Received: 8 August 2023 | Revised: 22 March 2024 | Accepted: 26 April 2024

DOI: 10.1111/vsu.14103

CLINICAL RESEARCH

WILEY

Presentation, diagnosis, and outcomes of cats undergoing surgical treatment of ectopic ureters

Gabriela L. Cortez DVM, CVA[1] | **Christopher B. Thomson DVM, DACVS (Small Animal)**[2] | **Valery F. Scharf DVM, MS, DACVS (Small Animal)**[3] | **Allyson Berent DVM, DACVIM**[4] | **Nicole J. Buote DVM, DACVS (Small Animal)**[5] | **Brittney A. Carson DVM, MS, DACVS (Small Animal)**[6] | **Margaret Cassandra DVM**[6] | **Philipp D. Mayhew BVM&S, MRCVS, DACVS (Small Animal)**[7] | **Ameet Singh DVM, DVSc, DACVS (Small Animal)**[8]

[1]Massachusetts Veterinary Referral Hospital, Ethos Discovery, Woburn, Massachusetts, USA

[2]Veterinary Specialty Hospital, Ethos Discovery–North County, San Marcos, California, USA

[3]College of Veterinary Medicine, North Carolina State University, Raleigh, North Carolina, USA

[4]Animal Medical Center, Interventional Endoscopy Service, New York, New York, USA

[5]Cornell University College of Veterinary Medicine, Ithaca, New York, USA

[6]The Ohio State University, College of Veterinary Medicine, Columbus, Ohio, USA

[7]University of California-Davis, School of Veterinary Medicine, Davis, California, USA

[8]Department of Clinical Sciences, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada

Correspondence
Christopher B. Thomson, 2055 Montiel Rd, #104, San Marcos, CA 92069, USA.
Email: cthomson@ethosvet.com

Abstract

Objective: To describe the signalment, treatment, complications, and outcomes of cats treated surgically for ectopic ureters.

Study design: Retrospective, multi-institutional study.

Animals: Twelve client-owned cats.

Methods: Medical records of cats diagnosed with unilateral or bilateral ectopic ureters were reviewed and analyzed. Data reported included signalment, clinical signs, diagnostics, open celiotomy, or cystoscopic surgical interventions, and outcomes.

Results: Seven of the 12 cats in the study population were female or female spayed and the median age at time of presentation was 4 years, with an interquartile range (IQR) of 6 months–14 years. Presurgical diagnostic imaging diagnosed ectopic ureters by abdominal ultrasound (8/10), contrast enhanced computed tomography (3/3), fluoroscopic urography (3/4), or cystoscopy (6/7). Eight of 12 cats had extramural ectopic ureters and six cats were affected bilaterally. Eight affected cats underwent ureteroneocystostomy, one cat underwent neoureterostomy, two cats underwent cystoscopic laser ablation, and one cat underwent nephroureterostomy. Immediate postoperative complications occurred in three cats; one cat required additional surgical intervention. Short-term complications occurred in three cats, and long-term complications in two cats. All cats that underwent surgical or cystoscopic intervention had improvement of their urinary incontinence scores, with complete resolution in 11 cats.

Abbreviations: CLA, cystoscopic laser ablation; CT, computed tomography; IQR, interquartile range; NU, neoureterostomy; UNC, ureteroneocystostomy; UTI, urinary tract infection.

Conclusion: Surgical correction of ectopic ureters in cats is associated with good long-term outcomes. Ectopic ureters in cats are commonly extramural and bilateral. Postoperative outcomes were acceptable and there were few postoperative complications, with varying forms of surgical correction.

Clinical significance: Ectopic ureters in cats are rare but urinary incontinence can be corrected or improved successfully with surgery.

1 | INTRODUCTION

Ureteral ectopia is defined as a congenital condition in which one or both ureters terminate outside of the bladder.[1] Concurrent congenital defects reported in canine and feline populations with ureteral ectopia include cystic hypoplasia, renal hypoplasia, hydronephrosis, hydroureter,[2] or rarely, a duplex renal system.[3] Dogs with ectopic ureters present most commonly for urinary incontinence.[4] Urinary tract infection has been reported in up to 73% of affected dogs, which may further contribute to clinical signs of malurination.[5] Ureteral ectopia can be classified as extramural, which are ureters that bypass the bladder completely, or intramural, which are those that pass through the submucosal layer of the bladder wall and open distally along the genitourinary tract.[6]

The presence of ectopic ureters is considered to be uncommon in dogs, and exceptionally uncommon in cats.[7–9] Based on the information extrapolated from case reports, affected feline populations do not seem to have a sex predilection, tend to have extramural ectopic ureters, and have a higher incidence of bilateral ectopia.[2,9] In contrast, dogs with ectopic ureters are 20 times more likely to be female and canine ectopic ureters are more likely to be intramural, and are more commonly unilateral.[9,10]

Diagnosis of ectopic ureters can be performed via abdominal ultrasound, contrast enhanced computed tomography (CT), fluoroscopic excretory urethrography, and/or retrograde ureteropyelography, with cystourethroscopy or surgery considered to be the gold standard.[3,11–13] Surgical management is often pursued shortly after a diagnosis is made to reduce the incidence of incontinence, urine stasis, ureteral obstruction, or ascending urinary tract infection. Correction of ectopic ureters in dogs has been performed by neoureterostomy (NU), ureteroneocystostomy (UNC), or nephrouretectomy, or using cystoscopic laser ablation (CLA).[14–17]

The objective of this report is to further characterize the demographics, clinical signs, surgical treatment, and clinical outcomes of ectopic ureters in cats. We hypothesize that cats have variable urinary signs such as incontinence, hematuria, or stranguria related to ectopic ureters but demonstrate improved continence following surgery.

2 | MATERIALS AND METHODS

2.1 | Case selection

Medical record databases of seven veterinary institutions were reviewed for records of cats that underwent open surgical or cystoscopic correction of ectopic ureters between 2007 and 2020. Searches were performed for the procedures described (ureteroneocystotomy, neoureterotomy, CLA). The diagnosis of ureteral ectopia was based on diagnostic imaging studies and intraoperative (surgical or cystoscopic) findings. Intraoperative findings, correction, complications, and surgical times were recorded. Animals were included in the study based on the following criteria: feline species, confirmation of unilateral or bilateral ectopic ureter(s), and attempted surgical correction of ectopic ureter(s). Animals were excluded from the study based on the following criteria: insufficient medical records (defined as no physical examination or surgery report), and less than 14 days of follow up.

2.2 | Medical records review

Information was collected regarding each cat's signalment, presenting complaint, physical examination findings, diagnostics, surgical intervention, outcome, and postoperative follow up. The category of ectopic ureter (extramural or intramural) was based on both presurgical diagnostic imaging and intraoperative clinical findings from the surgery report. Clinical summaries from each cat were compiled and analyzed.

2.3 | Incontinence scoring system

Severity of incontinence was defined on a scale of 0–4, adapted from a previously published incontinence scoring system (Table 1).[18] Scores were assigned to each cat

TABLE 1 Urinary incontinence scoring system.

Score	Incontinence level
0	Cat always continent
1	Cat urine soils where the cat has been sleeping more than 50% of the time; the cat does not dribble urine, or have a wet perineal area when awake
2	Cat urine soils where it has been sleeping more than 50% of the time, dribbles urine; or has a wet perineal area when awake up to 25% of the time
3	Poorly continent; cat urine soils where it has been sleeping more than 50% of the time and has a wet perineal area 25 to 75% of the time
4	Cat is never continent, dribbles urine when awake and when sleeping, constantly has a wet perineal area, and leaves urine when rising from a sitting to standing position

Source: Modified from Bennett et al.[18]

retrospectively based on history of clinical signs provided by owners.

2.4 | Surgical classification

The choice of surgical procedure performed was made by the attending veterinarian. Ureteroneocystostomy was performed by a stab incision into the bladder wall, spatulating the ureter, and suturing the ureter to the bladder mucosa via circumferential simple interrupted sutures with 6–0 polydiaxonone. This is also termed the Leadbetter–Politano technique.[19] Neoureterostomy was performed via a ventral cystotomy, making an incision into the lumen of the intramural portion of the ureter proximal to the trigone, and suturing the ureteral mucosa to the bladder mucosa.[1] Both UNC and NU procedures were performed under the guidance of an operating microscope or magnified loupes that provided 2–22× magnification. All surgeries were performed by boarded veterinary surgeons with various levels of experience in microsurgery. Cystoscopic laser ablation was performed via transurethral cystoscopy (female cat) or the percutaneous cystoscopic approach (male cat) with a rigid 2.7 mm integrated cystoscope (Storz, Tuttlingen, Germany). Following catheterization of the ureteral ostium with a 3.5 Fr open ended ureteral catheter, a diode laser with a 200 μ laser fiber (Convergent Laser Technologies, California) was used to ablate tissue that forms the medial aspect of the ectopic ureteral wall so that a new ureteral opening could be positioned at the neck of the bladder.[13,20] Complications reported during surgery were reviewed and graded based on the classification of intraoperative (CLASSIC) criteria (Table 2).[21] Additional required procedures were also reported.

TABLE 2 Classification of intraoperative complications (CLASSIC) criteria.

Grade	Definition
0	No deviation from ideal operative course
I	Any deviation from ideal operative course Without the need for additional treatment or intervention
II	Any deviation from ideal operative course With the need for any additional treatment or intervention Not life threatening and not leading to permanent disability
III	Any deviation from ideal operative course With the need for any additional treatment or intervention Life threatening and/or leading to permanent disability
IV	Any deviation from ideal operative course With death of the patient

Source: Modified from Rosenthal et al.[21]

TABLE 3 The accordion severity classification of postoperative complications: contracted classification.

Level	Definition
1	Mild complication: Requires only minor invasive procedures that can be performed at bedside such as insertion of intravenous lines, urinary catheters, nasogastric tubes, and drainage of wound infections. Physiotherapy and the following drugs are allowed: antiemetics, antipyretics, analgesics, diuretics, and electrolytes
2	Moderate complication: Requires pharmacologic treatment with drugs other than those allowed for minor complications (e.g. antibiotics); blood transfusions and total parenteral nutrition are also included
3	Severe complication: All complications requiring endoscopic or interventional radiologic procedures or reoperation as well as complications resulting in failure of one or more organ systems
4	Death: Postoperative death

Source: Modified from Strasberg et al.[22]

2.5 | Postoperative outcomes

Reported postoperative complications were reviewed and graded based on the Accordion severity classification of postoperative complications (Table 3).[22] Postoperative complications were classified into immediate postoperative

TABLE 4 Presentation and diagnosis.

Cat	Sex	Age at presentation (years)	Incontinence score (0–4)	Other clinical signs/diagnoses	Affected ureter	Termination of ureter
1	FS	6	2	Hematuria and (UTI)	L	Extramural
2	FS	5	1	Perivulvar pruritis and UTI	R	Extramural
3	FS	0.83	3	Perivulvar pruritis and hemorrhage with UTI	B	Intramural and extramural
4	FI	0.5	3	Perivulvar dermatitis and UTI	R	Extramural
5	MN	1	3	Preputial dermatitis and phimosis	R	Intramural
6	FS	14	2	Hematuria and pollakiuria	R	Intramural
7	MN	1	3	Hematuria and UTI	L	Intramural
8	MN	8	2	Hematuria	B	Extramural
9	MN	4	4	Hematuria	B	Extramural
10	FS	5	4	Urine scald on pelvic limbs and hematuria	B	Extramural
11	FS	1	1	Hematuria, azotemia, and UTI	B	Extramural
12	FS	2	2	Urine scald	B	Extramural

Abbreviations: B, bilateral; FS, female spayed; L, left; MN, male neutered; R, right; UTI, urinary tract infection.

complications (prior to discharge), short-term complications (less than 2 weeks after discharge), and long-term (greater than 2 weeks after discharge).

To gain follow-up information, if less than 6 months of data were obtainable by the medical record, owners or referring veterinarians were contacted by phone directly. Information collected included renal functional indices (BUN, creatinine, USG, urinalysis) and evidence of incontinence, malurination, repeated urinary tract infections. Severity of incontinence was based on history provided by owners and assigned a number based on the urinary incontinence scale (Table 1).[18]

3 | RESULTS

3.1 | Animals

A total of 12 medical records met the inclusion criterion and were evaluated. The median age was 4 years, interquartile range (IQR) 6 months to 14 years. The median body weight was 3.92 kilograms (IQR 2.44 to 6.7 kilograms). Nine of the 12 cats were classified as domestic short haired cats with the remainder being one each of Scottish fold, Persian, and Himalayan. Five of the 12 cats were castrated males, one cat was an intact female, and six were spayed females. Eight of the affected cats presented for urinary incontinence since birth or adoption, four of the cats had an onset of urinary incontinence after 8 months to 9 years of age. All cats had a urinary incontinence score greater than 1 (median 2.5). Physical exam findings of the affected population revealed urine scalding along the perineum or back legs ($n = 6$), self-mutilation to the affected area with hemorrhage noted (2), hematuria (2), and phimosis (1). Five of the cats had normal physical examinations with no history of genitourinary abnormalities. One cat was previously diagnosed with a unilateral ectopic ureter, associated hydroureter, and hydronephrosis, and underwent a nephroureterectomy prior to presentation (Table 4).

3.2 | Preoperative diagnostics

A complete blood count was performed in each case. Nine of the 12 cats had no abnormalities. One cat was noted to have 93 000 platelets/dL (reference range 175 000–500 000 platelets/dL) with excessive clumping, one cat had excessive platelet clumping with a low number of toxic neutrophils, and one cat had a hemoglobin of 9.6 g/dL (reference range 10.9–15.7 g/dL). Serum chemistry was performed in each case. Six of the 12 cats had no abnormalities. Abnormalities in serum chemistry for the remaining cats included the following: phosphorus of 2.3 mg/dL (reference range 2.5–7.5 mg/dL) and total calcium of 10.9 mg/dL (reference range 8–10.5 mg/dL) in cat one; elevated SDMA in two cats (17, 19 μg/dL (reference range 0–14 μg/dL)); alkaline phosphatase of 88 U/L (reference range 12–65 U/L) in cat 10; and blood urea nitrogen of 43.4 mg/dL (reference range

4–33 mg/dL), creatinine of 6.3 mg/dL (0.8–1.6 mg/dL), phosphorous of 6.3 mg/dL, total protein of 5.2 g/dL (reference range 5.9–8.2 g/dL) in cat 11.

Urinalysis was performed in all 12 cats and showed a low specific gravity in six cats ranging from 1.016–1.033 (median 1.030) (reference range 1.035–1.060). The remainder of the cats had a normal specific gravity. All cats had a normal urine pH (between 5.0–8.5). Urine culture was performed in all cases and was positive in four cats. Organisms grown from urine cultures included *Enterococcus faecalis*, *Escherchia coli*, and *Proteus mirabilis*. Eight of the 12 cats had a negative urine culture. Urinalysis showed protein in five cases, red blood cells in seven cases, and leukocytes in two cases. Two cats had a negative urine culture but the presence of bacteria was noted on urine sediment. To treat urinary incontinence, two of the cats were treated with oral phenylpropanolamine (dose 1.5 milligrams per kilogram 2–3 times daily) for approximately 2 weeks but improvement of clinical incontinence was not observed.

Ten of the affected cats underwent abdominal ultrasound, which was diagnostic for ureteral ectopia in eight cases. Findings other than ureteral ectopia on abdominal ultrasound included hydroureter and hydronephrosis in six cats and bilateral hydronephrosis with sediment in the renal pelvis bilaterally in one cat. Other ultrasonographic abnormalities included the following: irregular renal papilla and echogenic debris within the bladder, ureteritis with periureteral steatitis, a severe distal ureterocele with double vena cavae noted and a right retrocaval ureter, mild and diffuse cholecystopathy with jejunal lymphadenopathy and pancreatic nodules, hemorrhage on the remnants of the renal crests noted within the dilated calyces of the right kidney, and a hypoplastic/dysplastic left kidney with hydroureter with dilation and tortuosity of the right ureter. Contrast enhanced computed tomography was performed in three of the 12 cases, which was diagnostic for one intramural ectopic ureter and two extramural ectopic ureters. Fluoroscopic urography was performed via the retrograde introduction of high osmolar iodine into the bladder via a urinary catheter. Contrast urography was diagnostic in three cats for one concurrent intramural/extramural ectopic ureter, one extramural ureter, and bilateral extramural ectopic ureters; the urogram was reported to be normal in one cat. Two of the cats were female and the catheter was introduced retrograde through the urethra; percutaneous antegrade cystoscopy was performed in the remaining cat that was male. Cystoscopy was performed in seven cases. Ureteral openings were not visualized in one case. Cystoscopy identified an intramural ectopic ureter in two cats, an extramural ectopic ureter in two cats, and both intramural and extramural ectopic ureter in one cat.

All cats included had at least one ureter that terminated in the urethra. Eight of the 12 cats had extramural ectopic ureters. One cat had both an intramural and extramural ureter, and three cats had intramural ectopic ureters. Six of the affected cats had bilateral ectopic ureters, four cats were only affected on the left side, and two cats were affected on the right side. A final diagnosis of location and lateralization of ectopic ureters was made via intraoperative or cystoscopic visualization (Table 4).

3.3 | Surgical findings

Surgical correction was performed in 12 of the affected cats; eight underwent UNC, two cats underwent CLA, one cat underwent a NU, and one cat had a nephroureterectomy.

No major intraoperative complications were reported for the 12 cats that underwent surgery. One cat experienced a grade II complication, consisting of intraoperative hypotension, which resolved with intravenous dopamine (5 μg/kg/min).

3.4 | Postoperative findings

Follow up time for all cats was a median of 340 days (IQR, 2 to 1875 days). Of the eight cats that underwent UNC, grade I complications occurred in four cats and a grade III complication was noted in one cat (Table 5). Grade I complications in the UNC group included transient but progressive urinary incontinence, progressive hydronephrosis and hydroureter (1–2 mm), and pyelectasia and hydroureter. Other grade I complications in the UNC group resolved with active surveillance and oral medications following discharge (see below) within the 2 week postoperative period. The grade III complication noted in the UNC group occurred in one cat approximately 24 h postoperatively. The cat was diagnosed with uroabdomen requiring exploratory laparotomy, which revealed a small defect of the UNC site, which was surgically repaired, and a 3.5 French transurethral-ureteral catheter was placed (MILA International Inc., Kentucky, USA).

Of the two cats that underwent CLA and one that underwent nephroureterectomy, no immediate postoperative complications were noted. The one cat that underwent NU experienced urethral spasms postoperatively, a grade I complication.

Urethral spasming was treated with acepromazine (0.03 mg/kg intravenously) and resolved prior to discharge (Table 5).

TABLE 5 Surgery and outcome.

Cat	Surgery performed	Immediate postoperative complications and level (Accordion severity)	Postoperative urinary incontinence score	Other complications
1	Ureteroneocystostomy	None: 0	0	None
2	Nephroureterectomy	None: 0	0	None
3	Ureteroneocystostomy-bilateral	Progressive urinary incontinence: 1	0	None
4	Ureteroneocystostomy	None: 0	0	Occasional stranguria
5	Laser ablation	None: 0	0	None
6	Laser ablation	None: 0	1	None
7	Neoureterostomy	Urethral spasm: 1	lost to follow up	N/A
8	Ureteroneocystostomy-bilateral	Progressive hydronephrosis and hydroureter: 1	0	Two episodes of urethral obstruction, recurrent rectal prolapses and stricture
9	Ureteroneocystostomy—bilateral	Static pyelectasia and hydroureter: 1	0	
10	Ureteroneocystostomy—bilateral	None: 0	0	One urinary tract infection
11	Ureteroneocystostomy—bilateral	None: 0	0	One urinary tract infection
12	Ureteroneocystostomy—bilateral	Uroabdomen secondary to defect in ureteroneocystostomy site: 3	0	

Medications sent home with cats included the following: sublingual buprenorphine (dose range 0.015–0.02 mg/kg) in eight cats, gabapentin (dose range 6–13.5 mg/kg) in three cats, amoxicillin/clavulanic acid (dose range 13.8–18 mg/kg) in 5 cats, prazosin (dose 1 mg/cat) in two cats, and prednisone (dose 0.5 mg/kg) in one cat. One cat received furosemide (dose 0.5 mg/kg) intravenously while in hospital to promote urine output.

All cats had postoperative bloodwork performed prior to their discharge (1–3 days). Postoperative blood work in the UNC group showed resolution of preoperative azotemia in one cat, and improvement without complete resolution of azotemia in one cat (BUN 43.4 mg/dL and creatinine 6.3 mg/dL preoperatively, BUN 20.5 mg/dL and creatinine 5.0 mg/dL postoperatively). One cat, which was treated with UNC, was not azotemic preoperatively (creatinine 1.6 mg/dL, BUN 30 mg/dL) but developed azotemia with creatinine values of 2 mg/dL and BUN 46 mg/dL on day 2 postoperatively and BUN 36 mg/dL and creatinine 2.4 mg/dL on day 4 postoperatively. No azotemia developed in the NU or CLA groups.

Short-term complications were noted in three cats, which included hematuria and stranguria in one cat from the CLA group, stranguria in two of the cats in the UNC group, and persistent but improved (incontinence score of 3 to 1) urinary incontinence in the CLA group. Nine cats were not reported to have complications within the 2 week postoperative window.

Long-term complications after surgery were reported in three of the cats in the UNC group, including urinary tract infections in two cats (grade I), and two episodes of urethral obstruction secondary to presumed feline lower urinary tract disease approximately 1 year postoperatively in one cat. Long-term complications noted in the CLA group included recurrent rectal prolapses in one cat secondary to persistent stranguria (grade III). This cat had a complicated medical history, which included a wedge preputioplasty as a treatment for ulcerated preputial swelling, which was performed prior to the diagnosis of the ectopic ureter. Following the wedge preputioplasty and CLA, the patient developed severe, recurrent rectal prolapse, presumed secondary to stranguria. The rectal prolapse was corrected via colopexy. A colonic stricture was later noted in the same cat and corrected via balloon dilation.

All cats that underwent surgical or cystoscopic correction of ureteral ectopia in this study were reported to have less than or equal to 1 urinary continence at the date of last follow up. The median preoperative incontinence score of 2.5 improved to a median incontinence score of 0 postoperatively. Eleven cats had a urinary incontinence score of 0 and

one cat had a score of 1. Eleven of the 12 cats were reported to be alive based on the last communication follow up. One cat was lost to follow up less than 2 weeks postoperatively but maintained no complications in the short term.

4 | DISCUSSION

Reporting of ectopic ureter appears to be uncommon in cats. This report describes the signalment, treatment, complications, and outcomes of 12 cats diagnosed and treated for ectopic ureter. Affected cats in this cohort presented with urinary incontinence and hematuria, stranguria, or local urine scalding and dermatitis. Initial diagnostics indicate that a high percentage of cats had urinary tract infections (33%), and some cats were azotemic at the time of presentation (16%). Several forms of diagnostic imaging were employed, including abdominal ultrasound, fluoroscopic excretory urethrography or retrograde ureteropyelogram, contrast enhanced computed tomography, cystoscopic evaluation, or intraoperative visualization. Surgical correction included UNC, NU, CLA, or nephroureterectomy We accepted our hypothesis in that resolution or improvement of urinary incontinence was observed in all cases and major intraoperative or postoperative complications appeared to be uncommon.

The most common presenting complaint for a dog or cat with ectopic ureter(s) is urinary incontinence, which may be exacerbated by concurrent urogenital anomalies or conditions that arise secondary to abnormal urogenital anatomy or function, such as urinary tract infections.[13,15] The incidence of ectopic ureters in dogs is estimated to be less than 0.05%, with female dogs overrepresented ranging from 8:1 to 25:1 ratios in comparison with the male population according to varying retrospective studies.[23,24] The majority of dogs with ectopic ureters have unilateral disease and they are most commonly intramural.[5] This disease is less commonly reported in cats as there have been fewer than 25 published case reports of ureteral ectopia in cats. Our study here included medical records search of seven separate institutions over a 20-year period and was only able to identify 12 cases. Due to its rare frequency, characterizing breed and sex predispositions is difficult. However, data extrapolated from published cases and our report here suggest that cats are more likely to present for surgical correction if they have bilateral ureteral ectopia and cats tend to have extramural terminations of the affected ureters.[2,9,25,26] The diagnosis may be more readily made in cases of bilateral disease due to a more severe clinical presentation, as cats with bilateral disease had higher urinary incontinence scores (Table 4).

It may also be more difficult for clinicians to make a diagnosis of ectopic ureters in cats, which may account for the rare reporting. Cats may have more subtle clinical signs of urinary incontinence and are more fastidious in grooming efforts when compared to dogs. Dysfunction of the urinary tract may often be attributed to feline idiopathic cystitis (FIC) without additional investigation. In general, both affected feline and canine populations with ectopic ureters can exhibit clinical signs other than urinary incontinence, such as stranguria, hematuria, urinary obstruction, or they may even be asymptomatic. Ectopic ureters have been diagnosed in middle-aged animals incidentally while investigating elevated kidney values or hydronephrosis. It is therefore likely that the true incidence of ectopic ureters in both feline and canine populations is higher than current literature indicates.[13,25]

Each of the cats in this retrospective study were presented for chronic urinary incontinence and several had chronic urinary tract infections with urine scalding. The affected cats were treated for their urinary tract infections and treated medically for incontinence, but a lack of resolution of clinical signs warranted further testing.

Diagnostic success in this case series was generally similar to the reported rate of successful identification of ectopic ureter in dogs. Abdominal ultrasound was diagnostic in 80% of cats with ectopic ureter despite the small size of feline anatomy and superimposition of tissues. Abdominal ultrasonography has a reported 91% accuracy rate and close agreement with ultrasonographic measurements and postmortem measurements in dogs.[11,27] However, sonographic identification of feline ureters is potentially lower due to the small size of feline ureters, and ultrasonography can be based heavily on operator experience. Abdominal ultrasound is therefore often practiced as a first-line diagnostic when investigating urinary incontinence in both cats and dogs but is occasionally followed by additional diagnostic imaging.[13]

The use of computed tomography (CT) in diagnostic work up of ectopic ureters could be considered due to disparities in differentiating between extramural and intramural locations of ectopic ureters with ultrasound, as CT eliminates superimposition of tissues via thin slices of high-definition images.[6,13] Computed tomography was diagnostic in 100% of cats in this population and fluoroscopic excretory urography or retrograde ureteropyelogram detected ureteral ectopia in 75% of cases, or three out of four cats.

Cystoscopy identified ureteral openings in six out of seven cats in this study, or 85%. The feline urethra poses a challenge for visualization due to its small diameter. A transurethral approach is often feasible in female cats but is particularly challenging in males due to the small urethral diameter. The approach to the male cat's urinary tract can therefore be carried out via cystoscopy following perineal urethrostomy, a prepubic percutaneous approach,

or a surgical antegrade access.[28,29] In this study, male cats were evaluated via a small (~5–10 mm) celiotomy approach to the urinary bladder to allow for cystoscope passage and infusion of iodine contrast under fluoroscopic guidance, as indicated. These techniques in cats are considered to be a means for assessment of cystitis, hematuria, incontinence, trauma, and urethral calculi in the cat and could be applied to visualize ureteral terminations.[28] Although this study maintained a small sample size, it appears that abdominal ultrasound, fluoroscopic urography, CT, cystoscopy, or a combination of these modalities were effective diagnostic methods for identifying feline ectopic ureters.

Surgical correction of ectopic ureters may vary based on the location of the ureter as well as clinician comfort and experience. As mentioned previously, the small diameter (~0.4 mm) and wall thickness of a normal ureter in cats poses unique challenges to the veterinary surgeon. Ureteral surgery in cats, including UNC and NU procedures, is most often performed using an operating microscope that provides 2 - 22× magnification to allow for appropriate apposition of mucosa, often using 6–0 diameter suture. The specialized equipment and advanced skill required for ureteral surgery in the cat makes it technically difficult. Similarly, CLA requires advanced equipment and expertise associated with the use of cystoscopy and a surgical laser. This report is the first to describe CLA in cats to the authors' knowledge; it may carry challenges or complications that have not been gleaned based on the small population included in this study. All surgical options should be weighed carefully based on the individual clinician's experience and skillset to treat the disease.

The sample size was too small to make any meaningful comparisons between outcomes; however, major complications were uncommon regardless of technique. Intraoperative complications in this study were rare; one cat experienced hypotension, which was responsive to dopamine, a grade II complication according to the CLASSIC criteria.[21] The lack of intraoperative and postoperative complications may be due to a number of variables including a small sample size, surgeon comfort, preoperative planning, advanced anesthetic protocols, and individual expertise. Each of the surgeons or interventionalists performing these corrections are located at a veterinary teaching hospital or referral hospital with advanced experience with procedures regarding the urinary system in both dogs and cats.

Postoperative complications were noted to be more common. Immediately postoperatively, three cats had Accordion grade 1 complications.[22] These three cats had urethral spasming, which was treated medically; progressive hydroureter/hydronephrosis, which resolved without intervention; and progressive urinary incontinence, which also resolved without additional treatment. One cat experienced a grade III complication developing leakage from his neoureterocystostomy site progressing to uroabdomen and requiring surgical revision. Urine leakage following various forms of ureteral surgery in 117 cats in a 2016 study found that 7% of the population was diagnosed with a uroabdomen postoperatively, some managed conservatively and others requiring surgical treatment.[19] The frequency of leakage leading to uroabdomen in this population appeared uncommon ($n = 1$ or 8.3%) potentially due to the smaller sample size of this study and the presurgical dilation of the ureters from the underlying disease.

Complications noted within 2 weeks of discharge were considered mild in most cats. Short-term complications included stranguria, hematuria, and persistent urinary incontinence. Several of these clinical signs were noted at the time of presentation but they are common postoperative findings following urinary surgery and may be related to irritation from introduction of a cystoscope into the urethra or iatrogenic trauma to associated tissues urogenital tissues.[4] Fortunately, the clinical signs in each cat resolved without treatment.

Long-term complications were uncommon and generally low in severity, as the short-term complications resolved with appropriate supportive care. Interestingly, the only cat that suffered a long-term grade III complication (chronic stranguria leading to rectal prolapse and eventually stricture) became urinary continent following surgery and did not initially present with stranguria. The same cat also had a history of phimosis corrected with a wedge preputioplasty, which may have contributed to his ongoing urinary signs.

All cats were alive at the time of last follow up and their outcomes were considered good. One cat did have residual incontinence that improved from a score of 2 to 1 after surgery. One cat also experienced to episodes of urethral obstruction that responded to medical management but it is difficult to determine if this was related to a previous the anatomic anomaly or feline lower urinary tract disease (FLUTD).

The primary limitations of this study are similar to inherent problems of retrospective studies on rare conditions. They include selection bias and small sample size. As cases were selected by those that underwent surgical intervention, the study may have selected for cases with more severe clinical signs without improvement following medical management. Fortunately, despite potentially selecting for more severe disease, improvements in clinical signs were still observed in all cases. Due to the small sample size, it is difficult to draw large conclusions about incidence, clinical signs, diagnostic accuracy of medical imaging, and comparisons of which surgical technique is associated with the best outcome.

The findings of this study support the view that surgical intervention for feline ectopic ureters can be associated with an improvement of clinical signs. Major intraoperative and postoperative complications were rare. This study also supports the view that cats with ureteral ectopia undergoing surgery are more likely to have extramural disease and are more likely to be bilateral in nature. This study begins to support the use of several diagnostic imaging modalities and surgical techniques for ureteral ectopia in cats.

ACKNOWLEDGMENTS

Author Contributions: Cortez GL, DVM, CVA: Identified medical records, compiled data from other institutions, interpreted data, drafted and revised the manuscript. Thomson CB, DVM, DACVS (Small Animal): Identified suitable medical records and was responsible for surgical management of one case, oversaw data collection, compiled data from other institutions, interpreted data, drafted and revised the manuscript, and provided inline editing of the manuscript. Scharf VF, DVM, MS, DACVS (Small Animal): Identified and contributed suitable medical records and was responsible for the surgical management of two cases. Berent: A, DVM, DACVIM: Identified and contributed suitable medical records; was responsible for surgical management of three cases and provided intraoperative photographs. Buote N, DVM, DACVS (Small Animal): Identified and contributed suitable medical records and was responsible for the surgical management of one case. Carson BA, DVM, MS, DACVS (Small Animal): Identified and contributed suitable medical records and was responsible for the surgical management of one case. Cassandra M, DVM: Identified and contributed suitable medical records. Mayhew PD, BVM&S, MRCVS, DACVS (Small Animal): Identified and contributed suitable medical records and was responsible for the surgical management of three cases. Singh A, DVM, DVSc, DACVS (Small Animal): Identified and contributed suitable medical records and was responsible for surgical management of one case. All authors provided a critical review of the manuscript and endorsed the final version. All authors are aware of their respective contributions and have confidence in the integrity of all contributions.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this report.

ORCID

Christopher B. Thomson https://orcid.org/0000-0002-3673-7800
Valery F. Scharf https://orcid.org/0000-0002-5011-9005
Nicole J. Buote https://orcid.org/0000-0003-4623-3582
Ameet Singh https://orcid.org/0000-0002-8095-9339

REFERENCES

1. Mayhew PD, Lee KCL, Gregory SP, Brockman DJ. Comparison of two surgical techniques for management of intramural ureteral ectopia in dogs: 36 cases (1994-2004). *J Am Vet Med Assoc*. 2006;229(3):389-393.
2. Kuzma AB, Holmberg DL. Ectopic ureter in a cat. *Can Vet J*. 1988;28:59-61.
3. Greenfield ZP, Berent AC, Weisse CW. Urinary incontinence in a dog with a duplex renal system and extramural ectopic ureter. *J Small Anim Prac*. 2021;63:1-5. doi:10.1111/jsap.13399
4. Berent AC, Weisse C, Mayhew PD, Tood K, Wright M, Bagley D. Evaluation of cystoscopic-guided laser ablation of intramural ectopic ureters in female dogs. *J Am Vet Med Assoc*. 2012;240:716-725.
5. Ho LK, Troy GC, Waldron DR. Clinical outcomes of surgically managed ectopic ureters in 33 dogs. *J Am Anim Hosp Assoc*. 2011;47:196-202. doi:10.5326/JAAHA-MS-5495
6. Fox AJ, Sharma A, Secrest SA. Computed tomographic excretory urography features of intramural ectopic ureters in 10 dogs. *J Small Anim Prac*. 2016;57:210-213. doi:10.1111/jsap.12460
7. Lonc KM, Kaneene JB, Carneiro PAM, Kruger KM. Retrospective analysis of diagnoses and outcomes of 45 cats with micturition disorders presenting as urinary incontinence. *J Vet Int Med*. 2019;34:216-226.
8. Eisele JG, Jackson J, Hager D. Ectopic ureterocele in a cat. *J Am Anim Hosp Assoc*. 2005;41:332-335.
9. Di Mauro FM, Singh A, Reynolds D, Defarges A. Combined use of intravesicular ureteroneocystostomy techniques to correct ureteral ectopia in a male cat. *J Am Anim Hosp Assoc*. 2014;50:71-76. doi:10.5326/JAAHA-MS-5968
10. McLoughlin MA, Chew DJ. Diagnosis and surgical management of ectopic ureters. *Clin Tech Small Anim Pract*. 2000;15(1):17-24.
11. Lamb CR, Gregory SP. Ultrasonographic findings in 14 dogs with ectopic ureter. *Vet Radiol Ultrasound*. 1998;3:223-281. doi:10.1111/j.1740-8261.1998.tb00343.x
12. Longo M, Andreis ME, Pettinato C, et al. Use of bolus tracking technique for the tomographic evaluation of the ureterovesicular junction in dogs and assessment of dose records. *BMC Vet Res*. 2016;12:64. doi:10.1186/s12917-016-0690-z
13. Owen LJ. Ureteral ectopia and urethral sphincter mechanism incompetence: an update on diagnosis and management options. *J Small Anim Prac*. 2019;60(1):3-17.
14. Smith AL, Radlinsky MG, Rawlings CA. Cystoscopic diagnosis and treatment of ectopic ureters in female dogs: 16 cases (2005-2008). *J Am Vet Med Assoc*. 2010;237:191-195.
15. Reichler IM, Specker CE, Hubler M, Alois B, Haessig M, Arnold S. Ectopic ureters in dogs: clinical features, surgical techniques and outcome. *Vet Surg*. 2012;41:515-522. doi:10.1111/j.1532-950X.2012.00952.x
16. Lautzenhiser SJ, Bjorling DE. Urinary incontinence in a dog with an ectopic ureterocele. *J Am Anim Hosp Assoc*. 2002;38:29-32. doi:10.5326/0380029
17. Rogatko CP, Berent AC, Adams LG, Weisse CW, Bagley D. Endoscopic laser-ablation for treatment of orthotopic and ectopic ureteroceles in dogs: 13 cases (2008-2017). *Vet Surg*. 2019;33(2):670-679. doi:10.1111/jvim.15424
18. Bennett TC, Mats BM, Henderson RA, et al. Total prostatectomy as a treatment for prostatic carcinoma in 25 dogs. *Vet Surg*. 2018;47(3):367-377. doi:10.1111/vsu.12768

19. Wormser C, Clarke D, Aronson L. Outcomes of ureteral surgery and ureteral stenting in cats: 117 cases (2006-2014). *Am Vet Med Assoc*. 2016;248(5):518-525.
20. Berent AC, Mayhew P, Porat-Mesenco Y. Use of cystoscopic-guided laser ablation for treatment of intramural ureteral ectopia in male dogs: four cases (2006-2007). *J Am Vet Med Assoc*. 2008;232(7):1026-1034.
21. Rosenthal R, Hoffman H, Clavien PA, Heiner BC, Dell-Kuster S. Definition and classification of intraoperative complications (CLASSIC): Delphi study and pilot evaluation. *World J Surg*. 2015;39:1663-1671.
22. Strasberg SM, Linehan DC, Hawkins WG. The accordion severity grading system of surgical complications. *Ann Surg*. 2009; 250:177-186.
23. Hayes HM. Ectopic ureter in dogs: epidemiologic features. *Teratology*. 1974;10:129-132.
24. Holt PE, Moore AH. Canine ureteral ectopia: an analysis of 175 cases and comparison of surgical treatments. *Vet Rec*. 1995; 136:345-349.
25. Steffey MA, Brockman DJ. Congenital ectopic ureters in a continent male dog and cat. *J Am Vet Med Assoc*. 2004;224:10. doi:10.2460/javma.2004.224.1607
26. Holt PE, Gibbs C. Congenital urinary incontinence in cats: a review of 19 cases. *Vet Rec*. 1992;130:437-442.
27. Balogh O, Degrandi F, Hassi M, Reichler IM. Validation of screening examinations of the ureteral orifices in dogs: comparison of ultrasonography with dissection. *Res Vet Sci*. 2015;101:199-205.
28. McCarthy TC. Cystoscopy and biopsy of the feline lower urinary tract. *Vet Clin North Am Small Anim*. 1996;26:463-482. doi:10.1016/S0195-5616(96)50078-1
29. Chew DJ, Buffington T, Kendall MS, Osborn SD, Woodworth BE. Urethroscopy, cystoscopy, and biopsy of the feline lower urinary tract. *Vet Clin North Am Small Anim*. 1996;26(3):441-461. doi:10.1016/S0195-5616(96)50077-X

How to cite this article: Cortez GL, Thomson CB, Scharf VF, et al. Presentation, diagnosis, and outcomes of cats undergoing surgical treatment of ectopic ureters. *Veterinary Surgery*. 2024;53(6):1019-1028. doi:10.1111/vsu.14103