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STANDARD ARTICLE

Retrospective evaluation of cystoscopic-guided laser ablation of intramural ectopic ureters in female dogs

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Abstract

Background: Cytoscopic-guided laser ablation (CLA) is a technique that can be used to correct intramural ectopic ureters (EUs) in dogs.

Hypothesis/Objectives: To describe clinicopathologic, imaging, and cystoscopic findings in dogs undergoing CLA for intramural EU correction, and whether any of these findings are associated with continence outcomes.

Animals: Thirty-one client-owned dogs undergoing CLA between 2009 and 2019.

Methods: Retrospective cohort study. Data collected from medical records included signalment, clinical findings (including continence score at presentation), clinicopathologic findings (serum biochemistry profile, urinalysis, and urine culture results before CLA), ultrasonography, and cystoscopy findings. Follow-up information was collected at 1 day to 1 week, 1 week to 1 month, and at >1 month time points after CLA. Final continence score was determined based on this follow-up information. Multiple logistic regression was used to determine factors that were associated with final continence score.

Results: Median continence score of dogs at initial evaluation was 2 (range, 2-4). Median continence score after CLA alone was 3 (range, 1-5). Seventeen of 31 (54.8%) dogs received adjunctive medical management after CLA. Median continence score after CLA with or without adjunctive medical management was 5 (range, 1-5). Overall, 67.7% of dogs were considered continent after CLA with or without adjunctive medical management. No preoperative or perioperative factors were found to be associated with final continence score.

Conclusions: Cystoscopic-guided laser ablation for intramural EU in female dogs provides improvement in incontinence. Dogs remaining incontinent after CLA may improve with adjunctive medical management. Surgical management is required to manage incontinence in dogs with extramural EU.

KEYWORDS
congenital disease, cystoscopy, incontinence, interventional radiology, lower urinary tract

Abbreviations: CLA, cystoscopic-guided laser ablation; CT, computed tomography; EU, ectopic ureter; US, ultrasound; VD, ventrodorsal.

1 | INTRODUCTION

Ectopic ureter (EU) refers to any ureter that does not terminate in the trigonal region of the bladder.[1] Distal ureteral termination can occur in the urethra, vagina, vestibule, or rectum. Ectopic ureter occurs as a consequence of embryologic malformation of the mesonephric and metanephric ducts and abnormal incorporation into the urogenital sinus.[1] Phenotypically, EUs can be either intramural or extramural, with intramural EU being identified in 64% to 95% of dogs.[2-6] Regardless, the usual clinical outcome is juvenile onset, persistent urinary incontinence.[2,3,6-10] Female dogs typically have onset of incontinence from birth or weaning,[8,10] whereas male dogs have a later onset of incontinence.[7] In several reports, females are over-represented compared to males and specific breeds have been identified to be at increased risk.[2,5,11-13]

Ultrasonography,[14] contrast excretory and retrograde urography, computed tomography (CT), and cystoscopy[2,10,15] have been evaluated as methods of diagnosing EU. The ideal imaging modality would reliably identify caudal displacement of the ureteral orifice in dogs with EU and characterize the phenotype to direct appropriate therapeutic decisions. Although ultrasonography and contrast excretory and retrograde urography have been demonstrated to have high sensitivity for detection of EU,[14] several studies have affirmed that CT and cystoscopy have the highest agreement with surgery and necropsy findings for both detection and phenotypic characterization of EU.[15-17]

Considering that cystoscopy has high accuracy for diagnosis of EU and most dogs have intramural EU, cystoscopic-guided laser ablation (CLA) has been described as a minimally invasive option that allows for diagnosis and correction of EU in female and male dogs.[8,10,18-20] Simply, this procedure combines retrograde ureterocystography and cystoscopy to identify the distal EU orifice and differentiate intramural and extramural phenotypes, followed by ablation of the tissue that forms the medial aspect of the EU wall so that the distal ureteral orifice is relocated into the urinary bladder trigone.[8,10,18,19] Although CLA is only feasible for dogs with intramural EU, major perceived advantages compared to surgical techniques include absence of the need for open laparotomy and the ability to evaluate distal urogenital structures including the vagina, urethra, and vestibule.[8,10,21] Evaluation of these structures is crucial because many dogs with EU will have other congenital abnormalities that contribute to ongoing incontinence. These may include pelvic bladder and short urethra,[2,11,16,22] or vestibulovaginal abnormalities such as paramesonephric remnant, double vagina, or vaginal septum.[17,21]

For both CLA and surgical techniques that have been described to correct EU, several studies have reported variable continence outcomes and complication rates.[6,8,10,19,23] The proportion of dogs achieving continence with surgical techniques ranges between 22% and 72%,[4,6,23] increasing to 81% with adjunctive medical management.[6] The proportion of dogs achieving continence after CLA ranges between 25% and 50%,[8,10] increasing to 75% with adjunctive medical management.[8] Incontinence in these dogs likely is related to the presence of concurrent congenital urogenital abnormalities, but no study has identified any specific factors that are associated with ongoing incontinence in dogs.

Our purpose was to retrospectively describe the outcomes of dogs undergoing CLA for correction of EU and identify factors associated with continence after CLA.

2 | MATERIALS AND METHODS

2.1 | Case selection

Medical records of all female dogs that underwent CLA of unilateral or bilateral EU at the University of Montreal - Centre Hospitalier Universitaire Vétérinaire from July 2009 to January 2019 had their medical records reviewed and were enrolled in the study.

2.2 | Inclusion criteria

All patients presented for investigation of urinary incontinence and underwent CLA of unilateral or bilateral EU.

2.3 | Medical records review

Information regarding patient signalment (breed, sex, age, and reproductive status), previous medical history (clinical signs, previous medical treatments), and clinicopathological results (CBC, serum biochemical profile, urinalysis, urine culture) were recorded. Before cystoscopy, all dogs underwent physical examination performed by 1 of the authors (M. Dunn or C. Vachon) and a complete abdominal or urinary tract ultrasound examination (US). Equipment used for the CLA procedure, procedure length, complications (intra- and postoperative), postoperative medical management, and short-term follow-up (<1 week, 1 week to 1 month, >1 month) were collected.

2.4 | CLA procedure

Each patient was placed under general anesthesia. The diagnosis of EU was confirmed by 1 of the authors (M. Dunn or C. Vachon) by means of cystoscopy and fluoroscopic (GE OEC 9800, C-arm fluoroscope, GE Healthcare, Marlborough, Massachusetts) retrograde ureteropyelography with concurrent cystourethrography, completed with the patient in dorsal recumbency (ventrodorsal [VD] projection). When the VD projection was insufficient to determine the anatomic pathway of the EU, lateral, oblique, or both fluoroscopic projections also were obtained. After confirmation of intramural EU, CLA was performed during the same anesthetic event. The patient was placed in dorsal recumbency. The vulva and caudal abdomen were clipped and aseptically prepared. Perioperative prophylactic antibiotic treatment (ampicillin 22 mg/kg IV every 90 minutes; Sterile Ampicillin Sodium Injection, Teva Canada Ltd) was given. An integrated rigid cystoscope (cysto-urethroscope 10.5 or 14 Fr, 30°; Richard Wolf Medical Instruments, Vernon Hills, Illinois) was used to perform transurethral cystoscopy. Throughout the procedure, irrigation was provided using sterile saline (0.9% NaCl; Sodium Chloride Injection USP, Baxter Corporation, Canada). Morphology of the EU (unilateral, bilateral, location of ureteral orifice, fenestrations, dimensions, length) as well as the presence of a pelvic bladder were documented based on findings of cystoscopy and fluoroscopy (Figure 1). Vaginoscopy and examination of the clitoral fossa also were performed, and abnormalities were recorded (septa, stenosis, or paramesonephric remnants). Diagnostic cystoscopy, contrast retrograde ureteropyelography with concurrent cystourethrography, and CLA of intramural EU were performed as previously described.[8,10] The medial aspect of the ureteral wall of the intramural EU was lasered (diode laser; Diode Vet-25, B&W Tek, Inc, Newark, Delaware or Hol:YAG laser; Odyssey holmium laser, Convergent, Inc, Alameda, California) until the ureteral orifice was visualized cystoscopically in the bladder trigone and confirmed by retrograde ureteropyelography with concurrent cystourethrography. These final contrast studies also confirmed that there was no extravasation of contrast. Urethral length was determined at the completion of the procedure using a combination of fluoroscopy and cystoscopy, and a short urethra (and therefore an intrapelvic bladder location) was defined as a urethral length (in centimeters) < 10% of the ideal body weight in kilograms or if the dog had an intrapelvic bladder location with complete distension with contrast material on fluoroscopic examination.

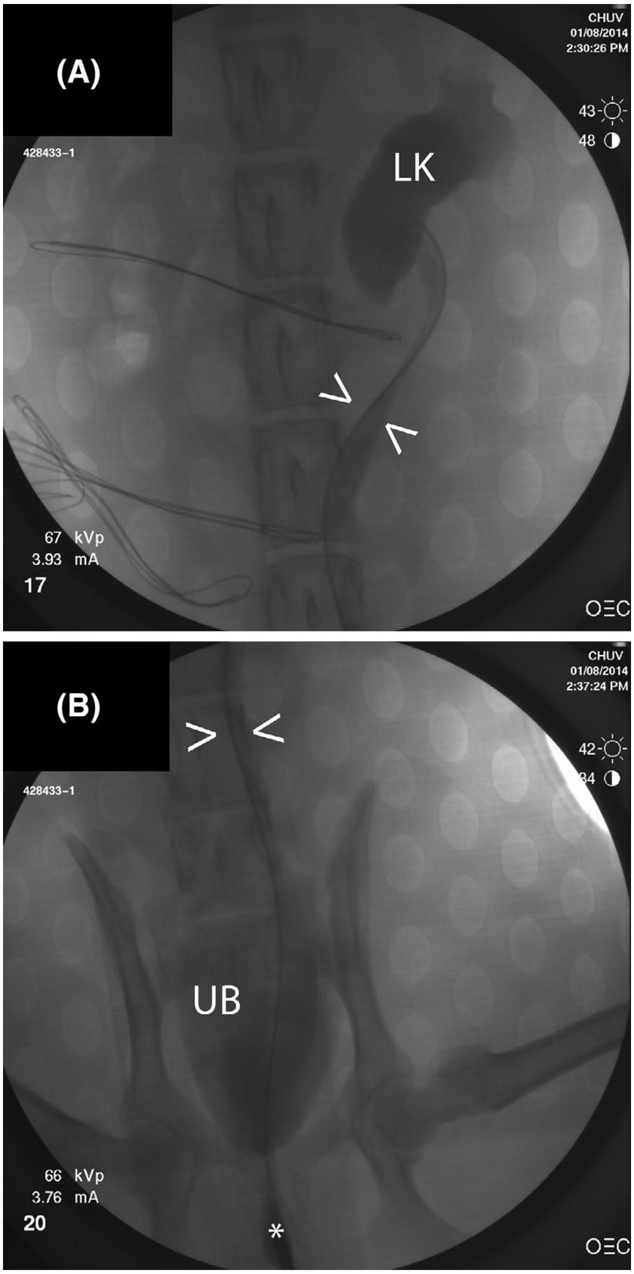

FIGURE 1 Ventrodorsal fluoroscopic images of the cranial (A) and caudal (B) abdomen used to define the anatomy of the EU. To visualize and catheterize the left ureterovesical junction and ureter, the cystoscope (*) is in the urethra instead of the urinary bladder (UB). A hydrophilic guidewire traverses the urethra, left ureterovesical junction, and left ureter (between > and <) before entering the dilated pelvis of the left kidney (LK). EU, ectopic ureter

Finally, dogs with vaginal abnormalities, such as a paramesonephric remnant or vaginal septum, also underwent laser ablation of these structures.

Upon recovery from anesthesia, if the renal function was assessed to be normal and clinically relevant hypotension had not occurred during anesthesia, meloxicam (0.1 mg/kg SC; Metacam, Boehringer Ingelheim, Canada) was administered. Dogs were discharged the day of or the day after the procedure once urination was observed.

2.5 | Postsurgical management

Patients were discharged from the hospital with a prescription of meloxicam (0.1 mg/kg PO q24h for 2-3 days; Metacam, Boehringer Ingelheim). Routine postprocedural antibiotic treatment (amoxicillin-clavulanic acid 15 mg/kg PO q12h; Clavamox, Zoetis, Canada or Clavaseptin, Vetoquinol, Canada) was given for 3 days unless otherwise indicated, according to urine culture results.

2.6 | Follow-up

For every dog in the study, information regarding continence and medical treatments initiated after the CLA procedure were documented. Owners were contacted by phone at the time of data collection for the study and were asked to fill out a client survey regarding continence at specific time points (<1 week, 1 week to 1 month, and >1 month) after the procedure and treatments (phenylpropanolamine, diethylstilbestrol, or both) given to improve continence. Information from this questionnaire was correlated with medical records when available. Urinary incontinence was scored using a semiquantitative scale (Table 1). Based on follow-up results, the highest continence score after the procedure was recorded for each dog both with and without concurrent medical management for ongoing incontinence.

TABLE 1 Urinary continence scale

Score	Incontinence description	Normal micturition
1	Constant urinary leaking when laying down or during exercise	Impossible
2	Intermittent urinary leaking that forms a puddle while laying down	Possible
3	Intermittent urinary leaking during exercise only (while walking, running, or playing)	Possible
4	Intermittent urinary leaking (only drops of urine) while laying down only	Possible
5	Absence of urinary leaking	Present

2.7 | Statistics

For statistical analyses, the commercial software Prism 8 (Graphpad Software, San Diego, California) was used. Data distributions were evaluated for normality using a Shapiro-Wilk test. Descriptive statistics were used to summarize findings and documented as mean (±SD) for normally distributed data and median (range) for non-normally distributed data. The Wilcoxon sign rank test was used to compare continence scores before the procedure, after the procedure and after the procedure with initiation of medical management for incontinence if required. Multiple logistic regression was used to investigate the association between final continence score and different clinically relevant variables. For this statistical evaluation, dogs were considered to be continent if they had a continence score ≥ 4, and incontinent if the continence score was ≤3. Variables analyzed included age at presentation, initial continence score, neuter status, urinary tract infection before the procedure, procedural findings (number of EU, presence of ureteral stenosis or fenestrations, location of termination of the EU, laser used for CLA, presence of vaginal abnormalities, and presence of other urogenital anatomic abnormalities). $P < .05$ was considered significant.

3 | RESULTS

3.1 | Study population

Between July 2009 and September 2019, records for 31 dogs that underwent CLA were reviewed. At initial evaluation, median age was 8 months (range, 1.75-42 months) with median age when incontinence was first reported being 2 months (range, 0-6 months). There were 22 intact females (71.0%) and 9 spayed females (29.0%). The median weight was 14.1 kg (range, 4-43 kg) and the population consisted of 4 Labrador Retrievers, 3 each of German Shepherds, Golden Retrievers and mixed breed dogs, 2 each of Australian Shepherds and French Bulldogs and 1 each of American Cocker Spaniel, Beagle, Bernese Mountain Dog, Chihuahua, Dachshund, English Shepherd, French Shepherd, Miniature Pinscher, Miniature Schnauzer, Rottweiler, Siberian Husky, Standard Poodle, Standard Schnauzer, and Wheaten Terrier. No significant associations were found between age at presentation, neuter status, and final continence score (Table 2).

3.2 | Clinical signs and physical examination findings

Before the procedure, 27/31 (87.1%) dogs were incontinent (continence score ≤ 3). The remaining 4/31 (12.9%) dogs had a continence score of 4. Based on the urinary continence scale, median continence score was 2 (range, 2-4). Other reported clinical signs included pollakiuria (4/31; 12.9%), pigmenturia (2/31; 6.5%), stranguria (1/31; 3.2%), and polyuria and polydipsia (2/31; 6.5%).

On physical examination, urogenital tract abnormalities detected included hypoplastic vulva (14/31; 45.2%), perineal dermatitis (7/31; 22.6%), and wide urethra on rectal palpation (1/31; 3.2%).

3.3 | Preprocedural medications

Most of the dogs (19/31; 61.3%) had received medications to treat incontinence or other reported lower urinary tract signs before initial presentation. Medications included antibiotics (19/31; 61.3%), phenylpropanolamine (13/31; 41.9%), hormone (estrogen) supplementation (2/31; 6.5%), and cranberry supplementation (1/31; 3.2%). Approximately half of the dogs (17/31; 54.8%) were receiving antibiotics at the time of presentation. Antibiotics included amoxicillin (2/17; 11.8%), amoxicillin-clavulanic acid (10/17; 58.8%), enrofloxacin (2/17; 11.8%), marbofloxacin (1/17; 5.9%), trimethoprim-sulfonamide (1/17; 5.9%), and doxycycline (1/17; 5.9%). No dogs had reported resolution of incontinence with any of these medications.

3.4 | Clinicopathologic and laboratory data

Preoperative clinicopathologic and laboratory data consisted of renal biochemistry profile (blood urea nitrogen, creatinine, and phosphorus concentrations) in 22/31 (71.0%) dogs, serum creatinine concentration only in 3/31 (9.7%) dogs, and qualitative measurement of blood urea nitrogen concentration in 2/31 (6.5%) dogs. Preoperative blood clinicopathologic data were not available for 4/31 (12.9%) dogs. For dogs with available blood clinicopathologic and laboratory data, blood urea nitrogen, creatinine, and phosphorus concentrations were within the reference range for all dogs.

Preoperatively, both urinalysis and urine culture were performed in 18/31 (58.1%) dogs. Urinalysis only was performed in 8/31 (25.8%) dogs, urine culture only was performed in 3/31 (9.7%) dogs, and the remainder (2/31; 6.5%) had no data regarding preoperative urine screening recorded.

Median urine specific gravity was 1.040 (range, 1.003-1.058). Urinalysis identified bacteriuria, pyuria, or hematuria in 16/26 (61.5%) dogs. Of these dogs, preoperative urine culture was performed in 13/16 (81.2%) and was positive in 8/13 (61.5%) dogs.

Where preoperative urine culture information was available (21/31; 67.7%), 9/21 (42.9%) dogs had a positive urine culture. Bacteria cultured included *Escherichia coli* (6), *Enterobacter cloacae* (1), and *Proteus mirabilis* (1). Bacteria cultured was not identified in 1 dog. All dogs with positive

TABLE 2 Association between final continence score multiple variables in 27 dogs with EU that underwent CLA

	Continent (n = 21)	Incontinent (n = 10)	*P* value
Age at presentation (mo), median (range)	8 (2-36)	8 (2.5-42)	.53
Initial continence score, median (range)	2 (2-4)	2 (2-4)	.52
Spayed at the time of CLA-EU	6/21	3/10	.94
Body weight (kg), median (range)	14.45 (4.2-35)	17.3 (4-43)	.31
Urinary tract infection before procedure	5/21	3/10	.91
Bilateral ectopic ureters	5/21	4/10	.68
Distal ureteral orifice abnormality (stenosis or fenestrations)	3/21	3/10	.97
Distal termination (distal half of urethra or termination in vestibule) of EU	11/21	5/10	.94
Use of diode laser for CLA	12/21	4/10	.24
Presence of vaginal abnormality	19/21	9/10	.61
Cystoscopic evidence of cystitis	3/21	2/10	.62
Short urethra and intrapelvic bladder location	9/21	7/10	.22
Urachal remnant visualized on cystoscopy	3/21	1/10	.82

Abbreviations: CLA, cytoscopic-guided laser ablation; EU, ectopic ureter.

perioperative urine culture were receiving antibiotics selected based on culture and sensitivity results at the time of presentation. These antibiotics were continued until the time of the procedure. No significant association was found between presence of urinary tract infection before the procedure and final continence score (Table 2).

3.5 | Imaging

Before CLA, US examination of the urogenital tract was performed in 31/31 (100%) dogs. Findings from imaging examinations performed included decreased corticomedullary definition (10/31; 32.2%), renal pelvic dilatation (15/31; 48.4%), echogenic material within the renal pelvis (1/31; 3.2%), intraluminal ureteral dilatation (22/31; 71.0%), focal dilatation of the distal ureter characteristic of a ureterocele (1/31; 3.2%), and tortuous pathway of the ureter or continuation of the ureter beyond the bladder trigone (22/31; 71.0%). Visualization of the ureteral papillae or ureteral jets was possible in 7/31 (22.6%) dogs, and location of the ureteral papillae or ureteral jets was appreciated in the urethra in 5/7 (71.4%) of these dogs. Intrapelvic bladder was appreciated in 4/31 (12.9%) dogs. For 3 of these dogs, tortuous pathway of the ureter or continuation of the ureter beyond the bladder trigone was still appreciable. In the remaining 1 dog, the pathway of the ureter could not be defined as a result of intrapelvic bladder location.

3.6 | Procedure

Retrograde cystoscopy and contrast ureteropyelography with concurrent cystourethrography could be performed in all dogs. These 2 diagnostic procedures identified EU in all dogs. Unilateral EU was present in 22/31 (71.0%) and bilateral EU in 9/31 (29.0%) dogs, identifying 40 EU in 31 dogs. Of these 40 EU, 38/40 (95.0%) were intramural, 1/40 (2.5%) was extramural, and 1/40 (2.5%) had both intramural and extramural conformation. The intramural component of this dog's EU terminated in the distal urethra, but the ureter appeared to course extramurally at the level of the proximal urethra. The termination of the EU was observed in the urethra (35/40; 87.5%) and vestibule (5/40; 12.5%). Overall, 16/31 (51.6%) dogs had at least 1 EU terminating in the distal half of the urethra or vestibule. Aside from abnormal location of ureteral termination, other ureterovesical junction abnormalities observed included ureteral fenestrations (3/40; 7.5%), ureterocele with ureterovesical junction stenosis (1/40; 2.5%), and ureterovesical junction stenosis (2/40; 5%). Based on contrast cystourethrogram studies performed, 16/31 (51.6%) dogs had an intrapelvic bladder location.

Concurrent vestibulovaginal abnormalities were observed in 28/31 (90.3%) dogs; specifically, paramesonephric remnant (<1 cm length; 24/28; 85.7%), vaginal septum (>1 cm length; 2/28; 7.1%), dual vagina (complete septum to the level of the cervix; 1/28; 3.6%), and vaginal stricture (1/28; 3.6%). Other cystoscopic abnormalities identified included changes consistent with cystitis (lymphoid follicles, thickening of the bladder mucosa; 5/31; 15.6%), intrapelvic bladder location (5/31; 15.6%), and urachal remnant (4/31; 12.5%).

All intramural EU (38/38) underwent CLA. Diode laser was used to perform this procedure in 16/31 (51.6%) dogs and holmium:YAG laser was used in 15/31 (48.4%) dogs. The dog with the extramural EU had bilateral EU (1 intramural, 1 extramural). The extramural EU terminated in the vestibule. The intramural EU was treated by CLA but the owner did not want to pursue surgery for the extramural EU. The dog with EU with both intramural and extramural

EU conformation had the intramural component treated by CLA. The owner did not want to pursue surgery to treat the remaining extramural component of the EU. Paramesonephric remnants and vaginal septa also underwent CLA. Median anesthesia time was 165 minutes (range, 98-394 minutes), and median procedure time was 113 minutes (range, 57-280 minutes). All dogs were discharged within 24 hours of the CLA procedure.

3.7 | Complications

Periprocedural complications were recorded in 3/31 (9.7%) patients, including inability to completely resolve EU because of the presence of an extramural EU or extramural portion of an EU (2/31; 6.5%) and trauma to the bladder mucosa secondary to cystoscopy (1/31; 3.2%).

Postprocedural (>1 day after CLA) complications were recorded in 10/31 (32.2%) patients and included pollakiuria (5/31; 16.1%), pigmenturia (3/31; 9.7%), excessive vulvar licking (1/31; 3.2%), and urinary tract infection (1/31; 3.2%). Complications were recorded between 1 day and 1 week postprocedure for 8/32 (25%) dogs, between 1 week and 1 month for 1 dog, and at >1 month for 1 dog. The same dog had a complication (pollakiuria, urinary tract infection) recorded at the 1 week to 1 month and >1 month time periods.

3.8 | Outcome

Continence score could be determined for all dogs after CLA. Median continence score after the procedure was 3 (range, 1-5). Fourteen of 31 (45.2%) dogs had a continence score ≥ 4.

Of the 17 dogs that remained incontinent after CLA, dogs were started on either phenylpropanolamine (10/17; 58.8%) or diethylstilbestrol (1/17; 5.9%) or both medications (6/17; 35.3%) to manage incontinence. Outcome after commencement of medications was recorded for all (17/17) of these dogs. Median final continence score for these dogs was 4 (range, 1-5). The dog with EU with both intramural and extramural conformation failed medical management for ongoing incontinence. This dog had transurethral submucosal collagen injections performed. Incontinence in this dog recurred 1 month after transurethral submucosal collagen injections.

Overall, median continence score (2; range, 2-4) recorded before the procedure was significantly different from median continence score recorded after the procedure (3; range, 1-5; $P < .0001$). After determination of continence score of dogs after receiving medical management postprocedure, median final continence score of all dogs (both with and without medical management after CLA) was significantly different (5; range, 1-5; $P < .0001$) compared to median preprocedure continence score. Based on final continence score, 21/31 (67.7%) dogs were considered continent (continence score ≥ 4), whereas 10/31 (32.3%) of dogs remained incontinent (continence score ≤ 3).

Procedural factors such as number of EU, location of termination of the EU, presence of distally terminating EU (in distal half of urethra or vestibule), laser used for CLA, presence of concurrent vestibulovaginal abnormalities, or other urogenital structural abnormalities were not found to be significantly associated with procedural outcome (Table 2).

4 | DISCUSSION

Our findings are in agreement with previous prospective and retrospective studies evaluating CLA for the treatment of intramural EU.[8,10] Cystoscopic guided laser ablation of intramural EU provides substantial improvement in continence. Further improvement in continence may be gained with medical management after CLA in dogs with EU.

In our study, the rate of continence after CLA alone and after CLA with adjunctive medical management was similar to previous reports describing surgical and endoscopic techniques to treat EU.[6,8,10] Ectopic ureters often occur in conjunction with other congenital urogenital abnormalities and other structural or urodynamic abnormalities could be contributing to incontinence in these patients. Preoperative and postoperative urodynamic studies, performed on a small number of dogs with EU undergoing surgical management, have documented decreased bladder capacity, bladder instability, and low urethral pressure profile.[6,24] No follow-up cystoscopy was performed in any patients in our study to investigate persistence of structural abnormalities. Urodynamic studies may have been helpful to further characterize the etiology of ongoing incontinence and tailor medications accordingly.[6,8,24]

Characteristics of the patient population were similar to previous reports describing the diagnosis and treatment of EU.[6,8,10] Female dogs were over-represented, and all dogs had incontinence reported at <6 months of age. Pigmenturia, stranguria, and pollakiuria were reported in a small group of dogs. Two of the 3 dogs with pollakiuria had positive urine culture. The remaining dogs with positive urine culture or cytologic evidence of urinary tract infection on urinalysis did not display any overt signs of lower urinary tract infection. Urine specific gravity was <1.008 in 2 dogs in our study, most likely as a consequence from polyuria or polydipsia. Incontinence and polyuria or polydipsia in dogs with EU may overshadow lower urinary tract signs of urinary tract infection.

In most dogs, US examination identified secondary changes in the kidneys and ureters, specifically intraluminal dilatation of the ureters and distal continuation of the ureter beyond the bladder trigone suggestive of the presence of EU. Although all dogs had EU confirmed cystoscopically, a proportion of dogs (7/31) had normal US findings. This observation is in disagreement with a previous investigation, in which all dogs with confirmed EU at surgery or necropsy (14/14) had ultrasonographic evidence of EU.[14] Based on our data, normal ultrasonographic examination cannot be used to exclude the presence of EU. In our dogs, intrapelvic bladder location did not appear to influence the ability to identify urogenital abnormalities suggestive of the presence of EU. Considering that US is commonly available, noninvasive does not require general anesthesia and does not require ionizing radiation, larger prospective investigations should be completed to evaluate the sensitivity and specificity of US for detection of EU in both male and female dogs.

In agreement with other previous studies, cystoscopy and retrograde urethrocystography were found to be effective for diagnosis and characterization of the anatomic conformation of the EU.[15] Vestibulovaginal abnormalities were detected in 90% of dogs in this group consistent with data presented previously[8] where 93% of dogs had vestibulovaginal abnormalities. Because of our study design, the overall sensitivity and specificity of cystoscopy and retrograde cystourethrography in diagnosis of EU cannot be determined.

A similar proportion of dogs compared to a previous investigation was found to have an intrapelvic bladder location.[8] Contrary to the findings of the previous study, where 3/14 dogs with intrapelvic bladder and EU were continent after CLA, in our population presence of intrapelvic bladder did not substantially affect the outcome of continence after the procedure nor did it affect requirement for, or response to, adjunctive medical management for incontinence after the procedure.[8] It has been previously found that intermittently intrapelvic prepubertal bladders in normal continent beagles eventually became intra-abdominal in all dogs.[25] No such information is available for dogs with EU. Prospective postoperative morphometric and urodynamic evaluation over time (juvenile and adult measurements) in these dogs would help to determine if intrapelvic bladder conformation is associated with functional changes in the urethra or bladder that clinically are associated with incontinence.

The major perioperative complication was inability to correct EU because of the presence of both intramural and extramural components. This conformation of EU has not been reported previously in the veterinary literature. Tortuous path of the EU and superimposition of urogenital structures may have resulted in difficulties in interpretation of contrast retrograde ureteropyelography with concurrent cystourethrography. In this dog, persistent incontinence was noted after CLA but continence score was improved (3) compared to initial continence score (2). Additional postoperative imaging, such as CT or alternatively repeat cystoscopy with retrograde ureteropyelography with concurrent cystourethrography was not available in this patient to confirm the presence of remnant extramural EU after laser ablation of the intramural component.

Contrary to 2 retrospective studies evaluating CLA where no immediate complications were recorded,[8,10] a small number of dogs in our study had mild postoperative complications (pollakiuria, hematuria), mostly reported in the short-term period after CLA that resolved without the requirement for additional treatment. Urinary tract infection was recorded in only 1 dog after the procedure, but it was not routine to screen dogs for urinary tract infection during postprocedural follow-up, therefore this likely represents an underestimation of the number of dogs with bacterial cystitis or subclinical bacteriuria after CLA. A previous study found a reduction in the incidence of bacterial cystitis and bacteriuria after CLA for EU, but in this population 30% of dogs had ≥1 positive urine culture during the follow-up period.

Limitations of our study are largely related to its retrospective design and small study population. Recall bias arose from the owner outcome questionnaire being administered almost 10 years after CLA for some dogs. Preprocedural clinicopathologic testing occurred at the discretion of the attending clinician managing the case and recording of procedural factors including cystoscopic examination findings was not standardized among patients. These factors resulted in incomplete records for some dogs. A prospective study would eliminate these limitations.

In conclusion, in this population of dogs, outcome after CLA for treatment of intramural EU was good to excellent in almost half of the dogs and comparable to previously reported results for dogs undergoing either endoscopic or surgical management. Outcome was further improved in a proportion of dogs with addition of adjunctive medical management. No preoperative or perioperative factors were found to affect final continence outcome in this population of dogs.

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CONFLICT OF INTEREST DECLARATION

Authors declare no conflict of interest.

OFF-LABEL ANTIMICROBIAL DECLARATION

Authors declare no off-label use of antimicrobials.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) OR OTHER APPROVAL DECLARATION

Authors declare no IACUC or other approval was needed.

HUMAN ETHICS APPROVAL DECLARATION

Authors declare human ethics approval was not needed for this study.

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