JAVMA

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Cystoscopic-guided scissor transection of intramural ectopic ureters as a novel alternate minimally invasive treatment option to laser ablation in female dogs: 8 cases (2011–2020)

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https://doi.org/10.2460/javma.21.03.0153

OBJECTIVE
To evaluate the safety and efficacy of cystoscopic-guided scissor transection of ectopic ureters (CST-EU) in female dogs.

ANIMALS
8 incontinent female dogs with intramural ectopic ureters.

PROCEDURES
For this retrospective case series, data were collected from medical records of dogs that underwent CST-EU to relocate the ectopic ureteral orifice to an anatomically normal trigonal location between June 2011 and December 2020. Outcome after hospital discharge was determined using owner telephone questionnaires.

RESULTS
Ectopic ureters were bilateral in 4 of the 8 dogs, and all dogs had other urogenital tract anomalies. Owner questionnaire follow-up was available for 7 dogs, and results indicated 6 dogs had improved urinary continence immediately following the procedure. At the last follow-up (44 to 3,384 days after CST-EU), 3 of the 7 dogs were completely continent with CST-EU alone, 3 others became continent or were markedly improved with the addition of medications for urethral sphincter mechanism incompetence, and 1 required ureteroneocystostomy, colposuspension, and an artificial urethral sphincter to become fully continent. Owners of 5 of the 7 dogs reported that they considered the outcome of CST-EU as good to excellent, and all owners reported that they would consider having CST-EU performed again should they have another incontinent dog. Complications were minor, and only 3 dogs showed transient lower urinary tract signs after CST-EU.

CONCLUSIONS AND CLINICAL RELEVANCE
Results indicated CST-EU could provide a safe, effective, minimally invasive alternative in the absence of laser technology for the treatment of intramural ectopic ureters in female dogs.

Ectopic ureters are a congenital abnormality of the urinary tract in which 1 or both ureters open distal to their normal location in the bladder trigone.[1,2] Ureteral ectopia is the leading cause of urinary incontinence in juvenile dogs, accounting for 52% (115/221) of cases in 1 study.[3]

Ectopic ureters arise when there is dysembryogenesis of the metanephric and mesonephric ducts, resulting in inappropriate termination of the affected ureter in the urogenital tract.[1] Intramural and extramural phenotypes occur, with intramural morphology accounting for up to 99% (174/175)[4] of canine cases.[5–9] Intramural ectopic ureters enter the dorsolateral serosal surface of the bladder in a normal trigonal location and then course distally below the submucosal layer to open through the mucosa in an ectopic position.[10]

Surgical treatment of intramural ectopic ureters has been the historical standard. Long-term continence rates are not excellent, with 37% (13/35)[11] to 67% (6/9)[12] of affected animals reported to maintain continence with surgery alone. Surgical complication rates have been reported at up to 44% (4/9)[12] for minor complications (self-limiting or medically managed) and 6% (2/35)[11] for major complications (requiring surgical revision or euthanasia). Cystoscopic-guided laser ablation has recently been described as a minimally invasive treatment for intramural ectopic

ureters and is currently considered the treatment of choice.[2] Long-term continence rates in females are reported at 31% (4/13)[13] to 47% (14/30),[14] increasing to 69% (9/13)[13] to 77% (23/30)[14] with the addition of medications for urethral sphincter mechanism incompetence. The benefits of cystoscopic-guided laser ablation over open abdominal surgery include minimal risk of complications, the ability to perform diagnosis and treatment during the same anesthetic period and using the same equipment, outpatient treatment or short hospitalization times, and reduced cost to owners. Only 3 dogs have had reported complications: 1 developed lymphoplasmacytic polypoid cystitis along the laser tract that resolved within 8 weeks, a different dog developed hydronephrosis, and a different dog developed encrusted cystitis due to *Corynebacterium urealyticum*.[13–15]

Cystoscopic-guided laser ablation of ectopic ureters requires the availability of costly equipment, technical expertise, facilities to ensure the safe operation of the laser device, and compliance with government occupational health and safety regulations. In some parts of the world without regional or country-wide access to laser equipment or expertise, treatment options for dogs with intramural ureteral ectopia are limited to open abdominal surgery. Endoscopic scissors are a readily available, comparatively low-cost tool that can be used with standard cystoscopic equipment to allow minimally invasive transection of the tissue separating the ectopic ureter from the urethra and bladder in a manner similar to laser ablation.

The purpose of the study reported here was to determine the outcome of cystoscopic-guided scissor transection of ectopic ureters (CST-EU) in female dogs with intramural ectopia. We hypothesized that this technique would be effective and have low complication rates and therefore could provide a minimally invasive treatment alternative in instances where cystoscopic-guided laser ablation of ectopic ureters is not available.

Materials and Methods

Case selection

Female dogs with intramural ureteral ectopia that underwent cystoscopic-guided scissor transection of the tissue separating the ectopic ureter from the urethra and bladder (the medial aspect of the ectopic ureteral wall) were included in the study. The dogs were treated at either Veterinary Specialist Services (private specialist hospital) or the University of Queensland Small Animal Hospital (university teaching hospital) in southeast Queensland, Australia between June 2011 and December 2020.

Medical records review

Medical records were obtained from the relevant treating hospital and the primary care veterinarian for each case. Data retrieved included signalment, body weight, urinary incontinence history, physical examination findings, preoperative laboratory results (serum biochemical analyses, urinalysis, urine bacterial culture, and susceptibility testing), imaging study reports, diagnostic cystoscopic findings, and details of the CST-EU procedure.

Cystoscopic-guided transection

Dogs undergoing CST-EU had an intramural conformation confirmed by a radiologist on the basis of findings from CT, by a board-certified specialist performing a cystocopic evaluation, or both. At the university teaching hospital, the procedures were performed by a specialist internist (ENM), and at the private referral hospital, they were performed by a specialist in either internal medicine (ALT) or surgery (PJD).

Individualized anesthetic protocols based on preoperative case assessment were used for the procedure. Anesthetized dogs were positioned in either dorsal or ventral recumbency according to clinician preference and aseptically prepared for retrograde vaginourethrocystoscopy. The lower urinary tract was examined with a 2.7-mm-diameter, 18-cm-long, or 4-mm-diameter, 30-cm-long (in bigger dogs), rigid cystoscope (64019 BA or 63005 BA HOPKINS II Forward-Oblique Telescope 30 degree, Karl Storz SE & Co KG) with constant irrigation of saline (0.9% NaCl) solution through a 3-way, 14.5F or 25F (in bigger dogs) operating sheath (67065 C or 63026 A Sheath, Karl Storz SE & Co KG) that had a working length of 15 cm or 22 cm, and 2 stop cocks. The location and appearance of the ureteral orifices were determined, and the remainder of the urinary and reproductive tracts were examined for other abnormalities.

A 0.035-inch, angled, hydrophilic guidewire (Weasel Wire, Infiniti Medical) was advanced up the ectopic ureter through the working channel of the cystoscope to direct the cut throughout the procedure and protect the lateral ureteral wall from trauma in some cases. Cystoscopic-guided transection of the tissue separating the ectopic ureter from the urethra was performed with flexible, 4F, 34-cm-long endoscopic scissors (62501 EK, Karl Storz SE & Co. KG) with single-action jaws, inserted via the operating sheath. Under endoscopic visualization, the jaws of the scissors were opened and advanced until the distal portion of the tissue was between the jaws, which were then closed **(Figure 1)**. Once any transection-induced hemorrhage had cleared, the process was repeated, progressively advancing the ureteral orifice toward the bladder trigone region. The procedure was stopped once the ureteral orifice had been advanced into an anatomically normal location or if the ureteral path started to diverge, suggesting a change from intramural to extramural conformation. If it was not possible to reposition the ureterovesicular opening into the trigone, the final location of the orifice and reason for incomplete correction were noted. At the university, retrograde urethrocystography was performed with fluoroscopy at the end of the procedure to ensure the absence of any leak.

Peri- and postoperative analgesia and antimicrobials were administered on a case-by-case basis

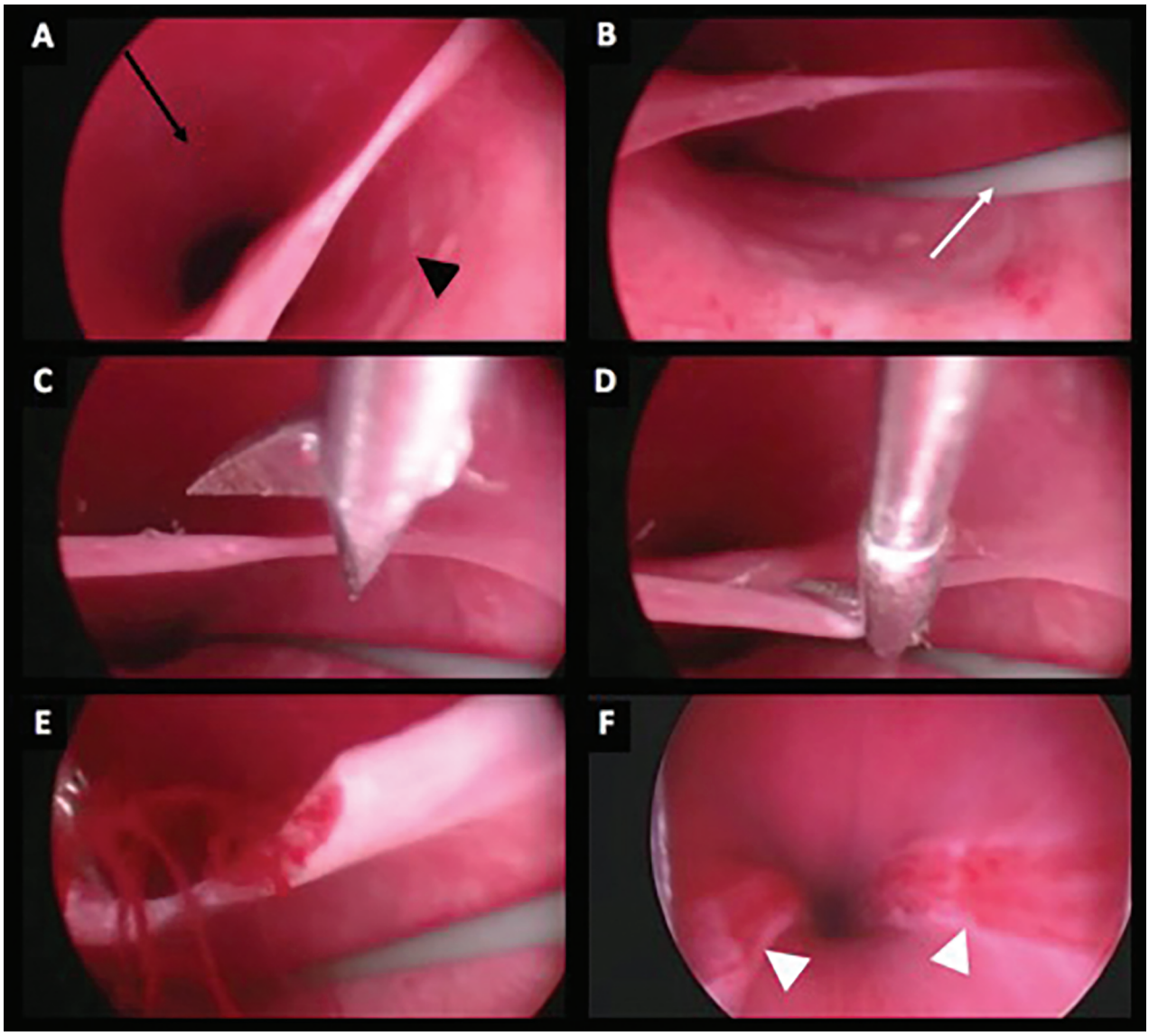

Figure 1—Representative cystoscopic images of the lower urinary tract of 1 of 8 female dogs during cystoscopic-guided scissor transection of ectopic ureters (CST-EU) between June 2011 and December 2020. This dog has a left-sided intramural ectopic ureter and is positioned in dorsal recumbency. A—The ectopic segment of the left ureter (black arrowhead) and urethra (black arrow) are shown. B—A sterile hydrophilic guidewire (white arrow) is inserted into the ectopic ureteral orifice. C—Endoscopic scissors inserted via the operating channel of the cystoscope are aligned to make an initial transection of the tissue separating the ectopic segment of the ureter from the urethra. D—An initial transection is made by closing the jaws of the scissors. E—Hemorrhage induced by the transection procedure is shown. After the hemorrhage has cleared allowing adequate visualization, the process shown in panels C and D is repeated until the ectopic ureteral orifice has been advanced into a normal anatomic location in the bladder trigone region. F—The ectopic segment of the left ureter and urethra after CST-EU are shown as in panel A, with the cut edges of the tissue that previously separated them evident (white arrowheads).

as determined by clinical assessment and results of urine testing.

Follow-up

Medical record data pertaining to ongoing urinary tract signs, urinary tract infections, and further surgical procedures after CST-EU were retrieved. Success of CST-EU was determined by the use of telephone interviews with owner after patients were discharged from hospital. All owners were contacted, and a standard questionnaire **(Supplementary Appendix S1)** was used based on that published by Delisser et al[16] modified to include the urinary continence scoring system reported by Berent et al.[14] Continence was scored using a scale of 1 to 10, where 1 is minimally continent or extremely incontinent (leaking urine all the time), 5 is moderately continent (only leaking urine when lying down or when the urinary bladder is full) but able to hold some urine between urinations, and 10 is perfectly

continent with no urine leakage at all.[14] Clients were asked to retrospectively score continence prior to CST-EU; immediately after hospital discharge; at 2 weeks, 2 months, and 6 months following CST-EU; and at the time of the questionnaire. Details of any complications (stranguria, dysuria, or hematuria), urinary tract infections, medications for urethral sphincter mechanism incompetence, or further surgical or endoscopic procedures were noted. Owners were asked to score the overall success of the procedure as excellent, good, moderate, minimal improvement, or poor.

Statistical analysis

Overall results were reported as median and range, and the numbers and percentages were reported for animals affected with variables of interest. Available software (Excel, Version 16.56, Microsoft Corp) was used for all calculations.

Results

Eight female dogs were included in the study. Median age at the time of CST-EU was 5 months (range, 3 to 41 months). There were 2 Labrador Retrievers and 1 each of Golden Retriever, Australian Kelpie, Australian Kelpie cross, Border Collie, Labrador Retriever cross, and Poodle cross. At the time of CST-EU, 3 dogs had already undergone ovariohysterectomy (performed prior to referral) and the remaining 5 were sexually intact. Median body weight at the time of the CST-EU was 18.5 kg (range, 7.6 to 27.5 kg).

Historical findings

All dogs were presented for urinary incontinence with the severity noted in medical records varying from urine leakage when resting or with excitement to constant dribbling of urine. Age at first episode of incontinence was known in 7 of the 8 dogs: 2 dogs had urine leakage noted by the breeder, and the remaining 5 dogs had signs since acquired between the ages of 8 and 10 weeks. Antimicrobials had been prescribed on at least 1 occasion prior to referral for 6 of the 8 dogs due to suspected urinary tract infections based on in-house urinalysis, suggestive clinical signs (worsened incontinence, pollakiuria, and foul-smelling urine), or both that improved with antimicrobials.

Clinicopathologic findings

Results of serum biochemical analyses were available for 6 of the 8 dogs **(Supplementary Table S1)** and showed mild abnormalities in 4 dogs. None of the abnormalities were considered clinically important and in many cases were likely related to the young age of the dogs. Concentrations of urea or BUN and creatinine were not above reference limits for any of the dogs for which biochemical analyses were performed. Preoperative urinalysis findings were available for the same 6 dogs that had biochemical analyses performed. Urine specific gravity ranged from 1.018 to > 1.050. All 6 dogs had urinalysis abnormalities, including hematuria (n = 4), proteinuria (3), pyuria (2), or bacteriuria (2), alone or in combination. Urinary tract infections were diagnosed in 4 dogs based on either urinalysis findings (n = 2) or urinalysis and bacterial culture results (2). Urine bacterial culture and susceptibility testing performed preoperatively for 5 dogs isolated *Staphylococcus pseudintermedius* from 1 dog and multidrug-resistant *Escherichia coli* from another dog. These 2 dogs had negative results for urine bacterial cultures confirmed while on antimicrobials prior to CST-EU.

Cystoscopy and imaging findings

Abdominal imaging was performed for all 8 dogs and consisted of abdominal ultrasonography (n = 6), IV contrast CT urography (3), and IV contrast radiographic urography (1), with 2 dogs having both abdominal ultrasonography and CT performed. Reports by board-certified radiologists were available for all CT urography studies (3 dogs) and 1 of the 6 dogs that had abdominal ultrasonographic examinations. The remaining 5 dogs had abdominal ultrasonographic examinations performed and reported by internal medicine specialists, residency-trained clinicians, or residents in training. Urogenital abnormalities were present in all studies except for 2 dogs that had unremarkable findings on abdominal ultrasonography. Ectopic ureters were suspected or confirmed in all but 1 dog based on imaging findings, with the final diagnosis made at cystoscopy in all dogs. During cystoscopy, a 0.035-inch, angled, hydrophilic guidewire (Weasel Wire, Infiniti Medical) was inserted under endoscopic guidance to confirm anatomic structure in 3 dogs. Ureteral ectopia was bilateral in 4 dogs and unilateral in 4 (3 left sided, 1 right sided). One dog had a unilateral ectopic ureter with 2 fenestrations in the midurethra and in the vestibule adjacent to the urethral orifice. The other dogs had ectopic ureters with single openings. Of these 13 ectopic openings, 2 were located in the bladder neck caudal to the normal trigone location, 3 were in the proximal third of the urethra, 3 were in the middle third of the urethra, 4 were in the distal third of the urethra, and 1 was in the vestibule adjacent to urethral orifice. All dogs had concurrent urogenital anomalies identified on imaging and cystoscopy, including hydroureter (n = 6 dogs), persistent paramesonephric remnant (4), hypoplastic bladder (2), short wide urethra (2), hydronephrosis with a small kidney and minimal parenchymal tissue (1), pyelectasia (1), dual vagina (1), a blind-ended tunnel in the distal urethra (1) or an os clitoris (1), alone or in combination. In all dogs with hydroureter, hydronephrosis, or pyelectasia, the abnormality was ipsilateral to the ectopic ureter.

Cystoscopic-guided transection

Six dogs were treated at the private referral hospital, and 2 dogs were treated at the university teaching hospital. Anesthesia was performed using individualized protocols. All dogs were premedicated with an opioid (methadone [0.15 mg/kg, or 0.3 mg/kg, IM or SC] or hydromorphone [0.1 mg/kg, IM]), with or without the addition of acepromazine

(0.01 to 0.02 mg/kg, IM or 0.02 mg/kg, SC) or medetomidine (5.5 to 6.1 µg/kg, IM). Anesthetic induction was performed with alfaxalone (0.6 to 3.5 mg/kg, IV) for 7 dogs or with propofol (4.4 mg/kg, IV) for the remaining dog. All dogs received isoflurane in oxygen for maintenance of anesthesia, with 1 dog also receiving constant rate infusion of alfaxalone (2.5 to 5.3 mg/kg/h, IV) to minimize reliance on volatile anesthesia as part of management of intraoperative hypotension.

Periprocedural antimicrobials were administered to 5 of the 8 dogs to treat urinary tract infections (n = 4) or as empirical treatment while awaiting results of urinalysis and urine bacterial culture (1). Antimicrobials consisted of amoxycillin–clavulanate (12.1 to 27.3 mg/kg, PO, q 12 h), cephalexin (18.4 mg/kg, PO, q 12 h), or cephazolin (22 mg/kg, IV, q 8 h) with treatment guided by results of bacterial culture and susceptibility testing where available. The dog that received empirical antimicrobial treatment while awaiting urine bacterial culture returned a negative result, at which point antimicrobials were discontinued. The other 4 dogs had antimicrobial treatments continued with amoxicillin–clavulanate (12.1 to 27.3 mg/kg, PO, q 12 h for 7 to 28 days) or cephalexin (26 mg/kg, PO, q 12 h for 7 days) after CST-EU.

General anesthesia and CST-EU duration was known for 6 and 5 of the 8 dogs, respectively. Median duration of anesthesia was 118 minutes (range, 65 to 320 minutes), and median duration of CST-EU was 105 minutes (range, 40 to 170 minutes). The durations tended to be shorter at the private hospital than the university teaching hospital. Complete transection of the medial wall of the ectopic ureter was achieved in 7 of the 8 dogs, resulting in an anatomically normal final ureteral orifice location. The remaining dog had bilateral ectopic ureters entering the distal urethra. Transection was attempted but terminated early bilaterally due to concern that the ectopic ureters were diverging into an extramural conformation and there was risk of uroabomen. A persistent paramesonephric septal remnant was transected at the time of CST-EU in 1 dog, and all other vestibulovaginal septal remnants were not treated (persistent paramesonephric septal remnants in 3 dogs and dual vagina in 1 dog).

Postprocedural analgesia plans were in place for all dogs, and analgesic medications were administered to 6 of the 8 dogs. Analgesia was given based on individual patient assessment and consisted of an opioid (fentanyl [2 to 6 µg/kg/h, IV, constant rate infusion; or 2.5 µg/kg, transdermal patch], methadone [0.29 mg/kg, SC], or tramadol [1.8 to 2.7 mg/kg, PO, q 8 to 12 h]), an NSAID (meloxicam [up to 0.1 mg/kg, PO, q 24 h), or both. Dogs recovered in the hospital and were discharged once observed to urinate normally. Median time to discharge was 1 day (range, 0 to 2 days).

Complications

Mild to moderate hemorrhage during the procedure was explicitly stated in the record for 4 of the 8 dogs but was likely to some degree in all dogs due to the nature of CST-EU. Intraoperative hemorrhage did not affect the ability to complete the procedure in any case, although it likely prolonged durations of CST-EU and anesthesia. After recovery, monitoring of the PCV and total protein concentration (TP) was performed for 1 dog that had moderate hemorrhage. Results 265 minutes after CST-EU (PCV, 38%; TP, 50 g/L) showed a mild reduction in these parameters, compared with preoperative results (PCV, 44%; TP, 61 g/L), but stabilized without further intervention (PCV, 48%; and TP, 54 g/L the following day). No other dog had a clinical indication for measurement of postoperative PCV and TP.

There was no evidence of lower urinary tract signs or pain after CST-EU in 6 of the 8 dogs. One dog had hematuria immediately following the procedure that resolved by discharge the following day, and the other dog had stranguria and hematuria in hospital for 24 hours that had resolved by the time of discharge 48 hours after CST-EU. The latter of these 2 dogs had a urinary catheter placed after CST-EU due to concern over urethral obstruction from urethral inflammation following the procedure in a small patient (7.6 kg). The urinary catheter remained in place less than 12 hours. No other dogs had urinary catheters placed after CST-EU.

Owner follow-up questionnaire

Owner questionnaires were available for 7 of the 8 dogs and were conducted during telephone interviews performed a median of 447 days (range, 44 to 3,384 days) following CST-EU. Owner-determined continence scores before and after CST-EU were compiled **(Supplementary Table S2)**. The dog with no available owner questionnaire follow-up had been euthanized by the referring veterinarian 3,021 days after CST-EU. Although complete medical records could not be obtained, through verbal communication it was determined that the dog had ongoing urinary incontinence. This dog was the one that had incomplete anatomic correction of its bilateral ectopic ureters during CST-EU. Owners of 6 of the 7 dogs with questionnaire follow-up available reported substantial improvement in their dogs' continence scores immediately after CST-EU, at which time no dogs were receiving medications for urethral sphincter mechanism incompetence. At final follow-up, 3 of the 7 dogs were reported as continent (score 10 on a scale of 1 to 10) with CST-EU alone, 3 other dogs were reported as largely continent (score 8 to 10) with the procedure and urethral sphincter mechanism incompetence medications, and the remaining dog was continent (score 10) after CST-EU and multiple additional procedures (ureteroneocystostomy, colposuspension, endoscopically injected urethral bulking agents and placement of an artificial urethral sphincter). Of the 3 dogs that had ovariohysterectomy performed prior to CST-EU, 1 was fully continent with the procedure alone and the other 2 were continent or near continent (score 9 to 10) with the addition of medications for urethral sphincter mechanism incompetence. An additional dog was spayed 213 days after CST-EU, shortly after being

started on phenylpropanolamine, which improved its continence from score 5 to score 8. The continence score remained unchanged (score 8) at final follow-up after 742 days. Two dogs with owner questionnaire follow-up available did not attain complete continence by the end of the study period, despite the addition of medications for urethral sphincter mechanism incompetence. One of these dogs had urine bacterial culture and repeat abdominal ultrasonography performed to exclude other causes of the ongoing incontinence. The other dog had these procedures and repeat cystoscopy recommended to the owner; however, despite multiple telephone calls to follow-up, the owner did not return the dog because the owner reported considering the outcome satisfactory.

Overall, for the 7 dogs with owner questionnaires available, owners reported that they considered the outcome of CST-EU excellent (n = 4), good (1), moderate (1), or poor (1). The dog with an owner-perceived poor outcome following CST-EU was the dog that underwent multiple procedures. Six of the 7 owners advised they would have the procedure performed again should they have another dog with ureteral ectopia, and the remaining owner (that considered their dog to have a poor outcome) advised they would still consider having the procedure performed again.

Minimal complications following CST-EU were reported by owners. Dysuria was not reported in any case. The owner of 1 dog reported mild hematuria for a week following the CST-EU. The dog that had multiple additional procedures performed after CST-EU had stranguria reported 9 years later. The stranguria was investigated with urine bacterial culture (negative), abdominal CT, cystoscopy, and biopsies, which identified chronic eosinophilic cystitis and urethritis. Signs resolved within a few days of treatment with firocoxib (6 mg/kg, PO, q 24 h).

Owners of 3 of the 7 dogs reported signs consistent with urinary tract infections at least once following the procedure, with the owners of the remaining 4 dogs reporting no urinary tract infections after CST-EU. Of the 3 dogs with suspected urinary tract infections after CST-EU, 1 had a single episode 2 months following the procedure with none subsequently (follow-up, 742 days); 1 had approximately 3 episodes/y, which the owner reported was improved, compared with prior to CST-EU (follow-up, 994 days); and the remaining dog (which had multiple additional procedures performed) had frequent ongoing urinary tract infections. All 3 dogs with recurrent urinary tract infections following CST-EU had persistent paramesonephric remnants, which were transected in 1 dog only at the time of CST-EU (the case with multiple additional procedures performed and frequent ongoing urinary tract infections).

Discussion

Results of the present study suggested that CST-EU of intramural ectopic ureters in female dogs was safe and provided an acceptable minimally invasive alternative to laser ablation, and we believe our findings would extend to institutions without suitable equipment or expertise for laser ablation. Low case numbers in the present study limited interpretation of continence rates; however, outcome in terms of continence scores and owner-perceived success was broadly similar to previous reports for cystoscopic-guided laser ablation of ectopic ureters.[13,14] In our study, 3 of the 7 dogs with owner questionnaire follow-up were reported to have been completely continent (score 10) following CST-EU alone and all dogs were continent or largely continent (score 8 to 10) with the addition of medications or further procedures. Five of the 7 owners reported that they considered the outcome of CST-EU good to excellent. Complications were few, and all were minor and self-limiting.

Patient population characteristics in the present study were similar to those in previous reports.[13,14] Urinary incontinence was the major presenting sign. All but 1 dog were presented as juveniles and had had urinary incontinence since very young. The remaining dog was presented at 3 years of age, having been acquired by a charity 2 years earlier, and having had urinary incontinence since that time. Although adult onset incontinence has been reported,[17] previous studies show that most female dogs present as juveniles.[4,13,14] Breeds previously reported[4,18] to be overrepresented had a strong presence in this case series, namely Labrador Retrievers, Golden Retrievers, and Poodles or their crosses, which accounted for 5 of the 8 dogs in the present study. Interestingly Australian Kelpie or Australian Kelpie cross dogs accounted for 2 of the 8 (25%) cases, whereas the breed presentation rate over the same time period (2011 to 2020) at the hospital that treated these cases (private referral hospital) was 0.5% (378/78,003). Three dogs in the present study had undergone ovariohysterectomy prior to referral and diagnosis of ectopic ureters, and another dog had ovariohysterectomy performed 213 days after its procedure at 1 year of age. Neuter status may theoretically contribute to urinary incontinence via acquired urethral sphincter mechanism incompetence. Given the young age of presentation of all dogs, it was unlikely that this would have had an impact on the degree of incontinence at presentation; however, it was possible that it may contribute to incontinence later in life. A recent study[19] looking at breed-related incidence of urinary incontinence shows only sporadic or low level urinary incontinence in spayed versus sexually intact female dogs in the breeds comprising this case series. The broader question of whether a dog with ureteral ectopia should be spayed is controversial[2] and beyond the scope of our study.

Urinary tract infections in dogs of the present study were common, being presumptively diagnosed and treated historically in 6 of the 8 dogs,

and confirmed on urinalysis, urine bacterial culture at the time of diagnosis of ectopic ureters, or both in 4 dogs. Urinary tract infections have previously been reported in 56% (9/16)[13] to 83% (25/30)[14] of cases with ureteral ectopia.[11,20] Urinary tract infections after CST-EU appeared to be improved in the current case series, with only 3 of 7 owners reporting signs consistent with a urinary tract infection after CST-EU, and of these 3, 2 had fewer episodes than prior to CST-EU. Routine postoperative monitoring of urinalysis and urine bacterial culture would need to be performed in a standardized manner to better determine the true rate of urinary tract infections before and after CST-EU.

Ectopic ureter morphology in the present study was split evenly between unilateral and bilateral presentations. Previous intramural ectopic ureter studies have variably shown unilateral or bilateral disease to be most common, with bilateral disease reported in 32% (55/174)[4] to 92% (22/24)[20] of cases.[11,13,14] Unilateral versus bilateral disease is not associated with severity of incontinence[20] nor does it appear to affect treatment outcome.[8,14] Three of the 4 dogs with unilateral ectopic ureters in the present study had the left side affected. Previous studies have reported left-sided unilateral ectopic ureters in 42% 5/12)[21] to 83% (10/12)[14] of cases.[4,8,9,12,22] Side affected has been shown not to affect the site of termination[4] nor outcome following surgical treatment.[8] In our study the ectopic ureteral terminations were evenly split between proximal (bladder neck distal to the normal trigone region or proximal urethra) and distal (distal urethra and vestibule adjacent to the urethral orifice) locations. A previous study[20] has shown distal ectopic ureteral terminations to be marginally more frequent than proximal terminations, and in 1 study,[14] 6 of 7 persistently incontinent dogs following cystoscopic-guided laser ablation of ectopic ureters had an ectopic ureter orifice in the distal urethra, suggesting that ectopic ureter orifice location may affect outcome. In our study, however, outcome did not appear related to ectopic ureter termination site.

Concurrent urogenital anomalies are commonly reported in ectopic ureter cases. In previous studies, 81% (13/16)[13] to 93% (28/30)[14] of dogs with ectopic ureters had concurrent anomalies. In our study, all dogs had ≥ 1 concurrent urogenital anomaly identified. This highlights the importance of imaging being performed concurrently with cystoscopic examination, as upper urinary tract anomalies would not be detected on cystoscopy alone. The importance of concurrent anomalies, their contribution to outcome, and whether they should be treated concurrently with ectopic ureters is unclear. In 2 previous case series[13,14] examining outcome with cystoscopic-guided laser ablation of ectopic ureters, any vestibulovaginal septal remnants present were treated concurrently. This differs from our study in which 5 of the 8 dogs had a vestibulovaginal septal remnant, only 1 of which was transected. Dogs treated surgically for intramural ectopic ureters are often neither diagnosed nor treated for concurrent vestibulovaginal septal remnants, and still have broadly similar outcomes to the cases for which these anomalies are corrected during cystoscopic-guided laser ablation.[11–14] Theoretical advantages to treatment of concurrent vestibulovaginal septal remnants include that they may contribute to urinary tract infections via urine pooling or urinary incontinence by applying dorsal traction on the urethral meatus holding it in a more open position. In a case series[23] of 36 dogs that had endoscopic-guided laser ablation of vestibulovaginal septal remnants, only 6 cases had vestibulovaginal septal remnants without concurrent ectopic ureters; however, all 6 of these treated dogs did have resolution of their signs (including urinary incontinence and recurrent urinary tract infections) suggesting that correction of these anomalies at the time of ectopic ureter treatment may be beneficial.

In the present study, 3 of the 7 dogs with owner follow-up had a final continence score of 10 with the procedure alone, and the other 4 dogs had continence scores of 8 to 10 with additional medical or surgical treatment. Five of 7 owners reported a good to excellent outcome for their dog. The dog without owner questionnaire follow-up (which had incomplete anatomic correction of its ectopic ureters) remained incontinent until it was euthanized 3,021 days after CST-EU. Previously reported continence rates for cystoscopic-guided laser ablation of ectopic ureters are 31% (4/13)[13] to 47% (14/30)[14] with the procedure alone, increasing to 69% (9/13)[13] to 77% (23/30)[14] with the addition of medications and further procedures. Intramural ectopic ureters treated surgically have had reported continence rates of 37% (13/35)[11] to 67% (6/9)[12] with surgery alone, increasing to 57% (20/35)[11] to 89% (8/9)[12] with the addition of medications or further procedures. Excellent owner-perceived success has been reported in 59% (19/32)[11] to 87% (26/30)[14] of cases for ectopic ureters treated with surgery and laser ablation techniques.[20] Although direct comparison of results between those studies and ours is difficult, especially given the small case numbers in our study, the outcome reported here is broadly similar to previous reports[13,14] suggesting that CST-EU is a suitable minimally invasive alternative to laser ablation.

The CST-EU procedure described here could be modified in future based on the current literature. Modifications that may be of benefit include the use of fluoroscopy, methods to control hemorrhage, and catheterization of the ectopic ureter. Fluoroscopy could be used to perform retrograde contrast urethrocystogram and ureteropyelography intraoperatively as reported with cystoscopic-guided laser ablation of ectopic ureters[14] to provide characterization of the ectopic ureteral conformation, assessment of the final ureteral orifice location and ensure no contrast leakage. The use of an open-ended ureteral catheter passed over a guidewire inserted into the ectopic ureter may further improve the safety of this technique by providing protection against inadvertent perforation of the lateral ectopic ureteral wall;[13,14] however, the risk of this complication is considered lower than with cystoscopic-guided laser ablation, as

scissor transection does not carry a risk of noncontact tissue damage. In CST-EU the jaws of the scissors are always under direct endoscopic visualization and can be directed medially when transecting the tissue separating the ectopic ureter from the urethra, avoiding the lateral ureteral free wall. Intraoperative hemorrhage is a key difference between CST-EU and cystoscopic-guided laser ablation, so methods to reduce this may improve the speed of the procedure and be useful in the rare event of substantial hemorrhage. Instillation of topical epinephrine may reduce hemorrhage and improve surgical site visualization[24] although evidence for this in the veterinary literature is lacking. A recent meta-analysis[25] of human patients with benign prostatic hyperplasia undergoing a variety of procedures that required bladder irrigation to prevent blood clot formation found that warmed irrigation fluids caused less perioperative hypothermia compared with use of room temperature fluids, and perioperative blood loss was not different between the groups. We therefore recommend the use of irrigation fluids warmed to body temperature during CST-EU in veterinary patients, where postoperative hypothermia can be a major concern. Irrigation flow rates can be reduced or stopped while waiting for any post-transection hemorrhage to clear to reduce the risk of bladder overdistension, and if visualization is clouded by hemorrhagic urine and fluid after hemorrhage has ceased, then the bladder can be emptied then saline irrigation restarted as per standard cystoscopic technique[26] to improve visualization.

Few complications were reported for dogs of the present study, aside from mild to moderate intraoperative hemorrhage, of which all instances were mild and self-limiting. No major or long-term complications were noted. This is similar to previous reports[13,14] in which complications with cystoscopic-guided laser ablation were all minor and easily managed. This makes minimally invasive techniques quite appealing compared with open abdominal surgery, for which minor (self-limiting) and major (requiring revision surgery) complications have been reported at up to 44% (4/9)[12] and 6% (2/35),[11] respectively, for intramural ectopic ureter correction. Intraoperative hemorrhage is a key procedural difference between CST-EU and cystoscopic-guided laser ablation of ectopic ureters. Although mild and apparently inconsequential in the present study, intraoperative hemorrhage may prolong procedural time while waiting for hemorrhage to clear. There is a small risk of substantial hemorrhage, for example in the rare occurrence of an undiagnosed coagulopathy (eg, von Willebrand disease) as reported by Adams et al[27] following laser lithotripsy for urolithiasis. Although not reported, a theoretical complication of CST-EU could be the obstruction of the ureteral orifice by a blood clot in the rare occurrence of more marked bleeding. Routine use of ultrasonography after CST-EU may help identify such a complication. The main risk of serious complication with both CST-EU and cystoscopic-guided laser ablation of ectopic ureters is uroabdomen, and although not reported in the present or previous[13,14] studies on these techniques, inadvertent perforation of the vaginal wall has been reported with cystoscopic-guided laser correction of vestibulovaginal septal remnants.[23] Owners should be counseled about this potential complication prior to performing minimally invasive ectopic ureter correction, and use of a ureteral catheter as discussed earlier could be considered.

Procedure and anesthetic durations in our study varied among dogs and between institutions; however, the small number of cases hindered any in-depth assessment. No obvious difference in outcome was noted between institutions. Reasons for variability in the duration of the procedure may have included involvement of specialist anesthetists and residents, student teaching, the use of fluoroscopic assistance, different operators performing the procedure, differences in patient conformation, variable degree of intraoperative bleeding, and unilateral versus bilateral treatment.

The main limitations of the present study were the small case numbers and the retrospective nature of the study design. Data were limited to those available in medical records, and some patients underwent multiple treatments. Additionally, there was a lack of owner questionnaire follow-up in 1 case, and owner recall bias may have affected outcome measures in the other cases. Ideally, dogs would have had repeat cystoscopy to assess how their incisions healed and for any retunnelization or stenosis of the modified ureteral opening; however, given that most of the dogs improved and were doing well, this additional procedure was hard to justify. Should incontinence reoccur in any dogs treated with CST-EU, repeat cystoscopy would be important to check for retunnelization. Urodynamic studies were not performed for any of the dogs in the present study but may have provided useful information about the presence of any concurrent urethral sphincter mechanism incompetence or detrusor instability.

In conclusion, CST-EU appeared to be a safe and effective minimally invasive alternative to laser ablation in the present study, and we believe our findings would extend to institutions without suitable equipment or expertise for laser ablation. Furthermore, larger studies are needed to confirm these results, and prospective comparative studies would be important to determine any differences in long-term outcome between available treatment options for ectopic ureters.

Acknowledgments

No external funding was used in this study. The authors declare that there were no conflicts of interest.

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Supplementary Materials

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