Received: 2 December 2020 | Revised: 13 May 2021 | Accepted: 22 July 2021

DOI: 10.1111/vsu.13702

ORIGINAL ARTICLE - CLINICAL

WILEY

Long-term outcome of female dogs treated for intramural ectopic ureters with cystoscopic-guided laser ablation

Christopher S. F. K. Hoey BSc, BVetMed, PGDipVCP, MRCVS[1] |
Ed Friend BVetMed, CertSAS, DipECVS, FRCVS[2] |
Lee B. Meakin MA, MRes, PhD, VetMB, DipECVS, MRCVS[2] |
Guillaume P. Chanoit DEDV, PhD, DipECVS, DipACVS, FHEA, FRCVS[2]

[1]Bristol Veterinary School, University of Bristol, Bristol, UK

[2]Langford Vets, University of Bristol, Bristol, UK

Correspondence
Guillaume P. Chanoit, Langford Vets, University of Bristol, BS40 5DU Bristol, UK.
Email: g.chanoit@bristol.ac.uk

[Correction added on 01 September 2021, after first online publication: The article title has been updated to *Long-term outcome of female dogs treated for intramural ectopic ureters with cystoscopic-guided laser ablation*.]

Abstract

Objective: To report the complications and long-term outcome of female dogs with intramural ectopic ureter(s) (iEU) undergoing cystoscopic-guided laser ablation (CLA) and determine the effect of post-CLA neutering on urinary continence.

Study Design: Retrospective clinical study.

Animals or Sample Population: Thirty-four client-owned dogs.

Methods: Medical records of female dogs that had iEU-CLA were reviewed. A 10-point continence score was assigned before, immediately after, and at a minimum of 12 months postprocedure via owner telephone contact. Neutering status prior to and postprocedure was recorded.

Results: Continence scores increased in all dogs after CLA ($p < .0001$, mean duration of follow-up: 63.9 ± 5.7 months) with an increase of the median score from 2 (preprocedure) to 10 (postprocedure). A urethral tear occurred in 2/34 dogs immediately after the procedure, successfully managed conservatively. Mild hematuria was present in 2/34, lasting less than 48 h. Postoperative urinary tract infections were documented in 6/34 dogs. Two dogs died of urinary-related issues at 1 and 5 months after CLA. Complete and near-complete urinary continence (scores 9 and 10/10) was achieved in 26/32 dogs including 3 dogs requiring medical (2) or surgical interventions (1). Post-CLA neutering did not affect continence scores ($p = .44$).

Conclusion: A large proportion of dogs regained and maintained full continence after CLA alone. Subsequent medical or surgical therapy allowed further improvements when needed. Post-CLA neutering did not negatively impact urinary continence score.

Clinical Significance: The beneficial effect of iEU-CLA in female dogs is long standing and not affected by postprocedural neutering.

This study was submitted in the form of an abstract to the 2021 online BSAVA clinical research abstracts.

1 | INTRODUCTION

Ectopic ureters (EUs) are congenital abnormalities where the ureteral orifice is located distal to the trigone of the bladder.[1] They are classified anatomically as either intramural or extramural, most (>95%) being intramural in dogs.[1–6] Intramural EUs (iEUs) enter the distal aspect of the urinary bladder and trigone in a relatively normal anatomic position but travel within the urethral wall in the submucosa failing to open into the bladder lumen.[7] EUs are the most common cause of urinary incontinence in juvenile female dogs.[8] Breeds with a high incidence of EUs include Newfoundlands, Labrador retrievers, Golden retrievers, Siberian huskies, terriers, miniature poodles, and toy poodles.[1,3,4,7,9] Clinical signs consist of intermittent or continuous urinary incontinence since birth/weaning or can rarely develop later in life. Other urinary conditions seen in dogs with EUs include urinary tract infections (UTI), ureteral stenosis, ureterocele, hydroureter, hydronephrosis, urinary tract anatomical abnormalities (such as short urethras/ pelvic bladder, renal agenesis/dysgenesis, vaginal septum, and others), or suspected urethral sphincter mechanism incompetence (USMI).[1,3–7,9–15]

Surgical correction has been historically described for both types of EU and remains the only treatment for extramural EUs (eEUs).[1,4–6,13] Persistent or recurrent incontinence after correction is reported in 22% to 78% of patients with iEU and eEU treated surgically.[1,2,4–9,13,16–18] Adjunctive medical treatment (phenylpropanolamine [PPA] or estrogens) may improve continence. A noninvasive method of treatment of iEU consists of resection/ablation of the intraurethral ureteric wall under cystoscopic guidance. The resection/ablation has been described using endoscopic scissors or laser. A prospective study documented the short- and long-term outcomes (median: 32.4 months) of 32 incontinent female dogs with iEUs treated with laser ablation[7]: 4 of 30 patients (47%) required no additional postoperative treatment to manage their urinary incontinence. A further 9 patients were improved with the addition of medical management, transurethral bulking agent injection, or placement of a hydraulic occluder.[7] These results were more favorable than those of an earlier study reporting a continence rate of 25% (median follow-up time: 10.5 months).[19] The discrepancies regarding the outcome of female dogs treated for iEUs with CLA justifies further evaluation, especially longer term assessment. Indeed, continence scores have been found to decline with time. For example, Noel et al.[9] found that incontinence recurred in 15 dogs after a mean period of 4.7 months. They also found a decline in continence after discharge (from 43/47 continent dogs after procedure to 32/43 long term). Finally, as CLA is still considered a relatively new method of treatment of EU, the potential benefits of this technique over open procedures are not formally established. Very few complications seem described in reports of CLA[7,11,19] while studies on open procedures repeatedly report minor (dysuria, hematuria) and major (uroabdomen) complications.[5,9,17,20]

Early neutering is known to increase the risk of urinary incontinence in female dogs,[21–29] especially in large breed dogs, who also tend to be more commonly affected by EU.[1,3,4,7,9,23,29] Conflicting results have been published regarding the impact of neutering on continence score after correction of EU. Ho et al.[20] reported persistent incontinence in 4/33 female dogs that were spayed after the surgical treatment of EUs while Noel et al.[9] did not report an impact of pre- or per- procedural neutering on continence score of 24 female and 8 male dogs treated surgically.

The primary aim of this study was to evaluate the complications and long-term outcomes of female dogs undergoing CLA of their iEU by comparing postoperative urinary continence scores prior to CLA, immediately after, and at least 12 months after CLA. The secondary aim was to compare continence scores in dogs neutered after the procedure or left intact. We hypothesized that CLA would have a sustained positive effect on continence score and that post-CLA neutering would not affect continence score.

2 | MATERIALS AND METHODS

Female dogs with iEU treated by CLA at the Langford Vets Veterinary Teaching Hospital of the University of Bristol, between December 2009 and March 2019 were eligible for inclusion. The study was approved by the University of Bristol Ethical Committee (VIN 19-014). History, physical examination, age, and weight at intervention, estimated age of start of incontinence, previous medical management, neuter status, anatomical abnormalities (including the position of the bladder) noted from imaging diagnostics and whether the EUs were unilateral or bilateral and which side, were searched for each patient. Patients were excluded if they had any previous surgical intervention of their urinary tract, if medical records indicated that one EU was extramural or if owners were not contactable for follow-up.

Preoperative diagnosis was established after a combination of computed tomography, abdominal ultrasonography, retrograde vaginourethrogram, and/or cystoscopy. CLA was then performed by a boarded veterinary surgeon. If cystoscopy was performed for diagnostic purposes, CLA was either conducted immediately after confirming the diagnosis or rescheduled, at the discretion of the surgeon. Anesthetic protocols varied depending on the anesthetist and were tailored to each dog. Dogs were placed in dorsal recumbency, the vulva was clipped of hair and aseptically cleaned. Patients that were receiving antimicrobial therapy at presentation for underlying or suspected urinary tract infections were treated perioperatively with intravenous antibiotics. A rigid cystoscope (4 mm, 2.7 mm or 9.5 Fr 30° lens telescope, Karl Storz) was advanced retrograde into the vestibule and then urethral orifice alongside manual or pressurized irrigation with 0.9% saline solution. The vagina, urethra, and ureterovesicular junctions were identified and evaluated. A guidewire was advanced up into the iEUs alongside the cystoscope under cystoscopic guidance. An open-ended urinary catheter was advanced over the guidewire into the distal iEU through the ureteral orifice, which was then secured in place (to a drape with a hemostat). The laser fiber (300-μm diode laser) was inserted into the working channel of the cystoscope to be directed at the medial aspect of the ectopic ureteral wall. The lateral aspect of the ureteral wall and urinary catheter were avoided. The medial aspect of the iEU wall was then dissected in a continuous or pulsed manner with the laser (power set up: 14–20 J). Dissection was stopped once the neoureteral orifice was within the bladder lumen, to a similar position to the contralateral ureter in dogs with unilateral EUs or if further dissection was deemed unsafe when the ureter seemed to transition from an intramural to extramural course. For dogs with bilateral iEUs, the procedure was repeated on the contralateral side. Postoperative analgesia and antibiotics were determined on a case basis. Antibiotics for positive urine culture results were selected from antimicrobial sensitivity panels. Patients were discharged the following day once they had urinated without complication.

Owners were contacted between September 2019 and March 2020 and asked to complete a telephone questionnaire assessing postoperative progress of their dog (Appendix S1; adapted from Gomes et al.[30]). This involved continence scoring before the interventional procedure, after the procedure (within 1 month) and the current dog's continence score (or prior to euthanasia/death). Continence was scored on an ordinal scale ranging from 1 (constant leaking) to 10 (complete continence). In addition, owners were asked to comment and score any urinary complications including straining, hematuria, infection, dysuria, longer urination time, or "other." Urinary complications were scored from 0 (normal) to 3 (constant/increasing frequency). Episodes occurring ≤1 per year (intermittent) were given a score of 1. A score of 2 was given if episodes occurred twice per year and a score of 3 if >2 episodes occurred per year. Complications were recorded as major if they necessitated intervention(s) under sedation or general anesthesia and minor if they were either self-resolving or resolving with medical management alone.

Medications given after CLA, current medications, and subsequent surgical procedures were recorded. Finally, owners were asked to state if they were living in a more rural or urban area and if they had access to a garden—they were also asked to score their satisfaction with the outcome (visual scale) from 1 (very unsatisfied) to 10 (very satisfied) and whether they would have the surgical procedure performed again if they had another dog with the same problem.

2.1 | Statistical analysis

Statistical analysis was performed by use of commercial software (Systat, Version 10.0; SPSS Inc, Chicago, IL). Continuous data were tested for normality using Kolmogorov–Smirnov tests; body weight and time to follow-up were normally distributed and were reported as the mean (SD); age, duration of hospitalization, duration of incontinence (prior to procedure), and owner satisfaction scores were not normally distributed and reported as median (range). Continence scores were ordinal data and were therefore reported as median (range). A Friedman test for repeated measures was performed to assess any difference between the continence scores on each subject, preoperatively with those at last follow-up. Mann Whitney U test was used to compare the effect of neutering after the procedure on the continence scores. p value <.05 was considered significant.

3 | RESULTS

3.1 | Demographics

Thirty-eight female dogs with iEU were treated by CLA but four were excluded as owners were not contactable for follow-up. At the time of the procedure, 5 (15%) of the 34 dogs were neutered females and 29 were entire (85%). Fifteen of the 29 entire females were neutered after the procedure (52%). In two of these dogs, neutering occurred during additional surgery for persistent urinary incontinence (repeat laser ablation in one and placement of a urethral cuff in the other). Fourteen (41%) female dogs remained entire at time of last follow-up (time of procedure ranging from December 2009 to September 2018). One of the non-neutered dogs was reported to have not had a heat cycle (procedure date November 2016).

Breeds consisted of 4 (12%) crossbreeds and 30 (88%) pure breeds; 11 golden retrievers, 7 labrador retrievers, 2 cocker spaniels, 2 border collies, 2 English bulldogs, 1 Bedlington terrier, 1 cockerpoo, 1 Hungarian visla, 1 soft-coated wheaton terrier, 1 jack russell terrier and 1 husky. Median age at time of procedure was 7 (3–76) months. The median duration of incontinence prior to procedure was 4 (1–62) months. Body weight at the time of procedure was recorded in 33/34 cases ranging from 4.6 to 43.5 kg (15.5 ± 8.56 kg). Physical examination was reported in all cases; abnormalities included perineal urine soiling (12 cases), perineal dermatitis (6), hindlimb urine soiling (5), vaginitis (5), urine dribbling (5), and a recessed or hooded vulva (2). All owners reported to live in a more rural location with access to gardens.

3.2 | Preprocedural medical management

A history prior to intervention of positive bacteriologic urine culture results was reported in 25 dogs (74%; specific bacterial infection not available for review in the majority of cases). Thirty-two (94%) dogs had prior treatment with antimicrobials for identified or suspected urinary tract infection(s) with amoxicillin–clavulanate in 25 dogs (78%), cephalexin in four dogs (13%) or the antimicrobial information not available in three dogs (9%). Other medical management consisted of PPA in nine dogs (26%), meloxicam in four dogs (12%) and estriol in two dogs (6%), with some dogs having a combination of medical management. Two dogs (6%) did not have medical management prior to procedure.

3.3 | Laboratory data

Serum biochemistry was available in 21 dogs (62%). Serum creatinine and urea were within the reference interval in 21 and 18 cases, respectively. Serum urea was increased in three cases (14%); 18.6 mmol/L (reference [ref.] 2–7 mmol/L), 8.7 mmol/L (ref. 1.7–8.5) and 8.6 mmol/L (ref. 2–7 mmol/L). Urinalysis was not available for these cases. Hematology was available for review in 20 dogs (59%) and was within the reference interval in all. Urinalysis was performed in 16 dogs (47%) and was normal in 9 dogs (56%). Seven dogs had hematuria (six mild hematuria, one moderate). Urine specific gravity (USG) was recorded in 11 dogs. Median USG was 1.015 (range 1.005–1.040).

Twenty-two (65%) dogs had urine culture and sensitivity performed at the time of procedure (most commonly collection method consisted in ultrasound-guided cystocentesis or via the cystoscope but was not specified in all cases). *Escherichia coli* was cultured in seven, *Proteus mirabilis* in four, *Staphylococcus pseudointermedius* in two, beta-hemolytic *Streptococcus* spp. in two, *Staphylococcus aureus* in one, *Staphylococcus* spp. in one (with no further differentiation), *Streptococcus faecalis* in one, gram-negative *Bacillus* in one, *Enterococci* spp. in one and *Corynebacterium urealyticum* in one. Four dogs had negative urine culture and four dogs had urine culture performed but the results were missing from our data base. One dog that had a negative urine culture had positive bacterial growth from bladder tissue (necrotic tissue within the bladder lumen retrieved cystoscopically) with an alpha-hemolytic *Streptococcus* spp. and *Staphylococcus pseudointermedius*.

3.4 | Results of imaging studies

Cystoscopy was used to localize each ureteral orifice. Five dogs (15%) had bilateral iEUs and 29 had unilateral (85%): 16 right (55%) iEUs, 12 left (41%), and in 1 case the side was not mentioned in the record (Table 1).

Other diagnostic imaging modalities were used in 32 cases, some combining computed tomography (CT) intravenous urogram (IVU) in 22 dogs, retrograde vaginourethrogram in 15 dogs, and abdominal ultrasonography in 12 dogs.

Additional urogenital tract abnormalities were identified in 27 dogs (79%), with some dogs having more than one abnormality (Table 1).

3.5 | Postoperative management

After CLA, 23 dogs (68%) were discharged with antibiotics prior to urine culture and sensitivity results. The duration of antibiotics administration varied. At discharge, 16 dogs (70%) were treated with amoxicillin–clavulanate, 3 (13%) with cephalexin, 2 (9%) with amoxicillin, 1 (4%) with enrofloxacin, and 1 (4%) with trimethoprim–sulfonamide.

Eighteen dogs (53%) were discharged with oral analgesia: meloxicam (12 dogs [67%]; 0.1 mg/kg once daily [SID] for 2–7 days), paracetamol (4 dogs [22%]; ~10 mg/kg two times daily [BID] for 2–5 days), tramadol (1 dog [5.5%]; 2.75 mg/kg BID for 5 days), and carprofen (1 dog [5.5%]; 4 mg/kg SID for 5 days). One dog was discharged with PPA which had been started prior to intervention (1.2 mg/kg BID for 7 days) (Table 1).

Thirty dogs (88%) were discharged the day after CLA. Two dogs (6%) were discharged 2 days after the procedure (owing to owners' commitments unable to collect the day after the procedure). One dog (3%) was discharged 4 days after the procedure and another 8 days after the procedure (3%). Both of these dogs had major complications requiring additional hospitalization.

TABLE 1 Summary of the breed, age at cystoscopic-guided laser ablation, imaging abnormalities, affected ureter(s), duration of incontinence, pre-CLA and post-CLA continence score, current continence score, complications, outcome, and neutered status on 34 dogs undergoing ectopic ureter cystoscopic-guided laser ablation

Dog	Breed	Age at CLA (months)	Imaging abnormalities (other than intramural ectopic ureter)	Affected ureter	Duration of incontinence (months)	Pre-CLA continence score	After-CLA continence score (within 1 month)	Current continence score (or prior to euthanasia/death)	Complications	Alive at time of questionnaire	Neutered status
Dog 1	Golden Retriever	6	Caudally positioned bladder	Left	4	3	10	10	None	Yes	Entire
Dog 2	Golden Retriever	5	None	Right	2	3	10	10	None	Yes	Entire
Dog 3	Golden Retriever	24	Marked left hydronephrosis	Left	21	5	10	10	None	Yes	Neutered prior to CLA
Dog 4	Golden Retriever	76	Left ureteritis, vestibulo-vaginal stenosis	Bilateral	24	1	10	10 Score 4 after neutering Score 10 with addition of PPA	UTI (1)	Yes	OVH after CLA (unknown timeframe)
Dog 5	Golden Retriever	6	None	Right	3	1	10	10	None	Yes	OVE after CLA (2 years)
Dog 6	Golden Retriever	4	Vestibulovaginal stenosis, vestibulovaginal mucosal irregularity/recess	Right	4	1	10	10	None	Yes	Entire
Dog 7	Golden Retriever	3	None	Right	1	5	10	10	None	Yes	Entire
Dog 8	Labrador Retriever	8	None	Left	6	4	10	10	None	Yes	OHE after CLA (6 months)
Dog 9	Labrador Retriever	24	Right CKD, right hydroureter, moderate right hydronephrosis, right pyelectasia, vaginal septum	Right	4	2	10	10	None	Yes	OVH after CLA (unknown timeframe)

(Continues)

TABLE 1 (Continued)

Dog	Breed	Age at CLA (months)	Imaging abnormalities (other than intramural ectopic ureter)	Affected ureter	Duration of incontinence (months)	Pre-CLA continence score	After-CLA continence score (within 1 month)	Current continence score (or prior to euthanasia/death)	Complications	Alive at time of questionnaire	Neutered status
Dog 10	Labrador Retriever	5	None	Left	2	1	4	10	Urethral tear identified (suspected during CLA)	No (due to polyradicular neuritis)	Entire
Dog 11	Cocker Spaniel	7	Marked right hydroureter (ureterocele), mild right hydronephrosis, mild left hydroureter	Right	5	1	10	10	None	Yes	OVH after CLA (unknown timeframe)
Dog 12	Cockerpoo	5	None	Right	4	3	5	10	UTI (1)	Yes	Entire
Dog 13	Poodle cross	43	Mild left hydroureter	Left	11	3	10	10	None	No (not urinary related)	Neutered prior to CLA
Dog 14	Border Collie	27	Mild urerine dilation (body and horns), urothelial hemorrhage	Right	24	1	10	10	None	Yes	Entire
Dog 15	English Bulldog	8	Mild right hydronephrosis	Right	6	4	9	10	None	No (due to BOAS)	Entire
Dog 16	Jack Russell Terrier	8	Mild left hydroureter	Left	4	2	10	10	None	No (due to MUO)	OVH after CLA (6 months)
Dog 17	English Bulldog	6	Mild right hydronephrosis, cystitis	Right	4	6	10	10	None	No (not urinary related)	OVH after CLA (4 years)
Dog 18	Hungarian Visla	8	Bilateral mild hydronephrosis, caudally positioned bladder	Bilateral	6	1	10	10	None	Yes	Entire

TABLE 1 (Continued)

Dog	Breed	Age at CLA (months)	Imaging abnormalities (other than intramural ectopic ureter)	Affected ureter	Duration of incontinence (months)	Pre-CLA continence score	After-CLA continence score (within 1 month)	Current continence score (or prior to euthanasia/death)	Complications	Alive at time of questionnaire	Neutered status
Dog 19	Spaniel cross	8	Bilateral ureteritis, cystitis, multiple distal urethral fenestrations	Bilateral	6	3	10	10	None	Yes	Neutered prior to CLA
Dog 20	Cocker spaniel	4	Right renal aplasia	Left	2	1	10	10	None	Yes	OVH after CLA (1 year)
Dog 21	Husky cross	5	Mild right hydronephrosis, focal mild (distal) right hydroureter	Right	3	2	10	10	None	Yes	OVH after CLA (7 months)
Dog 22	Golden Retriever	4	None	Right	1	1	4	10	None	Yes	OVH after CLA (4 m after) during hydraluilic occlude placement
Dog 23	Labrador Retriever	7	Left CKD, vaginal septum	Left	1	1	9	9	None	Yes	Entire
Dog 24	Golden Retriever	30	Moderate left hydroureter, caudally positioned bladder, vaginal septum, abnormal fold of tissue in left ureter, urolithiasis	Left	24	2	7	9	None	Yes	Neutered prior to CLA
Dog 25	Golden Retriever	5	Caudally positioned bladder	Left	1	4	9	9	UTI (2)	Yes	OVH after CLA (6 m after)

(Continues)

TABLE 1 (Continued)

Dog	Breed	Age at CLA (months)	Imaging abnormalities (other than intramural ectopic ureter)	Affected ureter	Duration of incontinence (months)	Pre-CLA continence score	After-CLA continence score (within 1 month)	Current continence score (or prior to euthanasia/ death)	Complications	Alive at time of questionnaire	Neutered status
Dog 26	Fox Terrier cross	8	Left CKD, left renal infarct	Left	6	1	4	6	None	Yes	Entire – never had heat cycle
Dog 27	Labrador Retriever	4	Mild right hydroureter	Right	3	1	10	5 PPA score 10	None	Yes	OVH after CLA (unknown timeframe)
Dog 28	Soft-coated Wheaton Terrier	3	None	Right	2	2	4	5 PPA and estriol score 5	None	Yes	Entire
Dog 29	Bedlington Terrier	12	Renal aplasia, ureter carried on in the bladder wall after ablation	Unilateral (side not reported)	1	1	6	4 PPA score 5	UTI (1)	Yes	OVH after CLA (5 years after)
Dog 30	Golden Retriever	10	Vaginal septum, cystitis, mild right hydronephrosis, mild right hydroureter, left ureter hook like shape, hypoplastic bladder	Right	3	2	2	4 PPA score 5	UTI (1)	Yes	OVE after CLA (7 months)
Dog 31	Husky	18	Caudally positioned bladder	Bilateral	16	1	3	3	Pollakiuria	Yes	OVH after CLA (1 year)
Dog 32	Border Collie	64	Mild left hydronephrosis, mild left hydroureter	Left	62	1	2	2	None	No (due to orthopedic disease)	Neutered before CLA

TABLE 1 (Continued)

Dog	Breed	Age at CLA (months)	Imaging abnormalities (other than intramural ectopic ureter)	Affected ureter	Duration of incontinence (months)	Pre-CLA continence score	After-CLA continence score (within 1 month)	Current continence score (or prior to euthanasia/death)	Complications	Alive at time of questionnaire	Neutered status
Dog 33	Labrador Retriever	3	Moderate right hydroureter, hypoplastic bladder	Bilateral	1	×	×	×	Major: AKI, death	No (urinary related)	Entire
Dog 34	Labrador Retriever	6	None	Right	3	×	×	×	Major: stranguria, scarring, stenosis	No (urinary related)	Entire

Abbreviations: AKI, acute kidney injury; BOAS, brachycephalic obstructive Airway syndrome; CKD, chronic kidney disease; CLA, cystoscopic-guided laser ablation; MUO, meningoencephalitis of unknown origin; OVE, ovariectomy; OVH, ovariohysterectomy; PPA, phenylpropanolamine; UTI , urinary tract infection.

3.6 | Major complications

Two dogs (6%) developed urine leakage from a defect in the urethra (Table 1). One was suspected during the procedure and confirmed with a vaginourethrogram. This dog was hospitalized with an indwelling urinary catheter. Daily serum biochemistry analysis was within normal limits. Repeat vaginourethrogram 7 days after procedure was normal. This dog had an initial continence score of 1/10 prior to the procedure, 4/10 in the short term after the procedure, then 10/10 at 12 months, and at the time of last follow-up without any further medical or surgical intervention.

The other dog had mild abdominal distension identified postoperatively suspected to be due to a urinary tract tear. Free abdominal fluid was confirmed with an abdominal ultrasound and a minor tear at the trigone/proximal urethral region was identified with a retrograde vaginourethrogram. The dog was managed with an indwelling urinary catheter. Daily serum biochemistry analysis was within normal limits. Repeat vaginourethrogram 4 days after procedure was normal. The dog had persistent urinary incontinence (no improvement on PPA [1.2 mg/kg BID]) and occasional stranguria. Repeat cystoscopy after 1 month revealed significant hematuria and urothelial hemorrhage. Repeat CT IVU 2 months after the initial CLA documented persistence of an intraurethral portion of the EUs. Due to lack of visualization from hematuria, CLA was not repeated. Both ureters were surgically reimplanted (ureteroneocystostomy) into the urinary bladder. The dog represented 3 months later for persistent urinary incontinence. A laparotomy was performed for artificial urethral sphincter implantation for suspected USMI. The dog was subsequently identified to have a multiresistant UTI with a gram-positive *Bacillus* only sensitive to gentamycin which was started as no other antibiotic choice was deemed appropriate. Despite careful monitoring (urine cytology for presence of casts, daily measurements of serum creatinine concentration) and appropriate fluid therapy support, the dog developed azotemia and died from suspected acute kidney injury. A follow-up continence questionnaire was not performed for this patient.

One dog developed stranguria 11 days after right-sided CLA. Serum biochemistry and urinalysis were within the reference interval. Urine culture revealed no bacterial growth. Retrograde vaginourethrogram revealed a urethral irregularity at the bladder neck with no apparent obstruction. Repeat cystoscopy revealed marked post-surgical scarring and stenosis of the proximal urethra at the bladder neck, the bladder was unremarkable. This region of stenosis was distended with a Foley catheter on two occasions 5 days apart, achieving a marked increase in urethral diameter on the second occasion. The dog was hospitalized for 14 days with intermittent indwelling urinary catheter placement. The dog was discharged with meloxicam and had an initial improvement with resolved stranguria and occasional incontinence (occurring less than daily), however, redeveloped stranguria 1 week after discharge and was euthanized 2 weeks after this. A post-mortem examination was not performed. A follow-up continence questionnaire was not performed for this patient.

3.7 | Minor complications

Two dogs (6%) had mild hematuria after laser ablation procedure that lasted <48 h. Six of 34 dogs (18%) had postoperative urinary tract infection(s) scored 1/3 for severity and frequency in 4 (67%), and 2/3 for severity and frequency in 2 dogs (33%, Table 1).

3.8 | Follow-up

Twenty-six dogs (76%) were alive at the time of questionnaire completion. Two deaths (6%) were related to urinary tract complications (one was euthanized due to persistent stranguria and the other died due to acute kidney injury) and six (18%) to non-urinary complications (two unknown reasons but not related to urinary tract pathology, one following diagnosis of polyradicular neuritis, one for meningoencephalitis of unknown origin, one for cruciate disease, and one dog died due to brachycephalic obstructive airway disease).

Mean time between CLA and follow-up questionnaire was 63.9 months (SD 35.7). Both dogs who were euthanized or died <12 months after CLA related to urinary clinical signs were included in the descriptive analysis, but their median continence scores could not be ascertained and were therefore excluded.

The median urinary continence score prior to CLA was 2 (range 1–6) and 10 (range 2–10) post-CLA. At the time of last follow-up, it was also 10 (range 2–10). There was a difference between continence scores prior to CLA and at time of last follow-up ($p < .0001$).

All dogs had an improvement in their urinary continence score. Complete urinary continence (score 10/10) was achieved in 20/32 dogs (63%) with CLA alone. With the addition of medical or surgical intervention(s), a further 3 dogs (23/32 dogs [72%]) had complete urinary continence (2 dogs with the addition of PPA and 1 dog after artificial urethral cuff placement and vulvoplasty). A postprocedure continence score of ≥9/10 was achieved in 26/32 dogs (81%). These additional three dogs were not receiving medical management nor had further surgical intervention.

Of the dogs with a post-CLA continence score of <9/10 (6/32; 19%), one had a score of 6 (receiving no additional medical management), three had a score 5 which were all receiving medical management (two with PPA and estriol and one with PPA alone), one had a score of three and the other of two; neither of which were receiving additional medical management or owners were interested in additional surgical correction.

Median long-term post-CLA continence score of dogs with caudally positioned or intrapelvic bladder (5 dogs) was 9 (range 3–10). Most (27/32; 84%) of owners graded their satisfaction for the procedure 10/10. Only 5/32 (16%) owners scored their satisfaction 5/10. Of the less satisfied owners, three dogs had continued urinary incontinence after the procedure with continence scores of 2, 3, and 4. One had a urethral cuff placed for suspected USMI and the other had a postprocedure continence score of 10, however, was euthanized due to polyradicular neuritis 14 months after the CLA. Twenty-eight (88%) owners felt if faced with the same clinical situation they would undertake EU-CLA again whilst two would not (6%; one that had urethral cuff placement and the other with a post-CLA continence score of 2). Two owners (6%) were unsure; one of them commented on costs of the procedure; these dogs had postprocedure continence scores of 3 and 4. The two cases that were euthanized or died <12 months after CLA related to urinary clinical signs were not asked to grade their satisfaction of the procedure.

3.9 | Effect of neutering

Fifteen dogs (15/34; 44%) were neutered at different time points (range: 4 months to 5 years after procedure; unknown for 4 dogs) after the CLA and 12 were still entire (12/34; 38%). Thirteen dogs (87%) underwent ovariohysterectomy, and two dogs (13%) underwent laparoscopic ovariectomy. Five dogs (15%) were neutered prior to the procedure and two of the entire dogs were euthanized or died <12 months after CLA related to urinary clinical signs and not included in continence score analysis.

No difference was detected between continence scores of dogs neutered after the procedure (10, range 3–10) and those remaining intact (10, range 5–10, $p = .45$). One dog (1/15; 7%) with a postprocedure continence score of 10 redeveloped urinary incontinence after neutering (continence score of 5) which responded to PPA (continence score of 10 alongside medical management).

4 | DISCUSSION

Laser ablation of iEUs in female dogs was associated with a good long-term outcome, as 72% (23/32) dogs had a long-term postprocedure continence score of ≥9/10 (score 10—completely continent; score 9—continent almost all the time with incontinent episodes only a few times in the year [seasonal]) with laser ablation alone. With the inclusion of cases with additional medical management or surgical intervention, 26/32 (81%) dogs had a postprocedure continence score of ≥9/10.

Only two third of dogs in this study received antibiotics after laser ablation of EUs unlike previous studies, where all dogs received antibiotics following laser ablation of EUs.[7] Dogs received antibiotics only if clinical signs were associated with a positive bacterial culture, as per current clinical recommendations.[31–33] We estimated that, as previously reported, subclinical bacteriuria should not be treated as it does not account for infection and may play a protective role preventing colonization by more pathogenic bacteria.[34–36]

The questionnaire used to assess urinary continence in this study improved the scrutiny of improvement. Although variable, continence improved in all dogs. A total of 63% (20/32) of dogs in this study reached complete urinary continence (score of 10/10) with CLA alone, which compares well to previous studies (25%[19] and 47%[7]). However, comparison warrants caution as scoring methods differed, sample size was small and study design varied (prospective for Berent et al.[7] vs. retrospective for Smith et al.[19] and the present study). Our favorable results could be partly explained by the demographics of our population, all owners living in rather rural areas with access to a garden. Such setting could allow underdiagnosed episodes of urinary incontinence. Nevertheless, our results were similar to the long-term continence of 77% in 30 dogs with the addition of medical, cystoscopic, or surgical interventions mentioned in Berent et al.'s study[7] but with a longer follow-up time (63 vs. 30 months). It could be noted, however, that our complication rate, especially procedure-related death is higher than in that study. [7]

Most owners (84%) were very satisfied with the procedure. However, the two cases that were euthanized or died <12 months after CLA related to urinary clinical signs were not asked to grade their satisfaction of the procedure which would likely lessen the satisfaction scoring. Owners satisfaction could be a reflection of the geographical location of our population which also explain why some dogs not optimal urinary continence having had owners declining further medical or surgical management. It is important to assess owner's satisfaction after this procedure as urinary incontinence has been shown to cause disharmony in 10%–20% of affected households with owners feeling anger or frustration.[24] Therefore, although urinary incontinence is only considered to have a minor impact on affected dog's welfare related to risk of dermatitis or recurrent urinary tract infections, the impact it may have on the owner/animal bond should be considered an important factor.[22]

The median postprocedure continence score did not vary between immediately postprocedure, 12 months after and at the time of last follow-up. However, there was an increase in median continence score over time. This may reflect resolution of inflammation caused by the procedure or further development of dog's urinary continence mechanism. Persistent incontinence may result from USMI or abnormal composition/anatomical abnormalities of the urinary tract. Urethral pressure profilometry was not available therefore not performed on any dog's during this study period to identify USMI. Even the presence of an intrapelvic bladder did not appear to have affected dog's long-term post CLA continence scores, in accordance with some earlier studies, although this has more recently been reported as a factor contributing to urinary incontinence.[7,24,37] Vaginal defects or vaginal septum were not reported as commonly as previous studies, however this may reflect the retrospective nature of our study if some findings were not clearly reported.[7,31,38]

Due to its minimally invasive nature, CLA is typically associated with short hospitalization times[7] as confirmed in most dogs of this study. Duration of hospitalization time is uncommonly reported in studies documenting outcome after surgical treatment of EUs. Only one study reported indwelling catheter placement for 24–48 h postoperatively, preventing comparisons.[9] Other putative advantages of the CLA over open procedures include reduced need for analgesia and a lower incidence of major complications. However, in our study, unlike other reports of CLA, urobabdomen, and urethral tears were documented in two dogs. Although not reported before, the risk of urethral due to lasering has previously been mentioned.[11,19] In the present study, the lack of concomitant fluoroscopy, used in other studies,[7] may have increased the risk of lasering portions of the iEUs that were close to the serosal layer of the bladder. Therefore, fluoroscopy may be recommended to correct abnormal ureteral anatomical position and assess where the course of the iEU diverges.

One dog with postoperative stranguria and marked postprocedural scarring and stenosis of the proximal urethra and neoureterovesicular junction responded to urethral dilation but was euthanized after recurrence of signs. This complication has not been reported before although inflammatory reaction at the neoureterovesicular junction of the laser tract has been mentioned.[19] Urothelial tissue can develop a proliferative reaction which may result in neoureterovesicular junction orifice obstruction. In this case, it is possible that overzealous use of laser at the neck of the bladder could have resulted in additional scarring over the proximal urethra.

In our study, postprocedural neutering after CLA did not impact urinary continence, although this result was gathered on a small population of dogs. Most dogs were entire before surgery, likely due to the age of onset of clinical signs and reluctance to neuter due to risks associated with incontinence.[21–29] The effect of age at neutering on urinary continence could not be evaluated as the precise date of neutering was not recorded. The very low number of dogs negatively affected by post-procedural neutering (one dog) may reflect the population studied and the inclusion of breeds that are not predisposed to post- neutering urinary incontinence.

Limitations of this study were related to its retrospective nature, unlike the other main study[7] on this topic, which was prospective. The diagnosis, medical management, and procedure were not standardized making comparison of this population difficult. Some of the more historical cases might have increased risk of misinterpretation due to owner's recollection of continence score and subjective nature of the owner assessment. Some data points were also missing (such as urinary culture results or collection method) in some of our earliest cases as they may have been collected at a time when our data system was changed and further discussion with referring veterinarians did not always allow us to gather more information. However, based on the reports, medications and communication log and recent discussion with the owners it would be presumed these cases did not have UTIs. Despite having a similar number of dogs as the previous largest case series, the total number of dogs for this study population was still low, especially for dogs undergoing analysis of the effect of neutering on continence score post CLA.

In conclusion, treatment of iEUs by CLA was associated with a significant and sustained improvement in urinary continence. Postprocedural neutering did not affect the continence score. This minimally invasive procedure included risks of scarring and proliferative reaction that resulted in stranguria. Although very rarely, some of these complications could lead to death/euthanasia.

CONFLICT OF INTEREST

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

AUTHOR CONTRIBUTIONS

Christopher S. F. K. Hoey: substantial contributions to the acquisition, analysis, or interpretation of data for the work; drafting the work and revising it critically for important intellectual content, final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **Ed Friend**: substantial contributions to the interpretation of data for the work; revising the work critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **Lee B. Meakin**: substantial contributions to the interpretation of data for the work; revising the work critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **Guillaume P Chanoit**: substantial contributions to the conception or design of the work and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

ORCID

Lee B. Meakin https://orcid.org/0000-0002-2161-9414
Guillaume P. Chanoit https://orcid.org/0000-0002-7414-6403

REFERENCES

1. McLoughlin MA, Chew DJ. Diagnosis and surgical management of ectopic ureters. *Clin Tech Small Anim Pract*. 2000;15(1):17-24.
2. Dean PW, Bojrab MJ. Constantinescu GM: Canine ectopic ureter. *Compend Contin Educ Pract Vet*. 1988;10(2):146–157.
3. Mason LK, Stone EA, Biery DN, Robertson I, Thrall DE. Surgery of ectopic ureters: pre-and postoperative radiographic morphology. *J Am Anim Hosp Assoc*. 1990;26(1):73-79.

4. McLaughlin RON Jr, Miller CW. Urinary incontinence after surgical repair of ureteral ectopia in dogs. *Vet Surg*. 1991;20(2):100-103.
5. Mayhew PD, Lee KC, 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.
6. Stone EA, Mason LK. Surgery of ectopic ureters: types, method of correction, and postoperative results. *J Am Anim Hosp Assoc*. 1990;26(1):81-88.
7. Berent AC, Weisse C, Mayhew PD, Todd 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(6):716-725.
8. Holt PE. Urinary incontinence in dogs and cats. *Vet Rec*. 1990;127(14):347-350.
9. Noël SM, Claeys S, Hamaide AJ. Surgical management of ectopic ureters in dogs: clinical outcome and prognostic factors for long-term continence. *Vet Surg*. 2017;46(5):631-641.
10. Steffey MA, Brockman DJ. Congenital ectopic ureters in a continent male dog and cat. *J Am Vet Med Assoc*. 2004;224(10):1607.
11. Berent AC, Mayhew PD, Porat-Mosenco 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.
12. Lane IF, Lappin MR, Seim HB 3rd. Evaluation of results of preoperative urodynamic measurements in nine dogs with ectopic ureters. *J Am Vet Med Assoc*. 1995;206(9):1348.
13. Holt PE and Moore AH. Canine ureteral ectopia: an analysis of 175 cases and comparison of surgical treatments. *Vet Rec*. 1995;136(14):345-359.
14. Cannizzo KL, McLoughlin MA, Mattoon JS, Samii VF, Chew DJ, DiBartola SP. Evaluation of transurethral cystoscopy and excretory urography for diagnosis of ectopic ureters in female dogs: 25 cases (1992–2000). *J Am Vet Med Assoc*. 2003;223(4):475-481.
15. Hayes HM Jr. Breed associations of canine ectopic ureter: a study of 217 female cases. *J Small Anim Pract*. 1984;25(8):501-504.
16. Holt PE, Gibbs C, Pearson H. Canine ectopic ureter—a review of twenty-nine cases. *J Small Anim Pract*. 1982;23(4):195-208.
17. Reichler IM, Eckrich Specker C, Hubler M, Alois B, Haessig M, Arnold S. Ectopic ureters in dogs: clinical features, surgical techniques and outcome. *Vet Surg*. 2012;41(4):515-522.
18. Volstad NJ, Beck J, Burgess DM. Correction of intramural ureteral ectopia by ureteral transection and neoureterostomy with the distal ureter left in situ. *Aust Vet J*. 2014;92(3):81-84.
19. 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(2):191-195.
20. Ho LK, Troy GC, Waldron DR. Clinical outcomes of surgically managed ectopic ureters in 33 dogs. *J Am Anim Hosp Assoc*. 2011;47(3):196-202.
21. Arnold S, Hubler M, Reichler IM. Urinary incontinence in spayed bitches: new insights into the pathophysiology and options for medical treatment. *Reprod Domest Anim*. 2009;44(Suppl):190-192.
22. Beauvais W, Cardwell JM, Brodbelt DC. The effect of neutering on the risk of urinary incontinence in bitches—a systematic review. *J Small Anim Pract*. 2012;53(4):198-204.
23. Byron JK, Taylor KH, Phillips GS, Stahl MS. Urethral sphincter mechanism incompetence in 163 neutered female dogs: diagnosis, treatment, and relationship of weight and age at neuter to development of disease. *J Vet Intern Med*. 2017;31(2):442-448.
24. De Bleser B, Brodbelt DC, Gregory NG, Martinez TA. The association between acquired urinary sphincter mechanism incompetence in bitches and early spaying: a case-control study. *Vet J*. 2011;187(1):42-47.
25. Holt PE, Thrusfield MV. Association in bitches between breed, size, neutering and docking, and acquired urinary incontinence due to incompetence of the urethral sphincter mechanism. *Vet Rec*. 1993;133(8):177-180.
26. Pegram C, Brodbelt DC, Church DB, et al. Associations between neutering and early-onset urinary incontinence in UKbitches under primary veterinary care. *J Small Anim Pract*. 2019;60(12):723-733.
27. Reichler IM, Hubler M, Jöchle W, Trigg TE, Piché CA, Arnold S. The effect of GnRH analogs on urinary incontinence after ablation of the ovaries in dogs. *Theriogenology*. 2003;60(7):1207-1216.
28. Thrusfield MV, Holt PE, Muirhead RH. Acquired urinary incontinence in bitches: its incidence and relationship to neutering practices. *J Small Anim Pract*. 1998;39(12):559-566.
29. Spain CV, Scarlett JM, Houpt KA. Long-term risks and benefits of early-age gonadectomy in dogs. *J Am Vet Med Assoc*. 2004;224(3):380-387.
30. Gomes C, Doran I, Friend E, Tivers M, Chanoit G. Long-term outcome of female dogs treated with static hydraulic urethral sphincter for urethral sphincter mechanism incompetence. *J Am Anim Hosp Assoc*. 2018;54(5):276-284.
31. Llido M, Vachon C, Dickinson M, Beauchamp G, Dunn M. Transurethral cystoscopy in dogs with recurrent urinary tract infections: retrospective study (2011–2018). *J Vet Intern Med*. 2020;34(2):790-796.
32. Carter JM, Klausner JS, Osborne CA, Bates FY. Comparison of collection techniques for quantitative urine culture in dogs. *J Am Vet Med Assoc*. 1978;173(3):296-298.
33. Sørensen TM, Bjørnvad CR, Cordoba G, et al. Effects of diagnostic work-up on medical decision-making for canine urinary tract infection: an observational study in Danish small animal practices. *J Vet Intern Med*. 2018;32(2):743-751.
34. McGhie JA, Stayt J, Hosgood GL. Prevalence of bacteriuria in dogs without clinical signs of urinary tract infection presenting for elective surgical procedures. *Aust Vet J*. 2014;92(1–2):33-37.
35. Wan SY, Hartmann FA, Jooss MK, Viviano KR. Prevalence and clinical outcome of subclinical bacteriuria in female dogs. *J Am Vet Med Assoc*. 2014;245(1):106-112.
36. Cai T, Mazzoli S, Mondaini N, et al. The role of asymptomatic bacteriuria in young women with recurrent urinary tract infections: to treat or not to treat? *Clin Infect Dis*. 2012;55(6):771-777.
37. Adams WM, DiBartola SP. Radiographic and clinical features of pelvic bladder in the dog. *J Am Vet Med Assoc*. 1983;182(11):1212-1217.

38. Burdick S, Berent AC, Weisse C, Langston C. Endoscopic-guided laser ablation of vestibulovaginal septal remnants in dogs: 36 cases (2007–2011). *J Am Vet Med Assoc*. 2014;244(8):944-949.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Hoey CSFK, Friend E, Meakin LB, Chanoit GP. Long-term outcome of female dogs treated for intramural ectopic ureters with cystoscopic-guided laser ablation. *Veterinary Surgery*. 2021;50(7):1449-1462. https://doi.org/10.1111/vsu.13702