The use of nephroscopy and ureteral retrograde hydroplulsion for urolith removal from the upper urinary tract in 11 patients

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SUMMARY

Renal and ureteral calculi are uncommonly diagnosed and present a challenge, requiring surgery in some cases. This retrospective study describes the use of nephroscopy and ureteral hydroplulsion via cystotomy for the removal of renal and ureteral calculi from nine cats and two dogs, over a three-year period. The data recorded included signalment, clinical signs, blood test results, radiographic and ultrasound findings, surgical procedure and outcome. Preoperative, postoperative, predischARGE and one-month postoperative serum creatinine (SCr) and blood urea nitrogen (BUN) concentrations were monitored. Most of the clinical signs associated with postrenal insufficiency (depression, anorexia, vomiting) were present in all the animals. All patients had nephroliths and ureteroliths. Nephroscopy was performed in all cases (unilateral in five cases, bilateral in six). A mortality rate of 18.8% was recorded before discharge, with the observed deaths due to uretroscopy leakage and disseminated intravascular coagulation. In two-tailed students’s t tests, postoperative and pre-discharge observations due to ureterotomy leakage and disseminated intravascular coagulation. In two-tailed students’s t tests, postoperative and pre-discharge mean SCr and BUN concentrations were found to be significantly lower than their respective preoperative means. Surgically assisted nephroscopy and ureteral hydroplulsion were found to be useful for the removal of renal and ureteral calculi in cats and dogs, and for limiting uretroscopy procedures. No nephroscopy-related complication was observed. Nevertheless, consequences of nephroscopy for renal function remain to be determined.

Keywords: Nephroscopy, retrograde hydroplulsion, uroliths, upper urinary tract, feline

INTRODUCTION

Unlike cystic calculi, which are quite common [21], renal and ureteral calculi are not commonly diagnosed and are rarely of clinical significance. However, despite the small number of symptomatic cases, the complications associated with the presence of uroliths in the upper urinary tract may be severe and require specific treatment [2]. Urolithiasis can be managed medically or surgically. The frequency of uroliths detected in the upper part of the urinary tract seems to have increased over the past 20 years, to current levels of 2 to 4% of feline uroliths being localized to the kidney or ureter [23]. A significant increase in the proportion of calcium oxalate calculi has also been reported over time, with a significant reciprocal decrease in the proportion of struvite calculi. These long-term changes are probably multifactorial and may reflect dietary and demographic (obesity, breed) changes. Regardless of their cause, these changes have led to an increase in the incidence of calcium oxalate calculi, which are difficult to manage non surgically [8, 14, 24, 27]. Thus, clinically significant uroliths are increasingly being treated by surgery.

Surgical treatment is necessary in cases of urine outflow obstruction of the upper urinary tract leading to impaired renal function, or following the failure of non surgical treatment. In veterinary surgery, upper urinary tract calculi are generally removed by nephroscopy and/or uretroscopy. It has been suggested that nephroscopy is associated with a decrease in renal function of up to 20% based on glomerular
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MATERIALS AND METHODS

PATIENT SELECTION

Cats and dogs presenting nephroliths and ureteroliths treated by nephroscopy and ureteral retrograde hydropulsion during a three-year period (July 2008 to July 2011) were reviewed with the hospital’s software. In all cases, surgery was considered as soon as possible. The inclusion criteria for all patients were the availability of medical records including breed, age, sex, clinical signs at presentation, complete blood test results (preoperative, immediate postoperative, before discharge and one-month postoperative), X rays and ultrasound images and results, time to surgery, preoperative and one-month postoperative urinalysis (by the infrared method, in a human laboratory), surgical findings and outcomes. The exclusion criteria were the use of ureteral stents, ureteroneocystostomy, ureteral anastomosis or ureteronephrectomy.

Two veterinary surgeons (including the Head of Diagnostic Imaging at the veterinary school hospital at which this study was performed) reviewed the X rays and ultrasound scans before surgery. They were asked to specify the number, size, distribution, and anterograde or retrograde movement of uroliths. Time to surgery was calculated as the time from presentation at the hospital to surgery. The time from the onset of clinical signs, as noted by the owners, to surgery was also recorded. The results of renal biopsies carried out during surgery were recorded, when available.

SURGICAL PROTOCOL

All patients were positioned in dorsal recumbent position for surgery. After ventral midline celiotomy, the affected kidney was freed from its retroperitoneal location. No vascular occlusion was performed. A sagittal puncture was made through the convex lateral surface of the kidney with an 11-blade scalpel, to introduce the trocar with a 2.7 mm 30° scope into the renal pelvis (Figure 1). Optical space within the renal pelvis lumen and ureters was obtained by flushing with a constant, slow, sterile isotonic saline solution (achieved with a pressure infusion cuff maintained at low pressure). The solution was introduced through the endoscope and removed via an 18-gauge needle inserted through the convex lateral surface of the kidney.

The pelvis and calices of the kidney were explored to confirm the presence of uroliths. An instrument portal was established with video assistance, about 1 cm from the endoscope portal, for ease of triangulation. Alligator grasping forceps were introduced through this portal, for the retrieval of the largest uroliths (Figure 2). Smaller uroliths (<0.5 mm) were flushed out through a cannula introduced via the instrument portal. The renal pelvis, calices and proximal ureter were explored, to confirm the complete removal of the calculi. A ventral cystotomy was also performed in all patients, to remove urocystoliths and/or to allow catheterization of the ureter (24-gauge intravenous catheter in patients, over a suture with a diameter of 3 metric, US Pharmacopeia size 2-0) emanating from the diseased kidney, to facilitate the retrograde flushing of possible ureteral calculi under video control. A thorough exploration was performed by nephroscopy. Both trocars were removed once the uroliths had been removed. Renal biopsies were performed before suturing the renal capsule. A nephropexy was performed to prevent torsion of the vascular pedicle.

Figure 1: A sagittal puncture was performed through the convex lateral surface of the kidney to introduce the trocar of the endoscope into the renal pelvis.
<table>
<thead>
<tr>
<th>Signalment (breed, sex, age in years)</th>
<th>Clinical signs at presentation</th>
<th>Site and number of uroliths</th>
<th>Time to surgery*</th>
<th>Surgical procedure</th>
<th>Outcome and time to discharge in days (d)</th>
<th>Urolith analysis**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 British SH Male, 1 y</td>
<td>Portal systemic shunt, pollakiuria</td>
<td>L nephroliths (3), L ureterolith (1)</td>
<td>1 d (6 d)</td>
<td>L nephroscopy, cystotomy</td>
<td>No evident clinical signs. Persistent chronic renal failure. 4 d</td>
<td>Urate</td>
</tr>
<tr>
<td>2 DSH Female, 3 y</td>
<td>Vomiting, loss of appetite, pollakiuria, dysuria</td>
<td>Bilateral nephroliths (1R/1L), R ureterolith (1)</td>
<td>1 d (9 d)</td>
<td>Bilateral nephroscopy, cystotomy</td>
<td>Weakness. Persistent chronic renal failure. 6 d</td>
<td>Calcium oxalate</td>
</tr>
<tr>
<td>3 DSH Male, 5 y</td>
<td>Weakness, dehydration, weight loss, loss of appetite, depression, pollakiuria</td>
<td>R nephrolith (1), R ureterolith (1)</td>
<td>4 d (20 d)</td>
<td>R nephroscopy &amp; ureterotomy, cystotomy</td>
<td>Ureretotomy urine leakage (necropsy). Death 2 days after surgery</td>
<td>Calcium oxalate</td>
</tr>
<tr>
<td>4 Norwegian cat Female</td>
<td>Weakness, dehydration, weight loss, hematuria</td>
<td>Bilateral nephroliths (&gt;5R/5L) Bilateral ureteroliths (2R/1L)</td>
<td>2 d (6 d)</td>
<td>Bilateral nephroscopy, cystotomy</td>
<td>No evident clinical signs. Persistent chronic renal failure. 6 d</td>
<td>Calcium oxalate</td>
</tr>
<tr>
<td>5 Chartreux cat Female, 10 y</td>
<td>Dysuria</td>
<td>L nephroliths (5), L ureteroliths (&gt;10)</td>
<td>1 d (4 d)</td>
<td>L nephroscopy, cystotomy</td>
<td>No evident clinical signs. Persistent chronic renal failure. 3 d</td>
<td>Calcium oxalate</td>
</tr>
<tr>
<td>6 Burmese cat Female, 7 y</td>
<td>Weakness, dehydration, depression, loss of appetite, pollakiuria, cystitis, moderate anemia</td>
<td>R nephrolith (1), R ureterolith (1)</td>
<td>7 d (12 d)</td>
<td>Bilateral nephroscopy, cystotomy</td>
<td>Disseminated intravascular coagulation Death 5 days after surgery</td>
<td>Calcium oxalate</td>
</tr>
<tr>
<td>7 Persian cat Female, 9 y</td>
<td>Weakness, dehydration, weight loss, vomiting, anorexia, depression, diarrhea, dysuria, hematuria, cystitis</td>
<td>L nephroliths (5), bilateral ureteroliths (&gt;5R/3L)</td>
<td>2 d (9 d)</td>
<td>Bilateral nephroscopy, cystotomy</td>
<td>Weakness. Persistent chronic renal failure. 4 d</td>
<td>Calcium oxalate</td>
</tr>
<tr>
<td>8 DSH Female, 7 y</td>
<td>Dehydration, weight loss, dysuria</td>
<td>Bilateral nephroliths (1R/5L), bilateral ureteroliths (2R/3L), cystoliths (3)</td>
<td>2 d (7 d)</td>
<td>Bilateral nephroscopy, cystotomy</td>
<td>Weakness. Persistent chronic renal failure. 3 d</td>
<td>Calcium oxalate</td>
</tr>
<tr>
<td>9 DSH Female, 4 y</td>
<td>Weakness, dehydration, weight loss, anorexia, abdominal pain</td>
<td>Bilateral nephroliths (&gt;5R/1L), L ureteroliths (1)</td>
<td>2 d (7 d)</td>
<td>Bilateral nephroscopy, cystotomy</td>
<td>No evident clinical signs. Persistent chronic renal failure. 6 d</td>
<td>Calcium oxalate</td>
</tr>
<tr>
<td>10 Coton de Tulear dog Female, 6 y</td>
<td>Abdominal pain, weakness, anorexia, depression, dysuria, hyperthermia</td>
<td>R nephroliths (&gt;5), R ureteroliths (2)</td>
<td>4 d (8 d)</td>
<td>R nephroscopy, cystotomy</td>
<td>No evident clinical signs. Normal renal parameters. 6 d</td>
<td>Struvite</td>
</tr>
<tr>
<td>11 CKC Male, 3 y</td>
<td>Hematuria, anemia, weakness, depression</td>
<td>L nephroliths (&gt;5), L ureterolith (1)</td>
<td>1 d (11 d)</td>
<td>R nephroscopy, cystotomy</td>
<td>No evident clinical signs. Normal renal parameters. 4 d</td>
<td>Calcium oxalate</td>
</tr>
</tbody>
</table>

* Time to surgery is the time in days (d) from hospitalization to the surgical procedure. The time from the presumed onset of clinical signs (noticed by the owner) to surgery is given in brackets. ** In urolith analysis, only the main component of urolith is given in each case.

Table I: Summary of signalment, clinical signs at presentation, localization and number of uroliths (right: R; left: L), time to surgery, surgical procedure, outcome and time to discharge, and urolith analysis.

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erythrocyte count= 4.6 x10^6/µl, hemoglobin= 7.6 g/dl; platelet count= 290 x10^3/µl. The median age of the animals was six years. Case management is summarized in Table 1. The nonspecific clinical signs observed included weakness (five cats and two dogs), depression (three cats and two dogs), dysorexia (five cats), anorexia (one dog), weight loss (five cats), vomiting (two cats), dehydration (six cats), abdominal pain (one cat and one dog). One dog was hyperthermic. The urological clinical signs observed were pollakiuria (four cats), dysuria (three cats and one dog) or hematuria (one cat and one dog). Urinanalysis revealed bacterial cystitis in cases 6 and 7. All cats had a low specific gravity while the two dogs had a normal specific gravity, as reported in Table 2.

Blood tests revealed preoperative SCr and BUN concentrations above for the upper limit of the reference range for all cats and within reference limits for the two dogs (table 3). Anemia was seen in one cat and one dog (cases 6 and 11). The cat (case 6) had a hyporegenerative anemia (normochromic and normocytic: MCV= 42,3 fl, MCHC= 31,7 g/dl; erythrocyte count= 4.3 x10^9/µl; hematocrit= 21%; hemoglobin concentration = 7.2 g/dl; leukocyte count= 20 x10^9/l; platelet count= 290 x10^9/µl). Hemobartonellosis (feline infectious anemia) was detected in this patient. The prothrombin time was normal for this cat (18 seconds). The dog (case 11) had a moderate regenerative anemia (normochromic and normocytic: MCV= 71,1 fl, MCHC= 34,9 g/dl; erythrocyte count= 4.6 x10^9/µl, hematocrit= 24.1%, hemoglobin= 8.3 g/dl, leukocyte count= 21.5 x10^9/l, platelet count= 270 x10^9/µl). The prothrombin time was normal for this dog (14 seconds).

Radiographic (Figure 3) and ultrasound (Figure 4) explorations were performed for each patient and revealed the presence of uroliths at various sites. Nephroliths were present in all cases. In four cats, the condition was bilateral. All cases had ureteroliths. Eight had ureteroliths on one side only, and three had ureteroliths on both sides. Four cases of hydronephrosis (cases 3, 5, 8 and 10) were identified preoperative, on ultrasound scans. Six cases of chronic kidney disease (cases 3, 5, 6 and 7; bilateral in cases 5 and 7) were suspected on the basis of ultrasound findings. The affected kidneys displayed architectural distortion (small, irregular and more diffusely hyperechoic). One case had concomitant cystoliths (case 8). One cat (case 5) had a megaureter. Five cats had bilateral pyelic dilatation (cases 4, 6, 7, 8 and 9). Two cats (cases 4 and 7) had bilateral ureteral subobstruction and one dog (case 11) had a left ureteral subobstruction.

All cases were managed medically before surgery, with intravenous fluid therapy adapted to each patient (lactated Ringer’s solution with a maintenance rate defined by the actual needs of the patients, supplemented as necessary for ionic disorders). Medical monitoring was attempted to address prerenal or postrenal insufficiency before urolith removal, with serial serum creatinine (SCr) and blood urea nitrogen (BUN) determinations.

Figure 2: Grasping alligator forceps were introduced to secure the uroliths by triangulation.

Urereotomy of the ureteral mucosal wall was performed exclusively for the removal of uroliths that could not be flushed out. A transverse simple interrupted 0.7 metric (6-0) polydioxanone (PDS® II) suture and surgical operating loupes (x 2-3,5) were used for ureterotomy closure.

All cases received 30 mg/kg cefalexin (Rilexine, Virbac) intravenously after the removal of the renal bacteriology sample, and at two-hour intervals thereafter, until the end of surgery.

POSTOPERATIVE FOLLOW-UP

Postoperative X rays and ultrasound scans were obtained, to assess the completeness of urolith removal in all patients. Renal parameters (BUN and SCr concentrations) were monitored after surgery, and then at two-day intervals until discharge. A final blood analysis was performed 12 hours after the cessation of fluid therapy, just before discharge. The time from surgery to discharge to the owner was also recorded. A clinical check-up was carried out one month after surgery and included a clinical examination, blood tests, urinalysis and an ultrasound scan.

STATISTICAL ANALYSIS

Comparisons between groups (preoperative, postoperative and before discharge) were performed for paired data (preoperative vs. postoperative BUN and SCr concentrations; preoperative vs. before discharge BUN and SCr concentrations) with Student’s t test (<0.05, two-tailed), after confirmation of the normality of the distribution in a Shapiro-Wilk’s test. Data were processed and analysed with R software (R: A Language and Environment for Statistical Computing, Vienna, Austria; R version 2.14.2 (2012-02-29, Platform: x86_64-apple-darwin9.8.0/x86_64)).

RESULTS

Nine cats and three dogs were treated during the considered 3-years period. One dog had to be excluded because of incomplete data. Finally 9 dogs and 2 cats were included in this retrospective study. The median age of the
Time from emergency admission to surgery varied between one and seven days (Table 1), with a median time of two days. Time from first clinical signs to surgery varied between four and 20 days, with a median time of eight days. In all cases, SCr and BUN concentrations were lower after than before surgery (Table 3). Postoperative and before-discharge mean SCr concentrations means were significantly lower than preoperative values ($p=0.004$ and $p=0.008$, respectively). Similarly, postoperative and before-discharge mean BUN concentrations were significantly lower than preoperative values ($p=0.039$ and $p=0.010$, respectively). One month after surgery, BUN and SCr concentrations remained stable, at values close to those recorded just before discharge, in all cases.

Nephroscopy was performed in all cases, including six bilateral procedures (55%) during the same anesthesia. Ureterotomy was performed in case 3 (9%). Two different experimented surgeons carried out the surgery (one operated on six cases and the other on five cases).

Table II: Preoperative and one-month postoperative urinalysis values (specific gravity (USG) obtained by refractometer, scores obtained by urinary dipstick: leukocyte (Leu), glucose (Glu), protein (P), bilirubin (Bili) and blood (Bl) and cystocentesis urine culture)

Table III: Preoperative, postoperative, pre-discharge and one-month postoperative blood urea nitrogen (BUN en mmol/l) and serum creatinine (SCr en μmol/l) concentrations for each case.

Reference interval (RI): BUN 5.9-10.5 mmol/l and SCr 60-135 μmol/l
Postoperative X rays and ultrasound scans revealed that urolith removal was complete in all patients. Postoperative care included fluid therapy for as long as required (lactated Ringer’s solution with a flow rate adapted to the needs of the patient), analgesia (morphine IV 0.2 mg/kg every 4 hours for 24 to 48 hours). Quantitative crystallographic analysis revealed calcium oxalate-containing uroliths in eight cats (89% of cats) and urates in case 1. One dog presented struvites uroliths and the other dog had calcium oxalate-containing uroliths. Bacteriological analysis of the urine taken from the pyelic cavity during surgery revealed only one case of staphylococcus pylonephritis (case 10), whereas the preoperative urinalysis taken by cystocentesis was negative. Struvites nephroliths and uroliths were diagnosed for this latter case. The pyelic urine bacteriological analyses of the ten other cases were negative.

Ten cases (91%) survived until discharge from the hospital, that occurred three to six days after surgery (median: 4 days). Two cases (18%) died within five days of surgery. (two days and five days postoperatively). Case 3 died from uroabdomen, and necropsy revealed urinary leakage from the ureterotomy suture site. Case 6 died from disseminated intravascular coagulation (CIVD). Preoperatively, case 6 was in poor condition: weakness, dehydration, depression, loss of appetite, very moderate anemia and hemobartonellosis. The preoperative moderate anemia was thought to be a consequence of chronic renal disease in conjunction with the hemobartonellosis. CIVD developed five days after surgery.

One month after surgery, the two dogs had excellent body condition. For the cats, cases 2, 7 and 8 continued to display weakness, but their general health had improved and they had a good appetite. The other cats displayed no evident clinical signs. Blood test findings were similar to those immediately before discharge. The seven cats that were still alive still had chronic renal failure, whereas the two dogs presented normal renal parameters. Urinalysis showed a low specific gravity in all cats. Cases 6 and 7 no longer had bacterial cystitis. Ultrasonography revealed the same chronic modification already present at the time of surgery. Cases 4 and 7 still had moderate pyelic dilation, but no residual uroliths were detected.

Pathological evaluations were performed in five cases (data for the others are not available due to the retrospective nature of this study); the conclusions were similar in all cases: severe generalized chronic tubulointerstitial nephritis (cases 2, 4, 7, 9 and 10).

Cases 2 and 8 were euthanized four and 10 months after surgery, respectively, due to progression of their chronic renal failure. Case 2 presented buccal ulceration and anemia. Both cases displayed vomiting and anorexia, but no sign of urinary obstruction were detected on ultrasound scans.

Seven patients were still alive in July 2012. Median survival after discharge was 20 months at that time (range: 4-48 months).

DISCUSSION

Surgical decision-making can be challenging in cases of upper urinary tract urolith management, which may be chronic and progressive [17]. Both medical management and physical removal can be recommended for urolith treatment, under specific conditions [1, 19, 20, 34]. Non obstructive nephroliths and ureteroliths are of little consequence for the progression of chronic kidney disease [33]. However, if nephroliths are not removed during the first intervention for ureterolith removal, a recurrence of ureteroliths is frequently observed [32]. The treatment of all upper urinary tract calculi during a single surgical intervention, as in this study, is of potential interest, because it may decrease the likelihood of recurrence.
Surgical removal may be required if partial or complete obstruction of the upper urinary tract lasts longer than one to three days [19, 36]. In the present study, surgical intervention was performed within a median of two days after presentation at the hospital. Preoperative BUN and SCr concentrations were high in 82% of the patients studied, whereas elevated values were reported in only 66% to 79% of the cases in previous studies [17, 32]. These high preoperative BUN and SCr concentrations may reflect the relative severity or chronic nature of these obstructions. They resulted in prolonged periods of postobstructive diuresis (median duration of hospitalization: 4 days) and a need for careful fluid management. As in previous studies, cases were referred to the hospital, which is a reference center, as a last resort. This accounts for the seriousness of the disease in the patients of the study, which had marked clinical signs, multiple uroliths and severe chronic renal failure. In most of these cases, earlier surgical management might have improved the outcome.

We did not use nephrostomy tube placement in this study. However, this method was recently reported to be a rapid and effective technique for relieving ureteral obstruction [6]. Nevertheless, complication rates related to this technique can be as high as 46% if carried out in emergency conditions (including urine leakage from a ureterotomy, poor drainage and dislodging of the tube) and are associated with high mortality [19].

Nephroscopy with a flexible endoscope has already been described in one case study [16]. McCarthy also described the use of endoscopy to examine the renal pelvis and recesses for nephrolith removal [29]. With a 2.7 mm rigid endoscope, we were able to visualize the renal pelvis and proximal ureter accurately. We performed a satisfactory renal pelvis exploration, and removed almost all nephroliths and ureteroliths, and flushed out any remaining small uroliths from the renal pelvis. Cystotomy allowed ureteral catheterization and efficient retrograde urohydropropulsion in 89% of cases. Proximal ureteroliths can move backwards, by up to 4 cm, in the renal pelvis [9]. In this study, using retrograde hydropulsion and nephroscopy, we removed ureteroliths located as far as 5 cm distal to the ureteropelvic junction in one cat (case 5). In 2004, Snyder used retrograde flushing associated with pyelotomy to remove ureteral calculi [35].

In this study, all the calculi (renal and ureteral) were removed in a one-stage procedure. Calculus removal probably decreases the rate of acute relapse. Indeed, in Kyle’s study, 85% of cases with postoperative recurrence had nephroliths diagnosed at the time of ureteral surgery [18]. Nephroscopy with a 30° rigid endoscope allows a thorough exploration of the renal pelvis, with magnification of the structure. This makes it possible to remove even very small calculi. Alligator forceps are most suitable for pelvic stone retrieval [10]. In Donner’s experimental study of percutaneous nephrolithotomy (PN) in five dogs, stones were retrieved either under fluoroscopic guidance alone or with direct endoscopic visualization [10]. In this study, we were able to place the kidney in a suitable position for easy triangulation with the alligator forceps, to detect calculi of any size, at any site in the renal pelvis. Some of the complications observed in PN are similar to those seen in nephroscopy. In Donner’s study, small tears occurred at the ureteropelvic junction in the first three cases of PN (five cases in total), with no further leakage at 48 hours [10]. This complication was not recorded in the present study study, but carefully monitoring should be carried out. It is possible that the open surgery approach proposed here provided satisfactory control over direction during endoscope introduction, despite the initial lack of experience of the surgeons with the technique. Moreover, percutaneous procedures are difficult in cats, due to the high mobility of the kidneys.

There are several theoretical advantages of nephroscopy over nephrotomy. There is a transient decrease in renal function after nephrotomy in healthy cats, of between 0 and 20% [7, 15]. However, the detrimental effects of nephrotomy may be magnified in patients with diseased kidneys, which may have a lower capacity for repair or compensation. A staged procedure could be used when uroliths are found in multiple sites in the upper urinary tract, as in cases of bilateral nephroliths [22]. In human patients, there is no evidence to suggest that renal function decreases after bilateral PN [28, 38]. In this study, postoperative SCr and BUN concentrations decreased significantly even when bilateral nephroscopy was performed in cats. A bilateral one-stage procedure with nephroscopy did not seem to induce noticeable acute adverse effects on renal function, but a GFR study is warranted to confirm this hypothesis. This may be a key advantage over nephrotomy.

Pathological changes to kidney ultrastructure have been described following tourniquet shock [30]. According to Kuntz and Rawlings, in their experience bleeding is moderate with nephroscopy and renal vascular occlusion is therefore not required in cats [16, 31]. This technique was not used in the cases either of the present study. This lack of need for vascular occlusion is another of the benefits of nephroscopy over nephrotomy.

Intersegmental nephrotomy may minimize renal damage and spare intraparenchymal vessels [37]. Nevertheless, only small incisions were used for nephroscopy in the series of the present study to minimize the size of the parenchymal lesions. The diameter required for PN in dogs is similar to that required to introduce the endoscope through the parenchyma of the kidney for nephroscopy in this study. PN results in minimal localized renal parenchymal trauma on pathological evaluations 2, 7, 14, 30 and 90 days after surgery [10].

Ureteral retrograde hydropulsion via combined cystotomy and nephroscopy made it possible to remove renal and/or ureteral calculi in most cases (91%) without the
need for additional surgical techniques. Thus, nephroscopy limits the need for ureterotomy, thereby decreasing the risk of associated complications [17]. Ureterotomy had to be performed in case 3, because the uroliths adhered to the ureteral mucosa. In cats, ureterolithotomy is challenging and requires surgical magnification. It is prone to complications, including urinary suture leakage (in 16 to 29% of the cases) as in case 3, and stricture formation, which can lead to ureteral obstruction and an increase in postoperative morbidity (31%) and mortality (21% after 3 days) rates [17, 32]. Nine cases (82%) survived to discharge from the hospital. Two cases (18% of all patients and 22 % of cats) died within five days of surgery. This survival rate is similar to those obtained in previous studies reporting complications of ureterotomy [17, 32]. However, a larger case series would be required to confirm these findings and to determine whether lower mortality rates could be obtained with nephroscopy.

The reversibility of renal dysfunction depends on both the completeness and duration of obstruction. In dogs, variable and permanent decreases in renal function have been found after seven days of acute complete ureteral (unilateral) obstruction [36]. Ligation of the ureters for 14 days in dogs results in only 46% recovery of original kidney function [39]. The duration of obstruction may have influenced the poor prognosis of some of the patients studied here. Indeed, the median duration of clinical signs was seven days in the animals that survived and 16 days in those that died. A large prospective study would be required to identify potential survival prognosis factors linked to this duration of obstruction.

Quantitative crystallographic analysis of the removed calculi makes it possible to adapt diet in specific cases, but such adaptations should not be introduced until the patient has fully recovered from surgery [31]. Bacteriological analyses of kidney samples were carried out to identify the most appropriate antibiotic treatment in cases of concomitant renal infection. It has been shown that struvite uroliths often develop primarily as a result of urease-producing staphylococcal infection of the urinary tract, especially in female dogs, like case 10 [25, 26].

Ureteral stents and subcutaneous ureteral bypass (SUB) are elegant and promising alternatives for concomitant presence of nephroliths and ureteroliths. These new procedures in the veterinary field overcome the need for ureterotomy and nephrotomy [5, 13, 39]. The first one precludes the absence of ureteral stenosis, the latter one being preferred for this condition because the SUB device physically bypasses the ureters. In a study, both procedures were compared and evaluated for outcome in cats. They had an overall good survival, and no parameter was associated with survival [13]. However, the cost of ureteral stents and bypass might discourage owners from choosing this procedure, and long-term complications and tolerance need to be investigated. In human beings, ureteral stents are prescribed for palliative and short-term treatment, as stent encrustation is a frequent complication [12].

The limitations of the present study include the small number of cases and the retrospective nature of the study. As this was a clinical study, no control healthy animals underwent the nephroscopy procedure alone. For objective assessments of renal function, GFR can be assessed in individual kidneys by Tc 99m scintigraphy [4]. Nevertheless, it is not possible to measure the GFR of obstructed kidneys accurately [3]. Finally, the consequences of nephroscopic exploration for renal function remain to be determined. A limitation of this technique is that it cannot flush out calculi adhering to the ureteral mucosa. In these particular cases, ureterotomy remains an effective technique for the surgical treatment of ureterolithiasis.

CONCLUSION

Changes in the frequency of obstructive ureteroliths over time, with an increase in the incidence of calcium oxalate ureteroliths in particular, are increasing the need for interventional procedures for urolith management. Nephroscopy combined with ureteral retrograde flushing was found to be useful for removing both renal and ureteral calculi in cats and dogs, thereby limiting the need for ureterotomy procedures. A significant improvement in renal blood parameters was observed in all patients and no complication related to the nephroscopy procedure alone was observed. Bilateral procedures were performed, with good results. The long-term consequences of nephroscopy for renal function remain to be determined.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

REFERENCES


