Use of a Boari flap and renal descensus as treatment for proximal ureteral rupture in a cat

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CASE DESCRIPTION
A 6-year-old neutered male domestic shorthair cat was evaluated because of signs of abdominal pain and anuria of 12 hours' duration after vehicular trauma.

CLINICAL FINDINGS
Lethargy, mydriasis, bradycardia, abdominal distension, and signs of pain on abdominal palpation were observed. Abdominal ultrasonography revealed moderate urinary bladder distension without evidence of free abdominal fluid; hematologic evaluation revealed leukocytosis with high BUN and serum creatinine concentrations.

TREATMENT AND OUTCOME
The patient was hospitalized, medical stabilization was attempted, and an indwelling urinary catheter was placed. Urinary output was < 1 mL/kg/h (< 0.45 mL/lb/h), and signs of abdominal pain persisted despite treatment. The next day, ultrasonographic examination revealed fluid in the retroperitoneal space, and ureteral rupture was suspected. Exploratory laparotomy confirmed retroperitoneal fluid accumulation; a large hematoma surrounded the right kidney and perirenal structures. An abdominal drain was placed to aid patient stabilization. Three days later, IV pyelography revealed rupture of the proximal part of the right ureter. Ureteroneocystostomy was performed with elongated cystoplasty through a Boari flap and caudal transposition of the right kidney (renal descensus). On follow-up examination 18 months after treatment, the cat was free of clinical signs, and results of ultrasonography, CBC, and serum biochemical analysis were unremarkable.

CLINICAL RELEVANCE
Results suggested that a Boari flap procedure with renal descensus could be a feasible alternative in the management of proximal ureteral rupture in cats, but research is needed in this area. (*J Am Vet Med Assoc* 2016;249:406–410)

A 5.5-kg (12.1-lb) 6-year-old neutered male domestic shorthair cat was referred to a veterinary hospital after being hit by a car. The patient had a history of extreme weakness, anorexia, and anuria of 12 hours' duration. During clinical examination, lethargy, bilateral mydriasis, bradycardia, abdominal distension, and vocalization during abdominal palpation were observed, and a large subcutaneous hematoma was evident on the ventral aspect of the abdominal wall. Orthopedic examination did not reveal any clinically important changes, although a skin laceration was present in the left tarsal region.

On abdominal ultrasonography, the urinary bladder was moderately distended and there was no evidence of free abdominal fluid. A CBC and serum biochemical analysis with electrolyte concentrations were performed. Results revealed leukocytosis (21.2 X 10³ WBCs/μL; reference range, 5.5 X 10³ WBCs/μL to 19.5 X 10³ WBCs/μL) with neutrophilia (14,300 neutrophils/μL; reference range, 2,500 to 12,800 neutrophils/μL). Circulating BUN (204.1 mg/dL; reference range, 30 to 65 mg/dL) and creatinine (5.54 mg/dL; reference range, 0.6 to 1.6 mg/dL) concentrations

were high. The patient was hospitalized, and medical stabilization was attempted. Saline (0.9% NaCl) solution was administered IV (4 mL/kg/h [1.8 mL/lb/h]), and the patient received cefazolin sodium[a] (10 mg/kg [4.5 mg/lb], IV, q 8 h) and morphine[b] (0.3 mg/kg [0.14 mg/lb], IM, q 4 to 6 h). An indwelling urinary catheter[c] was placed and attached to a closed system to measure urine output.

Despite mild clinical improvement after 24 hours of hospitalization, urine output was < 1 mL/kg/h (< 0.45 mL/lb/h), and signs of severe abdominal pain were still present. Abdominal ultrasonography was repeated, and results revealed a small amount of free fluid in the retroperitoneal space as well as areas of increased echogenicity that could be indicative of inflammatory changes to the retroperitoneum. No other clinically relevant abnormalities were identified, and a tear in the urinary tract was suspected.

The cat was premedicated with dexmedetomidine hydrochloride[d] (50 μg/kg [22.7 μg/lb], IM) and morphine[b] (0.5 mg/kg [0.23 mg/lb], IM) in preparation for an exploratory laparotomy. Anesthesia was induced with diazepam[e] (0.2 mg/kg [0.09 mg/lb],

IV) and propofol[f] (4 mg/kg, IV, to effect). The patient was intubated, and anesthesia was maintained with isoflurane[g] in oxygen. During the surgical procedure, additional boluses of fentanyl[h] (2 μg/kg [0.9 μg/lb], IV) were administered for analgesia. Abdominal exploration via a ventral midline approach with fenestration of the retroperitoneum confirmed the presence of free fluid in the retroperitoneal area; a large hematoma surrounded the right kidney and perirenal tissues. The urinary bladder did not appear damaged. A closed-suction abdominal drain[i] was placed to measure fluid production and allow the patient to stabilize prior to further investigation. Serum-to-retroperitoneal fluid creatinine (1:3) and potassium (1:2) ratios confirmed the suspected uroretroperitoneum.

Three days after placement of the abdominal drain, the cat's BUN concentration (46.3 mg/dL) and serum creatinine concentration (1.07 mg/dL) were within the respective reference ranges. The patient's clinical condition was also improved, and urine output measured through the closed urine collection system was > 2 mL/kg/h. Intravenous pyelography was then performed; with the patient under general anesthesia, iohexol[j] (2 mL/kg) was administered IV, and radiographs (lateral and ventrodorsal views) were obtained immediately and at 5, 10, 15, and 30 minutes after the injection. A complete rupture was identified in the proximal third of the right ureter, 2 cm from the renal pelvis (Figure 1).

The patient was prepared for laparotomy via a ventral midline approach during the same anesthetic episode. The surgical procedures included uretero-neocystostomy after elongated cystoplasty through the creation of a Boari flap (Figure 2) and kidney transposition to a lumbar position (renal descensus; Figures 3 and 4). After complete inspection of the damaged tissues and abdominal organs, the urinary bladder was exposed and the 1.5-cm-long ureteral tear was identified. Nonabsorbable 5-0 monofilament polypropylene suture[k] was used to ligate the distal portion of the avulsed ureter, and a 5-0 stay suture[k] was placed in the proximal portion. The right kidney
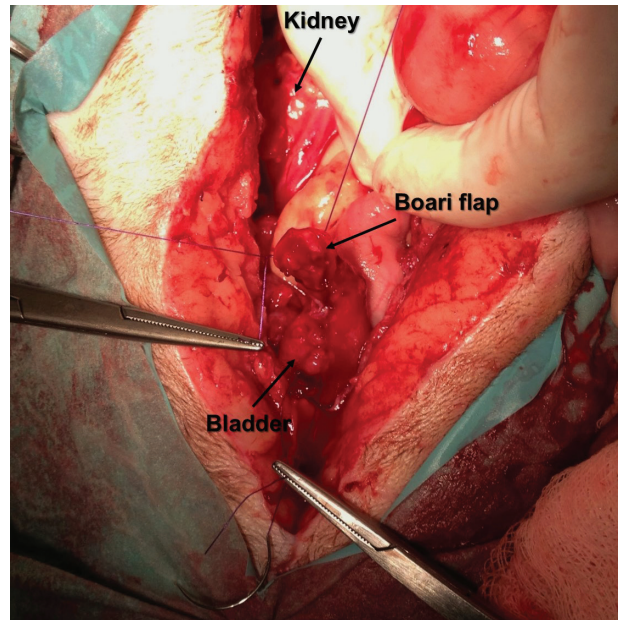

Figure 2—Intraoperative photograph showing creation of a Boari flap for elongated cystoplasty to reconstruct the ruptured right ureter in the same cat as in Figure 1.

Figure 1—Ventrodorsal radiographic view obtained during IV pyelography of a 6-year-old neutered male domestic shorthair cat with a history of extreme weakness, anorexia, and anuria of 12 hours' duration after sustaining vehicular trauma. Rupture of the right ureter is evident.
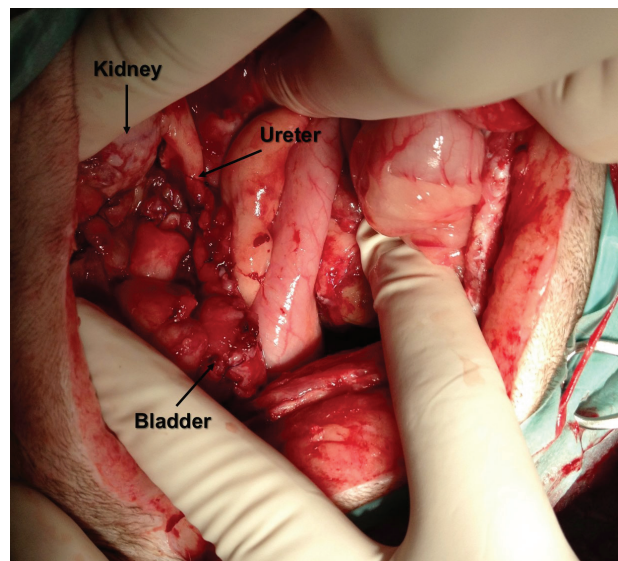
Figure 3—Intraoperative photograph showing the reconstructed ureter after renal descensus and the Boari flap procedure.
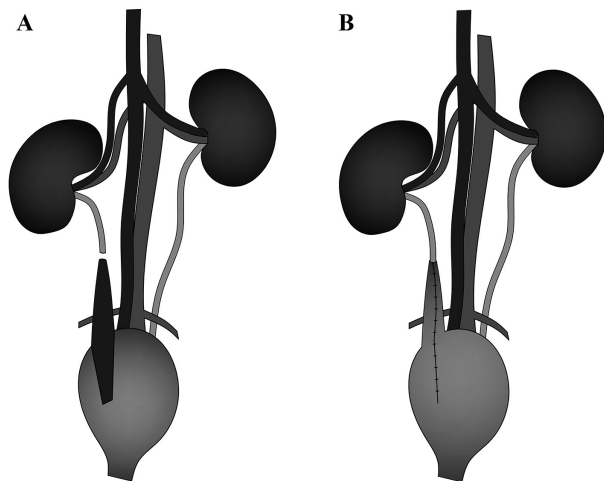
Figure 4—Illustrations depicting use of the Boari flap procedure for reconstruction of a ruptured ureter following renal descensus in a cat. After ligation of the distal aspect of the ureter, the damaged portion of the ureter has been excised. The caudally repositioned ipsilateral kidney has been pexied to lumbar abdominal musculature. A—A full-thickness flap of the urinary bladder wall, with the base located at the apex of the bladder, was reflected proximally. B—After the distal end of the remaining ureter was implanted through the reflected end of the flap and the ureteral wall was sutured to the bladder mucosa with a circumferential simple interrupted pattern, the bladder defect was closed as a tube in a simple continuous pattern.

Figure 5—Ventrodorsal radiographic view obtained during IV pyelography 1 week after surgical treatment by renal descensus and a Boari flap procedure. Excretion of iodinated contrast medium from the right kidney through the reconstructed right ureter into the urinary bladder is evident.

was exposed and released from its sublumbar attachments; once freed, the kidney was displaced caudally by the approximate length of 2 vertebral bodies. Pexy of the renal capsule to the lumbar muscle fascia was performed by placement of 4-0 polypropylene sutures[k] in a simple interrupted pattern.

An elongated cystoplasty (Boari flap procedure) was performed as described elsewhere.[1,2] A full-thickness flap of the urinary bladder was elevated from the ventral aspect of the bladder wall, with the base located at the apex of the bladder. A small mosquito hemostat was passed from the inside to the outside of the bladder flap at its distal end, and the distal end of the ureter was pulled through the bladder wall flap and drawn into the lumen. Periureteral fat was carefully removed, and the ureteral end was spatulated to slightly widen the opening. The ureteral wall was apposed to the bladder mucosa and sutured in a circumferential simple interrupted pattern with 7-0 monofilament absorbable suture.[l] Following the ureteroneocystostomy, the bladder defect was closed as a tube from the caudal aspect of the ventral incision to the apical part of the flap with 4-0 absorbable monofilament suture[l] in a continuous pattern. There was no leakage after the procedure. A new indwelling urethral catheter[c] and closed-suction abdominal drain[i] were placed before routine abdominal closure. Recovery from general anesthesia was uneventful.

Two days after ureteral surgery, the patient's BUN and serum creatinine concentrations were sta-

ble (51.1 mg/dL and 1.03 mg/dL, respectively) and its clinical condition had improved. Urinary output was > 2 mL/kg/h, and some urine was observed leaking out around the urinary catheter, which was then removed. At 72 hours after surgery, the daily abdominal fluid output was considered minimal (< 1 mL/kg/d); the abdominal drain was removed, and a bandage was placed for wound protection. One week after the surgery, IV pyelography was repeated. The movement of contrast medium into the urinary bladder via the right ureter and surgically created tube was confirmed, and there was no evidence of contrast medium leakage (Figure 5). The patient was bright and responsive and had a good appetite; a CBC and serum biochemical analysis revealed values within the respective reference ranges, and the cat was discharged from the hospital. On recheck ultrasonography 3 months after surgical treatment, no free abdominal fluid or remarkable renal changes were detected. A recheck of BUN and serum creatinine concentrations revealed values within the reference ranges. Eighteen months after the surgery, the cat was reportedly doing well; its most recent examination had included a CBC, serum biochemical analysis, and abdominal ultrasonography, each of which had unremarkable results.

Discussion

Ureteral rupture is a rarely reported condition in veterinary patients. It may be secondary to blunt trauma or penetrating injuries or can have iatrogenic

causes, most often during abdominal surgery.[3,4] Patients that have external trauma to the abdomen and associated ureteral injury can have various clinical signs associated with uroperitoneum, including lethargy, anorexia, signs of abdominal pain, vomiting, hypothermia, hematuria, ecchymosis, and azotemia.[3,5] However, when urinary leakage is confined to the retroperitoneum (uroretroperitoneum), the clinical signs may be more subtle, making diagnosis extremely challenging.[3,5] The cat of this report had no free abdominal fluid evidenced on the initial ultrasonographic examination. The following day, a small amount of retroperitoneal fluid was detected, but it was only after exploratory laparotomy and creation of a small fenestration of the retroperitoneuem that the placement of an abdominal drain was considered appropriate.

The location and small diameter of the ureters, associated with the lack of a flawless imaging modality, can make acute ureteral injuries challenging to diagnose. Abdominal ultrasonography can be unreliable for this purpose.[6] Computerized tomography and IV pyelography seem to be the most useful diagnostic tools, but both require heavy sedation or general anesthesia, which often is inappropriate given the critical condition of most patients.[6]

The main concern during ureteral repair is preservation of renal function. Direct end-to-end ureteral anastomosis is a challenging surgical technique, considering the reduced diameter of the feline ureter and the high proliferative capacity of the urothelium.[7] Postoperative stricture formation is commonly reported as a major complication following ureteral surgery.[8-10] When rupture occurs in the distal part of a ureter, ureteroneocystostomy can be performed as an alternative to end-to-end anastomosis. Possible tension-relieving techniques include renal descensus or psoas cystopexy.[3,4,7] Repair of a proximal ureteral rupture can be a very challenging procedure, especially in cats. The small diameter and limited length of the feline ureter make the end-to-end anastomosis (ureteroureterostomy) a technique that can easily fail, even when performed under magnification.[1] Different surgical approaches have been described to manage ureteral ruptures, with basic aims of restoring ureteral continuity and preserving renal function.[11] Careful ureteral debridement and mobilization as well as a tension-free, leak-proof anastomosis are the most important principles of ureteral surgery.[12-14] Postoperative complications such as stricture and urine leakage from the repair site can reduce the chances for a successful outcome. Other surgical treatment options include ureteral stenting, ureteral reimplantation (ureteroneocystostomy), and placement of ureteral bypass devices. Obstruction, stricture formation, and inflammation are some of the most frequent complications described after ureteral stenting.[8-10,15]

In the cat of this report, rupture occurred in the proximal third of a ureter. The clinical signs, the presence of azotemia, and the subsequent finding of ret-roperitoneal fluid accumulation raised suspicion for a tear in the urinary tract. However, the severe hematoma and inflammation involving the right kidney and surrounding tissues made visual assessment of ureteral viability unreliable during exploratory laparotomy and could have substantially increased the risk of surgery-related complications. Therefore, the decision was made to place an abdominal drain during the first surgical procedure to allow further patient stabilization prior to a more definitive treatment. Indeed, despite mild clinical improvement with supportive care, the cat was not clinically stable and had moderate azotemia, so any attempt at further diagnostic procedures which would have required extended anesthetic time could have worsened renal function.[16] Both the azotemia and the patient's clinical status improved within 3 days after drain placement.

Intravenous pyelography in the stabilized patient confirmed a rupture of the right ureter 2 cm away from the renal pelvis. Tissue debridement and a tension-free anastomosis, even over a stent, would have been difficult to achieve considering the 1.5-cm-long leakage area. Furthermore, inflammation of the ureter and within the retroperitoneum as well as the proximal location of the tear suggested that the patient would have a risk of stricture formation after attempting anastomosis.[17] In 2 retrospective studies published by Kyles et al[8,18] and a review by Berent[19] on management of ureteral calculi, procedure-related complications were reported in > 30% of cases, mainly attributable to in situ inflammatory reactions, stricture formation, and urine leakage after ureterotomy.

In our patient, only one-third of the ureter was intact, and direct anastomosis to another organ such as skin or colon or use of a subcutaneous ureteral bypass system could have been possible. However, in patients with ureteral anastomoses to sites other than the bladder, an increased risk of infection (with subsequent pyelonephritis), obstruction, urine leakage, and neurologic and metabolic abnormalities have been reported.[11,13,20,21] Although successful replacement of a ureter with an ileal graft in a cat has recently been described, further data are required to assess morbidity and success rate of this procedure.[20]

Considering the location of the ureteral tear in the cat of the present report, any attempt to perform an ureteroneocystostomy would have been compromised by excessive tension in the anastomosis, unless additional reconstruction techniques were performed before attempting ureteral reimplantation. Cranial mobilization of the urinary bladder and caudal mobilization of the affected kidney have been described as tension-relieving techniques to aid ureteroureterostomy.[14,22,23] Pexy of the urinary bladder apex to the caudal pole of the kidney or the iliopsoas muscle (cystopexy via a psoas hitch) and the creation of a Boari flap have also been described as techniques to prevent tension at the anastomotic site in cases of severe loss of distal ureteral length.[1,12,13,24] In the cat of the present report, the authors considered the cys-

toplasty technique through a Boari flap as an efficient means of approximating the bladder to the ureter. Renal autotransplantation could theoretically also be an option, but it is still considered an experimental procedure in veterinary patients, carrying substantially greater risks than the previously described tension-relieving techniques.[13]

Although a ureteronephrectomy could be considered a less complicated surgical procedure than other options,[7] the high prevalence of chronic kidney disease in older cats[25,26] and the possibility of development of other urinary tract diseases (eg, urolithiasis) should preclude this recommendation.[18] Renal descensus combined with the Boari flap procedure had a successful outcome in the patient of this report, suggesting this could be a feasible alternative to management of rupture in the proximal aspect of a ureter in cats. However, further evidence is required to establish complication and success rates of this procedure in cats.

Acknowledgments

Footnotes

a. Cefazolina, Labesfal, Viseu, Portugal.
b. Morfina 1%, B Braun Medical, Queluz de Baixo, Portugal.
c. Buster cat catheter, sterile, 1.0 X 130 mm, Henry Schein, Lisbon, Portugal.
d. Dexdomitor, Esteve Farma, Carnaxide, Portugal.
e. Diazepam, Labesfal, Viseu, Portugal.
f. Vetofol, Esteve Farma, Carnaxide, Portugal.
g. Isoflo, Esteve Farma, Carnaxide, Portugal.
h. Fentanilo, B Braun Medical, Queluz de Baixo, Portugal.
i. Multipurpose drain, Mila International, Barcelona, Spain.
j. Omnipaque, 240 mg/mL, Satis, Carnaxide, Portugal.
k. Premilene, B Braun Medical, Queluz de Baixo, Portugal.
l. Monosyn, B Braun Medical, Queluz de Baixo, Portugal.

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