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Clinical, Laboratory, Radiographic, Ultrasonographic Diagnosis and Surgical Treatment of Feline Lower Urinary Tract Urolithiasis: Study Carried Out of Ten Cats*

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Absract: In this study, it was aimed to present the results of diagnosis and treatment of urinary tract urolithiasis in 10 cats brought to our clinic. Ten cats with urinary tract complaint used for the study. Urolithiasis diagnosis was made through urine analysis, direct and indirect radiography and ultrasonographic findings. Eight cases were applied operative procedure and two cases were administered medical treatment. Accomplishment was gained with chalcolithic diet and infection control along with operative procedure in two of four cats with struvite urolith. Urethrotomy, cystotomy and urohydropropulsion were performed to remove calcium oxalate, calcium carbonate, calcium phosphate and ammonium urate urolith. Pets were postoperatively controlled on the 30th day in order to check whether uroliths were reappeared. In this study, it was found that frequency of uroliths in descending order may be sorted as struvite, calcium oxalate, ammonium urate, calcium carbonate and calcium phosphate. Consequently for the diagnosis of urolithiasis, it is required to evaluate urine pH, crystalluria, hematuria, urine leukocyte values and stone analysis along with the results obtained from direct positive contrast radiography and ultrasonography. Operative approach is indicated for urolith cases and post-operative special diets and medical treatment according to urolith type prevent relapse.

Keywords: Cat, Cystotomy, Urethrotomy, Urocystolithiasis, Urolithiasis.

Kedilerde Alt Üriner Sistem Ürolitiyazisinin Klinik, Laboratuvar, Radyografik, Ultrasonografik Tanısı ve Cerrahi Sağaltım: Çalışma On Kedi Üzerinde Yapıldı

Öz: Bu çalışmada; kliniğimize getirilen 10 kedide alt üriner sistem urolithiasis teşhisi ve sağaltımı sonuçlarının sunulması amaçlanmıştır. Çalışmada üriner sistem şikayeti olan 10 kedi kullanıldı. Ürolitiazis tanısı, idrar analizi, direkt ve indirekt radyografi ve ultrasonografik bulgular ile konuldu. Sekiz olguda operatif işlem, iki olguda medikal tedavi gerçekleştirildi. Strüvit ürolitli dört kediden ikisinde operatif uygulama yanında kalkulolitik diyet ve enfeksiyon kontrolü ile başarıya ulaşıldı. Kalsiyum oksalat, kalsiyum karbonat, kalsiyum fosfat ve amonyum urat ürolitleri üretrotomi, urohydropropulsion, sistotomi, üretro- sistotomi yöntemleri ile uzaklaştırıldı. Hayvanlar postoperatif 30. günde kontrol edilerek ürolitlerin tekrar oluşup oluşmadığı kontrol edildi. Bu çalışmada alt üriner sistem ürolitlerinin striuvit, kalsiyum okzalat, amonyum ürat, kalsiyum karbonat ve kalsiyum fosfat sıklık sırasına göre olduğu saptandı. Sonuç olarak; ürolitiazisin tanısını koymada; idrar pH'sı, kristalüri, hematüri, idrar lökosit değerleri ve taş kimyasal analizi, direkt ve pozitif kontrast radyografi ile ultrasonografinin birlikte değerlendirilmesi gerekmektedir. Ürolit olgularında operatif yaklaşımın endike olduğu ve operasyon sonrası ürolit tipine göre özel diyet ve medikal tedavinin nüksleri engellediği, kanısına varıldı.

Anahtar Kelimeler: Kedi, Sistotomi, Üretrotomi, Üretrolitiyazis, Ürolitiazis.

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INTRODUCTION

Urolithiasis is a common name given to lithiasis in any part of the urinary system and its results. If it occurs in urinary bladder, it is called as urocystolithiasis; if it occurs in urethra, it is called as ureterolithiasis (1,2). Abnormal microscopic precipitates in urine are called crystal, crystals in urine are known as crystalluria and macroscopic concentrations of crystals are called as urolith (1-6). Risk affecting the formation of urolith include race, age, sex, anatomical and functional anomalies of urinary system, metabolic anomalies, urinary system infections, diet and urine pH (3,4,7).

Low urinary tract uroliths are common in both male and female cats. However, urethral obstructions are more common in male cats since their urethras are long and narrower (6,8-10). Also, it was reported that urethral obstruction is localized behind os penis (11).

Struvite (magnesium-ammonium-phosphate) and calcium oxalate are the most common bladder stones in cats. However, urate, calcium phosphate, silicate, cystine, xanthine and mixed stones are less common bladder stones in cats (1,7,12). While struvite stones are commonly seen in female cats (especially in cross-breed female cats), calcium oxalte stones are commonly seen in male cats. Besides, silicate, urate and cysteine stones are also commonly seen in male cats (6,9).

The course of urolithiasis is different in cats compared to other animals. It is generally named Feline Urological Syndrome (FUS). Urethral plugs seen in FUS patients include typically struvite. Urine pH is 6-8 in healthy cats. There is no significant difference in urine pH values of health cats and cats with FUS. However, struvite is less likely to dissolve in basic medium. Therefore, alkaline urine is a risk factor for struvite stones. Struvite crystals are commonly seen especially in urine with a pH above 6.8. Also, formation of struvite stones is easier in a urinary tract with bacterial infection. These bacteria increase the pH of urine and reduce the solubility of struvite. In the case of acidic urine, calcium oxalate crystals form (3,13). Calcium oxalate stones commonly form in cats with hypercalcaemia and hypercalciuria. If the pH of urine decreases, the formation of calcium oxalate crystals accelerates (6,10). However, the risk of formation of calcium oxalate is higher in cats fed with canned pet food with a high amount of carbohydrates. It was observed that calcium oxalate stones are less likely to form in the cats fed with dry pet foods with a high amount of protein, calcium, phosphor, magnesium, sodium, potassium and chloride (14).

It was reported that radiopaque stones can be determined and information on their shapes and numbers of these stones can be obtained by direct radiography (8,11). However, some researchers reported that incorrect results are obtained since uro-cystoliths in urinary tract usually cannot be determined radiographically (9,15,16). Some researchers (17,18) reports that uroliths which cannot be determined by direct radiography can be determined by contrast radiography. In literatures, it was reported that uroliths are observed as hyperechoic lesions in ultrasonographic examinations, they create strong echo with acoustic shadow in their distals and, uroliths in bladder fall in the side down which the patient lies during the ultrasonographic examination (15,18-20).

It was reported that the disease may recur in some cases which the final diagnosis of urolithiasis was established and treated accordingly (3,20). In a study Osborne et al. (4), cases of recurrent struvite urolithiasis were reported in cats.

In this study, it was aimed to present the results of diagnosis and treatment of urinary tract urolithiasis in 10 cats brought to our clinic.

MATERIALS and METHODS

Working material consists of 10 cats with different race, age and gender which were brought with the complaints of urinary tract and found to

have findings such as difficulty urinating, haematuria, thamuria and urine incontinence as a result of medical history taken and clinical examination made (Table 1). Distribution by breed, age, sex and diet of totally 10 cases with lower urinary tract urolithiasis which constitute the study material of this study was recorded.

Table 1. Distribution of cases according to breed, age, sex and diet.
Tablo 1. Olguların tür, yaş, cinsiyet ve beslenme şekline göre dağılımı.

Case no	Breed	Age	Sex	Diet
1	Persian	6	♂	Homemade food
2	Tuxedo	2.5	♂	Food
3	Orange Tabby	2	♀	Food
4	Bombay	3	♂	Food
5	Van Cat	2.5	♂	Homemade food
6	Orange Tabby	2	♀	Food
7	Calico	5	♂	Food
8	Van Cat	4	♂	Homemade food
9	Orange Tabby	2	♀	Food
10	Van Cat	3	♂	Food

Physical, chemical and biochemical analyses that carried out on pre-operative Table 2 and on the 30th day of the post-operative period urine samples of the cases showed in Table 3. It was found that urine color and appearance turned to normal, and pH, protein, leukocyte and urine density reverted back to normal limits.

According to the results obtained from the chemical analysis of uroliths of the cases, urolith types were determined as struvite, calcium oxalate, ammonium urate, calcium carbonate and calcium phosphate (Table 4).

Radiographic and ultrasonographic imaging methods were employed. Direct and indirect images of the cases were taken. 6-12 ml/kg sodium amidotrizoate (Urografin 76%; Schering) diluted with %0.9 NaCl solution that given into the bladder via urinary catheter. Urination was stimulated by applying external pressure on the bladder. When urinary appear in the external urethral orificium L/L radiographs were taken and evaluated. Ultrasonographic examination was made with full bladder. Imaging process was carried out by comparing longitudinally and transversally.

Urine sample was collected by sterile cat catheter, through massaging bladder or during urination. The collected urine samples were subjected to physical and chemical analyses such as color, turbidity, pH, blood, hemoglobin, protein analyses. Also, after the urine samples were centrifuged at 3000 rpm for 3 minutes, microscopic examinations were made on the remaining precipitate. Thus, the samples were evaluated in terms of erythrocyte, leucocyte, epithelial cells and crystals.

Besides these analyses, uroliths obtained by surgical operations on lower urinary tracts of seven cases were analyzed biochemically. Analysis of Uroliths was made by Department of Biochemistry, Faculty of Veterinary Medicine in Kafkas University. Diet and medical treatment to be applied to the patients were determined based on the results of such analyses.

All surgical operations were carried out with general anesthesia. The patients were administered 0.08 mg/kg of medetomidin (Tomidin, 10 ml, Provet) and 5-7.5 mg/kg of ketamine (Ketasol 10%, 10 ml-Richter Pharma ag) intramuscularly. Movable uroliths in urethra were removed by urohydropropulsion method in one case, by urethrotomy in two cases, by both urethrotomy and cystotomy in two cases and by only cystotomy in three cases.

Foods which contain low amount of magnesium and phosphor but high amount of salt therefore will increase the acidity of urine were recommended for four cases diagnosed with struvite urolith based on the urolith analysis. Foods containing low protein and purine concentration were recommended for one case diagnosed with urate uroliths while foods with reduced protein and Na concentration were recommended for three cases diagnosed with calcium oxalate urolith. The same diet was applied for the cases diagnosed with calcium carbonate urolith. Nitrofurantoin (piyeloseptyl 25 mg/100 ml) or 5-15 mg/kg cefazolin sodium (cefozin 1 g IM, IV) were administered to the patients in order to eliminate bacterial infection and the treatment was continued with amino-acid supplement, oral methionine or prescription diet (purina u/r) in order to increase the acidity of urine.

RESULTS

While complaints such as difficulty in urination, hematuria and urine incontinence were reported in medical histories obtained from patient owners, in clinical examinations, hematuria and pollakiuria were determined in five cases; hematuria and dysuria in four cases; and urine incontinence and urinary tract symptoms such as hematuria and polyuria were determined in one case.

Table 2. Results of preoperative biochemical urine analysis.
Tablo 2. Preoperatif idrar biyokimyasal analiz sonuçları.

No	Hematuria	Appearance		pH	Protein	Leukocyte	Density
1	+	Turbid	Straw	Color	++	-	1035
2	+	Turbid	Reddish	6.2	+++	1-2 pcs	1040
3	-	Clear	Straw	7.5	+	-	1025
4	+	Turbid	Reddish	6.4	+++	1-2 pcs	1040
5	-	Clear	Straw	7.4	++	-	1035
6	+	Turbid	Reddish	6.1	+++	-	1045
7	+	Clear	Straw	7.3	+	-	1038
8	+	Turbid	Reddish	7.5	++	1-2 pcs	1038
9	+	Turbid	Pink	6.5	++	-	1035
10	-	Clear	Straw	7.5	++	-	1042

Table 3. Results of biochemical urine analysis on post-operative 30th day.
Tablo 3. Postoperatif 30. günde idrar biyokimyasal analiz sonuçları.

No	Hematuria	Appearance	Color	pH	Protein	Leukocyte	Density
1	-	Clear	Straw	6.8	-	-	1025
2	-	Clear	Straw	6.6	+	1-2 pcs	1030
3	-	Clear	Straw	7.0	-	-	1030
4	-	Clear	Straw	6.7	+	-	1035
5	-	Clear	Straw	6.7	-	-	1025
6	Dead						
7	-	Clear	Straw	6.8	-	-	1030
8	-	Clear	Straw	6.9	-	1-2 pcs	1025
9	-	Clear	Straw	6.8	-	-	1030
10	-	Clear	Straw	6.9	-	-	1025

Table 4. Results of urolith analysis.
Tablo 4. Ürolit analiz sonuçları.

Case no	Urolith Type
1	Ammonium urate
2	Calcium oxalate
3	Struvite
4	Calcium oxalate
5	Struvite
6	Calcium oxalate
7	Struvite
8	Calcium carbonate
9	Calcium phosphate
10	Struvite

While uroliths were determined in urinary bladders of the cases in ultrasonographic examination (Case no: 5, Fig. 1a), urinary bladder thickening was also observed.

While no urolith findings were found in six cases (Case no: 1, 2, 4, 6, 8, 9,) during direct radiography, uroliths were found in the same cases during contrast radiography. However, urolith findings were found in the remaining four cases (Case no: 3, 5, 7, 10) during direct radiography (Case no: 3, Fig. 1b). Urethrotomy was applied for two cases (Cases no: 4, 8) with urethral obstruction while ureterocystotomy was applied for other two cases (Cases no: 2, 5). Moveable uroliths in urethra were removed by Urohydropropulsion method (retrograde) (Case no: 1) and by cystotomy method in three cases (Case no: 3, 6, 9, Fig. 2) (Table 5).

Table 5. Operation results.
Tablo 5. Operasyon sonuçları.

Case no	Technique	30th day after the operation
1	Urohydropropulsion	Returned to normal
2	Ureterocystotomy	no crystal, 1-2 leucocytes
3	Cystotomy	Returned to normal
4	Urethrotomy	no crystal, 1-2 leucocytes
5	Ureterocystotomy	Returned to normal
6	Cystotomy	Not evaluated
7	Diet and Medical Treatment	Returned to normal
8	Urethrotomy	Returned to normal
9	Cystotomy	Returned to normal
10	Diet and Medical Treatment	Returned to normal

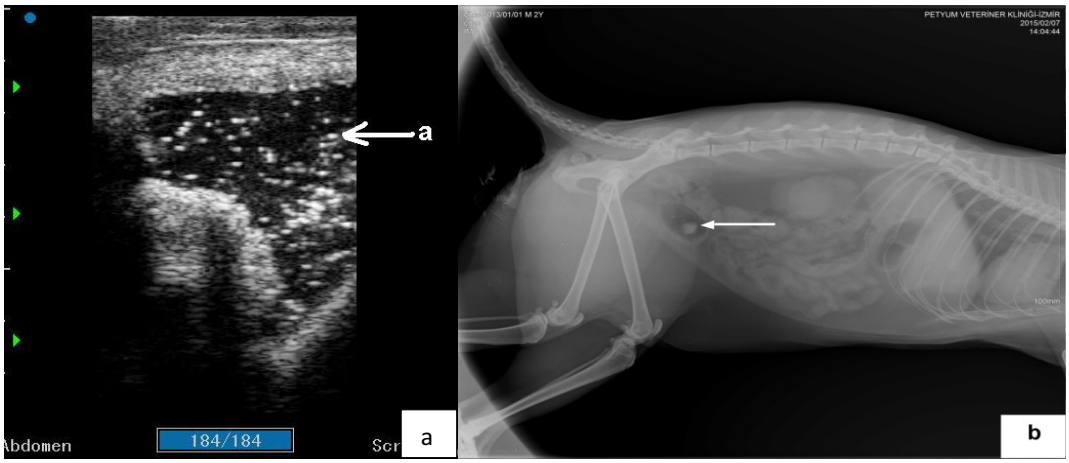

Figure 1. a. Ultrasonographic view of case no. 5 (a: struvite uroliths) **b.** Direct L/L; radiological view of case no. 5.
Şekil 1. a. Olgu 5'in ultrasonografik görünümü (a: struvit ürolitleri) **b.** Direkt L/L; Olgu 5'in radiyolojik görünümü.

In the period following the operation, hematuria was determined in two cases (Case no: 4, 8), urethral stricture in one case (Case no: 2). No complications developed in four cases after the surgical operations (Case no: 1, 3, 5, 9). One of the cases died (Case no: 6). Wound complications developed in one case (Case no: 2). It was determined that urethral catheter did not pass behind os penis during the urethral catheter insertion in one case (Case no: 9) and frequent getting in position to urinate and frequent urination was determined in one case (Case no: 6). It was determined that one case have been previously undergone cystotomy due to calcium phosphate urolith. Recurrence was observed in this case and uroliths were removed by cystotomy (Case no: 9).

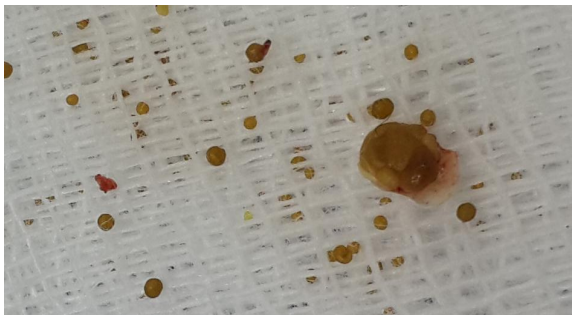

Figure 2. Uroliths removed by surgical operation from case no. 5.
Şekil 2. Olgu 5'ten operasyonla uzaklaştırılan ürolitler.

While seven cases administered with diet and medical treatment in the post-operative period (Case no: 1, 2, 3, 4, 5, 8, 9) and two cases administered with diet and medical treatment without a surgical operation (Case no: 7, 10) returned to normal, one case died due to insufficient post-operative care and diet (Case no: 6).

DISCUSSION and CONCLUSION

Lower urinary tract uroliths are commonly seen in both female and male cats. However, urethral obstructions are more common in male cats since their urethras are longer and narrower than those of female cats (1,6,8-10). Also, it was reported that urethral obstruction is generally localized behind os penis (11). We were determined that lower urinary tract urolithiasis which situated behind the os penis are commonly seen in male cats.

While struvite (magnesium ammonium phosphate) and calcium oxalate stones were the most common bladder stones in cats, urate, calcium phosphate, silicate, cysteine, xanthine and mixed stones have been found less in research (1,7,12). In this study as previous research the most common type of bladder stone was struvite (40%). However, other types of bladder stones included calcium oxalate (30%), ammonium urate (10%), calcium carbonate (10%) and calcium phosphate (10%) have been detected.

It was suggested that radiopaque stones can be determined and information on their shapes and numbers can be obtained by direct radiography (4,15,20). However, some researchers reported that incorrect results are obtained since uro-cystoliths in urinary tract usually cannot be determined radiographically (9,16). Some researchers Alkan (17), Kealy and Mcallister (18) reports that uroliths can be determined by contrast radiography which cannot be determined by direct radiography. In this study, radiopaque uroliths with various shapes, size and numbers were found by direct radiographic examination in six cases diagnosed with clinical strangury, pollakiuria or hematuri. However the presence of uroliths was determined by contrast radiography and ultrasonographic examination in four cases that urolith findings were not seen by direct radiography. It was concluded that direct and contrast radiography should be evaluated together with ultrasonographic data for diagnosis of lower urinary tract urolithiasis in cats.

It was reported Kealy and Mcallister (18), Johann (19) that uroliths are observed as hyperechoic lesions in ultrasonographic findings, they create strong echo with acoustic shadow in their distals and uroliths in bladder fall in the side down which the patient lies during the ultrasonographic examination. In our study, uroliths which have various size and numbers, hyperechoic appearance, acoustic shadow in their distal and displace as the patient moves were found by ultrasonographic examinations.

Reasarchers Osborne and Finco (3) showed that the disease may recur in some cases which the final diagnosis of urolithiasis was established and treated accordingly. In another study Osborne et al. (4), it was reported that there are cases of recurrent struvite urolithiasis in cats. In this study, it was determined that recurred one case diagnosed with struvite urolithiasis and have been previously operated in order to remove uroliths. Also, it was concluded that crystalluria should be monitored that critical for the success of treatment and recurrence of the disease.

It was determined in our research that struvite crystals were commonly seen in the cases with a high urine pH. Altought struvite crystals are commonly seen especially in urine with a pH above 6.8, no significant difference reported by researchers in urine pH values of healthy cats and cats with feline urological syndrome (FUS) (4,13). It is known that urethral plugs seen in patients with FUS include typically struvite. On the other hand, bacterial infection in the urinary tract facilitates the formation of struvite stones by increase the urine pH and decrease the solubility of struvite (1,3,13). Conversely, when the pH of urine decreases, the formation of calcium oxalate crystals accelerates (6,10). Moreover, calcium oxalate stones commonly form in cats with hypercalcaemia and hypercalciuria. Also, the risk of formation of calcium oxalate is higher in cats fed with canned pet food with a high amount of carbohydrates. On the contrary, it was showed that Lekcharoensuk et al. (14), Albasan et al. (7), calcium oxalate stones are less likely to form in the cats fed with dry pet foods with a high amount of protein, calcium, phosphor, magnesium, sodium, potassium and chloride. It was reported that Houston et al. (12), Osborne and Finco (3), the aim of the treatment should be prevent the changing on pH that formed these uroliths. Because of struvite is likely to form in basic medium and, calcium oxalate, urate, cysteine, calcium phosphate and silicate uroliths are likely form in acidic medium. In this study, it was determined that the patients responded to the treatment based on the urine analysis made on the 30th days after the operation. It was also concluded that the treatment accomplished by the diet and medical treatment applied depending on the urolith type to disrupt the necessary pH of the medium for the recurrence of uroliths.

Consequently; the most common urolith type is struvite and other common types of uroliths include calcium oxalate, ammonium urate, calcium carbonate and calcium phosphate respectively. Clinical, laboratory, radiological and ultrasonographic findings should be evaluated to make the diagnosis of urolithiasis. Diet and medical

treatment to be applied with or without a surgical operation is critical to prevent recurrence of the disease.

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