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Modified endoluminal ureteral stenting for the management of proximal ureteral obstruction in two cats

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Abstract

Case series summary Two cases of placement of modified endoluminal ureteral stents are described, for revision of a subcutaneous ureteral bypass (SUB) and for primary treatment of obstructive ureterolithiasis. Modified endoluminal stents were inserted through the ureterotomy, anchored in the renal pelvis with a single pigtail and shortened to a length sufficient to span the proximal ureter and ureterotomy site.

Relevance and novel information The advantages of this approach as a surgical option for feline obstructive ureterolithiasis are demonstrated, including the avoidance of disruption, or bypass, of the ureterovesicular junction, minimisation of implanted foreign material and avoidance of intravesicular stent mass, maintenance of the physiological route of urine flow, including preservation of active distal ureteral function, and limitation of the potential complications of ureterotomy. The clinical efficacy of this adaptation of the previously published endoluminal stenting technique is demonstrated with its applicability de novo and in the revision of other stenting procedures.

Keywords: Ureterolith; stent; ureterotomy; ureter

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Introduction

Endoluminal ureteral stents and nephrovesical bypass conduits have become the standard of care in the management of feline obstructive ureterolithiasis.[1–9] Both limit the risk of complications associated with historical techniques for this condition, including ureterotomy, neoureterocystomy, partial ureteral resection and ureteronephrectomy.[3,10,11] A significant incidence of complications has, however, still been reported with these approaches. One comparative study reported a higher incidence of complications with double-pigtail stents, including lower urinary tract signs, stent obstruction and uroabdomen.[12] The reported incidence of lower urinary tract signs, including dysuria and pollakiuria, is in the range of 20–48%.[1,2,12–14] Other complications include stent migration, ureteritis, pyelonephritis and the need for stent exchange, reportedly required in up to 27% of cats.[1,2,12–14] Complications associated with subcutaneous ureteral bypass (SUB), including SUB occlusion, kinking, leakage, infection and mineralisation, are also common,[4,5,8,12] with a major complication rate of 48% reported in one study,[5] leading some authors to explore ureteroneocystostomy to limit the implantation of foreign material and morbidity of conventional techniques.[15]

Endoluminal stents are placed retrograde, via cystotomy, either at open surgery or endoscopically; antegrade, via the kidney; or in both directions, via a ureterotomy incision.[1–3,10,12–14] The small diameter of the

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feline ureter, particularly at the vesicoureteral junction, complicates placement, and luminal obstruction or narrowing can compound this difficulty.[10,13] Accordingly, endoluminal ureteral stenting has been associated with extended surgical times, additional surgical trauma and circumstances where placement is not achievable.[3,13]

Lower urinary tract signs and flank pain are commonly reported postoperative complications of endoluminal stent placement[1] and limit their widespread use.[3,14] The proximal urethral location in the cat contributes to urethral and trigonal mucosal irritation by intravesicular stent mass.[13] Dysuria, urgency and flank pain are frequently reported in human patients with ureteral stents,[16] affecting up to 80–90% of patients. In humans, lower urinary tract signs have been related to stent diameter[17] and length,[18,19] particularly the position of the stent termination crossing the midline of the bladder[19,20] or terminating within the ureter.[21–23] Pain is associated with vesicoureteral reflux and increases in renal intra-pelvic pressure, particularly during urination,[18,21,24] as stents bypass the ureterovesicular junction and impede ureteral peristalsis.

Recently, intra-ureteral termination of the distal end of endoluminal ureteral stents has been reported to significantly reduce lower urinary tract symptoms and improve quality-of-life scores during short-term placement in humans.[21–23] This report describes modified endoluminal ureteral stenting, with intra-ureteral stent termination, in two cats.

Case series description

Case 1

An 8-year-old male neutered domestic shorthair cat was presented for dysuria, haematuria, peritoneal effusion and subcutaneous swelling 6 weeks after ureterotomy and uncomplicated unilateral SUB (SUB 3.0; Norfolk Vet Products) placement for obstructive ureterolithiasis. The peritoneal fluid was a modified transudate with low-grade inflammation and fluid, and urine culture was negative. Meloxicam (0.05 mg/kg PO q24h) and buprenorphine (0.01 mg/kg SC q12h) did not resolve the dysuria. Serum creatinine was 131 µmol/l (reference interval [RI] 71–212).

The SUB system was appropriately positioned, without obstruction or leakage. The proximal right ureter was dilated to the level of the previous ureterotomy. Pyelography was performed by injection of dilute iohexol (Omnipaque 300; GE Healthcare Australia) via the SUB port, demonstrating obstruction of the right ureter at that level. Ureterotomy revealed fibrous tissue with no intraluminal obstructive material. Ureteral stenting was performed as described below and the entire SUB system removed. The margins of the renal stoma were approximated with a single mattress suture of monofilament absorbable suture after nephrostomy tube removal.

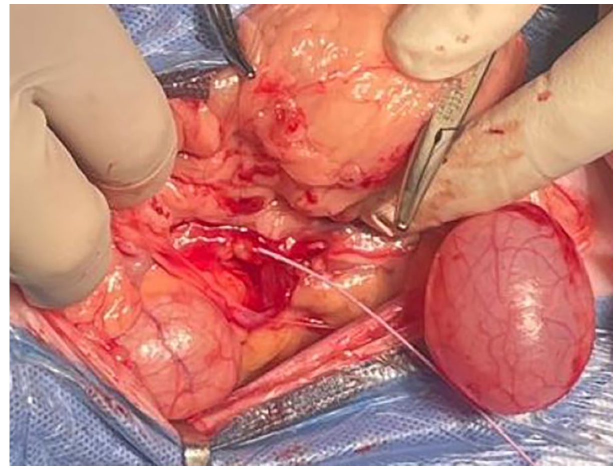

Figure 1 Intraoperative photograph demonstrating placement of the ureteral stent via the ureterotomy in case 2

Case 2

A 5-year-old female spayed domestic shorthair cat was presented with azotemia and abdominal ultrasound findings consistent with right-sided obstructive ureterolithiasis, including renal pelvis and proximal ureteral dilation, and a hyperechoic ureterolith. Serum creatinine was 757 µmol/l (RI 69–160).

Intraoperatively, a ureterolith was palpated within the right ureter, one-third of the length of the ureter from the kidney, with proximal ureteral dilation. Ureterotomy was performed and the ureterolith removed. Ureteral stent placement was performed as described below.

Surgical technique

A 0.018-inch hydrophilic guide wire was passed retrograde into the renal pelvis via the ureterotomy, using fluoroscopic guidance (Figures 1–3). A 2+F stent (Vet Stent-Ureter; Infiniti Medical) was introduced over the wire and into the renal pelvis. After wire removal, the distal end of the stent was cut at a length sufficient to bridge the ureterotomy site. The stent end was introduced into the distal ureter and advanced approximately 1 cm beyond the ureterotomy. Ureterotomy closure was achieved with USP 6-0 polydioxanone (PDS*II; Ethicon) in a simple interrupted pattern. In case 1, an intraoperative pyelography was performed via the SUB port to confirm the patency of the ureter after stent placement.

Outcomes

Case 1

Dysuria was resolved immediately postoperatively. Resolution of the peritoneal effusion and subcutaneous swelling was confirmed sonographically 5 weeks postoperatively. Lower urinary tract signs had not recurred at 8 months postoperatively. Abdominal radiographs

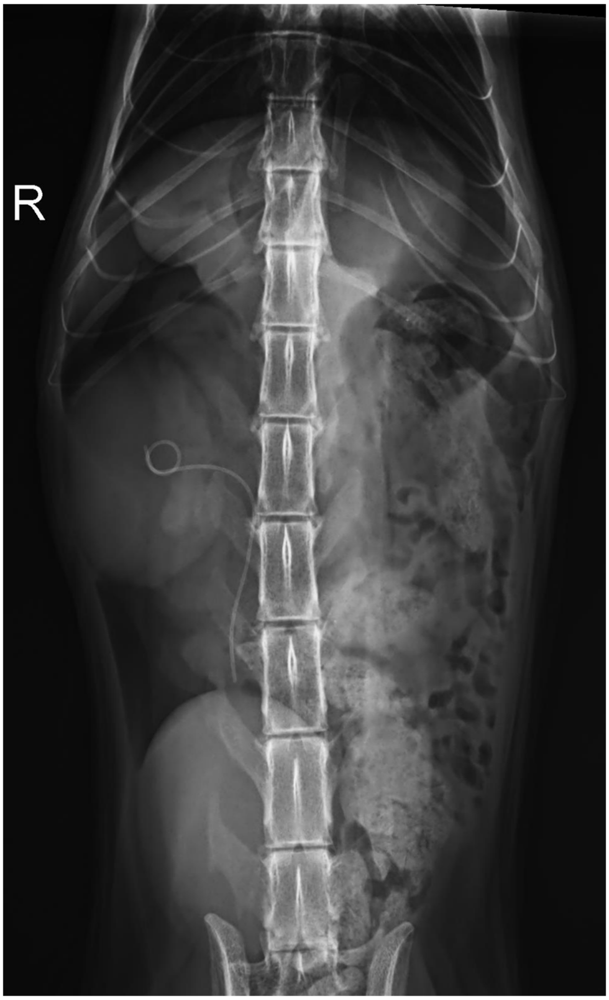

Figure 2 Immediate postoperative ventrodorsal abdominal radiograph demonstrating the location of the modified endoluminal stent in case 2

Figure 3 Immediate postoperative lateral abdominal radiograph demonstrating the location of the modified endoluminal stent in case 2

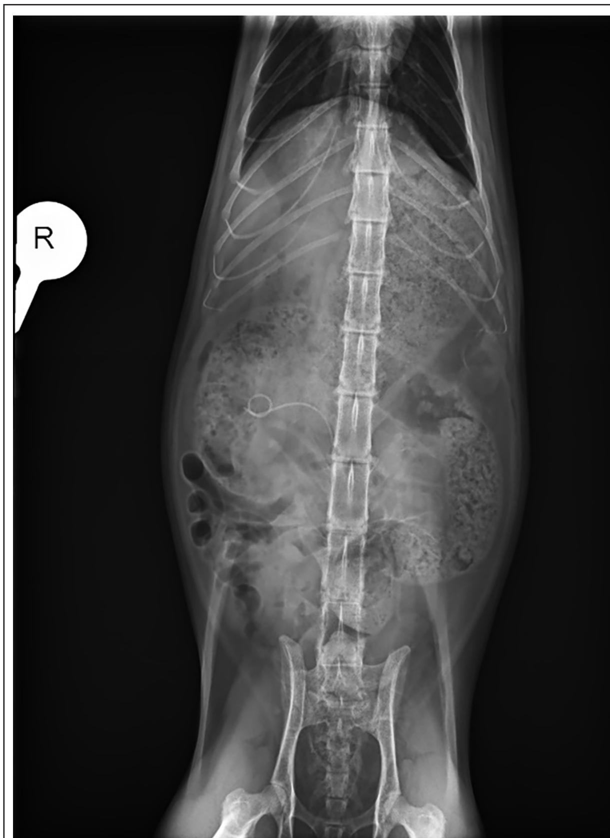

Figure 4 A ventrodorsal abdominal radiograph 7 months postoperatively demonstrating the location of the stent in case 2

revealed no change in the position of the stent. Ultrasound of the stent termination revealed no abnormalities. Serum creatinine was 109 µmol/l.

Case 2

Improvement in the azotemia was observed with serum creatinine reducing to 186 mmol/l (RI 69–160) and serum urea 24.0 mmol/l (RI 5.8–11.5) 6 weeks postoperatively. The cat was clinically normal at the last examination, 7 months postoperatively. Abdominal radiographs revealed no change in the position of the stent (Figures 4 and 5). Ultrasound of the stent termination revealed no abnormalities. Serum creatinine was 139 µmol/l.

Discussion

The benefit of endoluminal ureteral stenting in achieving renal decompression, improving the physiologic perturbations of ureteral obstruction and limiting the postoperative complications of ureterotomy is well established.[12,25] Currently available endoluminal stents, though, are associated with a high incidence of patient

Figure 5 A lateral abdominal radiograph 7 months postoperatively demonstrating the location of the stent in case 2

morbidity.[1–3,10,12,13] In case 1, a shortened endoluminal stent was placed to revise a unilateral SUB device causing abdominal discomfort, dysuria, haematuria and abdominal effusion. Modification of the conventional endoluminal stenting technique evolved from the need to bypass a complete mid-ureteral obstruction, and the request of the owner to remove the SUB and avoid further intravesical implantation. The technique was repeated in case 2 for its simplicity and efficacy.

The value of ureterotomy, in addition to ureteral stenting or bypass for feline ureterolithiasis, is not well established. Ureterotomy relieves intraluminal obstruction and yields specimens for mineral and microbiological analysis at the risk of complications, including urine leakage, and ureteral obstruction, stricture and adhesion.[26] In a recent report of SUB, ureterotomy was determined to prolong anaesthesia and surgery time, without affecting survival.[27] The rationale for stenting a ureterotomy to avoid luminal obstruction by mural soft tissue inflammation, alteration in ureteral anatomy by ureterotomy closure or stricture has been published.[26] These benefits relate specifically to the ureterotomy site. The need for the stent to extend further along the length of the ureter, other than for anchorage, has not been established. In fact, a stent spanning the entire ureter creates intravesical stent mass, renders the ureterovesicular junction non-functional and compromises the efficacy of the ureteral peristaltic activity. The physiologic and urodynamic effects of endoluminal ureteral stenting have been studied in a porcine model, revealing significant vesicorenal pressure transduction and reflux, with generalised ureteral dilation, proposed as a hypertrophic response to inefficient peristalsis, and predominantly peri-stent urine flow.[28] Other urodynamic studies in undiseased porcine ureters demonstrated that endoluminal stents contributed to ureteric obstruction in a manner related to the diameter and length of the stent.[16,29]

The design of commercially available endoluminal stents supports cystoscopic placement and retrieval, which, although reported, is less readily achievable in feline patients.[13] The curled ends limit the potential for migration in either direction.[16] Ureteral stent migration has been reported in a small number of cats, both antegrade and retrograde, and rarely, antegrade in humans.[1,13,30,31] Retrograde migration of intra-luminal ureteral stents is not reported in the human literature.[22,23] In the present cases, the proximal curled end of the stent was retained to prevent distal migration. While the influence of the intra-luminal termination of the stent on postoperative migration is unknown, migration was not observed in the present cases 7 and 8 months postoperatively.

The technical challenge of endoluminal stenting is a commonly reported limitation of their widespread use and potentially contributes to ureteral trauma.[3,10,13,32] Stents are inserted retrograde via the bladder,[2] or normograde through the kidney; however, placement via ureterotomy has been reported in conjunction with cystotomy, with advancement into the bladder and retrograde passage into the kidney.[1,10,13] In the present cases, stents were advanced directly into the renal pelvis through the ureterotomy. Placement was simplified by ureteral dilation proximal to the site of obstruction, the proximity of the ureterotomy to the renal pelvis, avoidance of stent passage through the ureterovesicular junction and past the site of ureteral obstruction. Mismatch between the stent diameter and the undilated distal ureter was avoided, another proposed mechanism of stent-related morbidity in humans.[17]

In both cases described, there was grossly recognisable proximal ureteral dilation to the level of a discrete obstruction. The previously placed SUB in case 1 permitted antegrade pyelography to establish ureteral patency after endoluminal stent placement and ureterotomy closure. Patency of the ureter beyond the stent end was not established in case 2; this was presumed based on its normal intraoperative appearance. Intraoperative ureterography, via the ureterotomy, may be appropriate in future cases to exclude the requirement for more widespread ureteral stenting or ureteral bypass.

Although gross ureteral pathology was not apparent during ultrasound follow-up in either case, the physical effect of intra-ureteral stent termination on the ureter at the stent end, is unknown. Intra-ureteral stent termination also precludes minimally invasive cystoscopic or fluoroscopic-guided removal, which is limited to ureterotomy or transrenal methods, if removal was to become necessary. Ureterotomy is accompanied by a risk of urine leakage,[1,12] further ureteral obstruction and stricture; however, the small size of the ureterotomy required to remove the stent and the ureteral dilation that develops with endoluminal stenting is expected to minimise these risks. The use of stents with retrieval strings has been reported in humans, providing a less invasive option for removal.[21–23,33] Similar approaches may have application in the future design of feline endoluminal stents.

Conclusions

The clinical efficacy and technical ease of endoluminal stenting with intra-ureteral termination for the relief of proximal ureteral obstruction is demonstrated in the cases described. The additional benefits proposed, including avoidance of intravesicular stent mass and bypass of the ureterovesicular junction, and partial preservation of ureteral peristaltic function, are supported by the reported clinical outcomes.

Although further investigation of this approach in a larger case series with a longer follow-up is necessary to allow meaningful comparison to contemporary stenting practices, this report highlights the potential advantages of the thoughtful evolution of endoluminal stent design and approaches to their placement.

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Ethical approval The work described in this manuscript involved the use of non-experimental (owned or unowned) animals. Established internationally recognised high standards ('best practice') of veterinary clinical care for the individual patient were always followed and/or this work involved the use of cadavers. Ethical approval from a committee was therefore not specifically required for publication in *JFMS Open Reports*. Although not required, where ethical approval was still obtained it is stated in the manuscript.

Informed consent Informed consent (verbal or written) was obtained from the owner or legal custodian of all animal(s) described in this work (experimental or non-experimental animals, including cadavers) for all procedure(s) undertaken (prospective or retrospective studies). No animals or people are identifiable within this publication, and therefore additional informed consent for publication was not required.

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