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SURGICAL APPROACH OF RENAL CALCULI IN A MIXED BREED FEMALE DOG: CASE REPORT

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Abstract

A 5-year-old mixed breed female dog was diagnosed with renal calculi and recurrent cystitis and referred for second opinion. The patient presented lack of appetite, abdominal distention, progressive weight loss, dysuria and haematuria. During clinical examination, temperature, heart rate, blood pressure and respiratory rates were slightly elevated. Blood biochemistry revealed elevated creatinine and blood urea nitrogen. Using abdominal ultrasound examination, two ellipsoidal structures compatible with uroliths were visualized in the left kidney and proximal ureter. Abdominal radiography showed an irregular radiopaque calculus in the pelvis of the left kidney, confirming the ultrasound diagnosis, unilateral nephroureterolithiasis. Urinalysis confirmed struvite. Urolithiasis is a general term referring to aggregates of crystalline that can lead to ureteral obstruction, deterioration of renal function, bacterial urinary tract infection, haematuria and pain. Ureteral obstruction is a common indication for surgical intervention in small animals. Following abdominal radiography, nephrolithotomy and ureteral stenting were performed. Ureteral stenting is frequently performed following ureterotomy or ureteral anastomosis in order to reduce the risk of ureteral stricture. Ureteral stenting is the surgical treatment providing a direct communication between the bladder and kidney.

Key words: *calculi, dog, surgery, lithiasis, kidney.*

INTRODUCTION

Uroliths are polycrystalline concretions consisting mainly of organic or inorganic crystalloids along with smaller quantities of organic matrix. Uroliths generally consist of one or more types of minerals. These minerals can be present in a pure form, layered, or mixed throughout the urolith. Additionally, certain drugs can crystallize within the urinary tract and become part of the urolith. Magnesium ammonium phosphate crystals are observed most frequently whereas, the relative incidence of calcium oxalate, cystine, and ammonium urate tends to vary (Senior & Finlayson, 1986; Koehler et al., 2009).

The response of the body to a blockage in the ureter is intricate, occurring both before and after the blockage is resolved. Studies involving healthy dogs have indicated that the pressure in the ureter increases as soon as an obstruction occurs and may take over 24 hours to return to normal after the obstruction is relieved (Wen et al., 1999). Following the increase in pressure, renal blood flow decreases to 40% of its normal level within the initial 24 hours and subsequently drops to 20% of normal within the following two weeks. The heightened pressure is transmitted to the nephron, resulting in a decline in the glomerular filtration rate (GFR) due to the release of vasoactive mediators, the influx of leukocytes, and eventual fibrosis (Coroneos et al., 1997; Wilson, 1977). In response, the contralateral kidney will undergo an increased GFR. Irreversible effects are based on the severity and duration of the obstruction. A study involving healthy dogs demonstrated that after 7 days of obstruction, the GFR was permanently reduced by 35%, and after two weeks of obstruction, the GFR was reduced by 54%. Many individuals encounter partial blockage while also experiencing concurrent renal impairment, such as chronic kidney disease (CKD). Aggressive management and resolution of the obstruction are advised to enhance the overall outcome (Berent, 2011).

At the time of diagnosis, azotaemia is frequently observed, with 83% of cats and 50% of dogs showing azotaemia in cases of unilateral obstruction (Berent, 2011). Historical information varies, depending on whether the stone has caused obstruction or whether concurrent infection is present. Nephroureteroliths are often found incidentally. Clinical signs can be intermittent, especially if the animal has received antibiotic treatment. Typical signs include stranguria, hematuria, and pollakiuria. Uncommon signs might involve abdominal discomfort and hypersalivation (Fossum et al., 2019)

The preferred method for diagnosing ureteral obstructions is a combination of radiographs and ultrasound. Radiographs are beneficial for documenting the size, number, and location of stones, as well as the presence of concurrent nephrolithiasis (Berent, 2011).

Surgical intervention is necessary when a ureterolith is causing recurrent urinary tract infections due to its immobility. Other factors to consider before surgery are the patient's overall kidney function, the presence of other stones in the urinary tract, the position of the ureterolith within the ureter, and the patient's general systemic health (Snyder et al., 2005).

The typical double-pigtail ureteral stent is a catheter with multiple openings and a pigtail loop at both ends. The first loop is placed inside the renal pelvis, while the catheter's shaft is located within the ureteral lumen, and the second loop ends inside the urinary bladder. By guiding urine from the renal pelvis directly into the urinary bladder through and around the stent, the double-pigtail stent effectively bypasses the ureteral obstruction (Berent et al., 2011).

Unilateral or bilateral ureteral stents are used to bypass obstruction, especially in cats, regardless of where the obstruction is or the number of stones that reside in the kidney or ureter. Stents enable passive ureteral dilation, restoration of urine flow, and potential recovery of the affected kidney. The placement of ureteral stents can be done endoscopically with cystoscopic and/or fluoroscopic guidance, and the stent can be placed through the ureterovesicular junction or from a ventral midline approach. Using an open approach, stents can be placed normograde via pyelocentesis, retrograde via cystotomy through the ureterovesicular junction, or retrograde through ureterotomy incision. Complications related to ureteral stents include stent migration, stent fracture, recurrent obstruction, recurrent UTI, and chronic urinary tract disease (Fossum et al., 2019).

The presence of urinary calculi or uroliths in the kidneys, ureters, bladder, or urethra is referred to as urolithiasis. Nephrolithiasis or ureterolithiasis specifically denote the condition of having renal or ureteral calculi (e.g., nephroliths or ureteroliths). Removal of renal calculi from the renal pelvis through an incision in the kidney parenchyma is called nephrolithotomy. Making an incision into the renal pelvis and proximal ureter is known as pyelolithotomy. The removal of calculi from the ureter by making an incision is referred to as ureterolithotomy (Fossum et al., 2019).

In dogs, the most frequently encountered types of uroliths are struvite (magnesium ammonium phosphate) and calcium oxalate. Additional types consist of urate, silicate, cystine, and mixed stones (Fossum et al., 2019).

Whether all renal or ureteral stones should be removed is controversial. Removal should be considered if renal stones are associated with refractory infection or hematuria, or if ureteral stones are causing complete obstruction. The removal of kidney stones that are not infected could potentially cause more harm than the stones themselves. Other factors to be considered in deciding surgery includes the effectiveness of medical therapy in dissolving the stone, renal function in the affected and contralateral kidney, the animal's overall health, and the presence of obstructive uropathy (e.g., hydronephrosis, hydroureter, or renal failure) (Fossum et al., 2019).

Ureteral stenting is the preferred choice for managing ureteral calculi that are difficult to remove by ureterotomy in dogs. It is commonly carried out following ureterotomy or ureteral anastomosis to reduce the likelihood of ureteral stricture development (Nicoli et al., 2012).

Urinary tract infection (UTI) caused by bacteria is a prevalent condition in dogs and frequently results in the use of antimicrobial medications. UTI occurs when infectious agents attach to, reproduce, and remain in the urogenital system, leading to inflammation and and related clinical signs (Harrer & Dorsch, 2020).

MATERIALS AND METHODS

A 5-year-old, 7.6 kg, canine mixed breed sterilized female was diagnosed with cystitis and nephroureterolithiasis and has undergone a surgical procedure for excision of the calculus that was located in the ureter, at another veterinary clinic. During the procedure, it was observed that the urolith has migrated and a purulent collection was drained. In the previous clinic, a urine culture sample was sent to a microbiology laboratory and the result was positive for *Proteus mirabilis* (>10.000 colony-forming unit - CFU). A wide spectre antibiotic was initiated according to the antibiogram result. The patient was referred for a second opinion nephrology consult on the 13th of October, 2022. Owner reported that the patient presented lack of appetite with progressive weight loss, abdominal distension, dysuria and haematuria. At the time the patient presented for the second opinion nephrology consult, the patient was on day 20 of antibiotic treatment for *Proteus mirabilis*.

During clinical examination, the following findings were noted: body temperature of 39.0°C, respiratory rate of 30 rpm, heart rate of 110 bpm, and body condition score of 3 with a mild muscle loss and a moderate painful sensitivity and defensive reaction to deep palpation of the abdomen. Arterial blood pressure showed slightly elevated values.

The complete blood count (CBC) was performed on Vetscan HM5 Hematology (5-part Differential) and determined: white blood cells (WBC), lymphocytes (LYM), monocytes (MON), neutrophils (NEU), eosinophils (EOS), basophils (BAS), LYM%, MON%, NEU%, EOS%, BAS%, red blood cells (RBC), haemoglobin (HGB), haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), red blood cell distribution width-coefficient of variation (RDWc), red blood cell distribution width-standard deviation (RDWs), platelet (PLT), mean platelet volume (MPV), plateletcrit (PCT), platelet distribution width-coefficient of variation (PDWc) and platelet distribution width-standard deviation (PDWs).

Serum biochemistry was performed on Vetscan VS2 Chemistry Analyzer with a comprehensive diagnostic panel that determined: albumin (ALB), alkaline phosphatase (ALP), alanine aminotransferase (ALT), amylase (AMY), total bilirubin (TBIL), blood urea nitrogen (BUN), calcium (CA), phosphorus (PHOS), creatinine (CRE), glucose (GLU), sodium (NA^+), potassium (K^+), total proteins (TP) and globulin (GLOB).

Blood gases and electrolytes were performed on EPOC (electrolyte point of care).

Urinalysis was performed on Vetscan UA Urine Analyzer and determined leukocytes, ketones, nitrites, urobilinogen, bilirubin, glucose, protein, specific gravity, pH, blood, ascorbic acid, microalbumin, calcium, creatinine and protein/creatinine.

Abdominal ultrasound of the right kidney did not show any alteration of the structure. Two ellipsoidal structures (1: 1/0.6 cm, 2: 0.95/0.7 cm) compatible with uroliths were visualized in the left kidney (5.9/3.1 cm) and proximal ureter (0.95 cm). Furthermore, the left ureter was dilated and the left kidney showed signs of hydronephrosis. The renal pelvis was extended to 1.07/0.51 cm (hydronephrosis grade 1 to 2).

Assessment of hydronephrosis typically involves visual examination and categorization into five levels, which span from a slight enlargement of the renal pelvis to significant hydronephrosis accompanied by cortical thinning in advanced stages of the condition (Hansen, K.L., Nielsen, M.B., & Ewertsen, C., 2015).

Abdominal radiography showed irregular radiopaque calculi in the pelvis of the left kidney, confirming the ultrasound diagnosis, unilateral nephroureterolithiasis (Figure 1a, 1b, 1c).

Figure 1a - Right latero-lateral exposure

Figure 1b - Left latero-lateral exposure

Figure 1c - Ventro-dorsal exposure

The patient was hospitalized and stabilized in order to be submitted to a nephro-uretero-litothomy surgical procedure.

Rehydration and electrolyte rebalancing were established by continuous rate of infusion (CRI) with Ringer solution (rate and dosage: 7 ml/kg/h) and partial parenteral nutrition based on levo-aminoacids was administered (rate and dosage: 0.6-0.8 g amino acids/kg/24 h). The active ingredients in the levo-aminoacids solution are: L-isoleucine, L-leucine, L-lysine monoacetate, L-lysine, L-methionine, L-phenylalanine, L-threonine, L-tryptophan, L-valine, L-arginine, L-histidine, L-alanine, N-acetyl-L-cysteine, L-cysteine, Glycine, L-proline, L-serine, L-tyrosine, N-glycine-L-tyrosine dehydrate, N-glycine/L-tyrosine. It contains a total of 100g/L amino acids.

In the following days leading up to the surgical procedure, the patient was given the following treatment: a potent and selective antagonist of the neurokinin (NK-1) receptor and a proton pump inhibitor. Nutritional supplements based on amino acids combined with a peptide that supports kidney functions and supplements that help maintain and support the urinary tract (based on DL-methionine) were introduced as adjuvants in the therapy. Analgesia was ensured with the use of methadone.

During hospitalization, the patient did not present food appetite. In addition to the ongoing medication and treatment protocol, suppository with mirtazapine was added and administered by intra-rectal route for three days consecutively.

On the day of the surgical procedure the cardiology exam revealed respiratory sinus arrhythmia with elevated ST segment.

Following stabilization, the patient was prepared for the surgical procedure. The approach of uroliths was done at the level of the left ureter by performing an ureterotomy through a small longitudinal incision. Afterwards, an indwelling Double J Catheter Stent of 6.0 French (Fr) and 26 centimetres (Figure 2) was placed by cystoscopy (retrograde) approach.

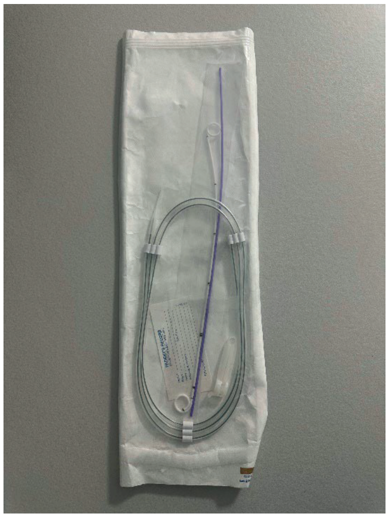
Figure 2 - Double J Catheter Stent, 6.0 French (F)

Ureteral stents are usually available in a Double-J or double-pigtail design and extend from the renal pelvis to the bladder along the length of the ureter. The most prevalent types of ureteral stents used in dogs and cats are currently made from a solid polymer, featuring a double-pigtail configuration and multiple fenestrations. Temporary and permanent urethral stents place in dog patients have been proven effective as treatment options. Temporary urethral stents are placed less frequently than permanent ones. Basic versions of temporary stents are generally crafted from rubber or polyurethane.

Temporary stents may serve as a temporary solution before permanent stenting. They can be used until a permanent stent is available or to determine if stenting will facilitate with urine drainage in a specific patient. In dogs, temporary stents are also considered when there is suspicion of reflex dysynergy or functional obstruction of urethral outflow. In these cases, permanent stenting may not be able to resolve the urethral obstruction, so temporary stents are used to assess the potential success of stenting (Palm et al., 2021).

Following the surgical procedure, the treatment protocol was modified in the following manner: a broad-spectrum antibiotic was initiated and a non-steroidal anti-inflammatory drug (NSAID) from the coxib class, which has a strong preference for the cyclooxygenase-2 (COX-2) enzyme (Kongara & Chambers, 2018).

The patient received renal diet.

RESULTS AND DISCUSSIONS

On the 13th of October 2022, the patient had the following serum biochemistry modifications: AMY 1365 U/L (RR: 200-1200 U/L), BUN 66 mg/dL (RR: 7-25 mg/dL), CRE 4.3 mg/dL (RR: 0.3-1.4 mg/dL), GLU 117 mg/dL (60-110 mg/dL). There were no changes regarding the complete blood count (CBC). Urine sediment showed leukocytes 10-15 high power field (HPF) (RR: 0-8 HPF) and magnesium ammonium phosphates (struvites). Urinalysis was performed from urine obtained through ultrasound guided cystocentesis and the following results were obtained: slightly turbid urine with a pH of 7 (RR: 6-7.5), specific gravity of 1.012 (RR: 1.015-1.045), leukocytes 25 Leu/uL and proteins 30 mg/dL. A urine culture sample was submitted to a microbiology laboratory and the result was negative (0 colony-forming unit - CFU).

Following the first night of hospitalization, serum biochemistry was re-evaluated and the following modifications occurred: ALB 2.5 g/dL (RR: 2.5-4.4 g/dL), BUN 50 mg/dL (RR: 7.0-25.0 mg/dL), CRE 2.1 mg/dL (0.3-1.4 mg/dL) and GLU 145 mg/dL (RR: 60-110 mg/dL).

After 72 hours of therapy, the serum biochemistry was: ALP 310 U/L (RR: 20-150 U/L), BUN decreased to 30 mg/dL (7-25 mg/dL), CRE slightly decreased to 1.7 mg/dL (0.3-1.4 mg/dL) and GLU slightly decreased to 124 mg/dL (RR: 60-110 mg/dL).

The following day, serum biochemistry results showed ALB 2.4 g/dL (RR: 2.5-4.4 g/dL) and ALP increased to 394 U/L (RR: 20-150 U/L).

On the day of the surgical procedure an electrolyte point of care (EPOC) analysis was performed and no parameters other than BUN, CRE, ALP and ALB were modified.

On the day of the surgical procedure the cardiology exam revealed respiratory sinus arrhythmia with elevated ST segment. Heart rate was between 80-90 beats per minute (bpm). Pimobendane was administered with a dose of 0.25 mg/kg. The heart rate slightly increased between 94-100 bpm.

During the pre-anaesthetic evaluation, heart rate was between 100-110 bpm, systolic blood pressure values were between 120-130 mmHg. No heart murmur was heard with a rhythmic-arrhythmic rate. Femoral pulse was present bilaterally, normodynamic and synchronous with the heartbeat. Vesicular murmur was present bilaterally. The patient's mucous membranes were pink and the capillary refill time was less than 2 seconds. The body temperature was 38.2°C and the Body Condition Score was between 4 and 5.

According to the American Society of Anesthesiologists (ASA) risk classification, the patient was graded score 3, indicating the presence of moderate systemic disease that limits normal function. Animals with an ASA score of 3 or higher are over 10 times more likely to experience peri-anaesthetic complications than animals in ASA scores of 1 or 2. Assigning an ASA score accurately is a reliable method for identifying at-risk patients. To assign the correct ASA status, a comprehensive pre-anaesthetic evaluation is essential (Duke-Novakovski et al., 2016).

The premedication protocol consisted of midazolam (0.2 mg/kg) IV, methadone

(0.3 mg/kg) IV and ketamine (0.3 mg/kg) IV. For induction, propofol was used in a dose of 8 mg/kg IV.
Loco-regional anaesthesia consisted of incisional and peritoneal blocks.
A constant rate infusion (CRI) of fentanyl-lidocaine-ketamine was used as part of the partial intravenous anaesthesia (PIVA).
Isoflurane, administered together with oxygen, was used as an inhalant anaesthetic for maintenance of the anaesthesia during the surgical procedure.
The surgical procedure that the patient had undergone was a nephro-uretero-litothomy.
Ureterotomy is occasionally performed to remove obstructive calculi, but it carries risks such as postoperative leakage and stricture formation, necessitating careful execution. Calculi removal is recommended when obstruction occurs or is anticipated (e.g., in cases of hydroureter or hydronephrosis). Although ureteral mucosa can regenerate around a stent if not entirely disrupted, the use of stenting catheters remains controversial due to potential risks of stricture formation and infection. When stents are used, they should be smaller than the diameter of the ureter. In some cases, ureteral stents may be placed to exit through the urethral orifice and are sutured externally (Fossum et al., 2019).
The patient did not present any complications in the following weeks regarding the urethral stenting.
The following surgery process steps were performed:

- the patient was placed in dorsal recumbency;
- the abdomen was prepared for a ventral midline incision. The prepared area was extended from above the xyphoid to caudal to the pubis;
- a longitudinal incision in the dilated left ureter proximal to the urolith;
- removal of the urolith;
- through the longitudinal incision, with a surgical Kocher clamp, it was possible to reach the nephrolith (the nephrolith was not embedded within the renal pelvis of the left kidney that was presented with hydronephrosis);
- a small soft rubber catheter was placed into the ureter proximal and distal to the incision, through which warm fluid was flushed;
- the incision was closed with a simple interrupted pattern with 6/0 absorbable suture;
- the Double J 6.0 Fr catheter was inserted through a cystoscopy (retrograde) approach.

Abdominal radiography was repeated the following day (Figure 3a and 3b).

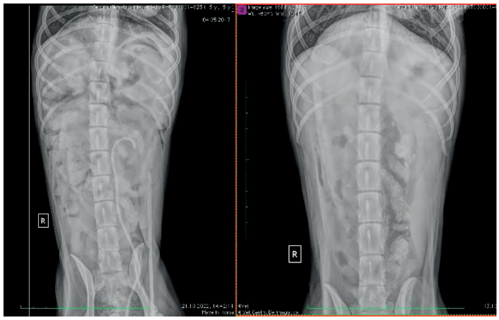

Figure 3a - Radiographs taken before (right) and after (left) the surgical procedure

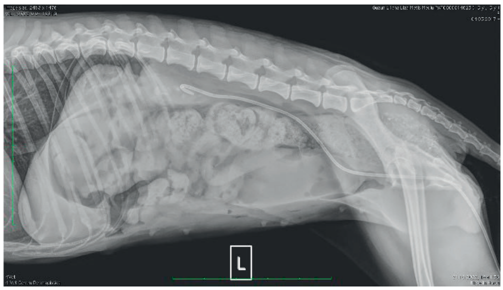

Figure 3b - Latero-lateral incidence of the patient taken after the surgical procedure

The patient was unstable during the procedure and it required specific medication support and special intra-operative monitoring. The heart rate decreased to 50-60 bpm. The patient was responsive to aggressive fluid therapy and inotropic medication. The patient was mechanically ventilated with SIMV-VC and IPPV.
After 24 hours, the bloodwork was re-evaluated and the following parameters were increased: ALB 2.1 g/dL (RR: 2.5-4.4 g/dL), ALP 315 U/L (RR: 20-150 U/L), BUN 42 mg/dL (RR: 7.0-25.0 mg/dL) and CRE 1.6 mg/dL (0.3-1.4

mg/dL). The CBC revealed an increase in WBC 26.69 10^9/l (RR: 6-17 10^9/l) and NEU 24.11 10^9/l (RR: 3-12 10^9/l).

On discharge day, serum biochemistry values showed: ALB 2.1 g/dL (RR: 2.5-4.4 g/dL), ALP 306 U/L (RR: 20-150 U/L), BUN 37 mg/dL (RR: 7.0-25.0 mg/dL) and CRE 1.4 mg/dL (0.3-1.4 mg/dL). The CBC showed a decrease on WBC with 19.39 10^9/l (RR: 6-17 10^9/l) and NEU 15.50 10^9/l (RR: 3-12 10^9/l). The patient was discharged with the following recommendations:

- nutritional supplements based on amino acids combined with a peptide (2000 mg every 12 hours) and supplements that help maintain and support the urinary tract (based on DL-methionine - 250 mg TID);
- calcium carbonate-based phosphorus binders (300 mg every 12 hours);
- supplements for enteric dialysis;
- first-generation cephalosporin antibiotic (22 mg/kg every 12 hours for 14 days);
- a selective proton pump inhibitor (20 mg every 24 hours for 7 days);
- pimobendane 1.25 mg, for 30 days with reassessment;
- probiotic food supplement (every 24 hours for 30 days);
- supplement for liver function support;
- renal diet.

Fourteen days after discharge, CBC, serum biochemistry, urinalysis and abdominal ultrasound were reassessed. There were no abnormalities on the CBC. Serum biochemistry revealed a mild elevation of ALP 160 U/L (RR: 20-150 U/L), ALT 145 U/L (RR: 10-118 U/L), AMY 1242 U/L (200-1200 U/L), CRE 1.5 mg/dL. Abdominal ultrasound of the right kidney revealed a regular contour with a suitable cortico-medullar ratio and renal pelvis dilation of grade 1 to 2. The left kidney has a regular contour with renal pelvis dilatation of grade 1 to 2. The urine sample was obtained by ultrasound guided cystocentesis and urinalysis showed leukocytes +3500 cell/uL, with a specific gravity of 1.030 and a pH of 5.0. Urine sediment did not present any crystals but numerous leukocytes and bacteria. A urine culture sample was submitted to a microbiology laboratory and the result was positive for *Escherichia coli* (>100.000 CFU). The antibiotic of choice was a broad spectrum antibiotic from the aminopenicillin class of penicillin family. The owner was informed that after 28 days of antibiotic treatment, another urine culture sample will have to be sent again for microbiology.

The indwelling Double J Catheter Stent was removed after 14 days since the surgical procedure.

Twenty-eight days after the last check-up, another urine culture sample was sent to a microbiology laboratory and the result was positive for *Klebsiella pneumonia* (>100.000 CFU). An antibiotic from the class of fluoroquinolones was chosen and administered for the next 28 days. Urinalysis showed leukocytes +2125 cell/uL, specific gravity of 1.030 and pH of 5.0. Urine sediment did not present any crystals but numerous leukocytes and renal tubular epithelial cells. Renal tubular epithelial cells, located in the tubulointerstitium, are recognized for their important functions in acute kindey injury (AKI) and CKD (Hong et al., 2020). Abdominal ultrasound showed the right kidney with a regular contour with a suitable cortico-medullar ration and renal pelvis dilatation of grade 1. The left kidney had a regular contour with renal pelvis dilatation of grade 1 to 2 with a calculus of approximately 0.4 cm. The urinary bladder presented multiple hyperechoic particles in suspension with dimensions of about 4.5 cm.

The following re-check, urine sediment showed leukocytes, renal tubular epithelial cells, struvite (magnesium ammonium phosphate) and bacteria. Ultrasound of the left kidney showed a severely altered architecture with renal pelvis dilatation of grade 1 to 2 and ureter dilation due to the presence of a 0.5 cm urolith. The right kidney showed a characteristic architecture with a suitable cortico-medullar aspect ratio and no dilation of the proximal pelvis. The result for urine culture was positive for *Escherichia coli* (>100.000 CFU) with sensitivity to broad spectrum synthetic antibiotic. The antibiotic was administered for 28 days.

Every 30 days, a complete CBC, serum biochemistry, urinalysis and urine sediment, urine culture and abdominal ultrasound were re-evaluated. Over the following 12 months after discharge, a total of 11 urine cultures were determined. The patient had two negative urine cultures and nine tested positive for *Escherichia coli* (>100.000 CFU).

Since the surgical procedure, serum biochemistry values are as follows: BUN 31 mg/dL (RR: 7.0-25.0 mg/dL) and CRE 2.0 mg/dL (0.3-1.4 mg/dL). Urinalysis revealed a specific gravity of 1.030 and pH of 6.0. Urine sediment did not show any crystals but rare renal tubular epithelial cells.

UTIs in dogs and cats, with female dogs and cats at higher risk, are typically caused by a single pathogen in 75% of cases. In dogs, Escherichia coli is responsible for about half of all infections, followed by Staphylococcus, Proteus and Klebsiella species. Several factors such as incomplete bladder emptying due to neurological disease, the presence of urolithiasis, urinary incontinence and immunosuppression have been associated with an increased risk of UTI (Byron, 2019).

CONCLUSIONS

Stenting of the urinary tract is a minimally invasive and highly effective method of restoring the flow of urine and relieving the pressure in the kidney.

After stenting, regular monitoring is crucial to detect any complications that may necessitate the removal or replacement of the stent.

The combined use of radiology and ultrasonography is recommended to assess the upper urinary tract, as this approach offers greater diagnostic sensitivity than using each method independently.

Monthly clinical evaluation, laboratory tests, medication and a balanced diet can offer a good prognosis for patients diagnosed with nephroureterolithiasis that underwent nephrolithotomy intervention.

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