Ureteral Obstruction Leading to Nephrectomy in a Cat

Introduction

Ureteroliths have been documented to be the most common etiology of feline ureteral obstruction.[1] Ureteral obstruction, in cats, can be secondary to ureterolithiasis, ureteral strictures, infection, dried solidified blood calculi, iatrogenic ureteral ligation, ureteral ectopia, retroperitoneal fibrosis after renal transplantation, and neoplasia.[1]

Regardless of the etiology, acute kidney injury occurs due to an increased pressure within the renal pelvis and ureter that decreases renal blood flow and glomerular filtration rate (GFR), resulting in renal tubular inflammation and injury.[1]

Cats with ureteral obstruction typically have vague and non-specific clinical signs on presentation, which includes lethargy, decreased appetite or anorexia, vomiting, polyuria and polydipsia, abdominal pain, and weight loss.[1] Lower urinary tract signs, such as hematuria, stranguria, pollakiuria, incontinence, and periuria may also occur.[1] Severity of patient illness depends on the function of the contralateral kidney as well as other coexisting comorbidities.[1] Physical exam findings in cats with ureteral obstruction may include depression, pain on renal palpation, dehydration, nausea, uremic oral ulceration, renomegaly, one small or irregularly shaped kidney with a contralateral normal or enlarged kidney, variable bladder size, and muscle atrophy.[1]

Differential diagnoses for ureteral obstruction can be vast and may include the following: urinary tract infection, pyelonephritis, renal disease, urinary obstruction due to uroliths, diabetes mellitus, hyperthyroidism, inflammatory bowel disease, gastrointestinal lymphoma, and renal neoplasia.

Diagnostic testing for patients with suspected ureteral disease starts with imaging and blood testing.[1] Common biochemical and urinary abnormalities noted are azotemia, hyperphosphatemia, hypercalcemia or hypocalcemia, hyperkalemia, anemia, isosthenuria, hematuria, pyuria, bacteriuria, and crystalluria.[1] Diagnostic imaging is essential in patients with ureteral disease.[1] Abdominal radiographs alone have an 81% sensitivity for diagnosing ureteral calculi which can increase to 90% when combined with ultrasonography.[1] However, obstructive ureteroliths in cats can be smaller than 2 mm, which is less than the limit of detection with radiographs.[1] Abdominal ultrasound provides more detailed evaluation of the urinary tract because it allows for assessment of renal blood flow, changes to the echotexture of the parenchyma, evaluation of renal pelvis, echogenicity of the urine, small stones in the renal pelvis and ureter, ureteral narrowing, ureteral inflammation, retroperitoneal effusion, ureteral ectopia, urinary tract neoplasia, and regional lymph node involvement.[1] Ultrasonography alone is reported to have a sensitivity of 77% for diagnosing ureteral stones in cats.[1]

Computed tomography (CT) and anterograde pyelography are additional diagnostic options, but due to equipment needs and technical skill, may not be available to most practioners.[1]

Treatment/Management/Prognosis

Medical management for acute kidney injury, the uremia, and electrolyte disturbances secondary to ureteral obstruction is essential.[1] Fluid therapy with balanced isotonic crystalloids to restore intravascular volume and correct dehydration should be based on physical exam parameters and basic diagnostics.[1] Interstitial and intravascular fluid balance should be monitored every four to six hours in patients to assess for development of dehydration, hypovolemia, or fluid overload.[1] Other aspects of medical management include osmotic diuretic such as mannitol, alpha-receptor antagonists, ureteral smooth muscle relaxants, and antibiotics.[1] The purpose of mannitol therapy is to increase the volume of urine excreted in effort to "push" stones or debris through the ureter.[1] There is limited clinical veterinary data regarding the efficacy of ureteral relaxation with alpha-receptor antagonists or ureteral smooth muscle relaxation with glucagon or amitriptyline.[1] One retrospective study involving medical management alone showed 13% of cats had significant improvement in azotemia at time of discharge, with 57% of them having documented stone passage.[1] However, in the same study 30% of cats did not have a significant improvement in azotemia with medical management despite 71% having documented stone passage.[1]

Surgical management options for ureteral obstruction include single or multiple ureterotolithotomies (ureterotomy/ureterotmies), ureteral resection and anastomosis, ureteral reimplantation (ureteroneocystostomy), ureteronephrectomy, and subcutaneous ureteral bypass (SUB) device.[2] Given the small size of the ureter in cats (1 mm outer diameter, 0.4 mm luminal diameter), magnification is often needed for surgery, making it technically difficult.[2] Complications of ureteral surgery include re-obstruction, stricture, recurrence of obstructive calculi, migration of nephroliths, and urine leakage.[2] In cats, ureteral stents have been described

for the management of ureterolithiasis.[2] Benefits of stenting include passive ureteral dilation and ability to remove if infection or irritation becomes a concern.[2]

The SUB device involves the use of a locking loop nephrostomy catheter and a multi-fenestrated cystotomy catheter, each attached to a SC shunt port secured to the ventrolateral body wall.[2] Placement of a SUB device requires ventral midline laparotomy.[2] SUB placement is a good treatment option for cats with ureteral obstruction and is associated with good outcomes; however, placement can be technically challenging and should only be performed by trained veterinarians.[3] Complications are possible, and include obstruction of the device, upper and lower urinary tract infection, and lower urinary tract disease. [3]

Case History and Presentation

A 4-year-old, spayed, female, domestic shorthair cat presented for acute vomiting with possible exposure to household cleaning products. No previous history of vomiting was reported, and the patient had been stable leading up to this event. Physical examination was overall unremarkable. See table for vital signs (Table 1, 2). Serum chemistry identified a mild increase in SDMA likely indicative of renal changes and a mild monocytosis likely due to anxiety in the clinic (Table 3). Urinalysis revealed significant hematuria and proteinuria, as well as a mild pyuria indicating significant inflammation and possible infection (Table 3). Urine culture was negative for bacterial growth (Table 4).[a] Abdominal radiographs showed right sided renomegaly with a right ureterolith (Figure 1, 2). Ultrasound of the kidney confirmed presence of the ureterolith as well as mild right hydronephrosis. At time of presentation, the patient was on Hill's c/d stress prescription urinary diet.[b]

Case Management and Outcome

Hospitalization with intravenous (IV) fluid therapy, smooth muscle relaxant medication, and pain control was recommended but declined in favor of outpatient treatment. Prazosin[c] at 0.5 mg PO q12h and buprenorphine[d] at 0.036mg sublingually q8-12h was initiated and lactated ringers solution (LRS)[e] was given at a dose of 200 ml subcutaneously (SQ) once. No examination was performed on day two, but repeat radiographs showed no change to the placement of the right ureterolith or size of kidneys (Figure 3, 4). Maropitant[f] was started at 4mg PO q24h for suspected nausea contributing to inappetence and LRS was continued at a dose of 100 ml SQ q24h.

Outpatient treatment was continued through days three and four. The patient presented on day five for continued inappetence, lethargy, and discomfort. Physical examination revealed mild cranial abdominal discomfort, tachycardia, and adequate hydration. See table for vital signs (Table 1). Urinalysis was unable to be obtained due to the bladder being empty at time of sampling. Except for continued increase in creatine, lab values were unremarkable (Table 5). Mirtazapine[g] at 1.875 mg PO q48h and cyproheptadine[h] at 2mg PO q12h on the day mirtazapine was not being given was initiated to aid the inappetence. Options for treatment discussed with the client included aggressive IV fluid therapy with supportive medication and hospitalization, referral for SUB placement, or nephrectomy. Nephrectomy was chosen, and buprenorphine was continued until the patient presented for nephrectomy on day seven.

At surgery presentation, the patient was stable with continued mild stress tachycardia and mild cranial abdominal discomfort. See table for vital signs (Table 1). The patient was pre-medicated

using 0.35 mg dexmedetomidine[i], 0.04 mg butorphanol[j], and 5 mg ketamine[k] intramuscularly (IM), induced using 3 mg propofol[l] IV, and IV LRS was started at 15 ml/hr. The patient was intubated and maintained at an appropriate level of anesthesia using isoflurane.[m] Standard laparotomy procedure was performed. The peritoneum over the right kidney was dissected off using blunt and sharp dissection. The right kidney was rotated laterally, and both the renal artery and vein were located and double ligated at the level of the kidney using 3-0 PDS.[n] The ureter was identified and found to be severely dilated, thickened, and tortuous. The ureter was double ligated using 3-0 PDS near the bladder and the kidney was removed. Abdominal organs were examined for adequate perfusion prior to closure and the abdomen was closed routinely. The right kidney and ureter were incised after removal and one large ureterolith was found in the distal third of the ureter, as well as multiple smaller nephroliths in the renal pelvis (Figure 3). Cold laser therapy[o] was used on the abdominal incision to aid in decreasing inflammation. The patient was given 0.04 mg buprenorphine IM for postoperative pain and reversed using 0.35 mg atipamezole.[p] Recovery from surgery was unremarkable. The patient was continued on buprenorphine, mirtazapine, cyproheptadine, and maropitant as previously prescribed. Gabapentin[q] at 50mg PO q12h was initiated after surgery to aid in multimodal pain therapy.

The day following surgery the patient was not eating well and showing signs of moderate sedation. Physical exam showed no discomfort on palpation of abdominal incision and a mildly elevated ear temperature of 102.4 F. The gabapentin was reduced to 25 mg PO q12hr and the buprenorphine was reduced to 0.018 mg sublingually q8-12h to alleviate the sedation the patient was experiencing. A prophylactic SQ injection of 3.5 mg cefovectin[r] was administered. Ondansetron[s] was started at 2 mg PO q12h to mitigate existing nausea. The following day at discharge, the

patient was brighter and eating, and had an ear temperature of 100.6 F. Stone analysis was declined by the client and the patient was to be transitioned to Purina UR prescription urinary diet.[t]

Physical examination two weeks post-surgery was unremarkable. See table for vital signs (Table 1). The abdominal incision was healing well, and the patient had a normal appetite. The patient had finished the previously prescribed medications. Serum chemistry, complete blood count, urinalysis, serology, and endocrinology was overall unremarkable (Table 3). The creatinine value had decreased to the value on initial presentation. The patient had returned to normal function at that time and no further abnormalities were noted between this time and when the patient returned for routine wellness care six months post-surgery.

References

1. Clarke DL. Feline ureteral obstructions Part 1: medical management: Feline ureteral obstructions. *J Small Anim Pract* 2018;59(6):324-333.

2. Clarke DL. Feline ureteral obstructions Part 2: surgical management: Feline ureteral obstructions. *J Small Anim Pract* 2018;59(7):385-397.

3. Wuillemin F, Vachon C, Beauchamp G, et al. Subcutaneous ureteral bypass device placement in 81 cats with benign ureteral obstruction (2013-2018). *J Vet Intern Med* 2021;35(6):2778-2786.

Endnotes

[a]Idexx Laboratories, Westbrook, ME.

[b]C/D Stress, Hill's Pet Nutrition, Topeka, KS.

[c]Prazosin Hydrochloride, Teva Pharmaceuticals USA Inc., North Wales, PA.

[d]Buprenorphine hydrochloride 0.3 mg/ml, Par Pharmaceutical, Chestnut Ridge, NY.

[e]Lactated Ringers Injection, ICU Medical Inc., Lake Forest, IL

[f]Maropitant, Cerenia, Zoetis Inc., Kalamazoo, MI.

[g]Mirtazapine, Aurobindo Pharma USA, Inc., East Windsor, NJ.

[h]Cyproheptadine Hydrochloride, Zydus Pharmaceuticals, Pennington, NJ.

[i]Dexmedetomidine hydrochloride 0.5 mg/ml, Dexdomitor, Zoetis Inc., Kalamazoo, MI.

[j]Butorphanol tartrate 10 mg/ml, Covetrus North America, Dublin, OH.

[k]Ketamine hydrochloride 100 mg/ml, Covetrus North America, Dublin, OH.

[l]Propofol injectable emulsion 10 mg/ml, PropoFlo 28, Zoetis Inc., Kalamazoo, MI.

[m]Isoflurane, Fluriso, MWI, Boise, ID.

[n]3-0 Polydioxanone, PDS, Ethicon, Johnson & Johnson, New Brunswick, NJ.

[o]Companion Therapy Laser,

[p]Atipamezole hydrochloride 5.0 mg/ml, Antisedan, Zoetis Inc., Kalamazoo, MI.

[q]Gabapentin, Granules Pharmaceuticals, Inc., Chantilly, VA.

[r]Cefovectin sodium, Convenia, Zoetis Inc., Kalamazoo, MI.

[s]Ondansetron, Rising Health, LLC, Saddle Brook, NJ.

[t]UR, Nestlé Purina Petcare Company, St. Louis, MO.

Laboratory Data/Imaging

Table 1: Vital Signs

Vital Sign	**Value on 03/25/2019**	**Value on 03/30/2019**	**Value on 04/01/2019**	**Value on 04/15/2019**
Weight (kg)	3.54	3.41	3.41	3.55
Temperature (F)	99.8	100.2	100.8	99.2
Heart rate (bpm)	200	220	200	200
Respiratory rate (rpm)	48	48	44	44
Body condition score (bcs)	5/9	5/9	5/9	5/9
Muscle mass score (mms)	3/3	3/3	3/3	3/3

Table 2: Muscle mass scoring system

Muscle Mass Score	Amount of Muscle Loss
3/3	No muscle loss (normal)
2/3	Mild muscle loss
1/3	Moderate muscle loss
0/3	Severe muscle loss

Table 3: Serum Chemistry, Complete Blood Count, Urinalysis, Urine Culture

Test	**Values on 03/25/2019**	**Values on 04/15/2019**	**Normal Reference**
Serum Chemistry			
Glucose	85 mg/dL	94 mg/dL	72-175 mg/dL

SDMA	20 ug/dL	11 ug/dL	0-24 ug/dL
Creatinine	1.5mg/dL	1.3 mg/dL	0.9-2.5 mg/dL
BUN	27 mg/dL	33 mg/dL	16-37 mg/dL
BUN:Creatinine Ratio	18.0	25.4	
Phosphorous	3.7 mg/dL	4.3 mg/dL	2.9-6.3 mg/dL
Calcium	10.2 mg/dL	9.6 mg/dL	8.2-11.2 mg/dL
Sodium	156 mmol/L	155 mmol/L	147-157 mmol/L
Potassium	4.4 mmol/dL	4.5 mmol/dL	3.7-5.2 mmol/dL
Na:K Ratio	35	34	
Chloride	117 mmol/L	123 mmol/L	114-126 mmol/L
TCO2 (Bicarbonate)	21 mmol/L	18 mmol/L	12-22 mmol/L
Anion Gap	22 mmol/L	19 mmol/L	12-25 mmol/L
Total Protein	7.6 g/dL	6.5 g/dL	6.3-8.8 g/dL
Albumin	3.7 g/dL	3.5 g/dL	2.6-3.9 g/dL
Globulin	3.9 g/dL	3.0 g/dL	3.0-5.9 g/dL
ALB/GLOB ratio	0.9	1.2	0.5-1.2
ALT	65 U/L	47 U/L	27-158 U/L
AST	32 U/L	24 U/L	16-67 U/L
ALP	12 U/L	16 U/L	12-59 U/L
GGT	1 U/L	1 U/L	0-6 U/L
Bilirubin - Total	0.2 mg/dL	0.2 mg/dL	0.0-0.3 mg/dL
Bilirubin - Unconjugated	0.1 mg/dL	0.1 mg/dL	0.0-0.2 mg/dL
Bilirubin - Conjugated	<0.1 mg/dL	<0.1 mg/dL	0.0-0.2 mg/dL

Cholesterol	205 mg/dL	165 mg/dL	91-305 mg/dL
Amylase	1008 U/L	940 U/L	623-2,239 U/L
Lipase	130 U/L	94 U/L	0-45 U/L
Creatine Kinase	94 U/L	76 U/L	64-440 U/L
Hemolysis Index	N	N	
Lipemia Index	N	N	
Hematology			
RBC	9.39 M/uL	7.22 M/uL	7.12-11.46 M/uL
HCT (%)	45.1 %	36.4 %	28.2-52.7 %
HGB	14.2 g/dL	11.1 g/dL	10.3-16.2 g/dL
MCV	48 fL	50 fL	39-56 fL
MCH	15.1 pg	15.4 pg	12.6-16.5 pg
MCHC	31.5 g/dL	30.5 g/dL	28.5-37.8 g/dL
Reticulocyte (%)	0.1 %	0.1 %	
Reticulocyte	9 K/uL	7 K/uL	3-50 K/uL
Reticulocyte HGB	17.9 pg	18.5 pg	13.2-20.8 pg
WBC	9.0 K/uL	7.3 K/uL	3.9-19.0 K/uL
Neutrophil (%)	58.4 %	42.4 %	
Lymphocyte (%)	30.4 %	46.1 %	
Monocyte (%)	7.5 %	2.8 %	
Eosinophil (%)	3.6 %	8.6 %	
Basophil (%)	0.1 %	0.1 %	
Neutrophil	5256 K/uL	3095 K/uL	2620-15170 K/uL

Lymphocyte	2736 K/uL	3365 K/uL	850-5850 K/uL
Monocyte	675 K/uL	204 K/uL	40-530 K/uL
Eosinophil	324 K/uL	628 K/uL	90-2180 K/uL
Basophil	9 K/uL	7 K/uL	0-100 K/uL
Platelet	291 K/uL	238 K/uL	155-641 K/uL
Urinalysis			
Collection	Cystocentesis	Cystocentesis	
Color	Red/brown	Yellow	
Clarity	Turbid	Clear	
Specific Gravity	1.045	1.042	
pH	6.5	6.5	
Urine Protein	4+	Trace	
Glucose	Negative	Negative	
Ketones	Negative	Negative	
Blood/Hemoglobin	4+	Negative	
Bilirubin	2+	Negative	
Urobilirubin	Normal	Normal	
White Blood Cells	2-5/hpf	0-2/hpf	
Red Blood Cells	TNTC	0-2/hpf	
Bacteria	None Seen	None Seen	
Epithelial Cells	Occ squamous and transitional	Rare (0-1)	
Mucus	None Seen	None Seen	

Casts	None Seen	None Seen	
Crystals	None Seen	None Seen	
Endocrinology			
Total T4	1.7 ug/dL	1.1 ug/dL	0.8-4.7 ug/dL
Free T4 (ng/dL)		1.84ng/dL	0.7-2.6 ng/dL
Free T4 (pmol/L)		18.0 pmol/L	9.0-33.5 pmol/L
Serology			
FeLV Antigen by ELISA		Negative	
FIV Antibody by ELISA		Negative	
Feline Heartworm Antibody by ELISA		Negative	

Table 4: Urine Culture

Test	**Value on 03/25/2019**
Urine Culture	Negative

Table 5: In-clinic Serum Chemistry, Complete Blood Count, Electrolytes

Test	**Values on 03/30/2019**	**Normal Reference**
Serum Chemistry		
Glucose	99 mg/dL	74-159 mg/dL
Creatinine	2.1 mg/dL	0.8-2.4 mg/dL
BUN	21 mg/dL	16-36 mg/dL
BUN:Creatinine Ratio	10.0	

Phosphorous	4.4 mg/dL	3.1-7.5 mg/dL
Calcium	8.7 mg/dL	7.8-11.3 mg/dL
Total Protein	7.0 g/dL	5.7-8.9 g/dL
Albumin	3.1 g/dL	2.2-4.0g/dL
Globulin	3.9 g/dL	2.8-5.1 g/dL
ALB/GLOB ratio	0.8	
ALT	39 U/L	12-130 U/L
ALP	17 U/L	14-111 U/L
GGT	0 U/L	0-4 U/L
Bilirubin - Total	0.3 mg/dL	0.0-0.9 mg/dL
Cholesterol	142 mg/dL	65-225 mg/dL
Hematology		
RBC	8.63 M/uL	7.12-11.46 M/uL
HCT (%)	39.3 %	28.2-52.7 %
HGB	11.6 g/dL	10.3-16.2 g/dL
MCV	46 fL	39-56 fL
MCH	13.4 pg	12.6-16.5 pg
MCHC	29.5 g/dL	28.5-37.8 g/dL
Reticulocyte (%)	0.1	
Reticulocyte	9 K/uL	3-50 K/uL
WBC	13.6 K/uL	3.9-19.0 K/uL
Neutrophil (%)	39.0 %	
Lymphocyte (%)	55.0 %	

Monocyte (%)	2.0 %	
Eosinophil (%)	4.0 %	
Basophil (%)	0.0 %	
Neutrophil	5304 K/uL	2620-15170 K/uL
Lymphocyte	7480 K/uL	850-5850 K/uL
Monocyte	272 K/uL	40-530 K/uL
Eosinophil	544 K/uL	90-2180 K/uL
Basophil	0 K/uL	0-100 K/uL
NRBC	1	0-2 per 100wbc
Platelet	230 K/uL	155-641 K/uL
Electrolytes		
Sodium	159 mmol/L	150-165 mmol/L
Potassium	4.6 mmol/L	3.5-5.8 mmol/L
Na:K Ratio	35	
Chloride	120 mmol/L	112-129 mmol/L

Figure 1: Right Lateral Abdomen

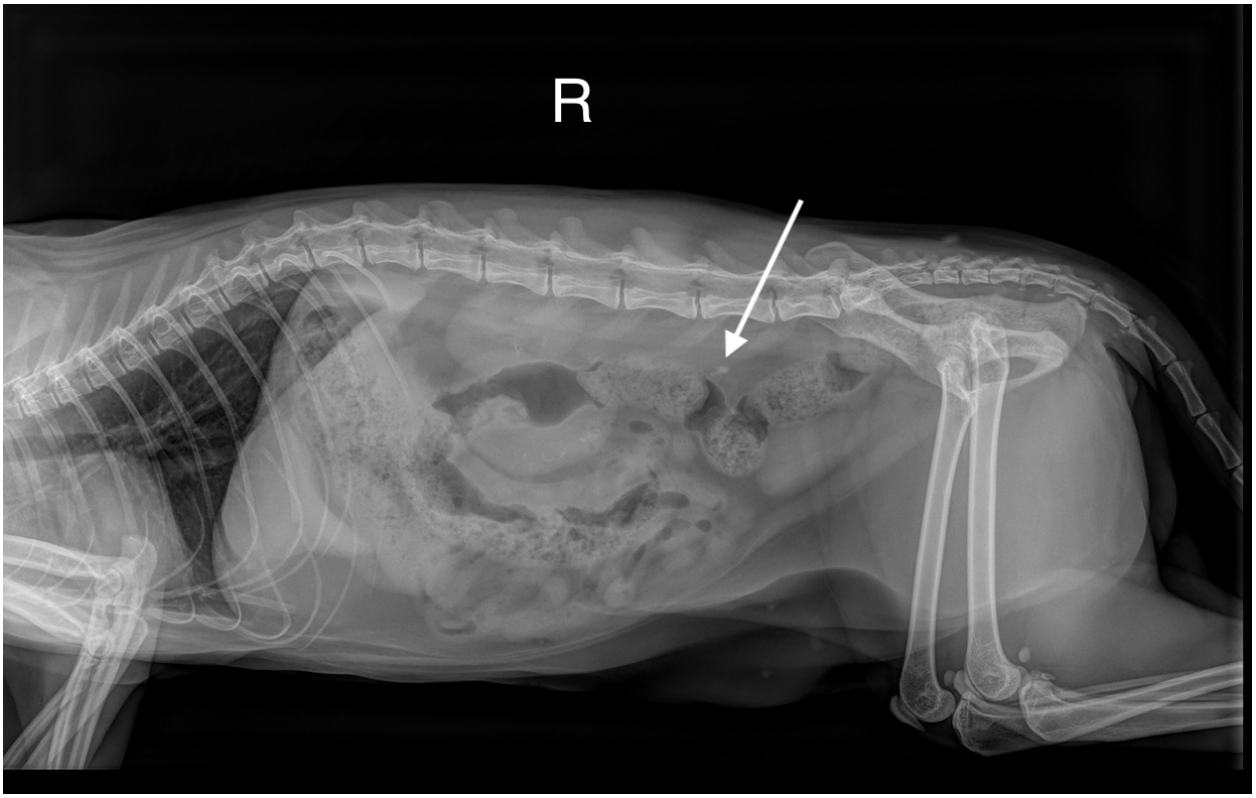

Figure 2: VD Abdomen

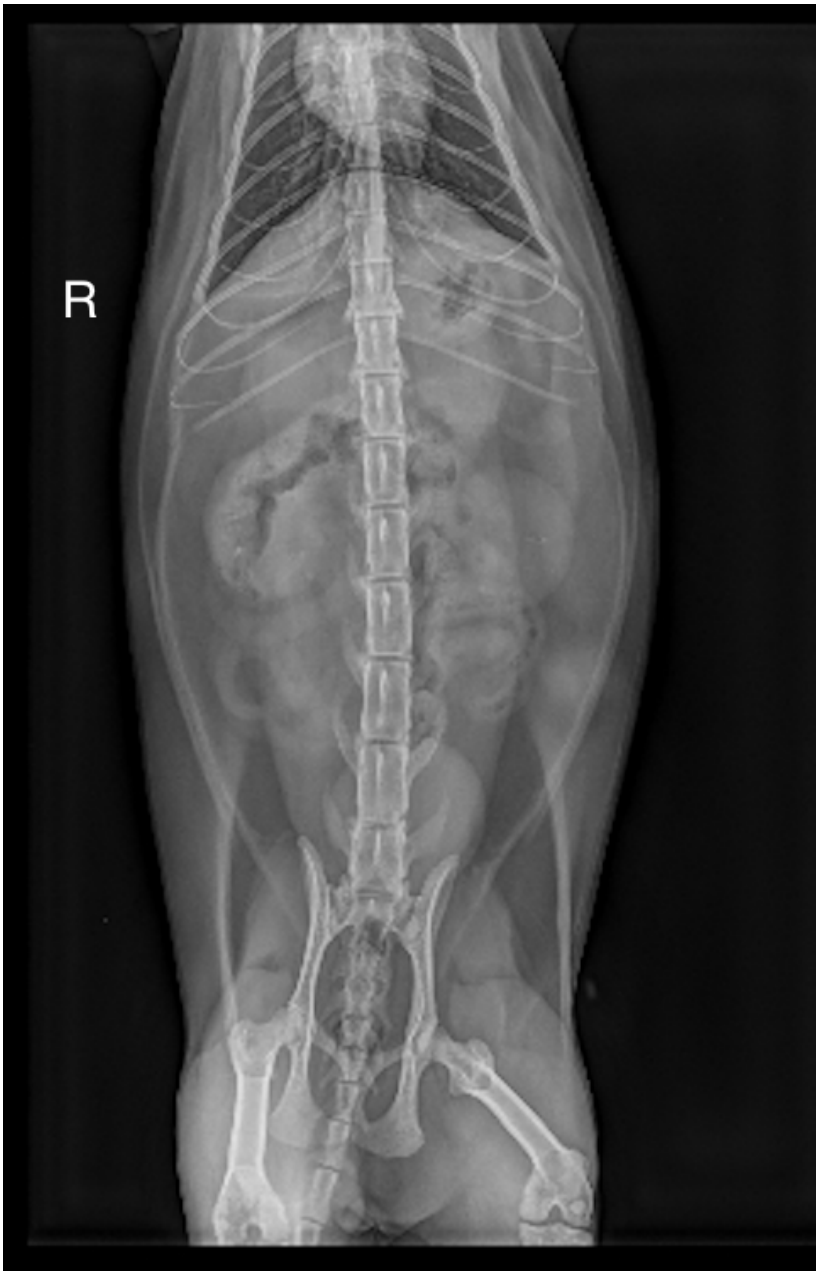

Figure 3: Right Lateral Abdomen

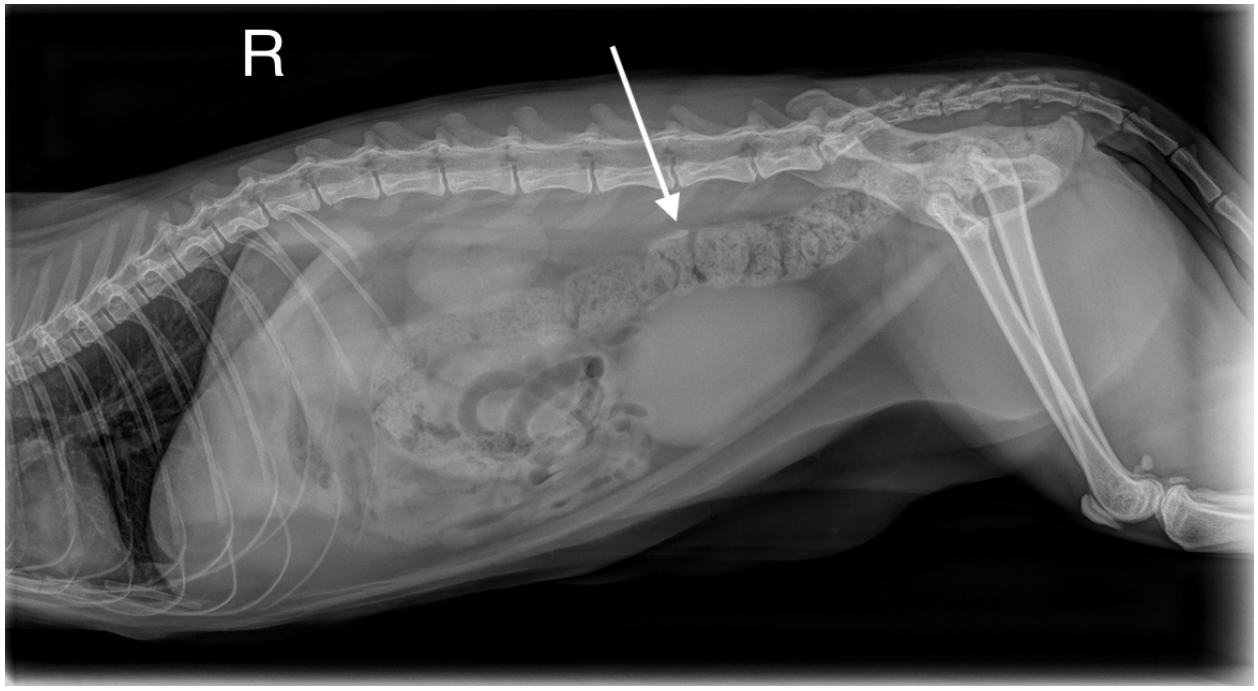

Figure 4: VD Abdomen

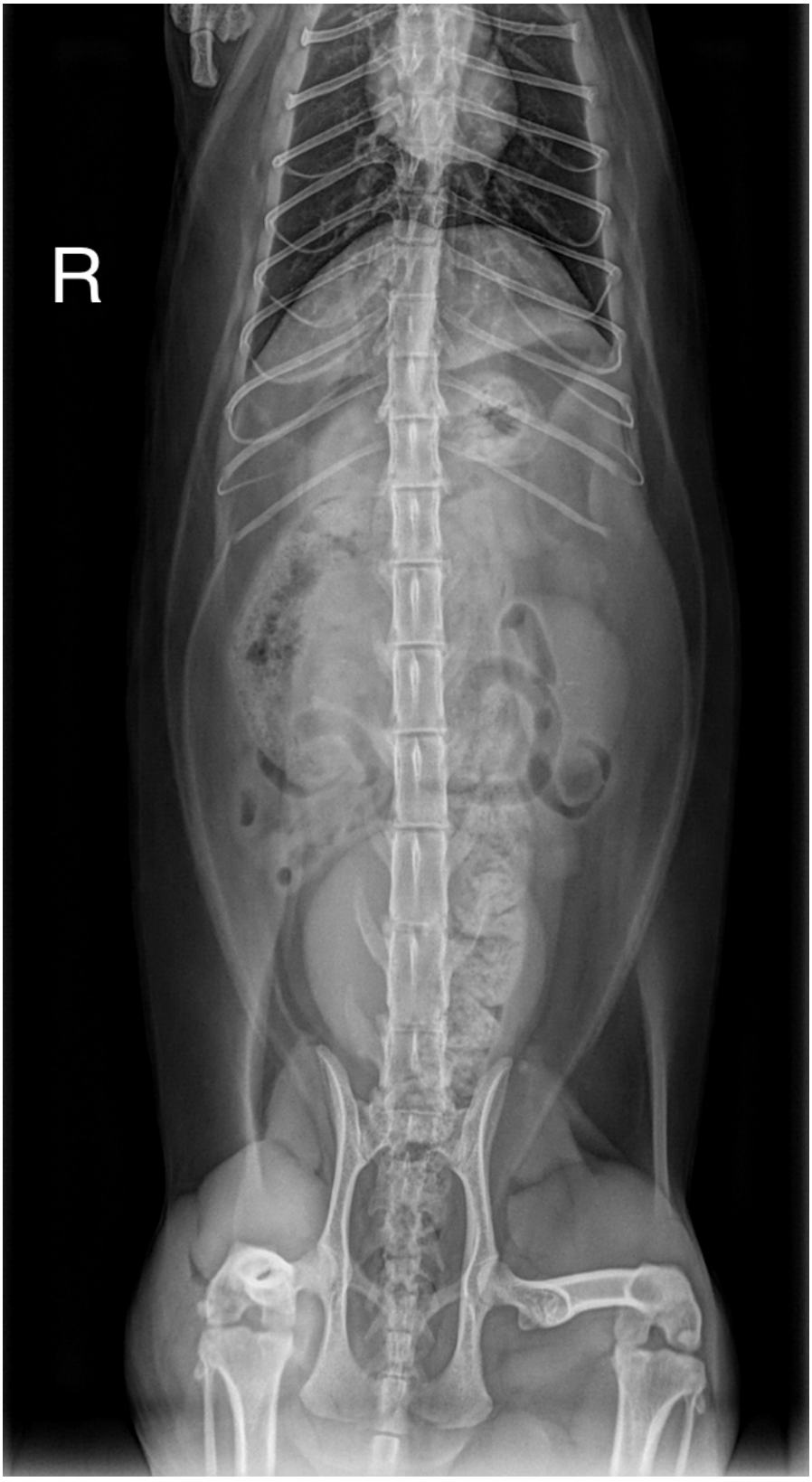

Figure 3: Right kidney post removal

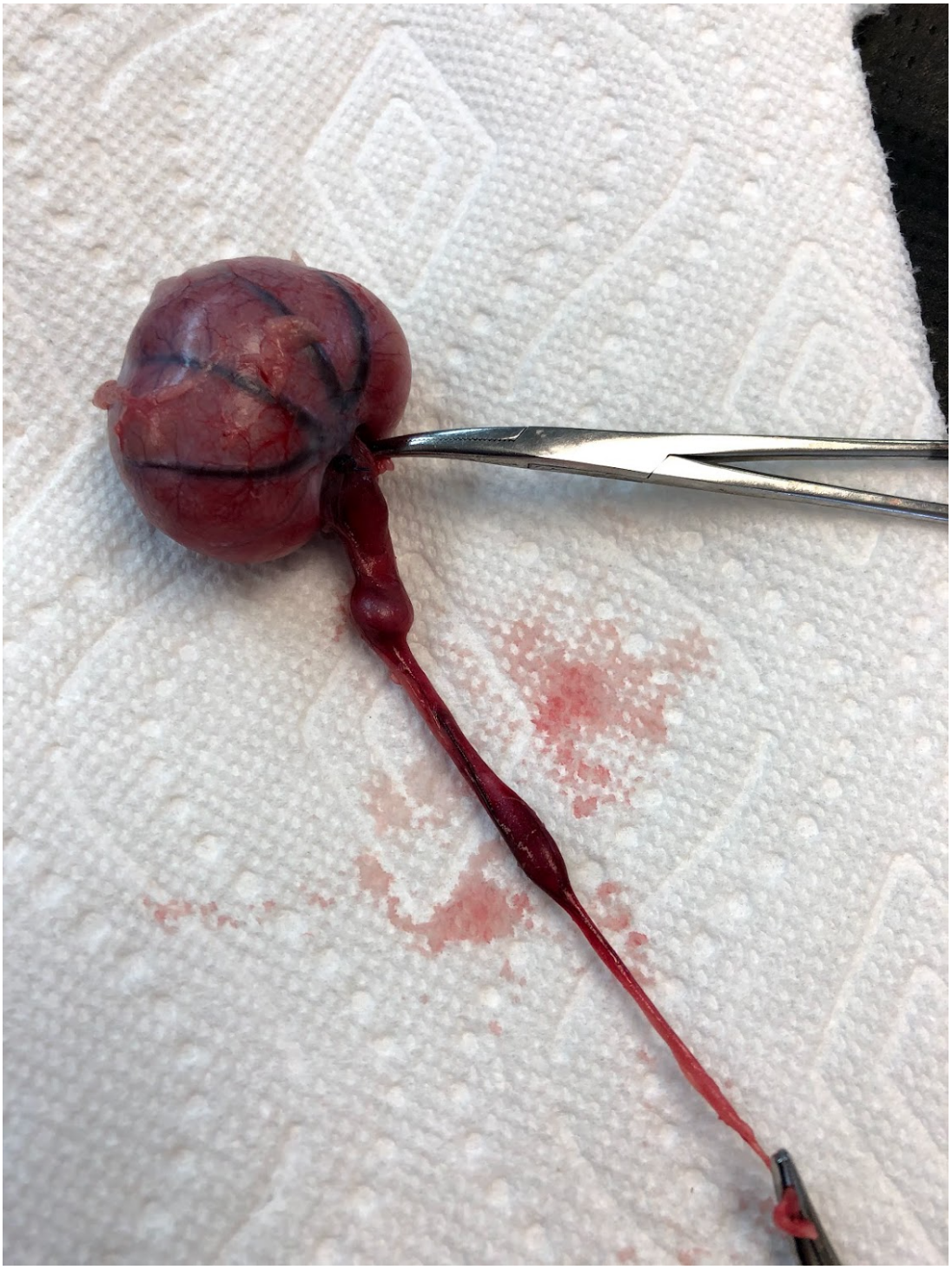

Figure 4: Right kidney post removal - incised