Treatment of traumatic penile urethral stricture in a dog with a self-expanding, covered nitinol stent

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Case Description—An 8-month-old castrated male mixed-breed dog was evaluated because of hematuria, stranguria, and dysuria of approximately 2 weeks’ duration that developed immediately following elective castration.

Clinical Findings—Results of physical examination, ultrasonography, retrograde double-contrast cystourethrography, and urethroscopy were consistent with a traumatic urethral stricture immediately proximal to the os penis resulting in a partial obstruction of urine outflow. Results of ultrasonographic examination of abdominal organs were considered normal. Digital radiography revealed no evidence of calculi.

Treatment and Outcome—Balloon dilation of the urethral stricture was performed and was followed by 2 bougienage procedures during the subsequent 2 weeks when clinical signs returned. The owners declined scrotal urethrostomy, and a self-expanding, covered nitinol stent was placed approximately 3 weeks after the initial evaluation, resulting in amelioration of clinical signs. Results of follow-up urethroscopy and contrast cystourethrography 1 year after stent placement revealed a statically positioned, patent urethral stent, although a small number of polypoid mucosal structures were identified distal to the stent and 1 small structure consistent with tissue ingrowth into the stent was identified.

Clinical Relevance—Placement of a covered nitinol stent resulted in long-term resolution of clinical signs associated with traumatic stricture of the penile urethra in this young dog. Because the os penis in dogs limits radial expansion of the urethra, its presence may limit the use of stents in this location. (J Am Vet Med Assoc 2013;242:1117–1121)

An 8-month-old neutered male Australian Shepherd mix weighing 18 kg (39.6 lb) was referred to the William R. Pritchard Veterinary Medical Teaching Hospital at the University of California–Davis with a 13-day history of hematuria, stranguria, and dysuria that developed immediately following a routine castration. Bleeding from the prescrotal incision and hematuria had been observed after castration, and the dog was kept hospitalized; an indwelling urinary catheter was placed and maintained for 4 days, and ampicillin and vitamin B12 (dose, route, and frequency not reported) were administered for 6 days prior to discharge from the hospital at the University of California–Davis with a 13-day history of hematuria, stranguria, and dysuria that developed immediately following a routine castration. Bleeding from the prescrotal incision and hematuria had been observed after castration, and the dog was kept hospitalized; an indwelling urinary catheter was placed and maintained for 4 days, and ampicillin and vitamin B12 (dose, route, and frequency not reported) were administered for 6 days prior to discharge from the referring clinic. Following discharge, the owner reported that the dog was dysuric and straining to urinate every 20 to 30 minutes.

On physical examination at the Veterinary Medical Teaching Hospital, the dog was bright, responsive, and well hydrated. Rectal temperature was 38.3°C (101.0°F). A surgical incision 3 cm in length was noted in the prescrotal region and was edematous with moderate erythema. The incision edges were apposed, with several surgical steel skin sutures present. A CBC, serum biochemical analysis, urinalysis, and microbial culture and susceptibility testing of a urine sample were performed, and results were within respective reference ranges for our facility.

Ultrasonographic evaluation of the urethra and surrounding tissues proximal to the os penis revealed a subjectively thickened urethral wall and a segment of urethra for which the lumen could not be defined. Results of abdominal ultrasonographic examination were considered normal. When observed outdoors by the attending clinicians, the dog urinated multiple times in a 5-minute period. The urine stream appeared consistently weak, with no overt straining detected. The urinary bladder was small on palpation, and abdominal ultrasonography following urination confirmed complete voiding of the bladder contents.

Results of digital radiography of the pelvic region with the dog under general anesthesia on the following day revealed no obvious radiodense structures consistent with calculi or other evidence of urethral obstruction. A 5F radiopaque marker catheter with 1-cm metallic markers was introduced into the colon to provide a standard for accurate measurement on fluoroscopic images. An 8F vascular access sheath was cut to a length of 6 cm and passed into the urethra so that it remained just distal to the suspected obstructed region to maintain access to the urethral lumen, and double-contrast retrograde cystourethrography was performed under fluoroscopic guidance. A 4F Berenstein catheter was introduced into the urethra via the vascular access sheath, and some initial resistance was encountered in the distal urethra.
before the catheter passed into the bladder. A 50:50 mixture of iodinated contrast medium and sterile saline (0.9% NaCl) solution was infused through the catheter, and images were obtained. A region of urethral narrowing was detected at the level of the caudal aspect of the os penis, adjacent to the site of the skin sutures (Figure 1). On completion of the procedure, a small amount of contrast medium was noted to be leaking into the subcutaneous tissues in the region of urethral narrowing. Measurements for possible stent placement were obtained from the fluoroscopic images by use of digital calipers. The narrowed region measured 10 mm in length, with a 3-mm luminal diameter at the narrowest point. The urethral lumen immediately proximal and distal to the affected region had a measured diameter of 5 mm.

Urethroscopy was then performed with a ureteroscope. This evaluation revealed a luminal narrowing approximately 10 mm in length and 10 mm proximal to the os penis. Tissue in this area was erythematous, and small numbers of polypoid projections arising from the urothelium were present in the narrowed region; strands of tissue were also present streaming into the lumen from the irregular and narrowed urethral wall. The scope was passed through the narrowed region into the proximal urethra with a moderate amount of pressure. The remainder of the urinary tract was apparently normal. The patient recovered from anesthesia without complications.

On the basis of history and clinical and diagnostic imaging findings, a diagnosis of traumatic urethral stricture was made, and treatment options, including balloon dilation of the stricture, urethral stent placement, and scrotal urethrostomy, were discussed with the owners. The owners chose to proceed with balloon dilation. Four days after the urethroscopy procedure, general anesthesia was induced, and contrast cystourethrography was repeated to localize the stricture and to guide the placement of the balloon. A balloon catheter with a balloon dimension of 3.5 × 15 mm was used, and dilation was performed 4 times for approximately 1 minute each time, gradually increasing pressures to a maximum of 6 atm. After dilation, the maximum luminal diameter in the affected area was 3.5 mm or 70% of the unaffected penile urethra diameter (5 mm in this dog). The patient was discharged from the hospital, and carprofen (2.1 mg/kg [0.95 mg/lb], PO, q 12 h) was prescribed for 3 days.

Over the subsequent 2 weeks, the clients reported that the patient had a recurrent weak urine stream. The dog underwent 2 bougienage procedures (3 days apart, under general anesthesia) with red rubber urinary catheters of gradually increasing diameter up to 10-F, which restored the urethral lumen to 80% of the diameter of the unaffected regional urethra. After each procedure, the patient’s urine stream initially improved after dilatation, but clinical signs of prolonged duration of urination and a weak urine stream returned. Approximately 3 weeks after the initial evaluation at the Veterinary Medical Teaching Hospital, the clients declined scrotal urethrostomy and elected to proceed with placement of a covered urethral stent.

Under general anesthesia, an 8F vascular access sheath was again placed in the distal aspect of the urethra, and a 4F Berenstein catheter over a 0.018-inch angled hydrophilic guidewire was introduced via the vascular access sheath. Cystourethrography was again performed, confirming a narrowing of the urethra to 10 mm proximal to the os penis. The stricture was observed in multiple views and measured approximately 2 mm. The catheters were removed, and a 6 × 40-mm self-expanding covered nitinol stent was introduced over the guidewire under fluoroscopic guidance. Appropriate placement of the stent through the stricture region required that the distal portion of the stent remain within the part of the urethra constrained by the caudal aspect of the os penis. The dog recovered from anesthesia without complications, and a strong urine stream was noted after the procedure. Evaluation of radiographs obtained the following day confirmed appropriate placement of the stent across the urethral stricture with expected (although incomplete) dilation of the stricture (Figure 2), and the patient was discharged the following day.

Follow-up information was obtained from the owners via telephone and e-mail communications at 5 days, 1 month, 3 months, and 1 year after stent placement. The owner continued to report that the dog had a normal urine stream, with no obvious signs of pain or discomfort. The patient returned to the Veterinary Medical Teaching Hospital 1 year later for elective evaluation of the stent. Results of preanesthetic PCV, circulating concentrations of total solids and blood glucose, and BUN concentration (determined with a dipstick test) were within normal limits. Under general anesthesia, fluoroscopic images revealed that the stent remained in its original position and had expanded to its normal size.
full diameter in the previously narrowed region (Figure 3). Contrast cystourethrography revealed a persistent luminal narrowing of the urethra immediately proximal to the stent (Figure 4). Additionally, a small, rounded filling defect was noted at the dorsal aspect of the urethral lumen within the midbody of the stent. The margins of the urethra just distal to the stent had a mildly irregular appearance. Urethroscopy revealed that the stent remained open and mostly patent, although multiple small, pedunculated, soft tissue masses suggestive of hyperplastic urothelium were present at the ends of the urethral stent, and 1 similar mass that appeared to breach the stent covering was observed within the midbody of the stent (Figure 5). Because of the lack of a working channel in the small urethroscope* used and concern for stent disruption, a biopsy sample was not obtained. On fluoroscopic examination, the small filling defect of the dorsal urethral wall and irregularities of the urethral wall proximal and distal to the stent were consistent with the small polypoid structures seen via urethroscopy. The patient recovered uneventfully from anesthesia and was discharged to the owner that evening.

Discussion

Placement of a covered nitinol stent successfully relieved clinical signs associated with traumatic stricture of the penile urethra in the young dog of this report. A prior report of metallic stent placement in the urethra of male dogs described placement in the proximal (prostatic) aspect of the urethra. Benign urethral stricture is not commonly reported in dogs but typically occurs secondary to urothelial trauma, which allows exposure of the deeper tissues to urine and subsequent development of inflammation and fibroplasia. In the dog of the present report, the inciting trauma was be-
lieved to have occurred during surgery. The prescrotal urethra is superficially located, and inadvertent trauma during routine elective castration is possible.

Current recommendations for the treatment of benign urethral stricture in dogs include balloon dilation or surgical management ranging from urethral resection and anastomosis to urinary bypass (eg, scrotal urethrostomy for treatment of distal lesions in males). Treatment via balloon dilation has been described for humans and dogs with urethral strictures; adverse effects include recurrence of the stricture and urethral trauma. In the treatment of benign esophageal strictures in dogs, success is often achieved with balloon dilation; however, the procedure must often be repeated multiple times to achieve a desirable endpoint, and this can become costly for the client. The use of balloon dilation, optical urethrotomy, or stent placement procedures for the treatment of traumatic urethral strictures in men remains controversial, with high rates of stricture recurrence following balloon dilation and high complication rates associated with placement of uncovered permanent metallic stents. Although the use of uncovered nitinol stents in the management of proximal urethral neoplastic diseases has been described in dogs, to our knowledge, no previous reports have described the clinical use of nitinol stents for treatment of benign urethral conditions in dogs.

Stents commonly used in the urethra are manufactured from nitinol (a nickel-titanium alloy), and the metal skeleton of the stent may be uncovered or covered with a polytetrafluoroethylene or polyurethane covering. Self-expanding stents, which are superelastic (ie, crush recoverable), are typically used. Stents that are slightly oversized relative to the organ lumen are typically selected for positioning purposes and to minimize migration. Because of this, the stent is constrained by the organ wall and does not fully expand to its preset shape. Therefore, it continues to exert a small amount of chronic outward force against the organ wall. Excessive chronic outward force in a stenosed luminal organ may cause tissue damage, but some force is necessary to retain the stent in the desired location. The current recommendation for stents placed in the proximal urethra of dogs is to choose stents that are oversized by 10% of the measured lumen diameter. Physical restrictions associated with the os penis in dogs may regionally limit urethral expansion, compared with the unconstrained urethra, and could contribute to a higher chronic outward force from stents placed in this location. This was of concern in our patient because the stent had to be placed at least partially within the os penis because of the stricture location.

Complications associated with the placement of uncovered stents for benign urethral strictures in men are as high as 53%, and most stem from obstruction secondary to urothelial hyperplasia and in-growth through the stent interstices. Stents that lack a covering become easily incorporated into the urethral wall with this hyperplastic tissue in-growth, and management of clinically important secondary obstruction is challenging. Because of this, if urethral stenting is elected, the use of retrievable covered stents with planned removal after 4 months is recommended in human patients. Unfortunately, retrievable covered stents were not available at the time our patient was treated, and size options for these remain limited. The most common complication associated with the use of covered stents in human patients is migration (34%), although it is thought that selection of a stent with oversized diameter relative to that of the urethral lumen may help to anchor it in position, and size of the stent described in this report was selected accordingly.

In an experimental study evaluating the use of polyurethane-covered, retrievable urethral stents in dogs, irregular filling defects induced by tissue response at the proximal or distal end of the stent were detected during follow-up urethrography in 17 of 20 dogs, consistent with the filling defects observed during contrast cystourethrography at the 1-year follow-up examination in our patient. Described gross and histopathologic changes of the urethra after stent placement include an increased number of epithelial layers, increased thickness of the submucosal layer and development of submucosal fibrosis, papillary projections of the urothelium, and inflammatory cell infiltration. Therefore, the gross changes observed in the dog of the present report at the 1-year follow-up evaluation were not surprising. It is uncertain whether the lesions will progress. Although we cannot definitively conclude that the development of polyloid tissue was secondary to stent placement and not to the initial trauma, findings in other studies of dogs, rats, and human patients support its association with long-term placement of the stent. Owners should be advised of this possibility when long-term placement of a covered stent is considered.

Results of an experimental study of urethral stent placement in dogs revealed that covered stents that did not expand to their full diameter immediately after deployment continued expanding over time. In that study, covered stents placed in the membranous portion of the urethra reached 63% of their fully expanded diameter immediately after placement and 90% of their fully expanded diameter before stent removal at 4 or 8 weeks. In the dog described in the present report, although presence of a narrowed region in the stent indicated that full dilation of the stricture was not achieved immediately after stent placement, the diameter of urethral lumen in the stenosed area did increase over time.

Optimal stent diameter relative to the measured diameter of the urethral lumen is currently unknown in human or veterinary patients. Although the use of covered stents is an important choice in reducing the morbidity associated with recurrent stenosis caused by mucosal hyperplasia, covered stents typically require greater relative oversizing, compared with uncovered stents, to minimize the risk of migration. Use of an oversized stent resulting in a higher persistent chronic outward force may contribute to greater local tissue reaction and risk of recurrent stenosis at the stent ends. The risk of recurrent stenosis in dogs with benign urethral stricture treated with covered stents has yet to be identified; however, temporary stent placement can be a viable, minimally invasive option in humans with recurrent benign urethral stricture. The use of removable covered urethral stents with removal at 4 months after
placement, as recommended in humans, may be beneficial in some veterinary patients as well. Other clinical factors that should be considered in the treatment of benign distal urethral strictures include the specific anatomy of the os penis in dogs, the amount of distal urethral expansion the os penis may restrict relative to the unconstrained urethra for a given stent size, and whether balloon dilation of the stricture prior to stent placement is necessary or desired. Long-term follow-up for the treatment of benign urethral strictures by use of nitinol stents in a large number of dogs is currently lacking; however, the outcome in this case was encouraging.

a. Marker catheter, Infiniti Medical LLC, Menlo Park, Calif.
b. Vascular access sheath, Infiniti Medical LLC, Menlo Park, Calif.
c. Berenstein catheter, Infiniti Medical LLC, Menlo Park, Calif.
d. Isovue-370 (Iopamidol) equivalent to 370 mg iodine/mL, Bracco Diagnostics Inc, Princeton, NJ.
e. Flex II Uretero Reno Fibroscope, Karl Storz Veterinary Endoscopy, Goleta, Calif.
f. Angled weasel wire, Infiniti Medical LLC, Menlo Park, Calif.
g. Covered self-expanding nitinol stent, Infiniti Medical LLC, Menlo Park, Calif.

References