Eurasian Journal of Veterinary Sciences
https://eurasianjvetsci.org
pISSN:1309-6958/**eISSN:**2146-1953
Eurasian J Vet Sci 2025;41:e0456
DOI:10.63673/EurasianJVetSci.456

Research Article

Evaluation of Surgical Treatment Results in Cats with Urethral Obstruction

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Abstract

The aim is to evaluate the extent to which the loss of physiological stability in the patient, due to delays in performing surgery when medical approaches such as catheterization or urohydropulsion are insufficient in the treatment of urolithiasis and/or cystolithiasis in cats, affects the prognosis during or after the surgical procedure. In this study, 92 cases presenting with urolithiasis or cystolithiasis at the Selçuk University Faculty of Veterinary Medicine Animal Hospital between years 2023 and 2025 were evaluated, including those that required surgical intervention. Thirty-two (34.7%) cats of different breeds, sex, age and weight were used as study materials. Clinical, ultrasonographic and radiological examinations were done. Cystotomy, perineal urethrostomy, transpelvic urethrostomy or both were performed in cases with clinical symptoms. Of the 92 cats with urolithiasis or cystolithiasis, 65.2% responded to medical treatment, while 34.79% required surgery due to lack of response, obstruction, rupture, or unchanged stone size. Catheterisation led to rupture in 18.75% of these surgical cases. Surgeries included cystotomy (61.29%), urethrostomy (25.8%), and both (12.9%). The overall prognosis was 93.75% favourable. It was 100% favourable in cystotomy or urethrostomy alone, but 40% unfavourable in combined procedures. In feline lower urinary tract urolithiasis, stone type significantly influences the need for surgery. Prolonged medical treatment risks metabolic imbalance, while repeated catheterisations increase urethral trauma and complications. Small uroliths should be managed with non-surgical methods like urohydropropulsion. Standardising the treatment duration is essential, as iatrogenic ruptures during catheterisation can worsen prognosis. Early surgical intervention—before metabolic deterioration—improves anaesthetic and postoperative outcomes.

Keywords: Cat, Cystotomy, Urethrostomy, Urethral obstruction

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Received: 01.01.2025
Accepted: 29.07.2025
Published: 31.08.2025

How to cite this article?
Cimen Z, Satici I, Sever HE, Erol BB, Arican M, 2025. Evaluation of Surgical Treatment Results in Cats with Urethral Obstruction. Eurasian J Vet Sci, 41, e0456.

Introduction

The annual incidence of feline lower urinary tract problems has been estimated to be between 0.5% and 1% in the UK and USA (Willeberg 1984, Lawler et al 1985). This disease affects approximately 8% of cats presenting to clinics and is associated with urethral obstruction in 18% to 58% of cases. 22-36% of these cats become obstructed for the second time within 6 months (Gerber et al 2008, Ruda and Heiene 2012, Nye and Luther 2018). The underlying cause of lower urinary tract problems is usually not identified and idiopathic lower urinary tract is diagnosed in approximately 57% of cases (Bass et al 2005, Gerber et al 2008). Although better understanding and management of the aetiology of this syndrome has reduced the need for surgical intervention, surgical treatment is still reported to play an important role, especially in persistent cases (Bass et al 2005, Gerber et al 2008). Regardless of the cause of feline lower urinary tract problems, the most common clinical signs include haematuria, dysuria, stranguria, pollakiuria, inappropriate urination behaviour and urethral obstruction (Lee and Drobatz 2003).

Urolith formation is not a disease, but rather a complication of various disorders (Bartges and Callens 2015). In other words, urolithiasis is not etiologically caused by a single cause but occurs as a result of abnormalities that interact with each other. Therefore, urinary stone formation can be defined as a combination of congenital or acquired pathophysiological factors that gradually increase the risk of sedimentation of

metabolites excreted in the urine to form urinary calculi (Albasan et al 2010). According to the Minnesota Urolith Centre (MUM), the most common mineral compositions of 143,365 feline uroliths between 1981 and 2011 were calcium oxalate (44.4%), struvite (44.1%) and purine (5.1%). Cystine, silica and calcium phosphates are less common (Albasan et al 2010). The most common types of uroliths in the cat are struvite (magnesium ammonium phosphate) and calcium oxalate crystals. Purine uroliths, matrix, calcium phosphate, blood clots and compound stones have also been reported (Labato 2017).

In urolithiasis problems in cats, a correlation was found between breed and urinary stones. Calcium oxalate stones are more common in cats such as Persian, Siamese, Burmese and Himalayan cats compared to short-haired domestic cats (Dear et al 2011). In terms of gender, struvite was found more frequently in female cats, while calcium oxalate and urate were found more frequently in male cats (Dear et al 2011, Bartges and Callens 2015). In male and female cats over five years of age, urate uroliths are found equally in males and slightly more in females over four (4±2) years of age (Houston et al 2011).

In most cases, it has been reported that urethral obstructions or uroliths can be pushed back into the urinary bladder by catheterising an obstructed cat (Cannon et al 2007). However, in cases where these methods cannot be applied, surgical intervention should be considered immediately (Tobias and Johnston 2012). The choice of surgical technique is determined depending on the cause of obstruction and its location in the urethra; the most common options available are cystotomy, cystotomy and uretrostomy together, perineal uretrostomy, prepubic uretrostomy and transpelvic uretrostomy (Berent et al 2014, Arıcan 2022). In the presence of stones in the urethra, the stone should be displaced towards the urinary bladder by retrohydropulsion method; then it has been reported that the stones can be safely removed by cystotomy (Phillips and Holt 2006). Operation should be considered if three episodes of urethral obstruction have occurred despite appropriate medical treatment techniques for lower urinary tract problems in cats (Williams 2009). Especially cats with complete urethral obstruction caused by large stones require urgent surgical intervention. Urohydropropulsion provides antegrade removal of urinary calculi through the urethra. It is recommended for small stones < 2.5 mm in diameter in female cats but is limited by the size of the penile urethra in male dogs. Feline penile and pre-prostatic urethral diameter has been reported to be 1.1-1.4 and 3.5-5.4 mm, respectively, with no significant difference between neutered and intact male cats (Segal et al 2020). Since the risk of urethral obstruction is high, urinary urohydropulsion should not be attempted in male cats.

The aim of the study was to evaluate the effects of the duration of surgery and the deterioration in the general condition of the patients on the prognosis in cases where medical treatment of urolithiasis in cats is inadequate and urethral rupture occurring during catheterisation and urohydropulsion require surgical intervention.

Material and Methods

In this study, 92 cases of urolithiasis admitted to Selcuk University, Faculty of Veterinary Medicine, Small Animal Hospital between 2023-2025 and the operated cases were evaluated. Thirty-two (34.7%) cats of different breeds, sex, age and weight were used as study material (Table 1). Blood, ultrasonographic and radiological examinations were performed. The general condition of the animals was examined by evaluating the anamnesis obtained from the owner and the consultation information obtained from the Department of Internal Medicine.

Blood examination

Radiometer (ABL90 Series, Denmark) blood gas analyser was used for blood gas measurements and Biotecnica (BT3000 Plus, Italy) for biochemistry measurements. Venous blood samples were collected in a 2 ml serum separation tube for haematological and biochemical analyses (BUN, creatinine, K, Na, P, Ph) and in a 1 ml heparinized blood gas syringe for blood gases and serum electrolyte analysis.

Ultrasonographic examination

Ultrasonographic examination was performed with a 5-7.5 mHz convex probe (Esaote Piemedical, Model 410477, Netherlands). During the application, the abdominal region was shaved, and transmission ultrasound gel was applied between the skin and the ultrasound probe. The images and ultrasound outputs were recorded.

Radiographic examination

For radiographic examination, a Siemens single-tube fixed radiography device (Model: 483388, China) was used in our clinic. Direct radiographic examinations were performed in various positions (ventro-dorsal, latero-lateral) and indirect (positive contrast cystography) radiographic examinations were performed for some cases. The bladder was first catheterized and emptied. Non-ionic iodinated positive contrast medium (2–5 ml/kg of Omnipaque 350 mgI, Iohexol) was then administered retrogradely into the bladder to evaluate the presence of uroliths, and the urethra was examined simultaneously. If only the urethra was to be evaluated, the contrast medium

Table 1: Patients who came to our clinic with the complaint of urolithiasis and underwent surgical intervention

Case	Breed	Year	Sex	Anamnesis	Treatment	Prognosıs
1	Norwegian Forest Cat	4	Male	Hematuria	Cystotomy	+
2	Scottish	6	Female	Stranguria	Cystotomy	+
3	British	5	Male	Hematuria, Dysuria	Cystotomy	+
4	British	4	Female	Hematuria, Dysuria	Cystotomy	+
5	Scottish	3	Female	Pollakiuria	Cystotomy	+
6	British	4,5	Female	Dysuria	Cystotomy	+
7	Scottish	3	Male	Anuria	Cystotomy	+
8	British	4	Male	Pollakiuria	Cystotomy	+
9	British	4	Male	Stone in penile urethra	Urethrostomy	+
10	Tabby Cat	3	Female	Pollakiuria	Cystotomy	+
11	Ankara	5	Female	Dysuria	Cystotomy	+
12	British	4	Male	Pollakiuria, Hematuria	Cystotomy	+
13	Scottish	2	Male	Hematuria, Dysuria	Cystotomy +Urethrostomy	+
14	British	3	Male	Anuria, Hematuria urethral obstruction	Transpelvic Urethrostomy	- (ex after 2 days) Cystitis and necrotic areas on the urinary bladder mucosa
15	Scottish	6	Female	Hematuria,Dysuria	Cystotomy	+
16	Tabby Cat	5	Male	Hematuria,Anuria	Cystotomy	+
17	British	6	Female	Hematuria, Pollakiuria	Cystotomy	+
18	British	2	Male	Hematuria, Anuria	Cystotomy	+
19	British	5	Male	Pollakiuria	Cystotomy	+
20	Tabby Cat	8	Male	Haemorrhagic cystitis treatment, Pollakiuria	Cystotomy	+
21	British	5	Male	Pollakiuria, Hematuria	Cystotomy +Urethrostomy	+
22	British	4	Male	Clot in the bladder, Hematuria	Urethrostomy	+
23	British	5	Male	Anuria	Cystotomy + Urethrostomy	+
24	Tabby Cat	5	Male	Anuria, urethral obstruction	Urethrostomy	+
25	Orange Tabby Cat	4	Male	Anuria, perforation of the urethra	Urethrostomy	+
26	Tabby Cat	6	Male	Anuria	Urethrostomy	+
27	Tabby Cat	4	Male	Anuria, urethral obstruction	Urethrostomy	+
28	Tabby Cat	4	Male	Anuria	Urethrostomy	+
29	Tabby Cat	3	Male	Hematuria, urethral obstruction	Urethrostomy	+
30	Scottish	4,5	Male	Dysuria	Urethrostomy	+
31	British	4	Female	Dysuria	Cystotomy	+
32	British	1,5	Male	Hematuria, urethral obstruction	Cystotomy+ Urethrostomy	- Cystitis (urethral obstruction) and necrotic areas on the urinary bladder mucosa.

Table 2. The numbers are to be cross-tabulated according to treatment type and prognosis.			
Treatment Type	Favorable Prognosis (n, %)	Unfavorable Prognosis (n, %)	Total (n)
Medical	60 (%65.2)	32 (%34.8)	92
Surgical	30 (%93.8)	2 (%6.3)	32
Total	90 (%72.6)	34 (%27.4)	124

(Omnipaque 350 mgI) was administered through the catheter at a dose of approximately 1.0 ml/kg (Akyol and Arıcan, 2023).

Medical application

Due to the late awareness of the patient owners and their reluctance to the operation, medical treatment was tried first. The most important factor affecting the clinician's protocol in medical treatment was the type and size of the stone. Medical treatment was applied in stones that could give results with medical treatment and would not cause obstruction. In the urine analysis conducted through microscopic examination, a diagnosis of 60% struvite and 40% calcium oxalate was made. Medical treatment was applied for an average of 10-14 days.

Surgical application

The surgical procedure was decided depending on the size, type, location and whether it caused obstruction or not.

Medetomidin hidroklorid (Domitor®-Zoetis) 0.04-0.08 mg/kg IM was administered before general anesthesia. Anesthesia induction was carried out using propofol Propofol (Propofol-Lipuro %1®): 6-8 mg/kg IV), and maintenance was achieved with İsofluran (İsoflurane, ADEKA İlaç®) (2.3-3.4%) with 0.70% inspired oxygen. Cats were ventilated with an end-expiratory positive pressure of 5-7 cm H_2O, utilizing a tidal volume of 10 mL/kg, a respiratory rate of 18-20/min, and maintaining a target end-tidal CO_2 level of 30-40 mm Hg. Continuous monitoring included clinical assessment as well as the observation of blood and gas levels.

Cystotomy; Abdominal cavity was entered by routine methods. The urinary bladder was taken out. Fixation sutures were placed on the apex of the bladder and trigonum for manipulation. For the incision line, the ventral and dorsal side of the bladder and the vascular-free area away from the ureter and urethra were preferred. Cystocentesis was performed beforehand. The stone was removed with slow manipulations. The urinary bladder was washed with saline. After the urinary bladder was opened and examined, it was closed with a single layer of continuous suture. Revised sutures were applied after leakage control.

Perineal urethrostomy; Tobacco bag suture was placed in the anus of cats lying in dorso-ventral position. If the penile urethra was open, it was catheterised. If the cases were not castrated, they were castrated first. An elliptical incision was made around the scrotum and prepuce, and these tissues were excised. The penis and distal urethra were freed from both sides with surrounding tissues. The dissection was removed ventrally and laterally towards the penile attachments in the arcus ischiadicus. The penis is lifted in the dorsal direction. The ventral ligament is separated. M.ischiocavernosus and m. ischiouretralis are cut at the attachment site to the ischium to minimise bleeding and not to damage the branches of n. pudensdus. The penis is orientated ventrally to expose the dorsal surface. The gl. bulbouretralis is replaced by the M. ischiocavernasus, which separates the proximal and dorsal parts of the musculus bulbospongiosus and the cranial part of the ischiouretralis. M.retractor was removed over the penile urethra. Penile urethra was incised. The

Table 3. The relationship between treatment type and prognosis is to be determined by statistical test results.			
Statistical Test	Value	df	p-value
Pearson Chi-Square (χ^2)	9,71	1	.002*
Continuity Correction	8,33	1	.004*
Fisher's Exact Test (2-tailed)	–	–	.001*
Likelihood Ratio χ^2	11,83	1	.001*
Linear-by-Linear Association	9,63	1	.002*
*p<0.05			

urethral incision was continued proximal to the pelvic urethra until approximately 1 cm beyond the level of the gl. bulbouretralis. Halsted moskito haemostatic forceps were advanced into the urethra to ensure adequate urethral width. The area was sutured with simple separate sutures.

Transpelvic urethrostomy; was performed in cases suspected of urethral rupture. Ventral incision was made in cats lying in dorso-ventral position. Urinary bladder was exposed and incision was made. The catheter was sent from the urinary bladder. Fat tissue was removed to expose the caudal and ventral sides of the symphysis pubis. An ostectomy site approximately 10 mm wide and 12 mm long was created. A ruptured urethra was found under the ostectomised pelvic region. The ruptured urethra was sutured. The area was closed with the routine method.

Statistical Analysis

Cross-table analyses were performed to evaluate whether there was a relationship between two categorical variables, such as treatment type (medical / surgical) and prognosis (favorable / unfavorable). Fisher's Exact Test was preferred considering that cell frequencies were low (Table 2).

While the positive prognosis rate was 65.2% in the medical treatment group, it was 93.8% in the surgical treatment group. A significant relationship was found between the type of treatment and prognosis, Fisher's Exact Test, $p = .001$; the Pearson Chi-Square test result was also significant, ($\chi^2 = 9.71$, $df = 1$, $p = .002$) (Table 3). Results are also expressed as %.

Results

Clinical results

The mean age of cases at the time of admission was 9-24 months (median 4 years and 4 months, range 1.5 years - 8 years). The sex distribution of the surgically operated cats was 71.8% male and 28.2% female. Similarly, 46.8% were British, 28.12% were Mongrel (Tabby, Orange Tabby Cat), 18.75 % were Scottish, 3.12 % were Norwegian Forest, 3.12 % were Angora breeds.

Laboratory results

Biochemistry and blood gas parameters were evaluated in 92 patients admitted to our hospital. The mean values in the patients are given in (Table 4). BUN, K and Na values were within the reference range.

There was no deterioration in general condition in patients who were catheterised and urine output was observed, but in patients who could not be catheterised due to urethral rupture or obstruction, abnormal blood values, loss of appetite, fatigue and deterioration in general condition were observed because urine output was not observed.

Ultrasonography findings

In urethral obstructions, enlargement of the urethral canal was observed. In some cases, stones were seen lined up along the canal and caused obstruction. Increased urethral diameter led to accumulation of urine and dilatation of the urinary bladder, resulting in overfilling of the urinary bladder and 'thickening of the urinary bladder wall' was observed. High urine pressure was found with stiffness or layered structures in the walls of the urinary bladder. The contents of the urinary bladder appeared sedimentary. Stones that cast a shadow (calcium oxalate) or stones that do not cast a shadow but are opaque (struvite) were detected (Figure 1 and 2).

Radiological findings

Radiological examination revealed rapyoopaque stones. The number, size and location of the stones were determined (Figure 3). Dilatation of the urinary bladder and widening of the duct were detected as a result of obstruction of the duct by the stones causing obstruction. Thickening of the urinary bladder wall was detected here as in USG. Hydronephrosis was observed in cats with obstructions in the renal pelvis and ureter. Abnormal growth was usually seen in one kidney. Urethral stones were identified by carefully examining magnified radiographs (Figure 4).

Table 4. Mean values of related parameters in urolithiasis patients

Parameters	Cases (Mean)	Ref. Value
BUN	33,55	19-34
Creatinine	1,73	0,9-1,8
P	5,6	3-6,10
pH	7,36	7,35-7,45
K	4,05	3,5-5,8
Na	159,5	135-152
Bas Deficit (B.D.)	-9,7	(-5) – (+5)

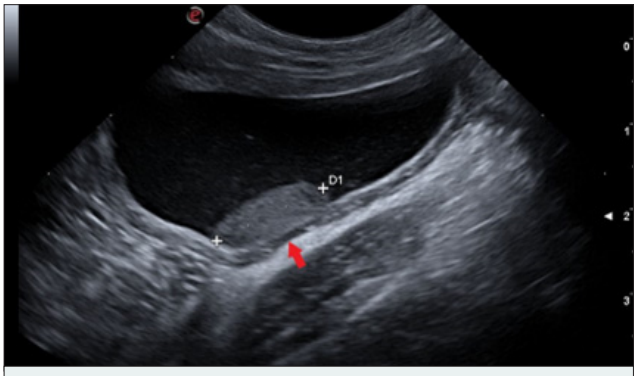

Figure 1. No. 12, British, Male, 4 years old, sistolithiasis (red arrow). Ultrasonographic image.

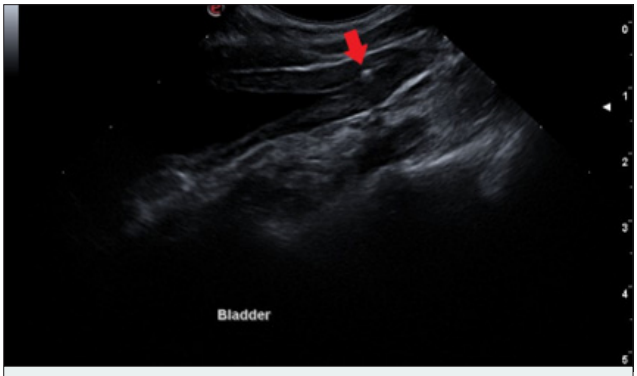

Figure 2. No. 12, British, Male, 4 years old, sistolithiasis (red arrow). Ultrasonographic image.

Medical treatment findings

Of the 92 cases diagnosed with urolithiasis, 65.2% responded to medical treatment, while 34.79% did not respond to medical treatment and were referred to surgery. Struvite responded to medical treatment while CaOx had a low response rate. Cats with no urine output, no catheterisation, obstruction or rupture and no change in stone size after medical treatment were referred to the surgical clinic. In 18.75% of these cases, rupture complication was detected as a result of catheterisation.

Surgical application findings

Of the surgical operations, 18 (61.29%) were cystotomy, 9 (25.8%) were urethrostomy (perineal urethrostomy (88.8%), transpelvic urethrostomy (11.2%), 5 (12.9%) were cystotomy + urethrostomy. Postoperative patients were followed up in the critical period. Prognosis was 93.75% favourable and 6.25% unfavourable ($p<0.05$). The prognosis was favourable in 100% of the cases in which cystotomy or perineal urethrostomy was performed, while the prognosis was unfavourable in 40% of the cases in which cystotomy + perineal urethrostomy was performed. Three of the cases recurred. They were reoperated on, and a urethral stoma was created extensively.

Discussion

In this study, only 34.7% of the patients diagnosed with urolithiasis and cystolithiasis were referred to surgical treatment. While the prognosis was favourable in 93.7% of the patients who underwent surgical intervention, the prognosis was poor in only 6.25%. In this 6.25% group, the fact that the decision for surgical intervention was not taken immediately suggested that the prognosis was unfavourable because of the loss of physiological stability. Especially in cases with metabolic problems in the postoperative period, it was evaluated that the effect of additional traumas in addition to the surgical process negatively affected the prognosis. In addition, it was observed that urolithiasis recurred in 50% of the cats receiving medical treatment. This only prolonged the time to surgery.

Urethral obstruction in cats is recognised as a life-threatening but treatable emergency (Hetrick and Davidow 2013). The hospital discharge rate of affected cats is around 93.6% (Lee and Drobatz 2003). More than 80-90% of uroliths in the lower urinary tract consist of calcium oxalate or struvite crystals (Bartges 2016). Calcium oxalate, in particular, accounts for 40-50% of all

Figure 3. No. 7, Scottish, Male, 3 years old, sistolithiasis (black arrow). Direct radiographic image.

Figure 4. No. 24, Tabby Cat, Male, 5 years old, urolithiasis (red arrow). Direct radiographic image.

uroliths in cats, and the main risk factors for the formation of calcium oxalate stones include increased urinary calcium and/or oxalate excretion and aciduria (acidic pH of urine) (Bartges 2016). However, calcium oxalate uroliths are stones that cannot be resolved by medical treatment; therefore, surgical or minimally invasive removal is recommended (Lulich et al 2009, McLoughlin 2011, Bartges et al 2013). Delay in the decision of operation has been reported to negatively affect the anaesthesia process and postoperative prognosis of the patients. It has been recommended that urine pH should be between 6.6-7.5 in cats against the risk of recurrence of calcium oxalate uroliths (Kirk et al 2003). Preventive measures aim to reduce urinary calcium and oxalate excretion, increase urine volume and ensure that urine reaches a neutral or alkaline pH level.

In cases where there is no complete obstruction among the materials used in the study, medical treatment is applied for at least two weeks. However, during this period, the cases often develop certain metabolic complications. Even though, medical resolution of sterile and infectious struvite uroliths is 2-5 weeks (Kaiser et al 2012). It has also been suggested that cystotomy and closure of the urinary bladder with sutures would eliminate the risk of suture-induced urolith recurrence, which may be responsible for up to 9% of urolith recurrences (Appel et al 2008, Kaiser et al 2012). However, although some researchers have suggested that medical dissolution may increase the risk of urethral obstruction, this complication has not been frequently reported in the veterinary literature and has been reported to occur with the same or less frequency in cases with medical dissolution compared to cases without surgical stone removal (Houston et al 2011, Bartges et al 2013, Lulich et al 2013). To support this outcome, further studies involving a larger number of cases are required.

Cases of feline urolithiasis/cystolithiasis may require surgical intervention due to a number of factors that are usually not adequately managed by conservative treatment alone. The main reasons for the need for surgical intervention include urethral obstruction, recurrent obstructions, large stones for the urethral canal, lower urinary tract infections and failure of medical treatment. Urolithiasis can lead to partial or complete obstruction of the urethra, which causes urine accumulation, bladder dilatation and increased pressure in the urinary tract. If left untreated, this can lead to rupture of the urinary bladder, kidney failure or death. In cats, the penile urethra is narrow, and urethral obstructions typically occur in this region. Since the membranous/pelvic urethra is wider, a perineal urethrostomy helps prevent potentially more severe complications. In this study, the postoperative success rate in cases with urolithiasis and cystolithiasis was attributed to this factor. A perineal urethrostomy surgical procedure is often required to overcome the urethral obstruction and restore normal urine flow. Intraoperative urethral stoma size is reported to vary between 1.98 mm and 3.3 mm, with a mean of 3.3 mm. The circumference of the bulbourethral urethra estimated by histological sections is approximately 4 mm, which corresponds to a cross-sectional area of approximately 1.9 mm^2 (Cannon et al 2007). It has been reported that the male cat's urethra may be narrow, which may make it difficult to remove uroliths with minimally invasive procedures. In such cases, uroliths can be urohydropropropelled back into the urinary bladder and removed by percutaneous cystolithotomy or cystotomy (Tobias and Johnston 2012).

In the majority of the 32 cases referred to us, recurrent obstructions were observed. When medical treatment proved ineffective, surgical intervention was required in the study. Recurrent urethral obstructions are frequently observed in some cats with urolithiasis, despite medical treatment. In such cases, surgical intervention is an important option to prevent further episodes and provide long-term relief. Because large or multiple uroliths may not resolve with non-invasive methods such as medical management, urethral catheterisation or lithotripsy. Surgical approaches allow direct removal of the stones, increasing the chances of treatment success and reducing the likelihood of recurrence. In the present study, the operation performed and the good prognosis in the post-op period support this view. In addition, frequent repetition of urinary tract catheterisation not only causes infection but also rupture in the weakened urethral mucosa. Furthermore, increased catheterisation is frequently associated with urinary tract infections and urolithiasis, and persistent or recurrent infections may further complicate the situation. Surgical intervention can improve the overall health of the urinary tract by addressing the underlying cause of infection through removal of the stones. Medical treatment is usually limited to dietary changes, fluid therapy and medications and may be successful in dissolving or managing small stones but is usually not effective for large or complex stones. In these cases, surgical removal of stones has emerged as the most reliable way to secure the cat's health status (Lulich et al 2013).

Before deciding on the preferred surgical method for removal of the stones, the size of the uroliths should be measured by radiography. Ultrasonography tends to overestimate the size and underestimate the number of uroliths and cannot be used successfully for all types of stones. In this study, the size of the stones was determined of some cases by ultrasonography. During ultrasonographic examination, the presence of stones was detected by shadow artefacts, but the number and measurements of uroliths were not performed for all cases. However, during

cystotomy surgery, the urinary bladder was opened and flushed with saline several times to remove small stones. When the perineal urethrostomy was opened up to the bulbourethral muscles, dilatation of the urethra occurred. However, the low success rate of cystotomy and perineal urethrostomy was attributed to the delay in the time of referral to surgery. Because some uroliths do not respond to dietary treatment. The process of dissolution of the stones is usually slow and large stones may take weeks or months to dissolve. During this time, cats may sustain symptoms such as bloody urine, straining and recurrent infections. While waiting for the stones to dissolve, the risk of life-threatening urethral obstruction remains. In addition, the development of metabolic conditions such as acidosis may adversely affect the success of treatment, even if surgical intervention has been performed. For cats with insoluble uroliths that have no clinical symptoms but are too large or irregular to pass into the urethra, only periodic monitoring and appropriate patient education are required. Removal of uroliths should be considered when clinical signs of haematuria, dysuria, urinary tract infection begin. Increasing stone size may limit future options for minimally invasive procedures. Careful waiting minimises unnecessary interventions, especially for recurrent urolith types; calcium oxalate, cystine, urate (Allen et al 2015). In addition, educating clients about the clinical signs of urinary tract obstruction is important in terms of providing timely and appropriate medical intervention.

In the study, not all cats diagnosed with urolithiasis respond to special diet foods. These diets can only be effective if administered correctly. Urination urohydropulsion is a less frequently favoured technique and potentially less successful due to the urethral diameter. If the stones in the bladder are very small, the bladder can be filled with lavage fluid through a catheter and then the stones can be expelled by holding the patient in an upright position and allowing the urine to drain. Sedation may be required during this procedure; in some cases, general anaesthesia may be necessary. However, this treatment may not be effective in some cases and is not recommended in male cats. In cats that develop re-occlusion of the urethra, the risk of additional complications is increased, further hospitalisation may be required, and the overall prognosis may worsen. Repeated catheterisations increase the risk of urethral trauma and complications (Smarick 2008). Studies such as Pavletic (1993), Schwartz (1999) and Smith (2002) have found that if the intraoperative stoma diameter is 2.64 mm or smaller, the likelihood of re-occlusion is high. In particular, obstruction recurred in all cats with a diameter of 1.98 mm. In contrast, a large intraoperative stoma with a diameter of 2.64 mm reduced the risk of obstruction recurrence by 6%. These findings may help surgeons performing perineal urethrostomy to better assess the risk of obstruction intraoperatively. In some cases, immediate postoperative assessment may allow the surgeon to decide to reconstruct the urethrostomy stomas during the initial surgery, thus avoiding potential complications. Furthermore, the fact that the cats (80%) were Persian cats may suggest that this breed may be more prone to re-occlusion or that its anatomical structure may be more delicate. However, there is no previously published evidence to support this view (Smith 2002). However, the cats included in the study were of the British Shorthair breed. Several factors may contribute to the higher incidence of urolithiasis in this breed, including genetic predisposition (Kupke et al 2022), a sedentary lifestyle and tendency toward obesity, dietary habits, as well as urine pH and concentration.

The recovery period was short in cases in which cystotomy was performed in the study. In perineal urethrostomy, the recovery period was short, and the hospitalization duration was one day. In cases with hematuria in the preoperative period, a catheter was placed until the urine returned to its normal color (1–3 days). In cases with perineal urethrostomy, the healing process is a combination of contraction processes with coagulation, inflammation, angiogenesis, fibroplasia and minimal epithelialisation (Schwartz 1999). Sutures made with excessive tension may contribute to the contraction process in the surgical field. Stenosis may develop with excessive anastomotic tension, ischaemic condition, inflammation, separation of the urethral margins and increased granulation tissue containing contractile myofibroblasts (Pavletic 1993). In previous studies, it was reported that the cross-sectional area of the urethral orifice decreased in the first 12 days after perineal urethrostomy. A significant reduction in the cross-sectional area of the urethral orifice was observed during the control period when the sutures were removed, but this was re-examined only in cats with recurrent obstruction. Smith (2002) reported that small internal stoma diameters are prone to stenosis and re-obstruction after perineal urethrostomy. Postoperative reduction in stoma size was also observed in cases without re-occlusion. In the present study, a rapid improvement was observed on post-op day 1 in patients who underwent perineal urethrostomy. In cases with cystotomy and perineal urethrostomy, despite the low number of cases, 60% of the cases improved, whereas 40% of the cases were unfavourable. The prevalence of urinary tract infections was clinically low. However, since urine cultures were not taken, it was difficult to evaluate the effect of infection on re-obstruction. The cases showed a recurrence of urethral obstruction (22%) after perineal urethrostomy. Since the intraoperative stoma diameter was not measured in these cases, the cause of obstruction is not fully understood.

However, previous studies (Gerber et al 2008, Segev et al 2011) did not find a significant difference in recurrence rates between uroliths, urethral plugs and idiopathic urethral obstruction. Segev et al (2011) could not conclude on the exact causes of obstruction recurrences; only five out of 24 cats had recurrences (Segal et al 2020). Segev et al (2011) reported obstruction recurrence rates of 22% and 24% within 6 months and 2 years, respectively. These results were similar to the results of the present retrospective study. In addition, cystitis and necrotic areas in the urinary mucosa were observed in both cases who died in this study. Segev et al (2011) reported that the most common biochemical abnormalities in cats with urethral obstruction were azotemia (85%), hyperkalaemia (48%), hypercalcaemia (56%) and hyponatraemia (55%).

The presented study has some limitations. Firstly, the case record is based on a retrospective design, and the study has an observational nature; treatment decisions were not standardized or controlled for each case. It is generally accepted that there are various etiological causes and contributing factors for lower urinary tract disease and urethral obstruction in cats. However, factors such as stress management, dietary changes, and the management of bacterial infections, as well as other elements contributing to reducing the risk of obstruction, were not considered in our study. Additionally, our study lacks long-term follow-up data; therefore, the correlation between the stoma incision area for perineal urethrostomy and the likelihood of recurrence after 6 months could not be determined. Other important factors, such as pre-surgical urethral diameter, traumatic catheterization, the number of obstruction episodes prior to perineal urethrostomy, and the presence of uroliths in the urethrostomy area, could not be evaluated in our study.

Conclusion

IIn conclusion, the characteristics of the stones (e.g., Ca oxalate, Struvite) in cats diagnosed with lower urinary tract urolithiasis are an important factor that increases the need for surgical intervention. The duration of medical treatment should be limited in a way that does not disrupt the overall metabolic system. Recurrence was observed in 50% of cases that underwent medical treatment, and surgical intervention was required in these cases. For surgical success, it is believed that the stoma created in the urethra should be at least 2.61 mm in size. If urethral re-obstruction occurs in a cat, the risk of additional complications increases, further hospitalizations may be required, and the overall prognosis may be adversely affected. Repeated catheterizations, urethral trauma, and other factors that increase the risk of complications are involved. Urocystoliths small enough to pass through the urethra should be removed by urine urohydropropulsion or other extraction procedures that do not involve surgical intervention. The duration of medical treatment for urethral obstruction due to stones in cats needs to be standardized. In particular, iatrogenic rupture created during urinary catheterization contributes to the unfavorable course of the condition. Deciding on surgery before metabolic changes occur due to obstruction in the cases will improve the anesthesia and post-operative prognosis success during the operation.

Declarations

Competing Interests

The authors did not report any conflict of interest or financial support.

Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author.

Ethical Statement

Selcuk University Experimental Research and Application Center, 15-01- 2025 /02 Number Ethics Committee Decision.

Author Contributions

Motivation/Concept: MA; Design: MA; Control/Supervision: MA; Data Collection and Processing: IS, ZC, HES, BBE; Analysis and Interpretation: MA, IS, ZC, HES, BBE; Literature Review: MA, IS, ZC, HES, BBE; Writing the Article: MA, IS, ZC, HES, BBE; Critical Review: MA, IS, ZC, HES, BBE

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