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Urethral Stenting for Obstructive Uropathy Utilizing Digital Radiography for Guidance: Feasibility and Clinical Outcome in 26 Dogs

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Background: Urethral stent placement is an interventional treatment option to alleviate urethral outflow obstruction. It has been described utilizing fluoroscopy, but fluoroscopy is not as readily available in private practice as digital radiography.

Objectives: To describe the use of digital radiography for urethral stent placement in dogs with obstructive uropathy.

Animals: Twenty-six client-owned dogs presented for dysuria associated with benign and malignant causes of obstructive uropathy that underwent urethral stent placement.

Methods: Retrospective study.

Results: Causes of obstructive uropathy included transitional cell carcinoma, prostatic carcinoma, hemangiosarcoma, obstructive proliferative urethritis, compressive vaginal leiomyosarcoma, and detrusor-sphincter dyssynergia. Survival time range was 1–48 months (median, 5 months). All dogs were discharged from the hospital with urine outflow restored. Intraprocedural complications included guide wire penetration of the urethral wall in 1 dog and improper stent placement in a second dog. Both complications were successfully managed at the time of the procedure with no follow-up problems noted in either patient.

Conclusion and Clinical Importance: Urethral stent placement can be successfully performed utilizing digital radiography. The complications experienced can be avoided by more cautious progression with each step through the procedure and serial radiography. The application of digital radiography may allow treatment of urethral obstruction to become more readily available.

Key words: digital radiography; minimally invasive; transitional cell carcinoma; urethral stent.

Urethral stenting is a minimally invasive procedure used to treat lower urinary tract obstruction not amenable to medical management or surgery. It was initially described utilizing fluoroscopic guidance for placement.[1] Since then, it has been described further for both malignant and benign urethral obstructions also utilizing fluoroscopy.[2–4] This procedure commonly requires referral to a specialty hospital and often to a tertiary referral facility. Digital radiography (DR) is more readily available in small animal practice, and the ability to utilize it for urethral stent placement may allow for greater availability of this procedure. The purpose of this report was to assess the feasibility of using digital radiography for guidance and placement of self-expanding metallic urethral stents for treatment of urethral obstruction.

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Abbreviations:

cm	centimeter
CR	computed radiography
DR	digital radiography
F	French
kg	kilogram
mg	milligram
mGy	milligray
mm	millimeter
PO	per os
PRN	pro re nata
TCC	transitional cell carcinoma

Materials and Methods

Records of patients that were referred between 2008 and 2014 with the complaint of inability to urinate and that received treatment by placement of a self-expanding metallic urethral stent were reviewed. Twenty-six dogs (18 females, 8 males) underwent urethral stent placement by digital radiography. The age of the patients ranged from 6 to 15 years (mean, 10.9 years), and weight ranged from 3 to 37 kg (mean, 18.6 kg). Informed consent was obtained from each client before treatment.

Evaluation included CBC, serum biochemistry, urinalysis, urine culture, abdominal ultrasound examination, and urethroscopy. All patients received premedication with buprenorphine 0.02 mg/kg and diazepam 0.2 mg/kg IV. Anesthesia was induced with propofol 4 mg/kg IV and maintained with isoflurane or sevoflurane in oxygen.

Urethral guide wire and catheter placement in male dogs was performed as previously described.[1] Patients were placed in lateral recumbency, prepared by sterile technique, and draped. An initial lateral survey radiograph was obtained of the patient with a marker catheter in the rectum.[a,b] With the patient in lateral recumbency, the penis was extruded from the prepuce and a 0.035-inch-diameter hydrophilic guide wire[c] was inserted through the urethral orifice and advanced into the urinary bladder. Placement was confirmed by DR. A 7-F vascular sheath and dilator[d] were placed over the guide wire and advanced into the penile urethra. The penis was released and allowed to retract into the prepuce. The vascular sheath was sutured to the prepuce and the dilator removed. A 4-F angled angiographic catheter[e] was advanced over the guide wire and into the urinary bladder, and the guide wire was removed.

In female dogs, cystoscopy or urethroscopy was performed with the patient in dorsal recumbency with a 1.9- or 2.7-mm rigid cystoscope based on patient size.[f] A 0.035-inch-diameter, angled hydrophilic wire[c] was introduced through the operating channel of the cystoscope sheath. In patients with urethral obstruction, the cystoscope was advanced to the point of obstruction in the urethra and the guide wire was passed via the operating channel through the obstruction and into the bladder. In 1 dog, the rigid end of the guide wire was used because of equipment deterioration resulting in perforation of the wire through the urethra. The wire was removed and replaced floppy end first via the cystoscope sheath into the urinary bladder. Urethral stent placement was not affected in this patient, and an indwelling urinary catheter was not needed postprocedure.

Once bladder access was obtained, the cystoscope was removed and placement of the guide wire in the urinary bladder confirmed by a digital radiograph obtained with the patient in lateral recumbency.[a] A 7-F vascular sheath[d] was advanced over the wire.

With the patient in lateral recumbency, a retrograde cystourethrogram subsequently was performed as previously described[1] and digital radiographs were obtained. The urinary bladder was distended with a 50 : 50 mixture of iohexol and 0.9% sodium chloride. In male dogs, the angiographic catheter was withdrawn to the distal urethra while injecting iohexol to maximally distend and visualize the urethra. In female dogs, the vascular sheath was withdrawn into the distal urethra over the guide wire to maintain bladder access and injection of iohexol was performed through the side arm of the vascular sheath. The sheath was withdrawn over the guide wire to maintain urethral and bladder access. Radiographic contrast was injected while withdrawing the urethral catheter or vascular sheath into the distal urethra and verified by a digital radiograph obtained during injection. As previously described,[1] the length of the obstructed urethra was calculated by the colonic marker catheter as a reference and the maximum diameter of adjacent healthy urethra was measured. The injection was repeated with a new radiograph obtained to verify the location, length, and severity of the obstructed area. If a different measurement was obtained for urethral diameter, contrast injection and radiograph were performed a third time and the larger of the 2 urethral diameters was used for stent selection. A stent diameter 10% greater than the maximum normal urethral diameter adjacent to the obstruction was previously reported as appropriate size selection.[1] In this population, this calculation resulted in the selection of a stent that was 2 mm larger than the measured maximum diameter. The stent length was selected to span a minimum of 0.5-1 cm beyond the proximal and distal ends of the obstruction.

In male dogs, the angiographic catheter was removed after completion of the cystourethrogram and the guide wire replaced through the vascular sheath and into the urinary bladder. In female dogs, the vascular sheath and guide wire were maintained. Placement of the urethral stent subsequently proceeded in the same fashion for both male and female dogs.

With the patient in lateral recumbency, placement of a self-expanding metallic stent[g] was performed by advancing the stent over the guide wire toward the expected location of the obstruction based on the urethrogram. A digital radiograph of the patient in lateral recumbency was obtained to assess the location of the stent in relation to the obstruction.

Based on the radiograph and the known location of the occluded region, the position of the stent was adjusted accordingly. Each time the stent was repositioned, a new radiograph was obtained to assess its position until the stent was in its desired location (Fig 1). The vascular sheath was maintained while advancing the stent in the event that injection of contrast was needed to verify positioning of the stent across the obstruction. Once stent position was correct, deployment commenced (Fig 2). The stent was deployed in approximately 1-cm increments; a radiograph was taken with each deployment to verify stent position within the obstruction (Figs 3 and 4). If the stent appeared to move away from the operator, back tension was increased to engage and stabilize the partially deployed stent within the occluded region. In 1 dog, radiographs were only taken after the first 2 1-cm increments and then after complete deployment. This resulted in migration of the stent cranially due to inadequate back tension on the delivery system. All patients after this patient had radiographs taken after each estimated 1-cm increment of deployment.

After deployment of the stent, the delivery system was removed over the wire (Fig 5). A final radiograph was taken to confirm stent position and a contrast cystourethrogram performed (Fig 6). The introducer sheath was removed, and the patient was recovered from anesthesia.

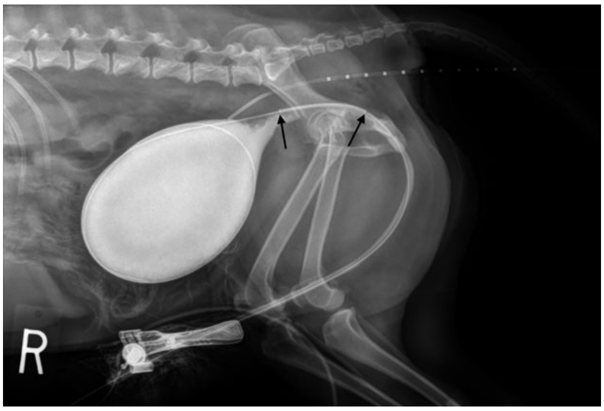

Fig 1. Urethral stent advanced into desired position within obstructed region (arrows) of a 10-year-old male castrated Welsh Corgi (solid arrows). An 8 × 40 mm urethral stent was selected.

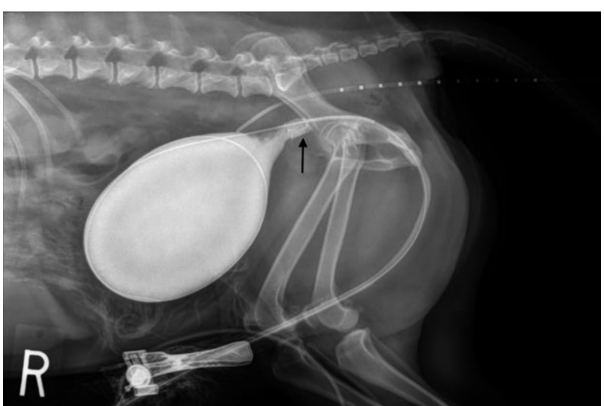

Fig 2. Initial deployment of urethral stent (solid arrow).

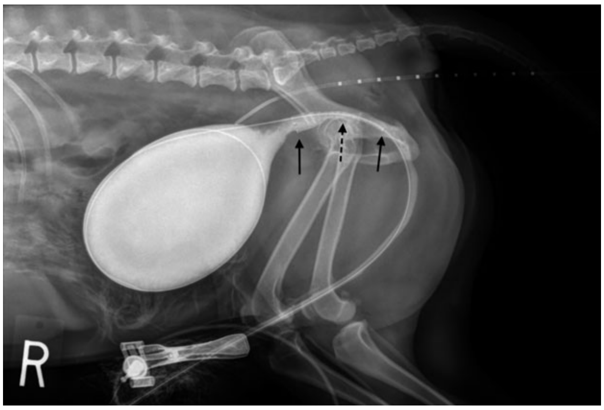

Fig 3. Radiograph after second incremental deployment of urethral stent. Solid arrows denote ends of stent, and dashed arrow denotes point to which stent is deployed.

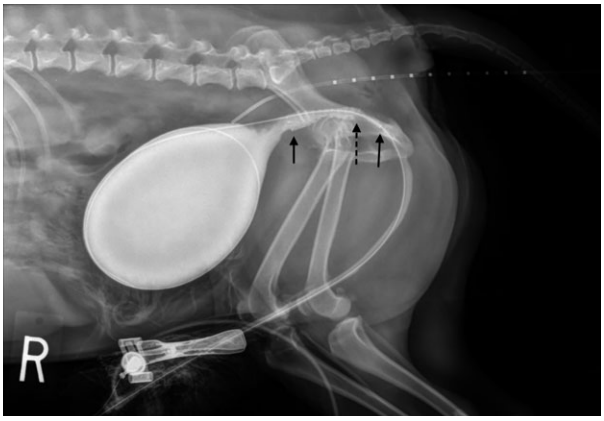

Fig 4. Radiograph after third incremental deployment of urethral stent. Solid arrows denote ends of stent, and dashed arrow denotes point to which stent is deployed.

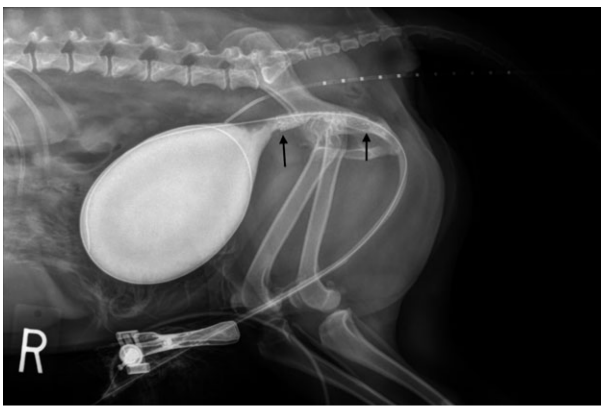

Fig 5. Fully deployed urethral stent placed within obstructed segment of urethra. Arrows denote proximal and distal ends of stent.

All patients received postoperative analgesia in the form of buprenorphine (0.02 mg/kg IV q6h prn) for 12–24 hours and meloxicam (0.1 mg/kg PO q24h) or piroxicam (0.3 mg/kg PO q24h). All patients remained on daily maintenance IV fluids for

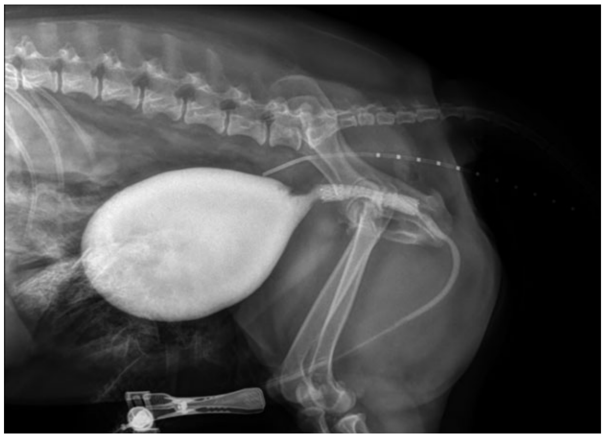

Fig 6. Contrast cystourethrogram to confirm urethral patency in a 10-year-old male castrated Welsh Corgi.

12 hours, and those that were started on antimicrobials by the referring veterinarian were maintained on prophylactic antimicrobials (amoxicillin 11 mg/kg PO q8h, amoxicillin/clavulanate 13.75 mg/kg PO q12h, or cephalexin 22 mg/kg PO q12h) pending urine culture and sensitivity results when performed by the primary veterinarian. Tramadol (2–3 mg/kg PO q6h prn for up to 5 days) was prescribed upon discharge. Patients were monitored for pain, subjective quality of urine stream, hematuria, stranguria, and incontinence, and assessment was recorded. Ultrasound examination was performed after urination to verify adequate bladder emptying.

Results

Urethral stents were placed in all 26 patients, restoring urethral patency (Supporting Information Appendix S1). Sixteen patients were diagnosed with transitional cell carcinoma (TCC; 14 females and 2 males), 5 patients with prostatic carcinoma, 1 patient with bladder hemangiosarcoma, 2 patients with proliferative urethritis (female), 1 patient with vaginal leiomyoma, and 1 patient with detrusor-sphincter dyssynergia (male). All patients had urethral patency restored after stent placement based on contrast cystourethrogram, observation postoperatively during hospitalization, and follow-up evaluation based on owner observation. The increase in urethral luminal diameter ranged from 5 to 8 mm (average, 6.9 mm).

Median survival time after stent placement for all patients was 5 months (mean, 7.7 months; range, 1–48 months). One patient was still alive at time of manuscript preparation (48 months) with a confirmed histopathologic diagnosis of TCC. Median survival time after stent placement for patients with prostatic carcinoma was 2 months in contrast to 6 months for patients with TCC. One female patient with hemangiosarcoma of the urinary bladder survived 3 months poststent placement. Median survival time for patients with neoplasia (n = 22) was 5 months compared to 11 months for patients with nonmalignant obstructions (n = 4).

The most common complication reported was urinary incontinence and occurred in 8 of 26 (30.7%) patients with 5 of 18 (27.7%) being female. Two patients developed urethral obstruction poststent placement. One patient experienced inability to urinate 3 days poststent placement, which resolved after urethral catheterization. Radiographs and ultrasound examination were performed, which did not identify the cause for inability to urinate and confirmed placement of the urethral stent with no migration. The second patient had tumor progression proximal to the stent and metastatic disease 6 months after stent placement. One patient with vaginal leiomyoma had an atonic urinary bladder caused by chronic urine retention before presentation for urethral stent placement. Hematuria, stranguria, or both were observed in 20 of 26 patients (77%) but this finding was present before stent placement and all affected patients had a neoplastic process.

One dog was diagnosed with detrusor-sphincter dyssynergia based on history, clinical signs, and failure to respond to medical management that included bethanechol, phenoxybenzamine, and prazosin. There was no evidence of an obstructive lesion on cystoscopic examination, but a filling deficit in the urethra was observed with cystourethrography. The patient clinically improved with urethral stent placement.

Two procedural complications were encountered during placement of the stents. In 1 female patient with urethral obstruction caused by TCC, the stent was placed such that approximately 25% of the stent was in the urethra and the remainder was protruding into the urinary bladder. The stent dislodged into the urinary bladder shortly after recovery from anesthesia. A second urethral stent of the same size was successfully placed and the first stent removed by cystotomy. In a second patient with urethral obstruction caused by proliferative urethritis, the floppy end of the guide wire was not successfully passed through the operating channel of the cystoscope sheath as a result of instrument deterioration. The rigid end of the guide wire was passed through the instrument channel successfully. The guide wire penetrated the urethral wall and entered the peritoneal cavity and was verified by DR. The guide wire was removed, and the floppy end was passed through the endoscope channel rather than the operating channel of the sheath. Correct placement was verified by DR. Urethral stent placement was completed and the patient recovered uneventfully. An indwelling urinary catheter was not placed after the procedure because the cystourethrogram did not identify any leakage of contrast material.

Bacteriologic culture and sensitivity before urethral stent placement were performed in 18 of 26 patients. Eight patients were treated with antimicrobials before presentation without bacterial culture and sensitivity of the urine performed. Urinary tract infection was identified in 10 patients, and isolated bacteria included *Escherichia coli* (n = 5), *Staphylococcus* spp (n = 4), *Enterococcus* spp (n = 4), and *Pasteurella* spp (n = 1).

Patient follow-up was performed until time of death in all patients by office visits or phone consultation. All patients diagnosed with TCC or prostatic carcinoma received treatment with nonsteroidal anti-inflammatory drugs (piroxicam 0.3 mg/kg PO q24h or meloxicam 0.1 mg/kg PO q24h), and 18 patients received chemotherapy (mitoxantrone 5 mg/m^2 IV q3weeks for 4 treatments or chlorambucil 2 mg PO q48h).

Discussion

Although fluoroscopy is the preferred and optimal modality for imaging during urethral stent placement, the procedure can be accomplished successfully by DR. In this patient population, 26 patients had urethral patency restored based on contrast cystourethrogram studies. Clinical assessments after stent placement and client feedback at follow-up were consistent with restoration of urethral patency.

In our population, 8 of 26 (30%) patients experienced urinary incontinence after urethral stent placement, affecting 5 of 18 (27.8%) females and 3 of 8 (37.5%) males. Urinary incontinence previously was reported in 4 of 12 (33%) dogs, in 3 of 8 (37.5%) male and 1 of 4 (25%) female dogs.[1] A second study reported urinary incontinence in 7 of 18 (38.9%) dogs, in 2 of 4 (50%) male and 5 of 14 (35.7%) female dogs.[2] The largest case study found urinary incontinence in 27 of 42 dogs (64.3%) after stent placement, in 9 of 19 (47.4%) female and 18 of 23 (78.2%) male dogs.[3] The results in our population appear to be similar to what previously has been reported by fluoroscopy. One patient was diagnosed with detrusor-sphincter dyssynergia based on history and clinical signs with no obstructive lesion identified on cystoscopic examination despite inability to urinate. This patient responded to urethral stent placement similar to a previous report in which 1 of 2 dogs with detrusor-sphincter dyssynergia showed improvement with urethral stent placement.[4]

Two complications occurred that did not ultimately prevent successful placement of urethral stents with DR. Fluoroscopy may have been helpful in preventing both situations with continuous visualization during deployment of the stent or advancement of the guide wire. Experience with stent placement probably is of greater importance compared to imaging modality to avoid the complications. Failure to maintain adequate back tension on the delivery system results in cranial extension of the stent toward the urinary bladder. Serial radiographs taken with incremental withdrawal of the delivery system sheath will verify appropriate stent position and adequate back tension on the delivery system. If the stent is observed to advance into the bladder lumen, back tension is increased on the delivery system and deployment can continue. With the first observed complication (stent migration requiring cystotomy), a radiograph was taken to verify stent position before deployment and after the initial 1 cm of deployment. Serial radiographs were not taken during the remainder of deployment because it was thought that adequate back tension was maintained. A radiograph taken after deployment showed improper placement of the stent. When a second stent was placed, incremental deployment with serial radiographs was performed to verify that stent position was maintained. This patient was the only 1 in the series that did not have serial radiographs taken for the entire deployment. Patients before and after this patient had urethral stents placed successfully with the sequential radiograph technique.

The second complication with the guide wire penetrating the urethral mucosa was caused by operational wear on the cystoscope sheath making the instrument channel inoperable. The patient had complete urethral occlusion, and therefore, the cystoscope could not enter the urinary bladder. Whereas the floppy tip end of the guide wire did not pass through the instrument channel, the opposite stiff end of the guide wire did pass. The rigid end can penetrate the urethral or bladder wall, and because visualization of the urethra and bladder was impaired by the tumor, the author was unaware of the location of the guide wire until a radiograph was taken. Upon identification of the improper location of the guide wire, the guide wire was removed. The cystoscope and sheath were reintroduced into the urethra, the endoscope was removed from the sheath, and the floppy end of the guide wire was inserted through the endoscope channel of the sheath into the urethra to the urinary bladder. The placement of the guide wire was performed without visual guidance, but appropriate placement into the urinary bladder was verified by DR. Replacement of the damaged cystoscope sheath and utilization of the floppy end of the guide wire prevented reoccurrence of this problem. In retrospect, another option for this situation includes passing the guide wire retrograde through the instrument channel (pass the nonangled end of the guide wire through the tip of the endoscope). The 2 complications experienced here did not increase the long-term level of care needed compared to other patients. Stent placement was successfully performed, and both patients had their obstructions alleviated. Both complications are risks related to stent placement and occurred in patients that were treated early (3rd and 5th, respectively) in this case series.

In comparison with placement of urethral stents by fluoroscopic guidance in which imaging and visualization of the stent and guide wire are continuous, adjustment of technique with DR is required in three ways. All 3 adjustments are limitations of the DR procedure when compared to utilizing fluoroscopy. First, although contrast cystourethrograms are performed routinely with DR, the more precise measurements required for urethral stent placement necessitate visualization of the urethra under maximal distension. Therefore, radiograph capture must be timed with injection of contrast under maximum pressure. In order to verify the location and size of the obstruction, this procedure should be repeated to confirm the location and measurements of the obstruction. Second, serial radiographs are required when advancing the guide wire or the urethral stent delivery system and when adjusting the position of the stent delivery system within the obstruction to evaluate location and placement. Finally, when deploying the stent, the delivery system sheath is withdrawn by approximately 1-cm increments with radiographs taken at each interval to verify deployment of the stent, accurate position of the stent, and adequate back tension on the stent and delivery system. As opposed to smooth, continuous deployment of the stent with fluoroscopy, several pauses are necessary when deploying the stent under DR guidance. Using DR requires the operator to make small, stepwise modifications in device position followed by static imaging and re-adjustment in position if necessary because visualization is not continuous. This adaptation does not appear to impair the ability to successfully and accurately place urethral stents. The complications occurred when this process was not strictly followed. The lack of continuous observation for stent placement achievable with fluoroscopy can be overcome with multiple serial radiographs and slow, cautious movement of devices and stent deployment when using DR.

It is the author's opinion that in order to utilize the DR technique, it is necessary to have rapid imaging on a clearly visible monitor adjacent to the procedure area. This will allow the operator to continue with the procedure while simultaneously monitoring stent placement on the screen. Positioning of the patient and the clinician is similar to stent placement under fluoroscopy (i.e, table side as opposed to behind lead shielding). In utilizing the DR technique, if operator position or handling changes to visualize the radiograph, or if the radiograph image is delayed, then inadvertent movement of the delivery system may occur and negatively impact the outcome of the procedure. Most DR systems allow for the display of the radiograph within 3–4 seconds. A computed radiography (CR) system would not be appropriate for urethral stent placement.

Radiation exposure to the clinician as well as patient can be a concern with interventional procedures. Skin tissue damage and hair loss have been reported with fluoroscopic procedures in human medicine.[5] Digital imaging technology, particularly DR, allows for decreased radiation exposure while simultaneously improving image quality.[6,7] Variation among machines and clinicians makes general comparison of radiation exposure between DR and fluoroscopy techniques virtually impossible. However, estimated radiation dose for a single radiograph is 0.5–0.7 milligray (mGy).[8,9] For carotid stent placement in humans, mean fluoroscopy time is reported at 40.5 minutes with mean radiation exposure of 1,382 mGy (range 326–4,405).[10] All procedures in the patient population described here were completed with fewer than 40 radiographs. There was a steady decrease in the number of radiographs taken with increased experience using DR. Fluoroscopy time for urethral stent placement has not been reported but is generally short. Calculation and comparison of radiation exposure with DR and fluoroscopy may be an area of future investigation.

Patients may experience persistent hematuria, pollakiuria, stranguria, urinary tract infection, and incontinence after urethral stent placement. However, dysuria and related lower urinary tract signs are the most common clinical signs reported in dogs with urinary bladder and urethral tumors.[11] Although all patients underwent urethral stent placement because of inability to urinate, the clinical signs of lower urinary tract difficulty often were part of the history before development of urethral obstruction. Treatments such as cystostomy tube placement and indwelling urethral catheter placement were reviewed but not considered superior to urethral stent placement. Therefore, the clients in these cases were willing to accommodate persistence of pollakiuria and hematuria in exchange for restoring urethral patency without the need for ongoing home intervention as is necessary with cystostomy tube placement. Because lower urinary tract signs often were observed before obstruction, they were suspected to cause by urogenital neoplasia rather than the procedure. A previous report utilizing fluoroscopy reported that only 1 of 12 patients had compromised quality of life associated with stranguria and 1 patient experienced stent migration caused by tumor regression and incorrect stent selection.[1] One additional dog experienced obstruction shortly after stent placement, which was resolved with restenting. When successfully placed, there were no appreciable short-term stent-specific complications in our population. One dog initially underwent unsuccessful stent placement. Stent migration occurred during the procedure in this patient and was caused by operator error. In previous study, 2 of 19 patients experienced stent migration with 1 being caused by improper stent size selection despite using fluoroscopy and 3 of 19 developed a second obstruction after stent placement.[2] One patient in our population was presented for re-obstruction of the urethra 6 months after stent placement but also had metastatic disease and therefore was euthanized.

Urinary tract infection is reported to be a common concurrent problem in dogs with TCC.[12] Positive bacteriologic culture was found in 56% of patients in our case series, and isolated organisms were similar to those previously reported. Eight patients were started on antimicrobials before presentation, which may have lowered the prevalence of urinary tract infection identified in our population. These patients continued to receive the antimicrobials prescribed by their primary veterinarians.

A limitation of our study is that it does not evaluate variability among operators or DR systems. Fluoroscopy provides continuous visual guidance during placement of urethral stents and consequently is the preferred imaging modality for interventional radiology procedures. Experience and training using fluoroscopy to place urethral stents may allow the clinician to gain the experience necessary to successfully utilize DR. The author recommends that supervised training be completed before attempting placement of urethral stents using DR.

A second limitation is that the patient population was not evaluated retrospectively for response to treatment of specific neoplastic processes. The purpose of the evaluation was to assess the feasibility of placing urethral stents utilizing DR. There were multiple causes of obstructive uropathy in our population including nonmalignant disorders. Chemotherapy treatment varied among patients with neoplasia based on owner preferences. Our patient population also included a patient with detrusor-sphincter dyssynergia. This disorder is a dynamic process that can be difficult to confirm. Because the patient had successful urethral stent placement and positive clinical response, it was included in this retrospective study. However, the variability associated with this disease can be considered a limitation of the study.

Urethral stents are utilized in human medicine and are placed under direct cystoscopic guidance without fluoroscopy or DR.[13–18] A common indication for urethral stenting in humans is detrusor-sphincter dyssynergia as was performed for 1 patient in our study population.[16–18] One study also evaluated the feasibility of endoscopic transesophageal stent placement; endoscopy was used as an effective means to place esophageal stents.[19] Although fluoroscopy is the preferred imaging modality for interventional procedures in veterinary medicine, urethral and esophageal stents are placed in human medicine without fluoroscopic guidance. The possibility of stent placement in veterinary medicine without fluoroscopy requires further investigation. To the author's knowledge, ours is the first case series describing urethral stent placement without fluoroscopy in veterinary medicine.

Our results suggest that urethral stent placement is feasible using DR. The primary limitations of this modality include the need to take multiple radiographs during contrast cystourethrography as well as serial radiographs during stent positioning and deployment. These limitations can increase risk of complication, but with adequate imaging and careful progression, the stent can be appropriately placed with good immediate outcome.

Footnotes

[a] Sound Eklin, Carlsbad, CA
[b] Marker Catheter, Infiniti Medical, Menlo Park, CA
[c] Weasel Wire®, Infiniti Medical, Menlo Park, CA
[d] Vascular sheath and dilator, Infiniti Medical, Menlo Park, CA
[e] Berenstein catheter, Infiniti Medical, Menlo Park, CA
[f] Karl Storz Veterinary Endoscopy, Goleta, CA
[g] Vet Stent-Urethra™, Infiniti Medical, Menlo Park, CA

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Conflict of Interest Declaration: Dr. Radhakrishnan has been a speaker for the urethral stent interactive session sponsored by Infiniti Medical at the 2011 ACVIM Forum, Denver, Colorado, 2013 ACVIM Forum, Seattle, Washington, 2014 ACVIM Forum, Nashville, Tennessee, 2015 ACVIM Forum, Indianapolis, Indiana, and 2016 ACVIM Forum, Denver, Colorado.

Off-label Antimicrobial Declaration: Authors declare no off-label use of antimicrobials.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:

Appendix S1. Summary of 26 patients treated with urethral stent placement for obstructive uropathy.