Bilateral ureteral obstruction and subcutaneous ureteral bypasses: a feline case report

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Chelsey Surgenor

RVN BSc (Hons) | Pride Veterinary Centre, Derbyshire, UK

chelseysurgenor@hotmail.com

Chelsey holds a Zoo Biology BSc (Hons) degree, has been in practice since 2014, qualified as an RVN in 2020 and started the Vets Now Cert VN ECC course in 2021. Having spent the first few years in general practice, Chelsey transitioned to an Internal Medicine nursing role soon after qualifying, while continuing to locum in emergency and referral practices. Her key areas of interest encompass critical care nursing and medicine diagnostics.

ABSTRACT Bilateral ureteral obstruction in felines is relatively uncommon, with subsequent placement of bilateral subcutaneous ureteral bypasses even more uncommon for veterinary nurses to encounter in practice. This case report covers the presentation, diagnostics, treatment, nursing care, complications and ongoing outpatient care of Kolo, a two-year-old ragdoll, who presented with this condition and ultimately required surgical intervention for a successful outcome. Part 1 encompasses the patient's journey from admission to hospitalised recovery. A glossary of terms can be found at the end of Part 1.

Key words renal, feline medicine, surgery, nursing care, intensive care, case study, ureteral

Introduction

Renal disease is relatively common in cats and can be divided into two entities: chronic kidney disease (CKD) and acute kidney injury (AKI). The key difference between the two is the rate of disease progression (Segev, 2018). Aetiology of AKI often involves toxic, ischaemic or infectious components (Aldridge & O'Dwyer, 2013). Ureteral obstruction can also cause AKI, with ureteral calculi being the most common cause of obstruction and calcium oxalate comprising 98% of ureterolithiasis in cats (Hardie & Kyles, 2004; Kyles et al., 2005).

Ureteral obstructions are an emergency and require immediate care. Consensus statements of The American College of Veterinary Internal Medicine (ACVIM) advise that medical management is rarely effective for the treatment of obstructive ureterolithiasis, and management should be achieved through surgical interventions such as ureteral stenting or subcutaneous ureteral bypass (SUB™) (Lulich et al., 2016).

Ureteral stenting is the placement of a small tube within the ureter(s) that enables passive ureteral dilation, prevents stricture formation and resolves obstruction (Wormser et al., 2016). However, the small diameter of the ureteral lumen in cats presents challenges for stent placement (Kulendra et al., 2021). Eliminating this challenge, the SUB™ system was first produced by Norfolk Vet Products in 2009. It has since been redesigned and advanced repeatedly in response to

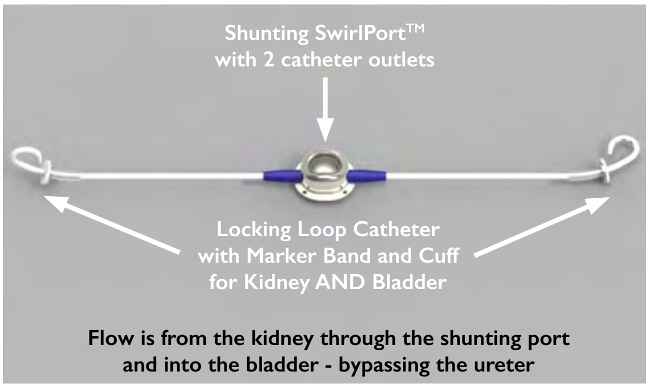

Figure 1. Subcutaneous Ureteral Bypass (SUB™) 2.0 device developed by Norfolk Vet Products (Norfolk Vet Products, 2018a).

reported complications. The key components of the SUB™ system include a nephrostomy catheter placed in the kidney, a SwirlPort™ placed subcutaneously and a cystostomy catheter placed in the bladder (Figure 1) (Norfolk Vet Products, 2018a). The catheters remain internal within the abdomen and, whilst the subcutaneous SwirlPort™ remains beneath the skin, it is palpable externally. Fundamentally, the SUB™ device is a permanent fixture that becomes an artificial ureter. Without complications, the patient's urinary system can function as normal without assistance. However, there is some maintenance required which is the key purpose of the SwirlPort™. This will be discussed in Part 2 of this case report.

Initial presentation

Kolo, a two-year-old female neutered ragdoll (Figure 2) presented with lethargy, inappetence and vomiting, over a 48-hour period.

Physical exam findings demonstrated in Table 1.

Table 1. Physical findings of the patient at time of admission.

Assessment	Findings
Demeanour	Depressed mentation, lateral recumbency but responsive, lip licking
Mucous membranes	Pale pink, with capillary refill time of two seconds
Chest auscultation	No abnormalities detected
Heart rate	Bradycardia of 150 bpm. Pulses synchronous
Electrocardiogram	Trace absent of P wave. QRS complexes normal
Temperature	Normothermia of 38 °C
Pain	Pain detected upon palpation of kidneys

Treatment, investigations and diagnostics

Veterinary nurses have a participating role in assisting and implementing investigations, diagnostics and treatment under the veterinary surgeon's direction.

An intravenous catheter was placed in the right cephalic vein and a blood sample obtained. In-house blood analysis was carried out including biochemistry, haematology and venous blood gas analysis (EPOC) (Table 2). Severe azotaemia and moderate hyperkalaemia were identified, consistent with AKI. The International Renal Interest Society (IRIS) AKI grading criteria categorises a blood creatinine value of more than 880 µmol/L at the highest, grade 5 (Cowgill, 2016). The patient's first blood creatinine value presented at 1326 µmol/L, indicating the severity of AKI.

Intravenous fluid therapy (IVFT) was commenced at a rate of twice maintenance, and medication of buprenorphine, maropitant, omeprazole and calcium gluconate were administered. Due to concerns regarding no improvement overnight and a guarded prognosis, emergency referral to an internal medicine department was offered and accepted.

Figure 2. Photograph of Kolo.

Table 2. Partial Results of Blood Analysis (EPOC). Measurements: CREA, (Creatinine) umol/L. UREA mmol/L. Na+ (Sodium) mmol/L. Ca++ (Ionised calcium) mmol/L. GLU (Glucose) mmol/L. WNL: within normal limits.

DATE	TIME	CREA	UREA	pH	Na+	Ca++	GLU
29.01.21	2043	1326 - HIGH	42.8 HIGH	7.09 - LOW	141 - LOW	0.94 - LOW	6.5 - WNL
30.01.21	0404	1326 - HIGH	42.8 HIGH	7.04 - LOW	137 - LOW	0.96 - LOW	6.2 - WNL
30.01.21	1038	1326 - HIGH	42.8 HIGH	7.13 - LOW	137 - LOW	1.14 - LOW	5.9 - WNL
30.01.21	1633	1326 - HIGH	42.8 HIGH	7.12 - LOW	139 - LOW	1.6 - HIGH	6.4 - WNL
31.01.21	1641	411 - HIGH	28.7 HIGH	7.15 - LOW	166 - HIGH	1.57 - HIGH	8.4 - HIGH
31.01.21	2140	330 - HIGH	27 HIGH	7.16 - LOW	165 - HIGH	1.54 - HIGH	7.3 - HIGH
01.02.21	0709	235 - HIGH	21.2 HIGH	7.2 - LOW	162 - WNL	1.36 - HIGH	6.9 - WNL
01.02.21	1746	169 - WNL	17 HIGH	7.2 - LOW	157 - WNL	1.33 - HIGH	6.6 - WNL
02.02.21	1040	132 - WNL	11.6 - WNL	7.3 - WNL	152 - WNL	1.31 - WNL	5.6 - WNL
03.02.21	0947	152 - WNL	10.2 - WNL	7.28 - WNL	156 - WNL	1.36 - HIGH	6.1 - WNL
04.02.21	0913	121 - WNL	8 - WNL	7.39 - WNL	154 - WNL	1.32 - WNL	5.7 - WNL
05.02.21	1438	130 - WNL	7.2 - WNL	7.44 HIGH	153 - WNL	1.23 - WNL	7.7 - HIGH
06.02.21	1151	103 - WNL	7.1 - WNL	7.42 HIGH	153 - WNL	1.27 - WNL	5.2 - WNL
07.02.21	1116	127 - WNL	5.7 - WNL	7.42 HIGH	154 - WNL	1.36 - HIGH	5.7 - WNL
08.02.21	0939	114 - WNL	7.3 - WNL	7.39 - WNL	154 - WNL	1.36 - HIGH	5.3 - WNL
09.02.21	0914	127 - WNL	9.6 - WNL	7.38 - WNL	154 - WNL	1.35 - HIGH	5.2 - WNL
18.02.21	0951	181 - WNL	11.4 - WNL	7.35 - WNL	150 - WNL	1.32 - WNL	5.7 - WNL
03.03.21	1334	117 - WNL	9.7 - WNL	7.41 - WNL	153 - WNL	1.27 - WNL	6.5 - WNL
04.05.21	0939	95 - WNL	8.5 - WNL	7.33 - WNL	152 - WNL	1.31 - WNL	6.8 - WNL

Following examination, the patient had a sedation plan created and administered. Abdominal ultrasound was performed. Key findings included pyelectasis, three ureteroliths measuring 1.0 mm, 0.7 mm and 1.2 mm in the distal aspect of the left ureter and one ureterolith measuring 1.7 mm in the distal aspect of the right ureter. Distally to the locations of the ureteroliths, both ureters were not dilating. The bladder was empty and poorly recognisable. All of which were consistent with bilateral ureteral obstruction. Subtle bilateral parenchymal renal changes were identified and therefore underlying CKD could not be excluded. Due to the critical state of the patient and the unlikelihood that the patient could be stabilised with medical management, emergency surgical intervention of bilateral SUB™ placement was required for resolution.

Anaesthesia and surgery

Transition from sedation to general anaesthesia was planned and implemented. Due to the severe biochemical disturbances and compromised nature of the patient's condition, an American Society of Anaesthesiologists (ASA) physical status score of 4 was allocated, thereby considered high risk (AVTAA, 2013)(Table 3).

Placement of the two SUB™s was achieved with open abdominal surgery, fluoroscopy guidance and modified Seldinger techniques. Nephrostomy catheters were placed first in both kidneys. Pyelocentesis samples were extracted for culture and sensitivity testing and a pyelogram performed to ensure appropriate patency and location of these catheters. The cystotomy catheters were then placed in the bladder. Bilateral abdominal incisions enabled attachment of the SwirlPort™s subcutaneously and were sutured to the abdominal wall. The systems were finally flushed to leak test and check patency before closing the abdomen. Visualisation of the same model of SUB™ device prior to placement can be seen in Figure 1. Radiographs of the SUB™ device in situ can be seen in Figures 3 and 4. A naso-oesophageal feeding tube was placed due to anticipated inappetence associated with kidney disease, and radiographs taken to confirm placement.

Recovery and nursing considerations

POST-OPERATIVE HOSPITALISATION

Once extubated, recovery was monitored continuously in the intensive care unit (ICU) using a multiparameter monitor including an ECG, pulse oximetry, oscillmetric blood pressure and temperature probe. Readings were recorded every 15 minutes once parameters considered stable. At each recording, heart rate was auscultated and pulse rate and quality palpated. Once the patient was responsive and moving, checks and recordings were performed hourly. Recovery was considered smooth and stable, excluding the complication of hypothermia which was rectified using a Bair Hugger™. After 24 hours, checks were reduced to TID.

IVFT (twice maintenance) and ketamine constant rate infusion (CRI)(10 mcg/kg/min) were continued for approximately six hours post-operatively. The ketamine CRI was then reduced (5 mcg/kg/min) for a further six hours, while potassium chloride (KCl) supplementation (40 mmol/L at maintenance rate) was introduced. Approximately 12 hours following surgery, the patient continued with twice maintenance IVFT and KCl supplementation. It should be noted that during ketamine CRI's, frequent corneal lubrication (q4h allocated to this patient) is important. When the

Table 3. American Society of Anaesthesiologists (ASA) Physical Status Scores. Adapted from (AVTAA, 2013).

ASA Score	Classification	Level of risk
I	Normal healthy animal. No underlying disease.	Minimal
II	Minor disease process present. Mild systemic disturbances that individual can compensate for. Neonates, geriatrics, obesity.	Slight
III	Moderate systemic disease present. Clinical signs present. Moderate anaemia, moderate dehydration, pyrexia, low grade heart murmur or cardiac disease.	Moderate
IV	Significantly compromised by disease. Constant threat to life. Severe dehydration, shock, uraemia, toxaemia, severe pyrexia, uncompensated heart disease, uncompensated diabetes, pulmonary disease, emaciation.	High
V	Moribund. Surgery usually required as final attempt to preserve life. Advanced heart, renal, liver or endocrine disease. Profound shock, severe trauma, pulmonary embolus, terminal malignancy.	Extreme

patient was transferred from ICU to cat ward, KCl supplementation was discontinued and IVFT reduced from twice maintenance to maintenance on day five post-surgery.

The patient was continued on methadone (0.2 mg/kg q4h), maropitant (1 mg/kg SID), cefuroxime (20 mg/kg q8h) and omeprazole (1 mg/kg BID) immediately after surgery. Pain scoring before each methadone administration was performed using the Glasgow Composite Measure Pain Scale for cats (CMPS-Feline). If a score of more than five was allocated, then a methadone "top up" of 0.1 mg/kg could be added, totalling the dose to 0.3 mg/kg. However, the patient was consistently scored at five or below. The patient was transitioned from methadone to buprenorphine (0.015 mg/kg q8h) on day three post-surgery. On day four, analgesia and omeprazole were discontinued. Pain scoring q4h was discontinued on day five as the patient demonstrated consistent comfort without analgesia. Maropitant and cefuroxime were discontinued the day before discharge. In total, the patient spent 12 days hospitalised.

ONGOING BLOOD GAS ANALYSIS MONITORING

Blood gas analysis was repeated twice daily in the 48 hours post-surgery. As seen in Table 1, the patient's blood creatinine returned to within normal parameters within 48 hours, and their blood urea nitrogen within 72 hours, of surgery. Thereafter, analysis was repeated daily until discharge.

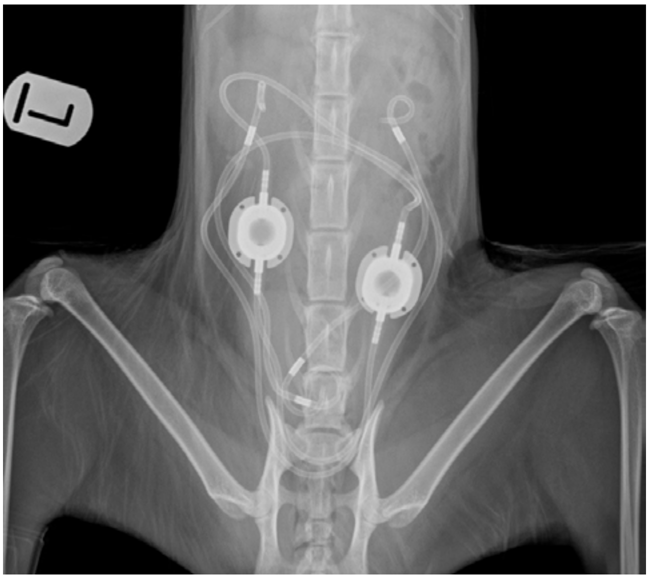

Figure 3. Dorsoventral radiograph of patient following SUB™ placement. Intellectual property of Pride Veterinary Centre.

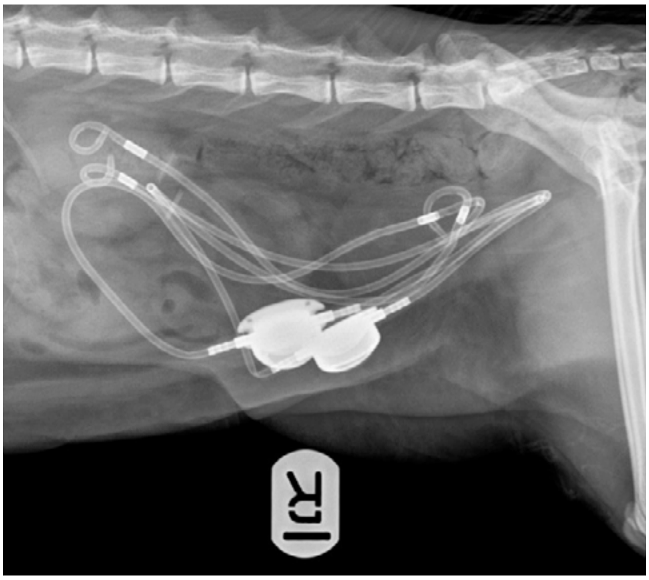

Figure 4. Right lateral radiograph of patient following SUB™ placement. Intellectual property of Pride Veterinary Centre.

NUTRITION AND OESOPHAGSTOMY FEEDING TUBE PLACEMENT

Nutritional requirement is an essential nursing consideration and is often challenging in critical and renal patients. An ideal diet has not yet been validated for AKI patients. However, there has been suggestion that diets suitable for CKD patients would also be suitable for AKI patients (Haskey, 2019). Such diets comprise of moderate protein and potassium, and low phosphate. However, with ultrasound findings being inconclusive of the presence of CKD in this case, such a diet could be considered unsuitable. Recommendations vary in AKI cases, with some advising reduced protein to reduce uraemic signs, and others advising increased protein to improve renal recovery (Francey, 2015). Ultimately, there has been insufficient evidence-based investigations, and therefore anecdotal accounts and pathophysiological justifications are to be relied on. With relevance to the case study, in-hospital nutrition primarily focused on tissue repair and renal recovery.

Inappetence and nausea are common consequences of uraemia. Therefore, many CKD and AKI patients will present with these clinical signs. On occasion, resolution of uraemia does not follow with an improved appetite. Reasoning for this is often attributed to learned food aversion. Learned food aversion occurs when the patient associates a negative physical manifestation such as nausea or pain with food as an acquired defence mechanism (Quimby, 2013).

In the discussed case, the patient continued to demonstrate inappetence throughout hospitalisation, despite resolution of uraemia seen in Table 2. Only during the last three days of hospitalisation did the patient eat very small amounts of dry biscuits and wet pouches intermittently. It could be suggested that there was a link to learned food aversion. A naso-oesophageal feeding tube was placed at the time of surgery but unfortunately was displaced two days after. Due to the SUB's requiring flushing five days post-surgery, it was opted that an oesphagostomy tube be placed at the same time to provide enteral nutrition and enable ongoing nutritional support after discharge if required.

Upon reflection, the prevalence of inappetence and food aversion in cats with renal disease may warrant placement of an oesophagostomy tube at the time of surgery in similar cases. A catabolic state is unsuitable for tissue repair and renal recovery. Thus, delay in providing a feeding tube could be considered detrimental. Furthermore, an oesophagostomy tube, as opposed to naso-gastric or naso-oesophageal tubes, may prove more suitable in reducing the requirement of another general anaesthetic and the potential need of ongoing nutritional support long term and at home.

CALORIE REQUIREMENT CALCULATIONS

Following placement of the oesphagostomy tube, a feeding plan was implemented. Resting Energy Requirement (RER) for the patient was calculated using a calculation appropriate for patients weighing >2kg:

RER in kcal = (Body weight in kg x 30) + 70

Due to more than three days of inappetence, the patient was started on ⅓ of the Resting Energy Requirement (RER) for the first 24-hour period, divided into five individual feeds comprising of Royal Canin recovery liquid diet. During the following 24-hour period, ⅔ of the RER was met and thereafter the full RER. The plan was in line with current recommendations of calculating RER and starting with ⅓ of the requirement. However, there is discussion regarding whether the incremental increases should be performed every 12 or 24 hours. It is important to consider that nutritional support for a critically ill patient is to achieve maintenance of homeostasis and not necessarily weight gain (Carlson, 2018). The patient's weight reduced slightly during hospitalisation, having been 3.7kg at admit and 3.5kg at discharge.

Some recommendations encompass an illness factor into the calculation by multiplying the RER by a factor of between 1.1 and 2, to increase the requirement to meet higher demands. However, findings utilising indirect calorimetry methods in dogs demonstrated that the conservative approach of calculating RER was more appropriate for critically ill and post-operative patients than the more generous illness factor inclusion (Chan & Freeman, 2006; Walton et al., 1996).

Summary

Part 1 has reported the case study from admission to surgery and throughout hospitalisation. Part 2 reports from discharge to ongoing outpatient care which requires life-long commitment.

Reflective professional development notes. To access hyperlinks to the references, scan the QR code on page 3.

Acknowledgements

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Definitions

Azotaemia Elevation of nitrogenous products such as blood urea nitrogen (BUN) and creatinine levels

BID Twice daily

Centesis Prefix for the act of puncturing a body cavity or organ to withdraw fluid

Cystitis Inflammation of the urinary bladder

Fluoroscopy Imaging technique that utilises continuous x-ray beams to provide real-time moving imaging

Homeostasis Self-regulation to provide internal equilibrium of physiological processes

Hyperkalaemia Elevated potassium levels in the blood

Paranchymel Relating to the functional tissue of an organ

Pyelectasis Dilation of the renal pelvis

Pyelo Prefix for renal pelvis

Pyelocentesis Withdrawing fluid from the renal pelvis utilising a needle

Pyelogram Imaging of the renal pelvis, usually utilising contrast

Q4h Every four hours

SID Once daily

TID Three times daily

Uraemia Elevated urea in the blood

Ureter Anatomical tube that carries urine from the kidneys to the urinary bladder

Ureterolith A stone or calculus in the ureter

Ureterolithiasis The concept of stones in the ureter

Urethra Anatomical duct that transfers urine from the urinary bladder to the exterior of the body

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