureterotomy or a pyelotomy. Uroliths may be visible on
inspection of the ureter or palpable along the length of the ureter. Once the location of the calculus is identified, the affected segment of ureter is isolated using silastic material proximally and distally. In addition to decreasing urine flow into the surgical field, this preparation prevents spontaneous retrograde movement of ureteroliths.\textsuperscript{1} Care is taken when manipulating the ureter so as not to disrupt the blood supply or inadvertently traumatize the ureter. A longitudinal incision is made in the dilated ureter just proximal to the obstruction. In some cases, because the urolith is embedded within the ureteral wall, the incision is made directly over the urolith. Following removal, a piece of suture material can be passed proximally and distally from the ureterotomy site to ensure ureteral patency. The ureterotomy incision is closed with either single interrupted sutures or a continuous suture pattern using monofilament suture material (8/0 vicryl or nylon). The most common complications associated with this procedure are urine leakage and stricture.

Uroliths lodged in the mid to distal ureter may be removed by ureterotomy or the affected area of the ureter may be removed in toto and a ureteroneocystostomy performed. There are two techniques, one intravesicular and one extravesicular, that can be used to appose ureteral mucosa to bladder mucosa. To perform the intravesicular technique, a ventral midline cystotomy is performed. A mosquito hemostat is placed through the apex of the bladder and then the end of the ureter is grasped and brought into the bladder lumen. The bladder is everted and the distal end of the ureter is excised. The end of the ureter is then spatulated a distance of 0.5-0.75cm using straight microvascular scissors. The ureteral mucosa is sutured to the bladder mucosa using either 8-0 nylon or 8-0 vicryl in a simple interrupted pattern. The first and most important suture is placed at the proximal end of the ureteral incision (point of the “V”). It is important that no periureteral fat is exposed once suturing is complete as this can lead to adhesions and granuloma formation potentially resulting in a ureteral obstruction. Following completion of the anastomosis, the bladder is inverted and closed routinely.

In the extravesicular technique, a 1cm incision is made on the ventral surface of the bladder through the seromuscular layer allowing the mucosa to bulge through the incision.\textsuperscript{2} A smaller incision (3 to 4mm) is made through the mucosal layer of the bladder at the caudal aspect of the seromuscular incision. The distal end of the ureter is prepared as previously described for the intravesicular technique. Using 8-0 nylon or 8-0 vicryl, ureteral mucosa is sutured to bladder mucosa. The proximal and distal sutures are placed first. Once the ureteral anastomosis is complete, the seromuscular layer is apposed in a simple interrupted pattern over the ureter with 4-0 absorbable suture. Although uncommon, ureteroneocystostomy can be performed when only the proximal third of the ureter is available for anastomosis. If tension on the ureteroneocystostomy is expected, renal descensus as well as a cystopexy to the abdominal wall and/ or cystonephropexy can be performed to reduce tension on the anastomosis. To perform this technique, the kidney is mobilized from its retroperitoneal attachments and moved caudally. The renal capsule is then be sutured to an incision made in the adjacent body wall using 4-6 interrupted sutures of 4-0 polypropelene. The bladder can be fixed cranially to the body wall or to the tendon of the psoas muscle. The nephrocystopexy is performed using 3-0 to 4-0 absorbable or nonabsorbable sutures.

Many patients present with calculi located in both the kidney and the ureter. If the calculi located in the kidney are not addressed at the time of surgery, it is important that the patient be periodically monitored since these stones have the ability to migrate into the ureter and cause subsequent obstructions. Unfortunately, the incidence of this complication is unknown. Patients with large numbers of ureteroliths located unilaterally or bilaterally represent a management
challenge. The placement of ureteral stents to relieve the obstruction has been successful in most cases. Complications identified with ureteral stenting in the cat include tearing and trauma of the ureter, the development of a uroabdomen, stent encrustation/obstruction and dysuria.

_Ureteral trauma_

Ureteral trauma can be associated with automobile accidents or falls, penetrating wounds secondary to bites, gunshot wounds and penetrating foreign bodies, iatrogenic injury secondary to surgical trauma and trauma related to the presence of obstructive or irritating calculi. Unilateral ureteral tears can be difficult to diagnose if urine accumulation is confined to the retroperitoneal space. Clinical signs in these patients are often vague and may include lethargy, dehydration, weak peripheral pulses, pale mucous membranes, prolonged capillary refill time, sublumbar pain, vomiting, anorexia and pyrexia. Clinicopathological findings in these patients may be normal. Abdominal radiographs often reveal a loss of retroperitoneal detail and an increased size of the retroperitoneal space. Ultrasound may identify fluid accumulation. If both ureters are disrupted, signs of acute azotemia will occur. If urine leakage enters the peritoneal cavity secondary to traumatic disruption of the parietal peritoneum, a uroperitoneum will develop. Excretory urography, antegrade pyelography or contrast enhanced CT is beneficial in cases of both unilateral and bilateral ureteral abnormalities. It is imperative that the patient be hemodynamically stable prior to performing these studies.

Treatment options for ureteral trauma are often dictated by patient stability, function of the contralateral kidney and integrity of the contralateral ureter, damage to the ipsilateral kidney, and location of the injury. Options include primary repair, end to end anastomosis (ureteroureterostomy), ureteral reimplantation (ureteroneocystostomy), ureteral stenting or ureteronephrectomy. Ureteral stenting can be used alone or in conjunction with primary repair or end to end anastomosis to allow for urinary diversion while the incision sites are healing. A nephrostomy tube can also be placed in these cases to divert urine away from the primary surgical site.

In many cases of trauma involving the proximal ureter, a ureteronephrectomy is performed in cats with normal contralateral renal function. Although rarely identified, small lesions resulting in urine extravasation can be repaired primarily using 8-0 nylon or 8-0 vicryl in a single interrupted or simple continuous suture pattern. More often, injuries to the proximal ureter are repaired using an end to end anastomosis. This technique is particularly difficult in cats and should only be performed using appropriate magnification and by someone with experience in microvascular surgery. To perform this technique, both ends of the ureter should be mobilized taking care not to disrupt the blood supply or inadvertently traumatize the ureter. Debridement of the disrupted edges should be performed. Because of the small size of the ureteral lumen in a cat, a wire or a ureteral stent can be placed retrograde from the ureterovesicular junction across the two ends to aid in suture placement. The ends of the ureter can also be spatulated with microvascular scissors prior to anastomosis to aid in closure. The author prefers to use 8-0 nylon or 8-0 vicryl in an interrupted suture pattern. The ureteral stent can be left in place to prevent stricture formation and allow for urinary diversion. The stent can be removed at a later date, cystoscopically in a female and with a limited surgical approach to the bladder in a male, if indicated. In addition, a nephrostomy tube can be placed alone or in conjunction with a ureteral stent to help in diverting urine away from the surgical site.

Finally, the Boari flap or a modification of the flap could theoretically be used if a significant loss of ureteral length exists. To perform this technique, a full thickness bladder flap
is created with the base located at the apex of the bladder. The bladder defect is closed routinely and the edges of the flap are sutured together to create a tube which can then be sutured to the distal end of the ureter. To minimize tension, a cystopexy can be performed. In a modification of this technique, following creation of the flap, the ureter can be placed through the flap, spatulated and then ureteral mucosa sutured to bladder mucosa. The edges of the flap are then sutured together to create a tube and the top of the tube sutured closed.

Ureteral surgery in cats is technically challenging even for the experienced surgeon. Meticulous surgical technique in conjunction with appropriate magnification is essential in preventing both short and long term complications. The surgical technique chosen is often dictated by the type and location of the pathology.

References: