Bilateral Ureteral Ectopia With Renal Dysplasia and Urolithiasis in a Dog

A 7-month-old, 4.3-kg, spayed female bichon frise was referred for evaluation of chronic urinary incontinence. Abdominal radiographs revealed calculi within the right kidney and ureter. An ultrasound revealed a small right kidney. An abdominal computed tomography scan with contrast revealed that the left ureter was extramurally ectopic, inserting into the proximal urethra. A right intramural ectopic ureter was identified during cystotomy. Ureteronephrectomy was performed on the right, and ureteroneocystostomy was performed on the left. A telephone conversation with the owner 4 months after surgery revealed that the dog exhibited no evidence of urine dribbling, and urinary continence was maintained well on phenylpropanolamine (1.75 mg/kg orally q 12 hours). This is the first report of successful surgical management of bilateral ureteral ectopia with concurrent, unilateral, renal dysplasia and urolithiasis. J Am Anim Hosp Assoc 2010;46:209-214.

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Introduction

Ureteral ectopia is a congenital abnormality of the terminal segment of one or both ureters in which the ureteral orifice is located at a site other than the trigone of the urinary bladder, such as the bladder neck, urethra, vagina, or uterus.1,2 Ureteral ectopia is most commonly seen in young, female dogs and appears to be much less common in cats.3 This anomaly is commonly associated with continuous or intermittent urinary incontinence.4-6 Ureteral ectopia is often present in combination with other urinary abnormalities, such as hydroureret, hydronephrosis, pylonephritis, bladder hypoplasia, and the presence of an intrapelvic bladder neck associated with a short urethra.7-9 To date, ureteral ectopia combined with renal dysplasia and urolithiasis has not been documented in a dog. The purpose of this case report is to describe the successful management of bilateral ureteral ectopia with renal dysplasia, a nephrolith, and multiple ureteroliths in a dog.

Case Report

A 7-month-old, 4.3-kg, spayed female bichon frise was referred to the University of Missouri Veterinary Medical Teaching Hospital for evaluation of chronic urinary incontinence. At the time of presentation, the dog was medically managed on phenylpropanolaminea (50 mg/kg orally [PO] q 12 hours), which was not controlling the urinary incontinence. The owner reported that the dog dribbled urine continuously, which was more noticeable when the dog was asleep.

A complete blood count (CBC) and serum biochemical profile were normal. Bacteriuria was present on urinalysis. The urine culture yielded >100,000 colony-forming units/mL of *Staphylococcus intermedius* and *Enterococcus* spp. that were susceptible to amoxicillin-clavulanic acid.b Abdominal radiographs revealed calculi within both the right kidney and right ureter [Figure 1]. An ultrasound revealed a small right kidney [Figure 2A] that was 1.8 cm × 1.2 cm (reference range, length: 2.5 to 3.5 × the length of the second lumbar vertebral body [L2]; width: 2.0 × L2) and mild pyelectasis of the left kidney. An abdominal computed tomography (CT)
scan demonstrated that the left ureter was extramurally ectopic, inserting into the proximal urethra [Figure 2B]. Uptake of iodinated contrast agent (180 mg/kg intravenously [IV]) was mild in the right kidney; however, no contrast entered the right ureter. The dog was prescribed amoxicillin-clavulanic acid (12.5 mg/kg PO q 12 hours) for 7 days.

Nuclear scintigraphy was performed prior to surgery to determine if the right kidney would be salvageable based on its glomerular filtration rate (GFR). Technetium-99m-labeled diethylenetriamine penta acetate was injected IV for renal scintigraphy. Uptake of the radiopharmaceutical within the left kidney was seen, but no uptake within the right kidney was evidenced. The radiopharmaceutical was observed within the retroperitoneal space and pelvic canal, consistent with the clinical history of ectopic ureter. The individual GFRs of the left and right kidneys were 3.2 and 0 mL/kg per minute, respectively (reference range 2.8 to 3.7 mL/kg per minute). A diagnosis of left ureteral ectopia with nonfunctional right kidney was made.

Two days later, the dog was premedicated for surgery with buprenorphine (0.01 mg/kg intramuscularly [IM]), glycopyrrolate (0.01 mg/kg IM), and acepromazine (0.05 mg/kg IM), followed by anesthetic induction with propofol (6 mg/kg IV). The dog was intubated, and anesthesia was maintained with isoflurane and oxygen. Lactated Ringer’s solution was administered IV at a rate of 5 mL/kg per hour until completion of the surgical procedure. The dog received cefazolin (22 mg/kg IV) at the time of anesthetic induction and was positioned in dorsal recumbency. An incision was made from the xiphoid to the pubis. Abdominal exploration revealed that the right kidney was small (approximately 2 cm long x 1 cm wide), and the right ureter contained three calculi. The right kidney was freed from its sublumbar attachment, and a ureteronephrectomy was performed. The
renal artery and vein were ligated using 3-0 polyglactin 910k and transected. The right kidney and ureter were bluntly dissected to the urinary bladder. The right ureter was then ligated as far distally as possible at the entry to the urinary bladder wall, using 3-0 polyglactin 910, and it was transected [Figure 3].

Figure 3—Photograph of the dysplastic right kidney and ureter after being removed. The horizontal arrow and oblique arrows indicate the small right kidney and the right ureter, respectively.

Four stay sutures were placed in the urinary bladder prior to ventral cystotomy. A stab incision was made on the ventral midline of the urinary bladder using a no. 11 scalpel blade. The incision was extended to the cranial aspect of the urinary bladder and then caudally to the urethra. A right intramural ectopic ureter was identified. No right ureteral opening was in the urinary bladder; instead, the right ureter entered the proximal urethra. The right ureteral tunnel was left in place without dissection. Similarly, no ureteral opening for the left ureter was identified in the trigone. The left ureter was bluntly dissected at the entry to the urethra. The ectopic left ureter had no intramural component. Thus, the left ureter was extramurally ectopic, while the right ureter was intramurally ectopic.

Ureteroneocystostomy was performed to create a new opening between the left ureter and the urinary bladder. A transfixing ligature was placed around the distal aspect of the left ureter as close to the urethra as possible, using 5-0 polydioxanone[Figure 4A]. A mosquito hemostatic forceps was placed on the left ureter cranial to the transfixing ligature. The left ureter was transected between the mosquito hemostatic forceps and the transfixing ligature. The hemostatic forceps was removed, and a stay suture was placed on the distal end of the left ureter using 5-0 polydioxanone. A full-thickness stab incision was made through the dorsal urinary bladder using a no. 11 scalpel blade. A mosquito hemostatic forceps was passed through the opening from the luminal side of the urinary bladder, and the stay suture on the left ureter was grasped and pulled into the bladder [Figure 4B]. The caudal aspect of the left ureter was incised through half of its diameter, and the incised edge was sutured to the mucosa of the urinary bladder using 6-0 polydioxanone in a simple interrupted pattern [Figure 4C]. Subsequently, the remainder of the distal left ureter was excised and anastomosed to the mucosa of the urinary bladder, using the same suture material and pattern [Figure 4D]. The cystotomy incision was closed using 4-0 poliglecaprone 25th in a simple continuous pattern, and the urinary bladder was distended by injection with saline to demonstrate no leakage around the ureteral reimplantation site. The linea alba was closed using 3-0 polydioxanone in a simple continuous pattern. The subcutaneous tissues and skin were closed with a simple continuous pattern using 3-0 poliglecaprone 25 and skin staples, respectively. A lidocaineo (1.2 mg/kg per hour IV) and morphinep (0.1 mg/kg per hour IV) constant-rate infusion was used to control pain postoperatively.

The nephrolith and ureteroliths were submitted for bacterial culture and quantitative mineral analysis, and the right kidney was submitted for histopathology. The uroliths were septic ground and cultured. The culture yielded a light growth of Staphylococcus intermedius and Enterococcus spp. Chemical analysis revealed the nephrolith and ureteroliths were composed of 90% calcium phosphate and 10% magnesium ammonium phosphate. Histopathological evaluation of the right kidney revealed a thin cortex composed of small, poorly perfused glomeruli and scant tubules and undifferentiated mesenchyme. The right renal pelvis contained large numbers of inflammatory cells (neutrophils, macrophages, and lymphocytes).

The dog was placed on amoxicillin-clavulanic acid (12.5 mg/kg PO q 12 hours) for 5 days. Two weeks postsurgically, the skin staples were removed. No evidence of continuous dribbling of urine was noted; however, the owner reported that urinary incontinence did occur intermittently when the dog was asleep. Phenylpropanolamine (2.9 mg/kg PO q 12 hours) was prescribed. A telephone conversation with the owner 4 months after surgery revealed that the dog exhibited no evidence of urine dribbling, and urinary continence was maintained well on phenylpropanolamine (1.75 mg/kg PO q 12 hours), prescribed by veterinarians.

Discussion

Ureteral ectopia is frequently associated with other congenital abnormalities of the urinary system, including short urethra, bladder hypoplasia, ectopic kidney, renal dysplasia, and renal hypoplasia.8,10 Ureteral ectopia is the result of faulty differentiation of the mesonephric and metanephric ducts during embryogenesis.11-13 Since development of the kidney, ureter, bladder neck, and urethra are all associated with the mesonephric duct,14 faulty differentiation of the mesonephric duct during embryogenesis can result in ureteral ectopia that is concurrent with other congenital abnormalities. When proximal displacement of a ureteric bud is extreme, ureteral ectopia can be expected, and the abnormally placed bud may unite with defective, involuting
nephrogenic or stromatogenous mesenchymal tissue; this can lead to renal dysplasia and renal hypoplasia. 14

Common concurrent congenital anomalies of the urinary system with ureteral ectopia have been studied in dogs by various investigators. 10-12 In Holt’s study, the most common concurrent congenital anomaly in dogs was short urethra (intrapelvic bladder neck), occurring in approximately 58% of ureteral ectopia cases, followed by bladder hypoplasia (23%). 10 Renal dysplasia, renal hypoplasia, or ectopic kidney occurred in approximately 0.02%, 0.01%, and 0.01% of ureteral ectopia cases, respectively. 10 In Smith’s study, bladder hypoplasia was the most common concurrent congenital anomaly, occurring in approximately 11% of ureteral ectopia cases. 11 In Owen’s study, renal hypoplasia was the most common concurrent congenital anomaly, occurring in approximately 13% of ureteral ectopia cases, followed by bladder hypoplasia (11%). 12 Based on these studies, renal dysplasia or ectopic kidney concurrent with ureteral ectopia is uncommon in dogs. In fact, only one report involves two dogs with ureteral ectopia and renal dysplasia. 10

During embryogenesis, the proximal aspect of the metanephric ducts migrate laterally and cranially, while the distal ends of the mesonephric ducts appear to remain close together in the midline and migrate caudally. 12 If the origin of the ureteric bud is at a position on the mesonephric duct that is more proximal than normal, and if time is not allowed for proper migration into the urinary bladder, extramural
urease-producing organisms. In the dog reported here, uroliths, but it is not likely a causative factor in the formation of calcium phosphate uroliths. In most cases of calcium phosphate uroliths in dogs, occurrence in approximately 3% of urolithiasis is uncommon in dogs. Calcium phosphate urolithiasis is rare in dogs, occurring in approximately 5% of urolith cases. Most cases of calcium phosphate uroliths in dogs are associated with hypercalcemic disorders, including primary hyperparathyroidism, neoplasia, vitamin D toxicosis, excessive calcium intake, thyrotoxicosis, and adrenal insufficiency. In the dog described in our report, hypercalcemia was not detected on routine blood work. Nonhypercalcemic disorders, including distal renal tubular acidosis and idiopathic hypercalciuria, might have caused the nephrolith and ureteroliths identified in this case. One case of calcium phosphate urolithiasis and renal dysplasia in a young dog has been reported. In that case report, the author suggests that a transient increase in calcium excretion could have been a factor in stone formation. Interestingly, in that case, the dog was young, and calcium phosphate urolithiasis was concurrent with renal dysplasia.

Magnesium ammonium phosphate urolithiasis is usually caused by the presence of a urinary tract infection with urease-producing organisms. In the dog reported here, urinary tract infection with Staphylococcus intermedius (a urease-producing bacterium) may have been responsible for the magnesium ammonium phosphate component of the uroliths, but it is not likely a causative factor in the formation of calcium phosphate, the major component of the stones. While renal dysplasia is not a cause of urolithiasis, and stones are not able to cause renal dysplasia, a study of a large case series is warranted to better determine the relation between calcium phosphate urolithiasis and renal dysplasia and other congenital abnormalities of the urinary system.

The evaluation of renal function in this case was based on determination of GFR using a urinary clearance procedure. Nuclear scintigraphy permits evaluation of the GFR of each individual kidney. The measurement of GFR is not always necessary prior to surgery for animals diagnosed with renal disease; however, measuring the individual GFRs of each kidney prior to surgery allows one to determine if a kidney is salvageable or not and if the remaining kidney will be functional enough for the animal to survive with one kidney. In the case reported here, the right kidney was small, and the left ureter was extramurally ectopic. Therefore, in this case, knowing the GFRs of both the right and left kidneys aided the surgeons in determining whether the dog would survive with one kidney prior to performing right ureteronephrectomy (and if the right ureteronephrectomy was, in fact, necessary).

Three types of surgical repairs for ureteral ectopia have been described in dogs: ureteronephrectomy in cases of a non-salvageable kidney, neoureterostomy for intramural ectopic ureter, and ureteroneocystostomy for extramural ectopic ureter. In the dog reported here, a combination of neoureterostomy on the right and ureteroneocystostomy on the left would have been indicated based on the ureteral abnormalities alone. However, a right ureteronephrectomy was ultimately performed, because the right kidney was not salvageable.

The two purposes of surgical management of an intramural ectopic ureter are to relocate the termination of the ectopic ureter in the trigone of the bladder and improve urinary continence. In the dog reported here, relocation of the termination of the right intramural ectopic ureter and removal of the intramural tunnel would have been indicated; however, the termination of the right intramural ectopic ureter was not relocated in the trigone of the bladder, because the right kidney was not salvageable. The intramural tunnel was not removed, because the ureter was deemed to lack patency and, therefore, was unlikely to permit urethroureteral reflux.

Treatment for dogs with calcium phosphate uroliths should initially be directed at removing factors contributing to urine super-saturation with calcium phosphate, such as primary hyperparathyroidism, neoplasia, vitamin D toxicosis, excessive calcium intake, thyrotoxicosis, and adrenal insufficiency. In the dog reported here, further treatment for calcium phosphate uroliths was not considered, since hypercalcemia was not detected, and the primary factors (including diet and vitamin supplementation) contributing to the formation of uroliths were not determined. The optimal diet for prevention of calcium phosphate uroliths in dogs is unknown; however, increasing net water intake through feeding a canned diet is likely to be an important dietary factor. If dietary therapy is used, achieving a neutral urine pH should be the target.

Calcium phosphate uroliths may dissolve without recurrence after resolution of the underlying disorder (such as primary hyperparathyroidism or neoplasia), because the treatment results in urine that can be maintained in a persistently undersaturated state. Several medical treatments,
including thiazide diuretics, sodium cellulose phosphate, and orthophosphates have been used to treat human patients with calcium phosphate uroliths associated with idiopathic hypercalciuria. However, clinical experience using these drugs in dogs with calcium phosphate uroliths has been minimal.16

Conclusion
This report describes the successful treatment of a young dog with urinary incontinence secondary to bilateral ureteral ectopia with unilateral renal dysplasia and urolithiasis (one nephrolith and several ureteroliths). Ureteral ectopia concurrent with renal dysplasia is a rare anomalous combination that is the result of an abnormally located ureteric bud uniting with defective, involuting nephrogenic or stromatogenous mesenchymal tissue, leading to renal dysplasia. Measurement of individual GFRs should be considered prior to surgery to determine if the dysplastic kidney is salvageable and if the contralateral kidney is functional enough for the dog to survive with only one kidney. A study of a large case series with long-term follow-up is warranted to better determine the overall success and complication rates for surgical management of dogs with ureteral ectopia combined with other anomalies of the urinary system. To our knowledge, this is the first case of ureteral ectopia combined with renal dysplasia and urolithiasis in a dog.

Footnotes
a Proin; PRN Pharmacal, Pensacola, FL 32514
b Clavamox; Pfizer Animal Health, Exton, PA 19341
c Omnipaque; GE Healthcare, Inc., Princeton, NJ 08540
d Tc 99m DTPA; Mid-America Isotopes, Inc., Ashland, MO 65010
e Buprenorphine; Bedford Labs, Bedford, OH 44146
f Glycopyrrolate; American Reagent, Inc., Shirley, NY 11967
g Promace; Ayerst Laboratories, Inc., Rouses Point, NY 12979
h Diprivan; AstraZeneca Pharmaceuticals, Wilmington, DE 19803
i Isoflurane; Hospira, Inc., Lake Forest, IL 60045
j Cefazolin; West Pharmaceutical Corp., Eaton Town, NJ 07724
k Vicryl; Ethicon, Inc., Somerville, NJ 08876
l PDS II; Ethicon, Inc., Somerville, NJ 08876
m Monocryl; Ethicon, Inc., Somerville, NJ 08876
n Visistat; Weck Closure Systems, Research Triangle Park, NC 27709
o Lidocaine; Hospira, Inc., Lake Forest, IL 60045
p Morphine; Hospira, Inc., Lake Forest, IL 60045

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