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Cat with lymphoplasmacytic inflammation leading to recurrent hydronephrosis and spontaneous renal rupture

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Abstract: A male cat, seven years old, who had a history of left hydronephrosis treated for what was thought to be idiopathic proteinaceous debris in the renal pelvis, recently developed anorexia and vomiting. Intravenous pyelography demonstrated a considerable quantity of free fluid in the retroperitoneal area after 48 hours, and the abdominal ultrasound confirmed bilateral hydronephrosis. The right kidney exhibited a very thin capsule with urine leakage and tiny, black deposits in the right renal pelvis after the nephrectomy, according to the gross examination. Right kidney histology showed considerable lymphoplasmacytic inflammation, necrosis of the renal cortex and medulla, compression atrophy, and hydronephrosis. The crystallographic study proved that the dark deposits included no minerals and were entirely protein. Proteinaceous pelvic materials produced the cat's hydronephrosis and spontaneous renal rupture, which was a result of the idiopathic renal lymphoplasmacytic inflammation. This case report shows the effectiveness of imaging in the diagnosis and monitoring of hydronephrosis, the detection of urine leakage, and the planning of surgery. It also suggests that cats may have spontaneous renal rupture due to immune-mediated renal illness.

Keywords: renal; ultrasonography; intravenous pyelography; crystallography; computed tomography; feline

INTRODUCTION:

Hydronephrosis refers to the dilatation of the renal pelvis and calyces due to a renal or postrenal uri- nary obstruction that induces the progressive atro- phy of the renal parenchyma (Rawlings et al. 2003). Hydronephrosis in cats is caused by a ureteral or ure- thral blockage by urinary tract calculi, inflammation, neoplasia, or retroperitoneal masses resulting in ex- traluminal ureteral compression (D'lppolito et al. 2006; Ragni and Fews 2008; D'Anjou et al. 2011; Zaid et al. 2011; Cohen et al. 2012; Foster and Pinkerton 2012; Selgas et al. 2014; Evans and Fowlkes 2016). Less common causes of hydronephrosis include ob- structions induced by blood clots in the renal pelvisor ureters after a renal biopsy, ectopic ureters, driedsolidified blood (DSB) calculi, and retroperitoneal fibrosis after a renal transplantation (Vanden et al. 2005; D'lppolito et al. 2006; Ragni and Fews 2008; D'Anjou et al. 2011; Zaid et al. 2011; Cohen et al. 2012; Foster and Pinkerton 2012; Lee et al. 2014; Selgas et al. 2014). Blood clots in the urinary tractare rare and may result from urinary tract calculi, infections, inflammation, neoplasia, trauma, clotting disorders, or idiopathic causes (Rawlings et al. 2003; DiBartola 2005; Vanden et al. 2005).

A spontaneous renal rupture is defined as the rupture of the renal parenchyma due to the renal pathology (Zhang et al. 2017). Possibly reflecting the dysregulation of the immune system, a lympho-

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cytic-plasmacytic inflammation is characterised by the infiltration of lymphocytes and plasma cellsinto certain tissues, particularly in the gastrointes- tinal tract and nasal or oral cavities (Willard 2003;Hall and German 2005; Simpson 2005). However, hydronephrosis and a spontaneous renal rupturedue to lymphoplasmacytic inflammation in the kid-ney have not been reported in veterinary medicine.We document the rare case of a seven-year-oldcat with recurrent hydronephrosis and a spontane-ous renal rupture with a suspected blood clot for-mation in the renal pelvis caused by an idiopathic lymphoplasmacytic inflammation in the kidney.

Case presentation

A six-year-old castrated male Korean Shorthair cat weighing 6.0 kg first presented with haematu-ria in January 2019 and was diagnosed with cys-
titis and bilateral renal diverticular calculi. After the cystitis was resolved, the cat's bilateral renal calculi were monitored with an abdominal radiog- raphy, abdominal ultrasound, and laboratory tests every month thereafter at a hospital. At the nine-month follow-up, the laboratory findings showed increased creatinine [274.3 μmol/l; reference range (RR): 70.8–159.3 μmol/l]. The total protein (8.3 g/l; RR: 5.7–7.8 g/l), albumin (3.6 g/l; RR: 2.3–3.5 g/l), and calcium (1 079.6 μmol/l; RR: 778.7–1 053.1 μmol/l) concentrations were mildly elevated. On the abdominal radiography, the location, size, and num- ber of the renal calculi remained unchanged; how- ever, the left kidney was slightly enlarged (2.64 timesthe length of the second lumbar vertebral body) relative to the right kidney (2.48 times the lengthof the second lumbar vertebral body). The abdominal ultrasound revealed a moderate-to-severe dilation of the left renal pelvis and a mild dilation of theleft proximal ureter, with amorphous and echo-

Figure 1C

Figure 1

Figure 1. Abdominal ultrasound findings in a cat with recurrent hydronephrosis and spontaneous renal rupture Longitudinal (A) and transverse (B) images of the left hydronephrotic kidney with amorphous and echogenic materials in the left renal pelvis at the nine-month follow-up. Dorsal (C) and transverse (D) images of the right kidney at five months after the first surgery showing hydronephrosis due to the amorphous, echogenic materials in the right renal pelvis along which it was asymmetrically dilated (white arrow) and a renal calculus (D)

genic material in the pelvis (Figure 1A,B). The cat was diagnosed with left hydronephrosis with radio- lucent, amorphous, and echogenic material in the renal pelvis. The differential diagnoses included blood clots, haemorrhage, inflammatory debris, DSB calculi, or mucus plugs in the left renal pelvis. The cat was hospitalised for observation and treat- ment, including intravenous (i.v.) fluids (22.5 ml/h, 5% dextrose and sodium chloride; CJ Healthcare, Eumseong, Republic of Korea), amoxicillin-cla- vulanic acid (13.75 mg/kg, q12h, Amocla; KuhnilPharmaceutical Co., Cheonan, Republic of Korea), metronidazole (15 mg/kg, q12h, Metrynal; Dai Han Pharmaceutical Co., Ansan, Republic of Korea), and famotidine (0.5 mg/kg, q12h, Gaster; Dong-A ST,Seoul, Republic of Korea). After four days of treat-ment, the hydronephrosis was resolved and the cat was discharged. However, the cat was readmitted seven days later due to a 2-day history of anorexia,vomiting, and diarrhoea. The subsequent abdominal ultrasound revealed recurrent, moderate-to-severe left hydronephrosis with amorphous and echogenic pelvic material, a small amount of free fluid in the retroperitoneal space around the left kidney, anda mild dilation with corrugation of the intestinal loops. The laboratory tests showed leukocytosis(25.7×10^9/l; RR: 5.5–19.5×10^9/l), increased cre- atinine (247.8 μmol/l; RR 70.8–159.3 μmol/l), and metabolic acidosis (pH = 7.242; RR: 7.32–7.44). The cat was hospitalised and administered fluids and an antibiotic therapy. Over next five days, the white blood cell (WBC) count and creatinine levels re- turned to normal, and the vomiting ceased. Despite improvement in the pelvic dilation, the hydrone- phrosis on the abdominal ultrasound and anorexia persisted. An intravenous pyelography (IVP) showed a normal bilateral renal excretory function. An ex-ploratory laparotomy was performed to directly identify the cause of the left hydronephrosis and revealed a slightly dilated left renal pelvis, a normal right kidney and bilateral ureters, and no obstructive material. On the pyelocentesis, approximately 0.8 ml of a mildly hazy urine was obtained using a 26-gaugeneedle. The abdominal ultrasound revealed allevia- tion of the hydronephrosis and a reduction in the amorphous material in the renal pelvis. An ultra- sound-guided cystocentesis was performed usinga 23-gauge needle, and a urinalysis was performed on both samples. The specific gravities of the pyelo- centesis and cystocentesis samples were 1.022 and 1.021 (RR: > 1.035), respectively. The pyelocentesis
sample showed an increased urinary protein/creati- nine ratio (UPC) (0.8; RR: < 0.2) and predominantly red blood cells (RBCs; > 50/high power field) on the microscopic examination of the sediment. The cysto- centesis sample showed a normal UPC (0.1; RR: < 0.2)and no mucus, bacteria, or casts. Both samples were devoid of crystals or minerals. The cat recovered welland was discharged after five days.
The hydronephrosis did not recur for approxi-mately four months. The cat presented at seven years of age with a one-day history of anorexia and vomiting.
The laboratory testing revealed a mildly increased globulin (5.3 g/l; RR: 2.7–5.2 g/l), severe azotae-mia, including an increased blood urea

nitrogen (6 911.5 µmol/l), creatinine (929.2 µmol/l) and phos- phorus (9.4 mg/l; RR: 2.6–6.0 mg/l), and metabolic acidosis (pH = 7.248). However, the right and left kid-neys were enlarged to 2.74 and 2.65 times the length of the second lumbar vertebral body, respectively. The abdominal ultrasound showed moderate right hydro- nephrosis and recurrent left hydronephrosis second- ary to the amorphous and echogenic pelvic material in the renal pelvis (Figure 1C). The right hydrone- phrosis was accompanied by a fluid-dilated, tubular structure connected to the renal pelvis toward theperiphery of the right renal parenchyma (Figure 1D). Moreover, a small amount of free fluid with increasedfat echogenicity was identified around both kidneys, suggesting pyelonephritis. The cat was hospitalised for a fluid and antibiotic therapy. Within six days,all the laboratory findings had returned to normaland the cat had stopped vomiting and regained its appetite.

Figure 1A

However, despite the ongoing treatment, the cat became anorexic again and developed an in- creased creatinine concentration (247.8 µg/l) on day seven. The abdominal ultrasound revealed persistent moderate bilateral hydronephrosis. Computed to- mography (CT) imaging with pre- and post-contrast was performed to investigate the hydronephrosis and the dilated tubular structure connected to the re- nal pelvis of the right kidney (Figure 2A). The post- contrast images revealed a very thin capsule on the right kidney, and the dilated tubular structure was identified as an asymmetric, severely dilated renal pelvis (Figure 2B). No other obstructions were noted. An IVP was then performed for 48 h showing good initial nephrographic opacification of both kidneys. However, the right kidney showed no evidence of py-elographic opacification during the procedure, andthe left kidney showed

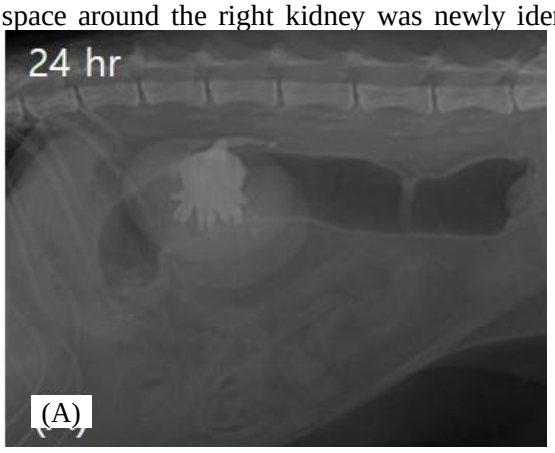
Figure 2B

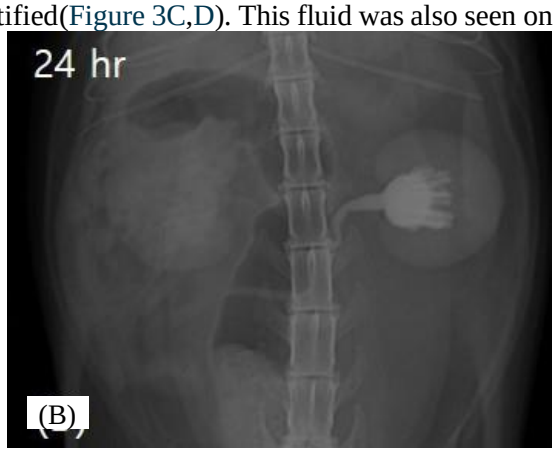
Figure 2. Pre-contrast (A) and post-contrast (B) transverse computed tomography (CT) images of the right renal pelvis in a cat with recurrent hydronephrosis and spontaneous renal rupture

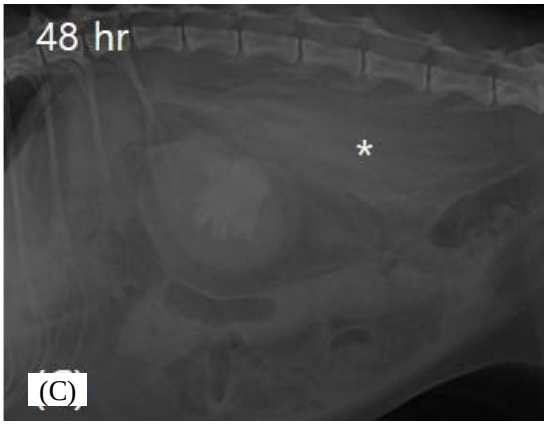
The pre-contrast image shows a right renal diverticular calculus (A). The post-contrast CT image shows hydronephrosis of the right kidney with a thin capsule (white arrow), accompanied by an asymmetric and severe dilation of the pelvis (B)

Figure 3D

dronephrosis and hydroureter (Figure 3A,B). A mod-erate amount of free fluid in the retroperitoneal space around the right kidney was newly identified(Figure 3C,D). This fluid was also seen on the abdom-







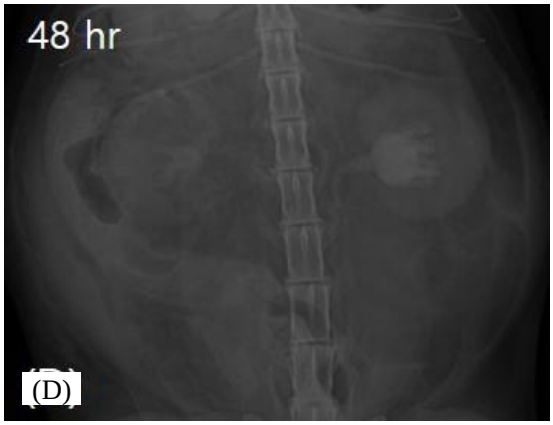


Figure 3. Intravenous pyelography at 24 h (A, B) and 48 h (C, D) in a cat with recurrent hydronephrosis and sponta- neous renal rupture
Bilaterally, good initial nephrographic opacification is shown; the right kidney shows no pyelographic opacification until 48 hours. The left kidney shows a delayed pyelogram with hydronephrosis and hydroureter during the procedure. A moderate amount of free fluid in the retroperitoneal and peritoneal spaces is newly identified at 48 hours (C, asterisk)

inal ultrasound. The ultrasound-guided abdominal fluid analysis revealed that the creatinine concentra- tion in the abdominal fluid was higher (1 681.4 μg/l) than that in the serum (16 mg/l suggesting the pres-ence of a uroabdomen. An exploratory laparotomy was performed to detect the urine leakage from the thin right renal capsule. During surgery, a moderate- to-severe amount of abdominal fluid was suctioned; a thin capsule with vascularisation, congestion, andan irregularly coarse parenchymal surface adjacentto the right renal pelvis was identified. Urine leak- age was present (Figure 4A), and the proximal lu- men of the right ureter showed a mild dilation with palpable, small, and soft deposits. A right nephrec-tomy was performed. The gross examination of theright kidney revealed several small, black depositsin the right renal pelvis and proximal ureteral lu- men (Figure 4B). The histopathology of the right kidney revealed hydronephrosis with compression atrophy, necrosis of the renal cortex/medulla, anda moderate lymphoplasmacytic inflammation. The crystallographic analysis showed that the deposits were composed of 100% protein and no minerals. The cat was hospitalised after the surgery, and ab- dominal fluid was again detected on the abdominalultrasound on the third day, with no definitive cause identified. The owner decided to discontinue treat- ment and requested to take the cat home, and it succumbed to the disease after 10 days

Figure 4A

Figure 4B

DISCUSSION

Our case involved a seven-year-old cat with persistent and marked bilateral hydronephro- sis associated with amorphous, echogenic pelvic materials with no shadowing or mineralisation identified on the diagnostic imaging. In such cas- es, an exploratory laparotomy can help directly identify the pelvic material. Although there wasa 5-month interval between the first and second surgeries for the left and right kidneys, respectively, the hydronephrosis on both sides was attributedto the same cause because of their similar imag-ing characteristics. The predominance of RBCs on the cytology at the time of the first surgery and the protein composition of the deposits in the re- nal pelvis affirmed our presumption that the de- posits were renal blood clots with necrosis. The lack of haematuria or cloudy urine on the gross examination prompted our consideration of other aetiologies. Most mucus plugs observed in cats are composed of large quantities of matrices with varying amounts of minerals, and fewer than 10% of plugs lack crystals (Houston et al. 2003). Hence, we ruled out mucus plugs. DSB calculi are radiolucent and do not appear as discrete calculion an abdominal ultrasound (Westropp et al. 2006; Novak and Craig 2011). However, unlike gelatinous blood clots, these calculi are very firm and stone-

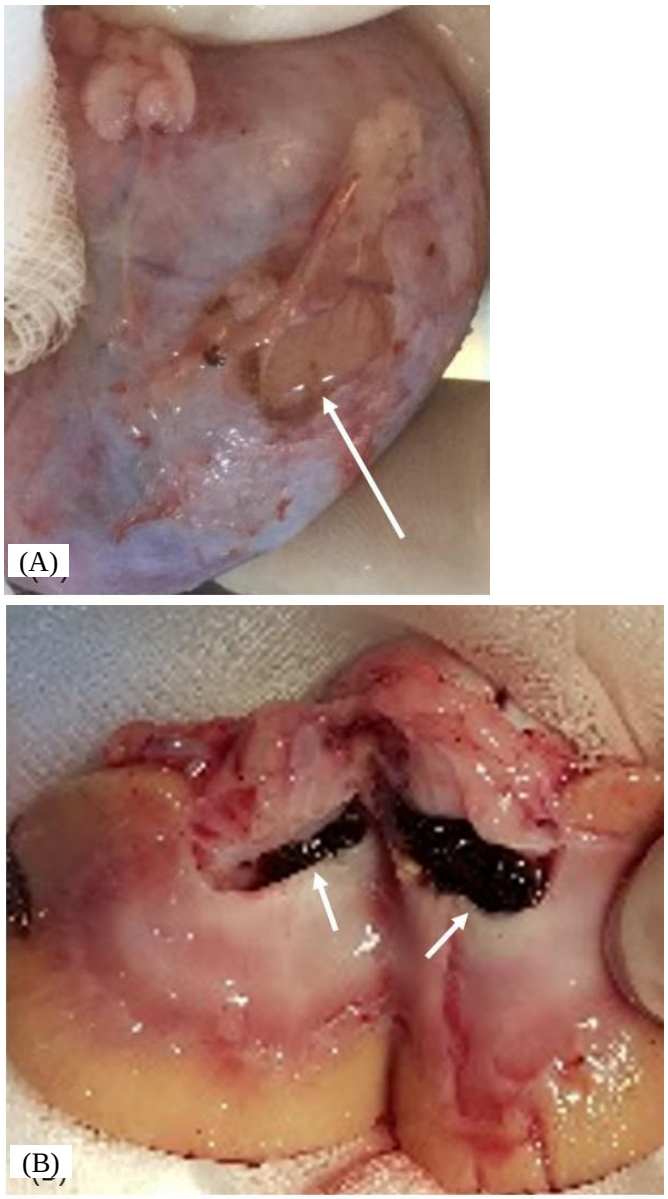


Figure 4. The right kidney and renal pelvis of a cat with recurrent hydronephrosis and spontaneous renal rupture after the right nephrectomy
This was accompanied by urine leakage (A, white arrow). A substantial amount of small, black deposits (100% protein composition) could be seen in the right renal pelvis (B, white arrows)

like (Westropp et al. 2006). Therefore, DSB calculi were less likely to be present in our case, because the pelvic material was soft when palpated during surgery. In addition, the hydronephrosis showeda spontaneous resolution with fluid and antibiotic therapy during hospitalisation, and the left hydro- nephrosis improved after the pyelocentesis during the first exploratory laparotomy. We presumed the material to be renal blood clots caused by an idi- opathic lymphoplasmacytic inflammation because there was no history of abdominal surgery or trau- ma; moreover, chronic renal disease, blood clotting disorders, and other inflammations or infectionsin the urinary tract were excluded by the imaging and laboratory examinations, including the sym- metric dimethylarginine test and urinalysis. Our case shows that progressive hydronephrosis
can result in spontaneous renal rupture and identi- fies the unique characteristics of hydronephrosis with radiolucent, amorphous, non-shadowing, and echogenic materials on diagnostic tests. We fur- ther demonstrated that the right renal rupture re- sulted from a lymphoplasmacytic inflammation, atrophy, and necrosis of the renal parenchyma due to progressive hydronephrosis. In addition, while the moderate ascites that recurred 3 days after the right nephrectomy could be attributed to the

spon- taneous rupture of the left kidney; this could notbe confirmed because the owner refused further examinations of the cat. If the presence of a lym- phoplasmacytic inflammation in the kidney had been confirmed, we could have improved the cat's condition or prolonged its life with dietary modification (e.g., hypoallergenic diet) and the ad- ministration of high-dose corticosteroids or im- munosuppressive drugs (Willard 2003; Zaid et al. 2011; Zhang et al. 2017).

Although the diagnostic imaging modalities could not definitively confirm the causative mate- rial for the hydronephrosis, they helped to diagnoseand monitor the hydronephrosis, detect the urine leakage, and plan the surgery. Our findings suggest that blood clots or a proteinaceous material should be considered as differential diagnoses in cats pre- senting with an upper urinary tract obstruction due to radiolucent, amorphous, and echogenic mate- rial with no shadowing. The continuous monitor- ing with an ultrasound and CT is important in such cases. The rapid surgical removal of clots or the injection of thrombolytic agents such as strepto- kinase into the clots may prevent progressive hy

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dronephrosis and renal rupture. If a specific cause cannot be identified from test results, an immune- mediated disease should be tested by biopsy, when possible. If a biopsy is infeasible, treatment with corticosteroids and a dietary change should be in- stituted, and the cat's response should be closely monitored.

Conflict of interest

The authors declare no conflict of interest.

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