Acta Scientiae Veterinariae, 2023. 51(Suppl 1): 867.

CASE REPORT
Pub. 867

ISSN 1679-9216

Extensive Emphysematous Pyelonephritis in a Nondiabetic Female Cat - Treatment with Unilateral Nephroureterectomy

Hyemin Kim[1], Yeong-Seok Goh[1], Hak-Hyun Kim[2], Dong-Woo Chang[3], Ki-Jeong Na[4] & Kyung-Mee Park[1]

ABSTRACT

***Background*:** Emphysematous pyelonephritis (EPN) is an acute, severe necrotizing infection of the renal parenchyma and surrounding tissues that results in gas formation in the kidney, collecting system, or surroundings. EPN is a rare condition in veterinary medicine and occurs most frequently in dogs with diabetes mellitus. Although the prognosis of medical management in animals is poor, the standardized treatment protocol according to EPN severity is unclear. This report describes the first case of a nondiabetic female cat with extensive EPN and good prognosis following direct nephroureterectomy (NU).
***Case*:** A 10-year-old spayed female cat presented with the chief complaint of an acute loss of weight within 1 week, vomiting, and disorientation including stumbling, discoordination, circling, wobbling, head tilting, and difficulties in standing. At presentation, the patient had a body condition score of 1/9 and weighed 2.6 kg. Blood examination revealed leukocytosis, anemia, and hypoproteinemia. Abdominal radiography revealed severely decreased serosal details. A massive gas silhouette observed in the peritoneal and retroperitoneal cavities, was diagnosed as abdominal free gas. Abdominal ultrasound showed an accumulation of moderately anechoic fluid mixed with gas and cyst-like capsules around the left kidney. Left partial ureteral obstruction and dilation were also observed. Computed tomography (CT) was performed without sedatives or anesthetic drugs. The findings showed severe inflammatory changes in the peritoneum and a loss of the normal inner structure in the left kidney. A pyelogram of the left kidney was not observed after injection of the contrast material. Diffuse fat stranding and free gas observed in the mesentery of the entire abdominal cavity and around the left kidney were considered septic peritonitis. Urinalysis revealed proteinuria and hematuria. Numerous neutrophils with rod-type bacteria were observed in the ascites. Following diagnostic examinations, the patient was diagnosed with extensive left EPN, including inflammatory ascites and abdominal free gas. Therefore, emergency NU of the nonfunctional left kidney and ruptured ureter and thorough abdominal lavage were conducted. Diffuse inflammation and a nephrolith were observed in the section of the harvested kidney. The nephrolith was composed of 100% calcium oxalate monohydrate. The real-time polymerase chain reaction (RT-PCR) test for feline infectious peritonitis (FIP) was negative. *Escherichia coli* was detected in the ascites, and antibiotic therapy was administered following the antibiotic sensitivity test. The histological findings from the left kidney and ureter included marked chronic inflammation and fibrosis. The patient was discharged 4 days after surgery. During the 8-month follow-up period, the patient's condition improved.
***Discussion*:** This was a unique case of EPN in a nondiabetic cat and the first reported case of EPN with a ruptured ureter, including abdominal free gas, inflammatory ascites, and peritonitis. This patient had a bacterial urinary tract infection with *E. coli*, which is the most frequently isolated pathogen in humans. This gas-forming bacteria produced a massive amount of gas and inflammation that were considered to have ruptured the urinary tract, so that the gas was released into the abdomen. This case corresponded to class 3B, with two risk factors according to the human EPN classification system. Direct NU and abdominal lavage were performed as emergency surgeries. The patient stabilized gradually and showed a good prognosis. Immediate surgical intervention is recommended in animal patients showing the extensive EPN stage.

Keywords: kidney, nephroureterectomy, emphysematous pyelonephritis, peritonitis, cat, *E. coli*.

DOI: 10.22456/1679-9216.126542

Received: 17 November 2022 Accepted: 18 March 2023 Published: 4 May 2023

[1]Laboratory of Surgery/Ophthalmology, [2]Internal Medicine, [3]Medical Imaging & [4]Laboratory Medicine, College of Veterinary Medicine, Chungbuk National University, Cheongju, South Korea. CORRESPONDENCE: K.-M. Park [parkkm@cbnu.ac.kr]. Faculty of College of Veterinary Medicine, Chungbuk National University. 28644 Cheongju, South Korea.

INTRODUCTION

Emphysematous pyelonephritis (EPN) is an acute, severe necrotizing infection of the kidney parenchyma and surrounding area that causes gas formation in the kidney, collecting system, and surrounding tissues [11,13]. Diabetes mellitus is the most common cause of EPN. Up to 95% of human patients with EPN have concurrent uncontrolled diabetes mellitus [4,14], which is also considered a risk factor for EPN in veterinary reports [3,8]. There is a preponderance of EPN in humans, in which an increased susceptibility to UTI seems to be the reason for the higher incidence in females [1,5,12]. Although the prognosis of medical management in animals is poor, the standardized treatment protocol according to the severity of EPN is unclear, unlike that in human medicine. This report describes the first case of a nondiabetic female cat with extensive EPN with severe inflammatory ascites, ureteral rupture, ureterolith, peritonitis, and a good prognosis after direct nephroureterectomy (NU).

CASE

A 10-year-old spayed female Scottish Fold cat presented to Chungbuk National University Veterinary Teaching Hospital in Cheongju, South Korea, after having been diagnosed with ascites and suspected abdominal mass 1 day prior by the referring veterinarian. The chief complaint was an acute loss of weight within 1 week, vomiting, and disorientation including stumbling, discoordination, circling, wobbling, head tilting, and difficulties in standing. At presentation, the patient was cachectic and weighed 2.6 kg. The respiratory rate was high at 60 breaths per min, while the blood pressure, temperature, and pulse were within normal limits. A complete blood count (CBC) revealed leukocytosis (53.56 $x10^3$/μL, reference interval (RI) 2.87-17.02 $x10^3$/μL), lymphocytosis (9.70 $x10^3$/μL, RI 0.92-6.88 $x10^3$/μL), segmented neutrophilia (43.50 $x10^3$/μL, RI 1.48-10.29 $x10^3$/μL), and anemia (6.38 $x10^6$/μL, RI 6.54-12.2 $x10^6$/μL) with decreased PCV (22.7%, RI 30.3-52.3%), hemoglobin (7.8 g/dL, RI 9.8-16.2 g/dL), and MCV (35.6fL, RI 35.9-53.1 fL). The abnormalities noted on serum biochemical profile included decreased total protein (5.3g/dL, RI 5.4-7.8 g/dL), albumin (1.3 g/dL, RI 2.1-3.3 g/dL), ALT (9U/L, RI 20-107U/L), and blood urea nitrogen (BUN, 17.8 mg/dL, RI 18-33 mg/dL) levels and increased serum amyloid A (SAA) levels (> 500 mg/L, RI 0-10 mg/L). Urinalysis showed proteinuria, hematuria, a specific gravity of 1.051, and a pH of 7.

Abdominal radiographs revealed severely decreased serosal details, which prevented the accurate evaluation of the silhouetted abdominal organs (Figure 1). Abdominal free gas was diagnosed along with a gas silhouette in the caudal area of the diaphragm of the horizontal view. Several multifocal materials with mineral opacities were observed in the retroperitoneal cavity around the L4 level. Abdominal ultrasound showed an accumulation of moderately anechoic fluid mixed with gas on the cyst-like capsule around the left kidney (Figure 2). The two materials, from each pelvis and ureter on the left kidney, showed strong acoustic shadows, partial ureteral obstruction, and dilation. The mesenteric fat around the ureter was moderately to severely hyperechoic and edematous.

Computed tomography (CT) performed without the use of sedatives or anesthetic drugs indicated severe inflammatory changes in the peritoneum and a loss of the normal inner structure in the left kidney. A pyelogram of the left kidney was not observed after injection of the contrast material[1]; the left renal cortex was hypoattenuated compared to the right; the Hounsfield units of the right renal cortex decreased over time, while those of the left kidney remained constant, presenting calculi and severe dilation in the left renal pelvis and ureter, and edematous changes in the overall ureteral wall. Diffuse fat stranding and free gas in the mesentery of the entire abdominal cavity (especially in the retroperitoneal cavity) and around the left kidney were considered indicative of septic peritonitis (Figure 3). Urinalysis showed proteinuria, hematuria, a specific gravity of 1.051, and a pH 7. Numerous neutrophils with pyknotic cells and rod-type bacteria were observed in the ascites.

Because this case was considered severe EPN with an extension of gas and abscess to the pararenal space, immediate surgical intervention including abdominal lavage and NU was performed. During surgery, samples for cytology and bacterial culture were harvested from the inflammatory ascites and sectioned kidneys. After laparotomy, severe peritonitis and abscess were observed in the patient's abdominal cavity (Figure 4); therefore, irrigation with sterile warm saline was performed. After incision of the retroperitoneum, a ruptured posterior ureter and abscess flowing from it

were observed. NU of the nonfunctional left kidney and ruptured ureter was performed. Diffuse inflammation and a nephrolith sized 10×5×5 mm were observed in the kidney section (Figure 5). The histologic examination, feline coronavirus antigen test for ruling out feline infectious peritonitis (FIP), nephrolith analysis, and antibiotic sensitivity test from inflammatory ascites were performed at the veterinary laboratory[2]. The results of the real-time polymerase chain reaction (RT-PCR) test for FIP were negative, and the nephrolith from the left kidney was 100% calcium oxalate monohydrate. *Escherichia coli* was detected in the ascites, and antibiotic therapy was administered according to the sensitivity results. The resected left kidney and ureter were histologically analyzed at veterinary laboratory[3]. The findings of the left kidney included marked, chronic-active, suppurative, and lymphoplasmacytic pyelonephritis with interstitial fibrosis, multifocal abscesses, as well as capsular fibroplasia. The findings from the resected left ureter included moderate, chronic, lymphoplasmacytic, and ulcerative ureteritis with surrounding fibroplasia.

The patient was hospitalized for 4 days. During hospitalization, cefotaxime[4] (10 mg/kg - IV, BID), metronidazole[5] (10 mg/kg - IV, BID), meloxicam[6] (0.1-0.2 mg/kg - SC, SID), tramadol[7] (3 mg/kg - IV, BID), mirtazapine[8] (0.5 mg/kg - PO, SID), and fluid therapy were maintained. A complete blood count (CBC), serum biochemistry profile, and blood gas

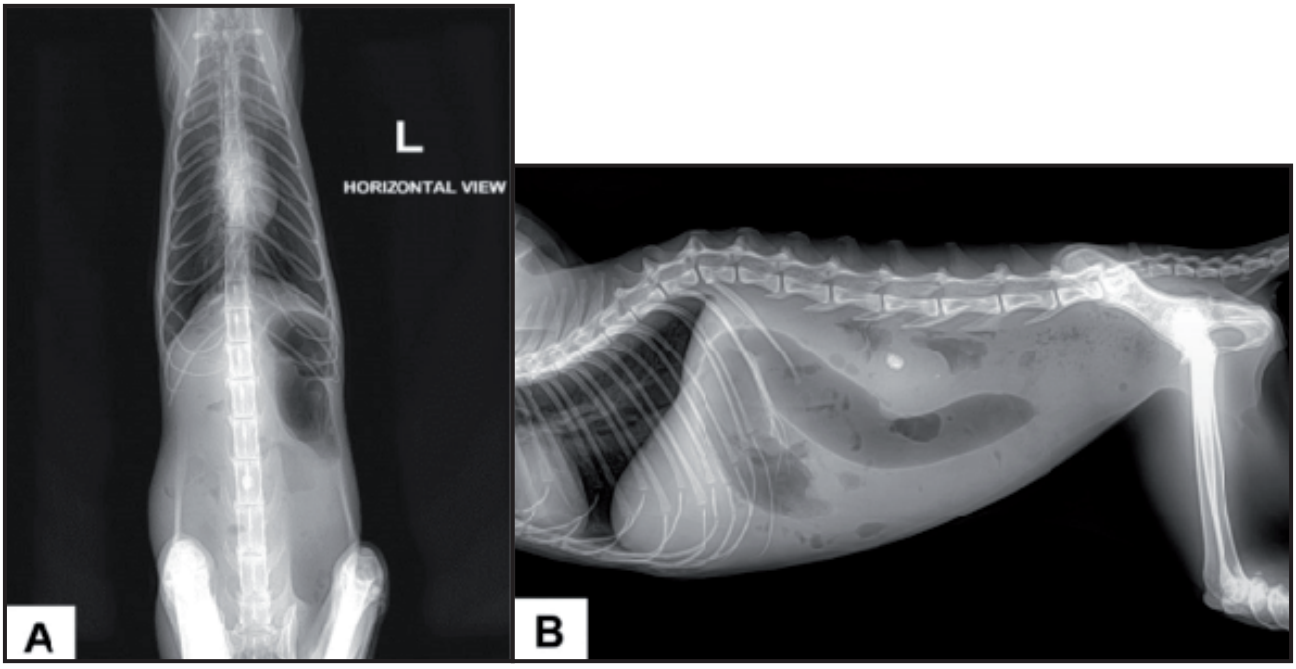

Figure 1. Abdominal radiographs showing abdominal free gas: A- Horizontal lateral view & B- Left lateral view. The gas and ascites, severely decreased serosal details, make it difficult to evaluate the abdominal organs. Some areas of mineral opacity are visible at the level L4.

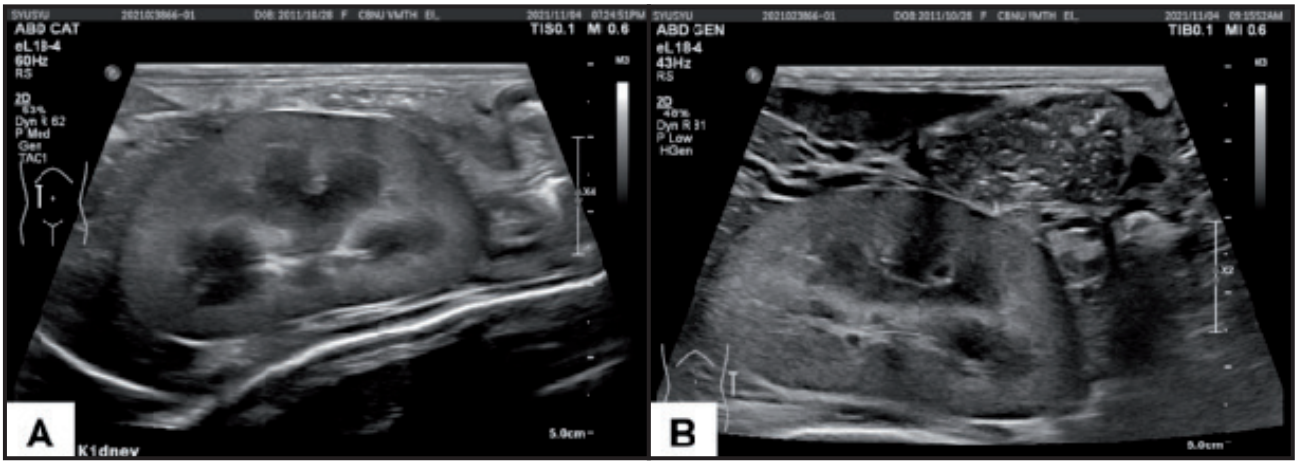

Figure 2. Ultrasonographic examination of the kidneys: A- Left & B- Right. Anechoic fluid mixed with gas is visible around the left kidney. Accumulation of moderately anechoic fluid is visible throughout the abdominal cavity.

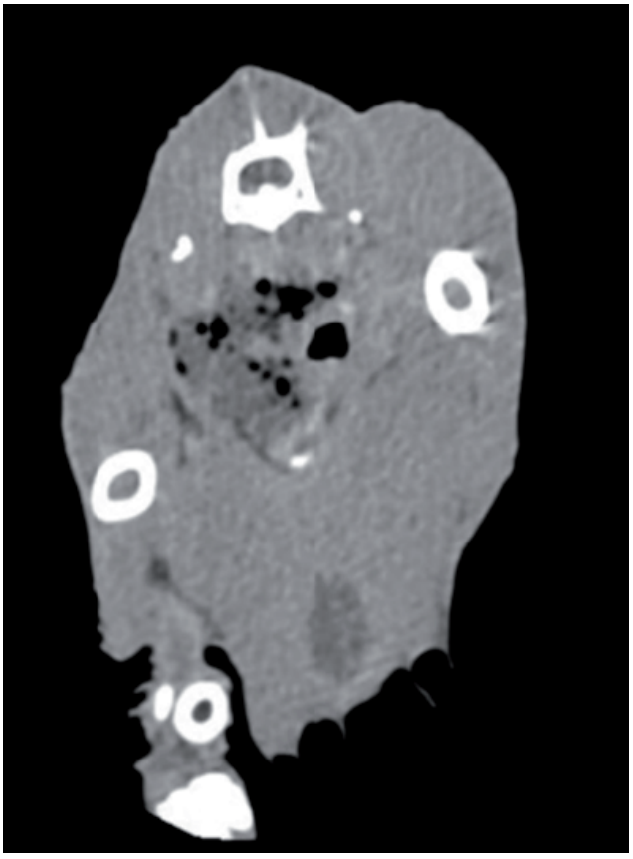

Figure 3. CT findings showing severe inflammatory changes in the peritoneum and a loss of the normal inner structure in the left kidney.

analysis were repeated daily. All abnormal panels improved over time.

After discharge, mild azotemia was observed 10 days after surgery (BUN 50.4 mg/dL, creatinine 2.7 mg/dL), with all panel values gradually normalizing at day 20 after surgery. Currently, the patient is doing well at 8 months after surgery. The owner reported that the cat's gait has returned to normal, and her condition has improved, with the cat even able to jump.

DISCUSSION

EPN is a rare condition in veterinary medicine that occurs most frequently in dogs with diabetes mellitus [9,10]. This case is unique in that EPN occurred in a nondiabetic cat; moreover, this is also the first reported case of EPN with a ruptured ureter including abdominal free gas, inflammatory ascites, and peritonitis. This patient had a bacterial urinary tract infection with *E. coli*, the most frequently isolated pathogen in humans [7,13]. This gas-forming bacteria produced a massive amount of gas, such that the inflammation in the urinary tract led to a rupture and the release of the gas into the abdomen.

The prognosis of the medical management of EPN in animals reported so far is poor [3,8]. Additionally, the treatment protocol according to severity or classification is unclear. Moreover, no studies have reviewed the prognosis of EPN in animals according to the treatment method. In humans, in addition to medical treatment, percutaneous drainage (PCD), ureteral catheter insertion, and NU have been applied for the treatment of EPN [2,5,6,11,15].

One human review reported a 50% mortality rate for patients with EPN treated with medical management alone. The rates for medical management with nephrectomy and medical management with PCD are 25% and 13.5%, respectively [12]. Similarly, another study reporting a detailed classification based on CT findings [5] classified EPN as follows: Class 1- presence of gas in the collecting system only; Class 2- presence of gas in the kidney parenchyma but not the extrarenal space; Class 3A- extension of gas or abscess to the perinephric space; Class 3 B- extension of gas or abscess to the pararenal space; and Class 4- bilateral or single kidney with EPN. In the previous report, the mortality rate was 40% for antibiotics used alone. However, all patients with localized EPN (Classes 1 & 2) survived when PCD or ureteral catheters and antibiotics were used. In 85% of patients with extensive EPN (Classes 3 & 4), if there were 2 or fewer risk factors (thrombocytopenia, acute renal failure, change of consciousness, and shock), the treatment prognosis was good with the use of PCD and antibiotics. However, when 2 or more risk factors were present, the treatment failure rate was 92%. Thus, nephrectomy was indicated, with success rates of 90%. This finding indicated that medical treatment with minimally invasive techniques could be initially beneficial; however, nephrectomy should be performed in cases with severe EPN [5,11,13].

The present case could be classified as Class 3B due to the presence of gas and abscesses in the pararenal space and the overall abdominal cavity. In addition, the patient had 2 risk factors: acute left renal function loss and disorientation. By applying the prognosis report in humans, direct NU was selected in the emergency case. Therefore, surgery was performed on the day of diagnosis. The prognosis remained good until the last postoperative follow-up. The medical treatments for EPN are considered in the early or localized stages. However, since the prognosis of medical treatment only in animal EPN patients has been poor

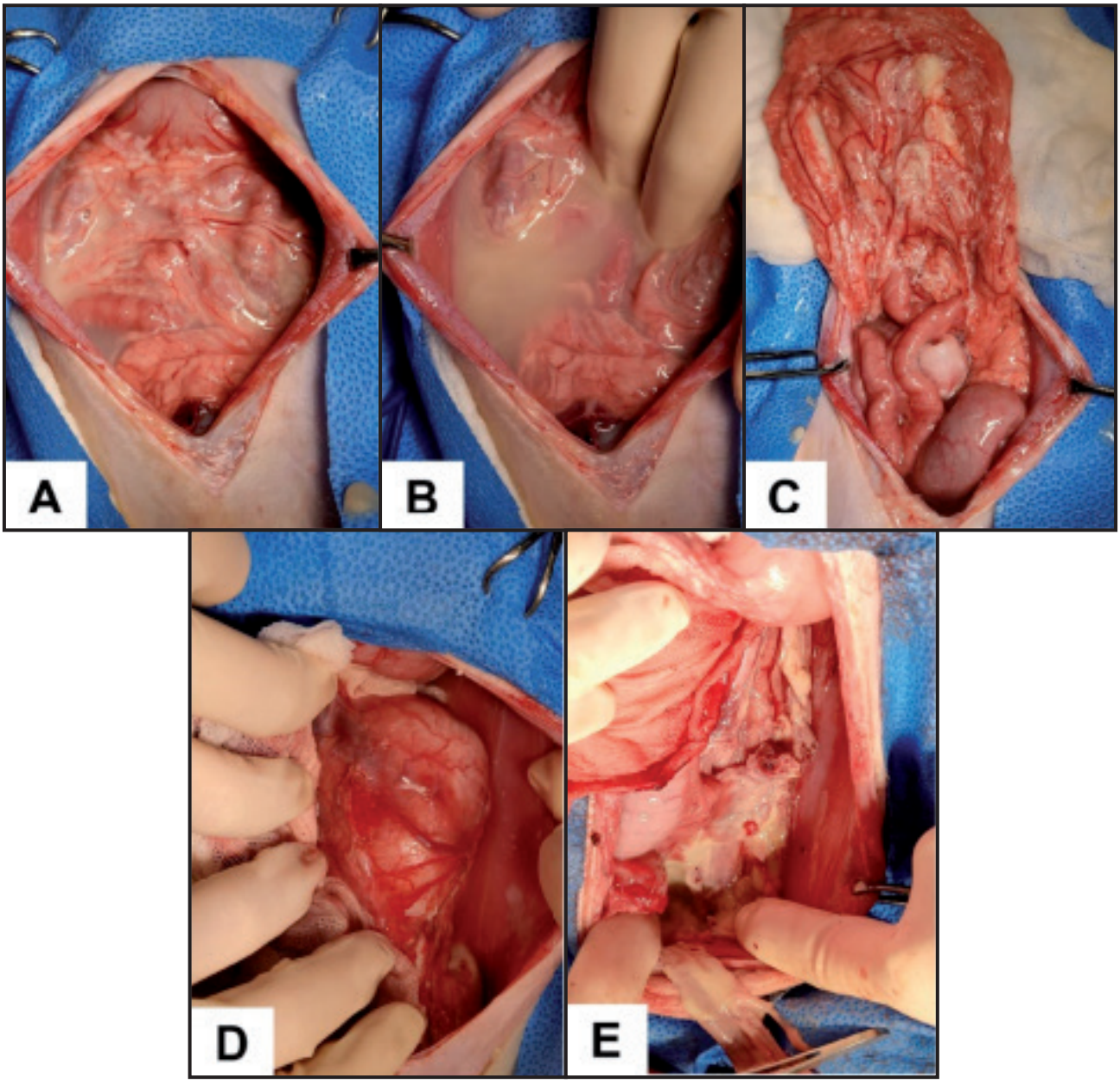

Figure 4. A & B- Photos after surgical laparotomy showing severe peritonitis and inflammatory ascites were throughout the abdominal cavity. C- After thorough abdominal lavage, inflammatory substances accumulated in the great omentum was shown. D- Angiogenesis, thickening of the renal capsule, and adhesion with surrounding tissues were also observed. E- Photo after NU and thorough abdominal lavage. Purulent inflammatory substances remained in the retroperitoneal cavity, and it was not washed well even after lavage. In particular, substantial amounts of inflammatory substances were deposited in the area between the ruptured posterior ureter and bladder.

so far, PCD or NU could be an effective therapeutic approach to improve the prognosis of EPN. In particular, in animal patients with extensive EPN with 2 or more high-risk factors, as in this case, direct NU may be the best option, as in human reports.

This report describes the first case of EPN in a nondiabetic cat. This patient was unusual because the ruptured ureter induced free abdominal fluid and gas. Immediate surgical intervention in severe EPN, which is similar to the extensive 3 B stage with 2 risk factors

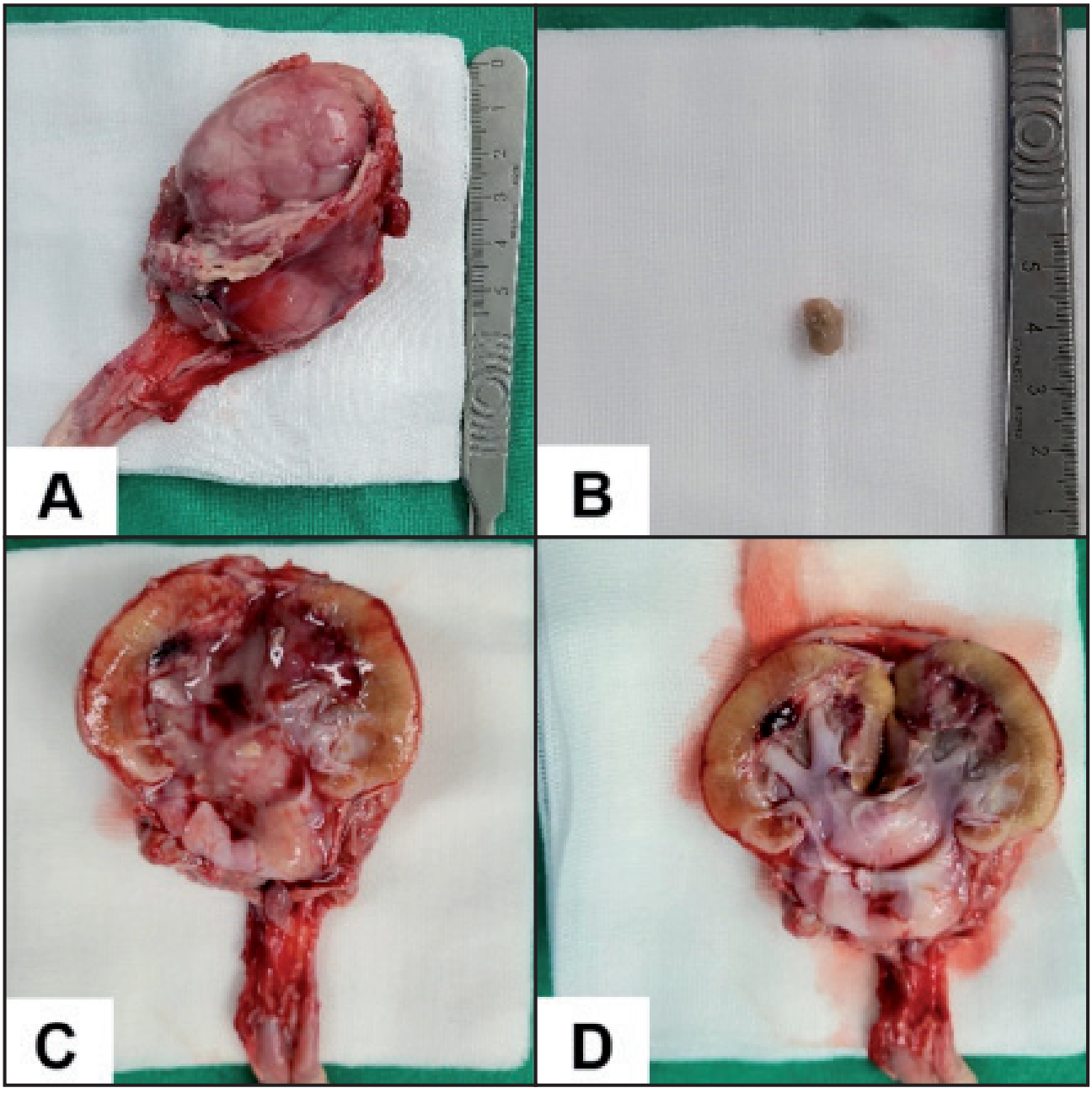

Figure 5. A- Resected left kidney and ureter. B- Nephrolith 10x5x5 mm in size obtained from the left kidney. C- Diffused inflammation and renal capsule thickening in the section of the kidney. D- Photos of the kidney section after washing the inflammatory substances.

in human EPN staging, could lead to a good prognosis in non-diabetic feline patients.

MANUFACTURERS

[1]GE HealthCare Technologies Inc. Chicago, IL, USA.
[2]IDEXX Laboratories Inc. Westbrook, ME, USA.
[3]Antech Diagnostics Inc. Irvine, CA, USA.
[4]Pharmgen Science Inc. Hawsung, Republic of South Korea.
[5]Dai Han Pharm. Co. Ltd. Seoul, Republic of South Korea.
[6]Boehringer Ingelheim. Rhein, Germany.
[7]Yuhan Foundation. Seoul, Republic of South Korea.
[8]MSD Merck Sharp & Dohme AG. Rahway, NJ, USA.

***Acknowledgements*.** This work was supported by NRF funded by the Ministry of Education, Science and Technology (2018R1D1A1B07050014), and the Basic Research Lab Program (2022R1A4A1025557) funded by the Ministry of Science and ICT. This work was also supported by Regional Innovation Strategy (RIS) through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (MOE) (2022E0701008).

***Declaration of interest*.** The authors declare no conflicts of interest. The authors alone are responsible for the contents of this study.

REFERENCES

1 **Abdul-Halim H., Kehinde E.O., Abdeen S., Lashin I., Al-Hunayan A.A. & Al-Awadi K.A. 2005.** Severe emphysematous pyelonephritis in diabetic patients. *Urologia Internationalis*. 75(2): 123-128.

2 **Cardinael A., De Blay V. & Gilbeau J. 1995.** Emphysematous pyelonephritis: successful treatment with percutaneous drainage. *American Journal of Roentgenology*. 164(6): 1554-1555.

3 **Fabbi M., Manfredi S., Bianchi E., Gnudi G., Miduri F. & Volta A. 2016.** Emphysematous pyelitis and cystitis associated with vesicoureteral reflux in a diabetic dog. *The Canadian Veterinary Journal*. 57(4): 382-386.

4 **Falagas M.E., Alexiou V.G., Giannopoulou K.P. & Siempos I.I. 2007.** Risk factors for mortality in patients with emphysematous pyelonephritis: a meta-analysis. *The Journal of Urology*. 178(3 Pt 1): 880-885.

5 **Huang J.J. & Tseng C.C. 2000.** Emphysematous pyelonephritis: clinicoradiological classification, management, prognosis, and pathogenesis. *Archives of Internal Medicine*. 160(6): 797-805.

6 **Koh K., Lam H. & Lee S. 1993.** Emphysematous pyelonephritis: drainage or nephrectomy? *British Journal of Urology*. 71(5): 609-611.

7 **Kua C. & Aziz Y.A. 2008.** Air in the kidney: between emphysematous pyelitis and pyelonephritis. *Biomedical Imaging and Intervention Journal*. 4(4): e24.

8 **Moon R., Biller D.S. & Smee N.M. 2014.** Emphysematous cystitis and pyelonephritis in a nondiabetic dog and a diabetic cat. *Journal of the American Animal Hospital Association*. 50(2): 124-129.

9 **Peli A., Fruganti A., Bettini G., Aste G. & Boari A. 2003.** Emphysematous cystitis in two glycosuric dogs. *Veterinary Research Communications*. 27: 419-423.

10 **Root C. & Scott R. 1971.** Emphysematous cystitis and other radiographic manifestations of diabetes mellitus in dogs and cats. *Journal of the American Veterinary Medical Association*. 158(6): 721-728.

11 **Shokeir A.A., El-Azab M., Mohsen T. & El-Diasty T. 1997.** Emphysematous pyelonephritis: a 15-year experience with 20 cases. *Urology*. 49(3): 343-346.

12 **Somani B.K., Nabi G., Thorpe P., Hussey J., Cook J. & N'Dow J. 2008.** Is percutaneous drainage the new gold standard in the management of emphysematous pyelonephritis? Evidence from a systematic review. *Journal of Urology*. 179(5): 1844-1849.

13 **Ubee S.S., McGlynn L. &Fordham M. 2011.** Emphysematous pyelonephritis. *BJU International*. 107(9): 1474-1478.

14 **Wan Y.L., Lee T.Y., Bullard M.J. &Tsai C.C. 1996.** Acute gas-producing bacterial renal infection: correlation between imaging findings and clinical outcome. *Radiology*. 198(2): 433-438.

15 **Zagoria R.J., Dyer R.B., Harrison L.H. & Adams P.L. 1991.** Percutaneous management of localized emphysematous pyelonephritis. *Journal of Vascular and Interventional Radiology*. 2(1): 156-158.