Endoscopic placement of ureteral stents for treatment of congenital bilateral ureteral stenosis in a dog

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Case Description—A 5-year-old 8.6-kg (18.9-lb) spayed female Pug was evaluated because of chronic hematuria and recurrent urinary tract infections.

Clinical Findings—Excretory urography, ultrasonography, and excretory CT urography were performed. Results indicated that the dog had bilateral hydrourephrosis and hydroureter and suspected proximal ureteral stenosis. Retrograde ureteropyelography confirmed the presence of stenosis at the ureteropelvic junction of each ureter, along with a large amount of endoluminal ureteral debris. Clinical findings suggested that the dog had a congenital bilateral anomaly of the upper urinary tract.

Treatment and Outcome—The dog was anesthetized, and 2 double-pigtail ureteral stents were placed cystoscopically with fluoroscopic guidance for immediate relief of the ureteropelvic junction obstructions. Each stent extended from the left or right renal pelvis to the urinary bladder. The procedures and the patient’s recovery from anesthesia were uncomplicated. Continuing improvements in severity of hydrourephrosis, hydroureter, and dysuria were evident during routine follow-up examinations at 2, 4, 12, 16, and 45 weeks after stent placement. Over the subsequent 12 months, all clinical signs remained resolved other than a urinary tract infection that was successfully treated with antimicrobials.

Clinical Relevance—Ureteral stenosis should be considered as a differential diagnosis for hydrourephrosis in dogs, particularly when urinary tract calculi or neoplasia is not present. Chronic hematuria and recurrent urinary tract infections can be associated with this condition. Placement of ureteral stents may be a successful treatment option for ameliorization of congenital ureteral obstructions. (J Am Vet Med Assoc 2012;140:983–990)

An 8.6-kg (18.9-lb) spayed female Pug was examined by a veterinarian because of hematuria. Two weeks prior to the evaluation, the dog had undergone ovariohysterectomy at 4.5 years of age and was adopted shortly thereafter. Initial bacterial culture of a urine sample collected at the evaluation yielded growth of both Staphylococcus intermedius and Escherichia coli, and the dog was treated with amoxicillin-clavulanic acid* (13.75 mg/kg [6.25 mg/lb], PO, q 12 h). After recurrence of clinical signs over the following 4 months, the dog was evaluated at a referral institution. At the referral examination, a blood sample was collected for a CBC and serum biochemical analysis; results (including BUN and creatinine concentrations) were within reference limits. Urinalysis revealed mildly low urine specific gravity (1.025), hematuria, and pyuria, but bacteria were not detected. Bacterial culture of a urine sample collected at this time yielded no growth. Abdominal ultrasonography# and excretory urography (Figure 1) were performed, the findings of which confirmed bilateral severe hydrourephrosis with bilateral proximal hydroureter. The diameters of the right and left renal pelves were approximately 20 and 10 mm, respectively. Pyelocentesis of the right kidney yielded evidence of hematuria, pyuria, and many triple phosphate crystals. Occasional bacteria were seen, but results of bacterial culture of a urine sample were negative. The dog was not being treated with antimicrobials at this time. Cytologic examination of aspirates from the right kidney revealed serosanguineous fluid and signs of mild to minimal purulent inflammation.

On the basis of suspicions of pyelonephritis, the dog was hospitalized and treated with saline (0.9% NaCl) solution (3 mL/kg/h [1.36 mL/lb/h], IV) and ampicillin sodium-sulbactam sodium‡ (50 mg/kg [22.72 mg/lb], IV) and exclusively fed a diet promoting low urine pH.§ After 24 hours of treatment, ultrasonography revealed a mild decrease in right pyelectasia and a large amount of sediment in the urinary bladder and both renal pelves. The dog was discharged from the hospital, and the owners were instructed to administer amoxicillin-clavulanic acid* (13.75 mg/kg, PO, q 12 h) and to feed the same low urine pH–promoting diet. Ultrasonography was performed 2 weeks later, which

**Abbreviation**

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<th>UPJ</th>
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revealed worsening hydronephrosis and hydrour met bilaterally. Computed tomographic excretory urogr phy (with 0.63-mm and 2.5-mm slice thicknesses) was also performed, which revealed bilateral abnormalities including dilation of the renal pelves, dilation of the pro ximal portions of the ureters, and marked narrow ing of each ureter at the UPJ (Figure 2). No extralu minal masses were evident, and no urinary tract calculi were present. Contrast medium was evident in the ur inary bladder and distal portion of the ureters; however, normal pulsatile flow was not observed. Given the findings of bilateral ureteral stenosis, the dog was further referred for bilateral ureteral stent placement. Prior to intervention, ultrasonographic examination of the dog’s urinary tract revealed that both renal pelves were approximately 10 mm in diameter.

After the dog (now approx 5 years old) was pre medicated with methadone hydrochloride (0.5 mg/kg [0.23 mg/lb], IM), midazolam hydrochloride (0.2 mg/kg [0.09 mg/lb] IM), glycopyrrolate (0.01 mg/kg [0.005 mg/lb], IM), and metoclopramide hydrochloride (0.3 mg/kg [0.14 mg/lb], SC), anesthesia was induced with propofol (3 mg/kg, IV) and diazepam (0.2 mg/kg, IV). The patient was intubated, and anesthesia was main tained with isoflurane gas and a continuous infusion of fentanyl (0.3 to 0.4 μg/kg/min [0.14 to 0.18 μg/lb/min], IV); inspiratory oxygen was provided throughout the procedure. Hair on the abdomen was clipped from the pubis to the dorsal aspect of the vulva, and the area was aseptically prepared. The dog was placed in dorsal re cumbency. Cefazolin sodium (22 mg/kg [10 mg/lb], IV) was administered at the time of induction of anesthesia and every 2 hours during stent placement.

A 2.7-mm integrated rigid cystoscope was placed into the urinary bladder via routine transurethral cystoscopy. An angle-tipped hydrophilic guidewire (diameter, 0.025 inches; length, 150 cm) was advanced through the working channel of the cystoscope and maneuvered into the left ureteral orifice. The wire was advanced approximately 3 to 5 cm with fluoroscopic guidance. A 4F open-ended ureteral catheter was advanced over the guidewire until it was in the distal portion of the left ureteral lumen. The guidewire was then removed, and retrograde ureteropyelography was performed with 5 mL of radiopaque contrast mater ial diluted in 5 mL of sterile saline solution. Results of ureteropyelography confirmed the presence of a local intraluminal narrowing of the proximal portion of the left ureter (Figure 3). Severe hydrour eter and hydronephrosis were evident, and a moderate amount of debris was present in the ureter and renal pelvis.

The guidewire was then readvanced through the ureteral catheter and passed up the ureter, through the stenotic lesion, and into the renal pelvis (Figure 4). Once the guidewire formed a curl inside the renal pelvis, the
ureteral catheter was advanced over the guidewire and through the ureteral narrowing to dilate the lumen. The catheter was subsequently used to measure the ureteral length and removed over the guidewire. A 3.7F, 14-mm-long double-pigtail stent was placed over the wire, extending from the left renal pelvis to the urinary bladder. Once the proximal portion of the stent became curled inside the renal pelvis and the shaft extended through the ureteral narrowing with the distal end inside the urinary bladder, the guidewire was slowly removed. Prior to complete removal of the wire, a ureteral stent pusher was used to advance the distal end of the ureteral stent into the urinary bladder forming the distal pigtail curl (Figure 5). This procedure was repeated on the right side. Because the diameter of the right ureteral lumen was slightly larger than that of the left ureteral lumen, a 4.7F, 14-cm-long stent was placed. Once complete, the urethral lumen was infused with bupivacaine hydrochloride (2 mg/kg [0.9 mg/lb]) for topical analgesia.

Figure 3—Retrograde ureteropyelographic image of the right renal collection system obtained from the dog in Figure 1 during cystoscopy. A ureteral catheter was placed in the distal portion of the ureter with fluoroscopic guidance, and contrast medium (red arrows) was infused in a retrograde manner. Notice the narrowing of the proximal portion of the ureter at the level of the UPJ (yellow arrow) and the severe renal pelvic dilation proximal to this narrowing. Vertebral bodies T13 to L4 are also visible.

Figure 4—Fluoroscopic images obtained during ureteral stent placement bilaterally in the dog in Figure 1. A—With the dog in dorsal recumbency, an open-ended ureteral catheter is placed in the left ureter to the level of the stenosis (white arrow). The renal pelvis is severely dilated (red arrow). There is a marker catheter in the colon to aid in stent length measurement (black dots). B—A guidewire is advanced inside the ureteral catheter (white arrows) and through the ureteral stricture and becomes curled inside the renal pelvis (black arrow). C—A double-pigtail ureteral stent (blue arrows) is advanced over the guidewire to bypass the obstruction and forms a loop inside the renal pelvis. D—After the procedure was repeated on the right side, ureteral stents are in place bilaterally (blue arrows).

Figure 5—Photographs of a double-pigtail ureteral stent similar to that used in the dog in Figure 1. A—The stent has 2 loops (arrows); after placement, 1 loop is contained within the renal pelvis, and the other loop is contained within the urinary bladder. The stent shaft extends through the entire length of the ureteral lumen. B—Multi-fenestration of the ureteral stent allows for urine drainage.
The dog recovered without complication from anesthesia and received an isotonic crystalloid solution (3 mL/kg/h, IV) for the next 6 hours. Total procedure time for bilateral stent placement was 1.25 hours. The dog was administered an α1-adrenergic receptor antagonist (prazosin hydrochloride; 1 mg/15 kg [1 mg/33 lb], PO, q 12 h) for prophylactic treatment of urethral spasm for 3 days and enrofloxacin (10 mg/kg [4.5 mg/lb], PO, q 24 h) for 14 days. Because of persistent crystalluria at the time of stent placement, the owners continued to feed the dog the prescribed diet.

Two weeks after surgery, a urine sample was collected for bacterial culture, which yielded no bacterial growth. One month after surgery, ultrasonographic examination of the urinary tract revealed renal pelvis dilatation only around the loops of both stents and minimal evidence of luminal debris. Clinicopathologic analyses revealed no abnormalities (BUN concentration, 17 mg/dL [reference range, 8 to 24 mg/dL]; creatinine concentration, 1.0 mg/dL [reference range, 0.5 to 1.4 mg/dL]). At this time, bacterial culture of a urine sample did not yield any growth, and no crystalline material was detected in the urine. Two and a half months after stent placement, the dog had evidence of blood in the urine. Bacteriologic culture of a urine sample was performed and yielded growth of *Streptococcus canis*. The dog was treated with amoxicillin-clavulanic acid (18 mg/kg [8.18 mg/lb], PO, q 12 h) for 8 weeks. Urine samples were collected for bacterial culture at 1 and 7 weeks after the antimicrobial treatment was started and at 2 weeks after the end of the antimicrobial treatment. Results of the 3 cultures were negative. Three months after stent placement, CT excretory urography was repeated, revealing a bilateral reduction in renal pelvic size with minimal pelvic and ureteral debris. Both renal pelves were decompressed around the proximal loop of the ureteral stents. The ureteral strictures were closely apposed to the ureteral stents, and the ureters were patent through the stents (Figure 6). Four months after stent placement, results of bacterial culture of a urine sample were negative; however, the dog developed clinical signs of urinary incontinence, which resolved without treatment. At 45 weeks after stent placement, the dog was doing well, but bacteriologic culture of a urine sample yielded positive results. Treatment with amoxicillin-clavulanic acid (18 mg/kg, PO, q 12 h) was instituted for an additional 8 weeks. Bacterial culture of a urine sample collected 10 days after antimicrobial administration was started yielded negative results, and at that time, prophylactic treatment with nitrofurantoin (4 mg/kg [1.8 mg/lb], PO, q 24 h given at night) was commenced. Over the next 12 months, results of bacteriologic culture of urine samples that were collected periodically remained negative, and the dog had no clinical signs of dysuria or hematuria.

**Discussion**

Ureteral obstruction is a serious and potentially life-threatening condition in human and veterinary patients. Ureteral obstruction leads to a restriction of urine flow, resulting in hydronephrosis and proximal hydroureter. Severe or prolonged obstruction may result in progressive loss of renal function, and if the obstruction is bilateral, uremia can develop. Mechanical ureteral obstruction can result from intraluminal obstruction, extraluminal compression, or ureteral mural lesions. Common causes of ureteral obstruction in dogs and cats include urolithiasis, neoplasia, and blood clots or dried solidified blood stones.1–3 Other less common

![Figure 6—Three-dimensional reconstructed CT images obtained from the dog in Figure 1 after IV injection of contrast medium during excretory urography performed 3 months after placement of ureteral stents bilaterally. A—Ventrodorsal view. Ureteral stent placement and ureteral patency are evident bilaterally. B—Ventrodorsal view with removal of the bone window. Each stent is in an appropriate position traveling through the ureteral lumen from the renal pelvis to the urinary bladder. C—Lateral view. Notice the depth of the renal pelvis around the loop of the ureteral stent.](image-url)
causes include trauma, congenital stenosis, inflammation, fibrosis, acquired strictures, and foreign bodies. Anatomic anomalies that result in hydronephrosis and hydroureter in veterinary patients have rarely been documented, aside from an association with ureteral ectopia. Not all of the reported anomalies have been associated with clinical disease. In a few previous clinical reports, other ureteral anomalies, such as altered renal pelvic anatomy, circumcaval ureters, and congenital ureteral strictures, have been described. To our knowledge, congenital bilateral ureteral stenosis or congenital UPJ obstruction has been reported for only 1 laboratory dog and resulted in death of that neonate because of fibrotic dysplasia of the ureters at the UPJ. The stenotic segments in the dog of that report were lined by hypoplastic urothelium and contained excessive collagen with disorganized smooth muscle fibers.

Congenital ureteral stenosis is a rare condition of children and other young animals. In humans, congenital ureteral stenosis is classically unilateral, occurring most commonly at the ureterovesical junction, at the UPJ, and, rarely, in the midportion of the ureter adjacent to the pelvic brim. The exact cause is unclear; however, it is postulated that the ureteral narrowing results from abnormal mesenchymal development during the 12th week of embryogenesis. During normal development, muscularization and development of the ureteral tube undergo a solid phase, which is then followed by canalization. If canalization is incomplete, a congenital ureteral stricture can develop. Vascular compression, which may play a role in disruption of this process, can lead to segmental dysplasia of the ureter, and this is likely what happens in patients with circumcaval, or retrocaval, ureters. Lower renal pole vessels that cross one another have been shown to directly contribute to UPJ obstruction by causing extrinsic compression; however, vascular compression is not always demonstrable at the time of diagnosis or postmortem examination. One theory is that the vessels disappear during embryological development, leaving behind permanent strictures. Ureteral stenosis typically becomes a clinical problem during periods of intraluminal obstruction, which can be intermittent and occur during an infection or as a result of the accumulation of ureteral debris at this area of diminished ureteral drainage. In humans, this condition can be diagnosed later in life (at 30 to 60 years of age). This seems to be a condition similar to that identified in the dog of this report.

On the basis of the location (UPJ), symmetry, and presence of intraluminal compression without evidence of urinary tract calculi, neoplasia, or dried solidified blood clots, we postulated that the dog of this report likely had congenital bilateral ureteral strictures, similar to those in a neonatal puppy described by Pullium et al. In the Pug of this report, there was no evidence of crossing vasculature or extrinsic compressive lesions in CT or ultrasonographic images, but given that exploratory surgery was not conducted because of the minimally invasive treatment performed, that cannot be completely excluded as a cause. A segmental tapering of the ureter at the site of suspected stenosis detected via CT and retrograde ureteropyelography is typical of congenital ureteral stenosis in humans. Because the clinical signs in the dog of this report were first detected following ovariohysterectomy, it is also important to differentiate congenital ureteral stenosis from strictures attributable to complications of ovariohysterectomy, such as ovarian stump granulation or, much less likely, proximal ureteral ligation. The lack of any clear extraluminal masses or compressive lesions, the lack of foreign material detected via CT, the partial patency of the ureteral lumen, and the symmetry of the lesions indicate that complications of ovariohysterectomy were unlikely to be the cause of the clinical signs in this dog; however, without a definitive histopathologic diagnosis, this is difficult to determine. Because the dog was spayed and adopted at approximately the time that clinical signs were first noted, a history of clinical signs prior to adoption could not be ascertained. Direct or laparoscopic observation of the proximal portion of the ureters and ovarian stump sites may have provided additional information in determining the cause of the stenosis but was considered unnecessary in light of the minimally invasive treatment being performed.

In children, ultrasonography is useful for antenatal or postnatal diagnosis of upper urinary tract dilatation, but may not be ideal for determining the cause of stenotic lesions. In general, it appears that excretory urography in humans does not always provide accurate information. Retrograde pyelography with fluoroscopic guidance is believed to be the most helpful technique for diagnosis of congenital ureteral strictures because it provides distinct visualization of the stricture, which facilitates the choice of treatment. Multislice spiral CT with volume rendering and maximum-intensity projection has been reported to be an effective method to identify the causes of congenital stenosis and associated crossing blood vessels and also provides useful information for appropriate treatment planning. It has been shown that results of MRI urography are more sensitive than results of ultrasonography, IV urography, renal nuclear scanning, or voiding cystourethrography for the diagnosis of congenital urogenital abnormalities in children. Although ureteroscopy appears to be useful for diagnosing intraluminal lesions, the technique is very difficult to apply in small or pediatric patients because the smallest ureteroscope available is 2.5 to 2.7 mm in diameter and the diameter of ureters in dogs and children is typically smaller.

Presumptive diagnosis of bilateral ureteral stenosis in the dog of this report was made on the basis of a combination of findings determined by use of ultrasonography, retrograde contrast ureteropyelography, and CT. Follow-up imaging involved CT excretory urography with 3-D reconstruction. It has been shown that plain radiography is a poorly sensitive tool for identification of ureteral disease other than nephroureterolithiasis. In human and veterinary patients with ureteral obstructions, assessment of radiographic views of the urinary tract is recommended to rule out radiopaque stone disease. In the dog of this report, findings of excretory urography aided diagnosis of bilateral hydronephrosis and proximal ureteral obstruction; however, with the exception of ureteroliths and tumors, other causes of intraluminal obstructions (strictures, blood clots, and urachal cysts) were completely excluded as a cause. Direct or laparoscopic observation of the proximal portion of the ureters and ovarian stump sites may have provided additional information in determining the cause of the stenosis but was considered unnecessary in light of the minimally invasive treatment being performed.
Ureteral stent placement is performed to facilitate urine passage from the renal pelvis to the urinary bladder by bypassing a partial or complete ureteral obstruction. A typical ureteral stent has a double-pigtail multifenestrated design that is made to form a loop in the renal pelvis, a long shaft down the ureteral lumen, and another loop in the urinary bladder. The pigtail design anchors the device within the renal pelvis and urinary bladder to prevent upward or downward migration. Stents are multifenestrated to allow for urine flow both through and around the stent. Following placement, a stent causes passive ureteral dilation, which encourages urine to drain more rapidly around the stent after only 2 days to 2 weeks. In a study in pigs, such a stent was also shown to decrease ureteral peristalsis, which can halt stone passage, but this has not been identified as a clinical problem in canine patients in the authors’ experience. Stents made of new soft materials are designed to minimize irritation of the trigonal region of the bladder. The stents can be introduced via cystoscopy, percutaneous nephrostomy, cystotomy, or by a combination of these methods.

This type of stent has been used in humans for various reasons since the 1950s; the stents are typically placed by use of endoscopic and fluoroscopic guidance. The use of indwelling double-pigtail ureteral stents in humans has been reported, but such stents are typically considered for temporary relief of ureteral obstruction, allowing for immediate alleviation of urinary obstruction and the prevention of post procedural edema after ureteroscopy, laparoscopy, lithotripsy, ureteral reimplantation, or renal transplantation. Benefits of ureteral stent placement include immediate and long-term improvement in passage of urine, passive ureteral dilation (allowing for improved urine passage), shorter duration of anesthesia (compared with that required for surgical or laparoscopic procedures), and technical ease (compared with microscopic surgery).

In humans, the most common reported complications include stent migration, bladder and urethral irritation, and stent encrustation. Stent-related discomfort includes signs of dysuria, hematuria, and ureteral colic. This rarely develops in dogs in the authors’ experience. In humans with intrinsic ureteral obstruction, the overall success rate for ureteral stent placement has been reported to be 88% to 100%. The success rate is typically determined by the cause of the obstruction and the stability of the patient. In humans, the maximum period that a stent can safely remain in place is partially determined by the type of stent, but other concurrent factors have yet to be defined. Results of studies have suggested that morbidity associated with polyurethane ureteral stents is minimal for up to 3 to 12 months following placement and that longer indwelling times are associated with increased frequency of complications such as migration and encrustation.

In our practice, over 200 patients have received ureteral stents with no evidence of stent encrustation. In contrast to findings in human patients, very few of those treated dogs have developed signs of stent-associated dysuria, stent migration, or chronic infections. To our knowledge, the use of ureteral stents for the treatment of partial or complete ureteral obstruction caused by calculi, strictures, or tumors has been minimally reported, and this is the first report of the use of endoscopic ureteral stenting for treatment of ureteral stenosis in a dog. In our experience, ureteral stents have remained in situ and patent in some
dogs and cats for over 4 years without adverse effects, suggesting that long-term stent placement may be a potential option for treatment of ureteral obstruction in those species. Placement of stents in canine ureters appears to be associated with few short- or long-term complications. Patient monitoring at 12- to 16-week intervals following ureteral stent placement is recommended, especially in animals with systemic diseases and a history of renal function or urolithiasis. Regular follow-up assessments including abdominal radiographic and ultrasonographic examinations and urinalysis (with bacterial culture of a urine sample) should be performed (every 3 to 6 months) to identify any potential complications that require intervention. In the dog of this report, ureteral stent placement was initially not a means of definitive treatment, but rather a means of immediate and simple decompression. As a result of the dog’s excellent stent tolerance and renal preservation, the owners elected to maintain the stent in place rather than have the dog undergo more definitive treatment, such as endoureteropapoplasty, ureteral balloon dilation, or ureteral resection and anastomosis. In other patients, such procedures could be considered if long-term stent drainage fails.

The dog of this report tolerated the stents well and did not develop any signs of discomfort or encrustation at any time up to and including the last follow-up examination (30 months). The dog had chronic urinary tract infections prior to stent placement, and although it did develop urinary tract infections while the stent was in place, those infections resolved with appropriate antimicrobial treatment. Bilaterally, the hydroureter or hydroureter did not progress after stent placement. In our experience, chronic urinary tract infections are not a major problem in veterinary patients with indwelling ureteral stents. The dog of this report continued to receive nitrofurantoin, which was effective in managing and preventing recurrent urinary tract infections in the long-term follow-up period, but an infection did occur approximately once per year. Nitrofurantoin, a bactericidal antimicrobial, is effective against most gram-positive cocci and gram-negative bacilli that are renally excreted and concentrated in the urine. Resistance to nitrofurantoin does not confer resistance to other antimicrobial agents, and its low cost makes it a good choice for management of chronic urinary tract infections. This antimicrobial is often considered for preventive treatment in animals with recurrent urinary tract infections. As a preventive measure, the drug is administered twice daily; for therapeutic purposes, the drug is administered 3 times daily.

Prior to stent placement, urinalysis revealed that the dog of this report had triple phosphate crystaluria; however, after treatment of a suspected urinary tract infection and a permanent change to a urine pH-modifying diet, the crystaluria resolved. In patients with evidence of permanent renal disease, a low-protein diet may also be recommended.

For the dog of this report, it was possible that the persistent hydroureteroscopy may have resulted in increased hydrostatic pressure to the remaining nephrons and worsening of renal function over time. Preservation of renal function was a priority, especially because bilateral partial obstructions were evident. If ureteral stenosis is unilateral, and contralateral renal function is adequate, one still should avoid unilateral ureteronephrectomy because the disease involves the ureters, not the kidneys, and ureteral intervention is ultimately what is needed. Traditional ureteral resection and anastomosis in the dog of this report was declined by the owners and ultimately not deemed necessary.

Although congenital ureteral stenosis in veterinary patients is rare, it should be included as a differential diagnosis for hydroureteroscopy and hydroureter, particularly in a young dog or cat. Although not all animals with ureteral stenosis have clinical signs of urinary disease, the risk of permanent renal damage due to worsening hydroureteroscopy warrants a quick and accurate diagnosis as well as a safe and effective treatment. Ureteral stenting was a successful treatment for the hydroureteroscopy in the dog of this report and should be considered as a minimally invasive treatment option in animals with ureteral obstructions.

References


