Journal of Applied Veterinary Sciences, 9 (1): 61-72 (January 2024).
ISSN*:* Online: 2090-3308, Print: 1687-4072
Journal homepage : https://javs.journals.ekb.eg

Studies on Feline lower Urinary Tract Disease in Egypt Cat Population

Shimaa M. Ayoub[1], Mohamed B. Mostafa[2] and Ahmed I. Abdelgalil[2]*

[1]MVSc candidate, Department of Veterinary Surgery Anaesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University, Giza, P.O. Box: 12211, Egypt

[2]Department of Veterinary Surgery Anaesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University, Giza, P.O. Box: 12211, Egypt

***Corresponding Author:** Ahmed I. Abdelgalil, **E-Mail:** ismael7591@cu.edu.eg

ABSTRACT

The present study was conducted on 56 cats (49 males and 7 females) who presented with signs of feline lower urinary tract disease (FLUTD). Abdominal radiographs and ultrasounds, urinalysis, bacterial culture, and stone analysis were performed. Serum blood urea nitrogen (BUN) and creatinine were investigated. Urine sample analysis was investigated microscopically. The results indicated that the most common causes of lower urinary tract affections were urolithiasis (37.5%), followed by feline idiopathic cystitis (FIC) (33.9%), bacterial urinary tract infection (UTI) (14.2%), urethral plugs (10.7%) and neoplasia (3.5%). Urethral obstruction was (42.8%) more frequent in cats with urolithiasis, urethral plugs and FIC. Cats with FIC and urethral plugs were significantly younger than other diagnostic groups. Cats with urolithiasis and neoplasia had higher body weights than other FLUTD groups. Persian cats (39.5%) were the most affected breed. The mineral compositions in the analyzed uroliths were calcium oxalate (62.5%), struvite (50%) and ammonium urate (25%). FLUTD urine sediment crystalluria were triple phosphate struvite crystals (51.7%), calcium oxalate crystals (16.0%), and ammonium urate crystals (12.5%). FIC, urethral plugs and urolithiasis showed a significant increase in crystalluria and urethral obstruction. Urethral obstruction represented 42.8%, and it occurred frequently in cats with urolithiasis, urethral plugs and FIC. Post-renal azotemia with increased BUN and creatinine concentrations was detected in obstructive urolithiasis, urethral plugs and FIC. The identified bacterial cultures included *Escherichia coli* (37.5%), *Staphylococcus aurous (37.5%) and Proteus species (25%)*. The results obtained from the study indicate that age, breed, sex and indoor confinement represent real challenges in developing lower urinary tract affections.

Original Article:
DOI:https://dx.doi.org/10.21608/javs.2023.240614.1280

Received : 04 October, 2023.
Accepted :03 December, 2023.
Published in January, 2024.

J. Appl. Vet. Sci., 9(1): 61-72.

Keywords: Cat, Crystalluria, FLUTD, Urolithiasis, UTI.

INTRODUCTION

Feline lower urinary tract disease (FLUTD) is a term that includes urethral and/or bladder disorders (**Saevik *et al.*, 2011**). The reported prevalence of FLUTD was 3–8% in feline practice in Canada (**Lund *et al.*, 2012)** and 2–13% in USA (**Lekcharoensuk *et al.*, 2001**). The most common causes of feline lower urinary tract disease were feline idiopathic cystitis (FIC) (55–57%) and urolithiasis (12–23%) (**Kruger *et al.*, 1991; Gerber *et al.*, 2005; Hunprasit *et al.*, 2019**).

Urethral obstruction has been reported in 18–58% of cats (**Kruger *et al.*, 1991; Lekcharoensuk *et al.*, 2001; Gerber *et al.*, 2005; Sævik *et al.*, 2011**). The other reported causes of FLUTD were urinary calculi, urethral plugs, and UTIs. Neoplasia was categorized as one of the less common causes of FLUTD (**Nururrozi *et al.*, 2020**). UTI represented 8% and 20% in European countries, which is higher than reported in USA at 1-3% (**Dorsch *et al.*, 2014; Nururrozi *et al.*, 2020**).

FLUTD was commonly accompanied by hematuria, stranguria, periuria, and dysuria **(Gunn-Moore, 2003; Forrester and Towell, 2015)**.Urethral obstruction is a common FLUTD complication in male cats. Urethral plugs were considered in 55% of obstructed cats and uroliths were found in 15% of cats **(Kruger *et al.*, 1991)**.

There was a paucity of literature focused on feline lower urinary tract diseases in Egypt cat population. Therefore, the aim of the study was to investigate the causes of FLUTD in Egyptian cats with special emphasis on the clinical characteristics, urine analysis, types of crystalluria and mineral composition of the urinary stones which will provide guidance for management.

MATERIALS AND METHODS

This study was carried out on 56 cats (49 male and 7 female) of different ages, sexes, weights, and breeds in the period from October 2020 to July 2023. The population studied comprised 48 Persian, 4 Egyptian Mau, 3 Siamese, and one short-haired scotch. The ages ranged from 6 months to 12 years with a mean±SD (8.56±5.23). Cats with clinical signs of hematuria, stranguria, pollakiuria, periuria, and urethral obstruction were involved in the study. Cats treated with antibiotics, perineal urethrostomies, or previous catheterizations were excluded from the study. All cats were sexually intact, in-door breeding consuming dry food. All data and samples collected from cats used for research were authorized by the owner by signing an informed consent form.

Lateral and ventro-dorsal abdominal radiographs were taken using an X-ray machine. (Fischer, Stuttgart, Germany). The radiographic parameters were 48 kV and 1 mA, and the focal spot film distance was 75 cm. Abdominal ultrasonography was scanned using a 7.5 MHz microconvex probe (Edan Dus 60, China) and an 8 MHz linear probe (Hitachi device Aloka F37, Japan).

Blood for biochemical analysis was collected in plain tubes and serum was separated by centrifugation. Analysis was performed using (Analyzer, Sensozne (company) STAT LAB2 (model), 2018, Obour City, Cairo, Egypt.

Standard urinalysis was performed using commercial urine dipstick analysis (Krulab; Kruuse, Marslev, Denmark). Color, turbidity, PH and specific gravity were determined. Microscopic examination of the urine sediment was done after centrifugation of 10 ml urine sample for 10 minutes at 1500 rpm for the presence of epithelial cells, red blood cells, crystal-like formations, casts, and urine that was amorphous. Haematuria was diagnosed when more than ten erythrocyte cells per X 400 were counted and pyuria was diagnosed when more than five leukocytes per X 400 cells were present in the field of view (**Osborne *et al.,* 1996**).

Urine bacterial culture was collected on MacConkey agar and blood agar (containing 5% sheep blood). The cultures were incubated at 37^{o}C for 24-48 h and determined antimicrobial susceptibility (**Dorsch *et al.,* 2019**). Crystal and calculus investigations were done by optical crystallography using polarized light microscopy. Additional quantitative clarification was needed by using Fourier transformation infrared spectroscopy (FT-IR) (**Gomes *et al.,* 2022**).

The cat population was categorized into five groups based on defined diagnostic criteria (**Dorsch *et al.,* 2014**). UTI was diagnosed when significant bacterial growth was evident in the urine culture. A urethral plug was diagnosed when the urethra was obstructed by plug. A urolith was diagnosed using abdominal radiography and ultrasonography. Neoplasia was diagnosed ultrasonographically by the identification of a mass lesion (**Lamb *et al.,* 2018**). FIC was diagnosed by eliminating the other specific possibilities. Obstructive FLUTD was considered when an overly distended rigid urinary bladder was painful by genital palpation during physical examination.

Statistical analysis

The normality of the distribution was assessed using the Shapiro-Wilk test. Data analyses were conducted using SPSS statistical programs version 16 (IBM Corp., NY, USA). Descriptive statistics (mean, standard deviation) were calculated. A comparison of continuous parameters was performed using a one-way ANOVA followed by Dunn's post hoc test to compare continuous variables between groups. Chi-squared tests were used to test differences in the five diagnostic groups. Statistical significance was set at $p<0.05$.

RESULTS

The incidence of FLUTD was obtained from 56 cats during period between 2020 to 2023 attended to Veterinary Surgery Clinic. The study population enrolled on 49 (87.5%) males and 7 (12.5%) females. Persian cats represented 48 (85.7%) (Table1).

Table 1: Numbers and percentages of breeds of cat populations in five different diagnostic groups of (FIC, UTI, U plugs, Urolithiasis and Neoplasm).

Breads	Number	FIC (19)	UTI (8)	U plugs (6)	Urolithiasis (21)	Neoplasm(2)
Persian	48 (85.7%)	17 (35.4%)	8 (16.6%)	4 (8.5%)	19 (39.5)	0.0
Siamese	3 (5.3%)	-	0.0	2 (66.6%)	1 (33.3%	0.0
Egyptian Mao	4 (7.1%)	1 (25%)		0.0	1 (25%)	2 (50%)
Short hair scotch	1(1.7%)	1 (100%)	0.0	0.0	0.0	0.0
Total	56 (100%)	19 (33.9%)	8 (14.2%)	6 (10.7%)	21 (37.5)	2 (3.5%)

Significant at (P<0.05).

Feline idiopathic cystitis (FIC); urethral plugs (U plugs); urinary tract infection (UTI).

The most common diagnosis were urolithiasis in 21 cats (37.5%), feline idiopathic cystitis in 19 cats (33.9%), 8 cats (14.2%) urinary tract infection (UTI) in 8 cats (14.2%), urethral plugs in 6 cats (10.7%), and neoplasia in 2 cats (3.5%). UTI represented the highest percentage in females: 4 (57.1%), 2 cats (28.5%) had urolithiasis, and one cat (14.2%) had FIC.

The mean age of the cat population with FLUTD in Egypt was 4.8 ± 1.26 years. The age variation was high, from 6 months to 12 years. The mean age of cats with UTI and neoplasia was significantly (P = 0.03) higher compared with FLUTD diagnostic groups. The mean age in cases of UTI (7.9±3.1) years and neoplasia (8.45± 3.78) was older than in other diagnostic FLUTD groups. The mean body weight of cats with urolithiasis and neoplasia was significantly (P = 0.05) higher than the FLUTD diagnostic groups (Fig.1).

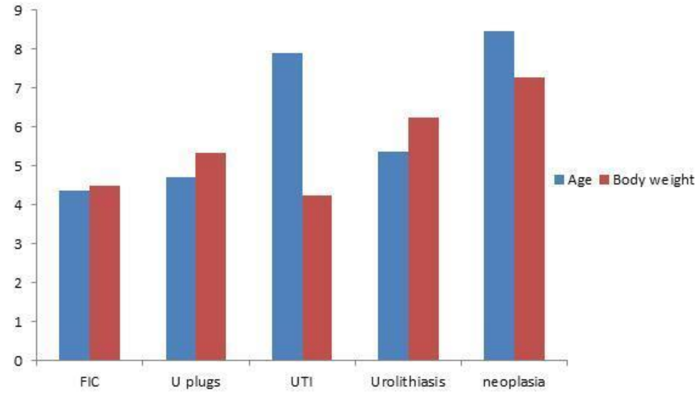

Fig.1: Correlation between age and body weight and different diagnostic groups of FLUTD in cat population in Egypt.

` The clinical signs associated with different groups of FLUTD diagnostic groups were documented in Table 2. Hematuria (46.4%), stranguria (33.9%), pollikuria (21.4%), and periuria (5.3%) were the common signs of FLUTD. Hematuria was common in urethral plugs, neoplasia, and urolithiasis compared with other clinical signs. Stranguria was noted to be highest in neoplasia; UTI and urolithiasis represented 100%, 62.6%, and 38%, respectively. Obstructive FLUTD was diagnosed in 42.8%, mostly in urethral plugs (100%), urolithiasis (66.6%), and FIC (10.2%).

Table 2: The number and percentage of the clinical signs in diagnostic cat population with FLUTD in Egypt

Clinical signs	All cats	FIC	UTI	Urethral plugs	Urolithiasis	Neoplasm
Total	56 (100%)	19 (33.9%)	8 (14.2%)	6 (10.7%)	21 (37.5%)	2 (3.6%)
Hematuria	26 (46.4%)	9 (47.3%)	1 (12.5%)	6 (100%)	13 (61.9%)	2 (100%)
Stranguria	19 (33.9%)	6 (31.5%)	5 (62.5%)	0.0	8 (38.0%)	2 (100%)
Pollikuria	12 (21.4%)	2 (10.5%)	2 (25.0%)	4 (66.6%)	4 (19.0%)	0.0
Periuria	3 (5.3%)	1 (5.2%)	1 (12.5%)	0.0	1 (4.7%)	0.0
Urethral obstruction	24 (42.8%)	2 (10.2%)	0.0	6 (100%)	14 (66.6%)	2 (100%)

Feline Idiopathic cystitis (FIC); Urinary tract infection (UTI).

Abdominal radiography was used to confirm the presence of urinary crystal and calculi. Uroliths were radiographically opaque (Fig. 2).Ultrasonography was used to diagnose 17/21 cases of urolithiasis in the bladder and 4/21 uroliths were localized in the urethra. Ultrasonographic images of uroliths were identified by hyperechogenicity, accompanied by a shadow cone (Fig. 3). Urinary bladder wall tumor was scanned as a heterogeneous papillary and pedunculated mass originated from the dorsal margin of the bladder projecting in the bladder lumen (Fig.3).

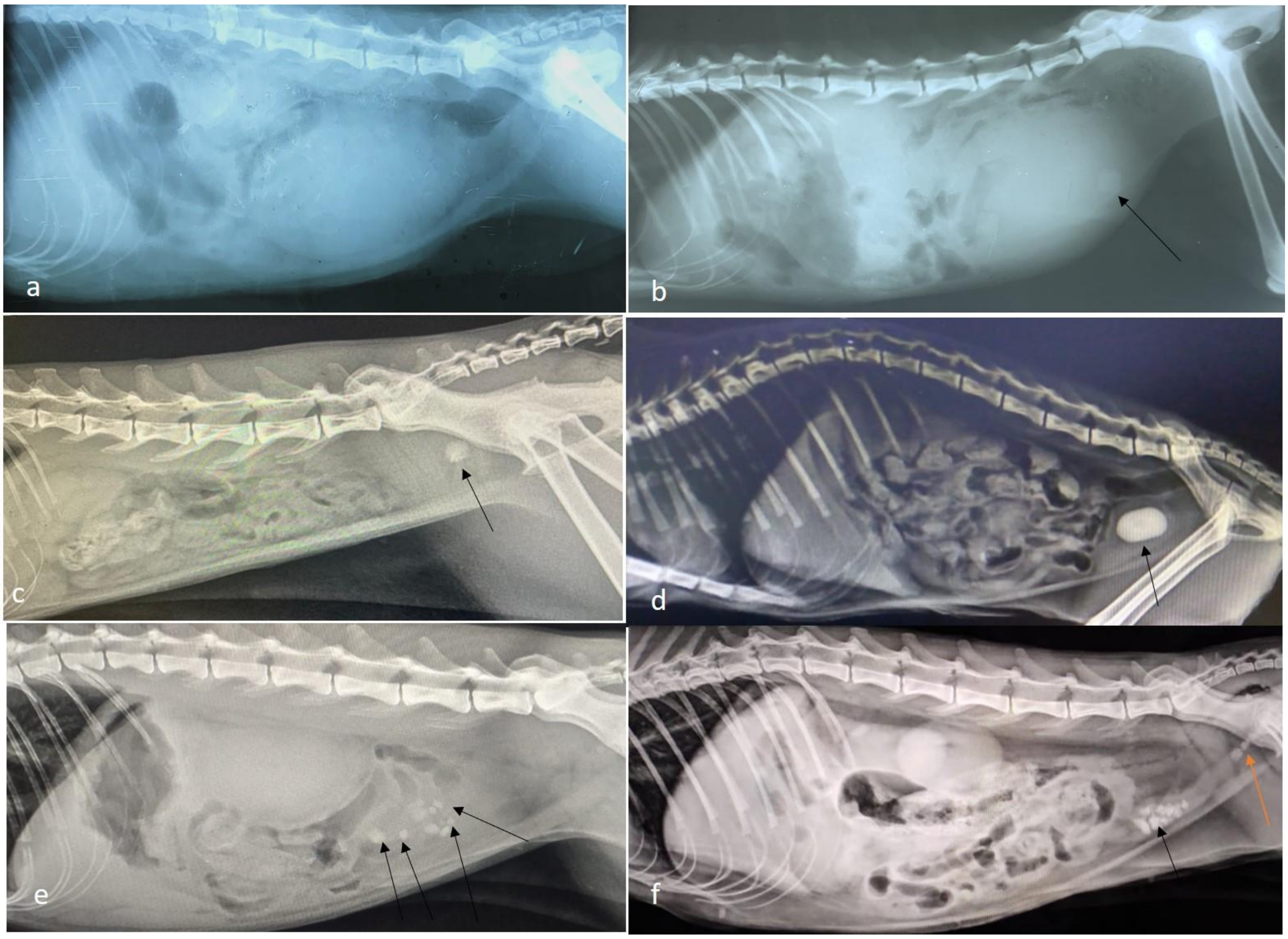

Fig.2: Lateral abdominal radiographs a) in 4 years tom cat revealed distended urinary bladder. b) In 6 years tom cat revealed distended bladder with moderate radio dense rhombus structure with irregular surface (cystic calculus). c) In 3 years tom cat revealed small spherical radio opaque calculus. d) In 6 years tom cat showed radio dense ovoid calculus. e) In 4 years queen revealed multiple small sized radiodense calculi (black arrows). f) In 3 years tomcat revealed multiple small sized radiodense calculi (black arrows) and multiple calculi at the neck of bladder and urethra (red arrow).

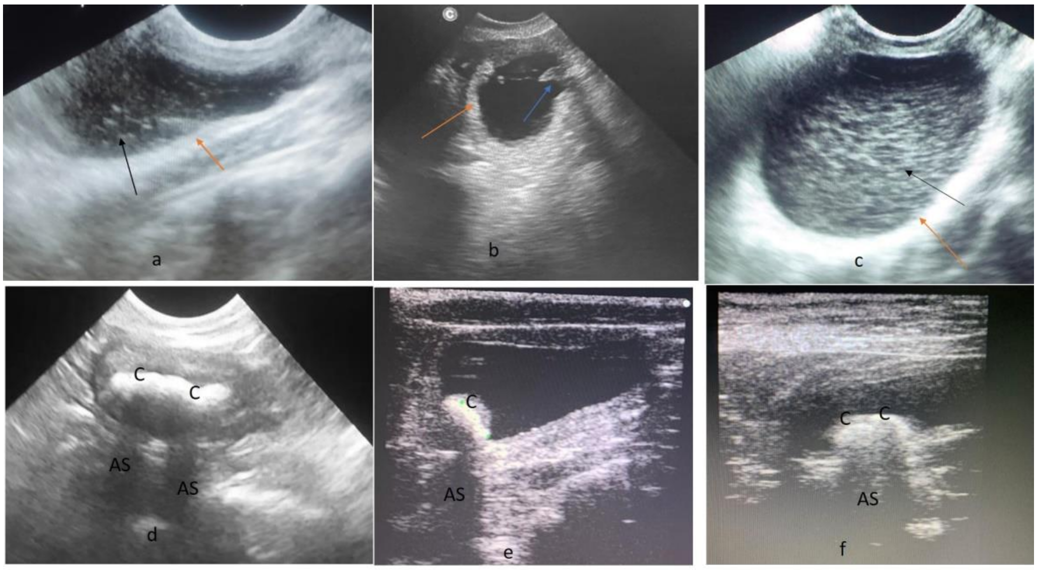

Fig.3: a) Long-axis sagittal image of the urinary bladder in a 4 years tom cat showed the urinary bladder containing a small heterogeneous echogenic dots (black arrow) and thickened hyper echoic wall (red arrow). b) Long-axis sagittal image of the urinary bladder in a 7 years tom cat. The bladder wall showed thickening of the bladder wall (red arrow) and echogenic structure extending into the lumen (blue arrow) consistent with cystic tumor. c) Long-axis sagittal image of the bladder in a 6 years tom cat revealed heterogeneous echogenic materials (black arrow) consistent with bloody urine and thickened hyper echoic wall (red arrow). (d,e&f) Long-axis sagittal scans of the urinary bladder in 4 years queen, 5 years tom cat and 5 years queen respectively revealed hyperechoic structures (C) with distal acoustic shadowing (AS) within the urinary bladder lumen and these findings were consistent with cystic calculi.

Cystotomy was performed according to **Nikousefat *et al.,*** (**2018**) in 8/17 in order to remove the stone (Fig.4). The remaining of nine cases was not determined and the owners refused the surgical treatment. Perineal urethrostomy was performed according to **Nye and luther,** (**2018**) in 4 cases.

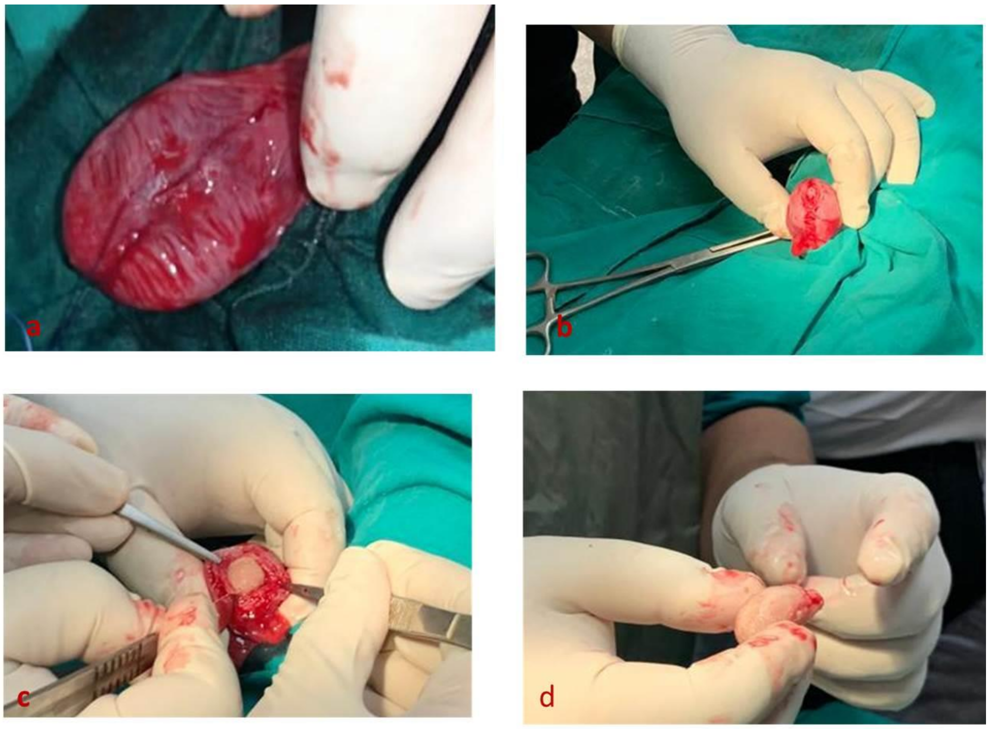

Fig.4: Cystotomy in a 3 year- old tom cat a) Exposure of Urinary bladder. b) Surgical incision of the bladder. c) Widening the bladder wound and the cystic stone appeared inside the lumen of the bladder. d) Calcium phosphate stone after extraction.

There were no significant differences in the urine color, pH and specific gravity between the different FLUTD groups (Table 3). Regarding the amount of red blood cells in urine sediment is high in urolithiasis and FIC groups. Macrohematuria (bloody urine) was significantly (P<0.05) seen in 46.4% of diagnostic FLUTD groups. The amount of epithelial cells, casts, crystals and urine amorphous did not differ significantly between groups. There was an increased amount of white blood cells (P< 0.05) in the urine sediment of UTI and urolithiasis.

Crystals were seen in urine sediment of different diagnostic groups. Triple phosphates were the most common crystals in this study (51.7%), followed by calcium oxalates (23.8%) and uric acid crystals in 12.5% (Table 3). Urine sediment was evaluated and the most common findings were haematuria and Pyuria. Amorphous phosphate (struvite) was (66.0%) followed by amorphous ammonium urate that represented (23.8%). There was a significant (P< 0.01) higher amount of struvite amorphous crystalluria in the urine sediment of cats diagnosed with urolithiasis (71.4%) and FIC (68.4%) of diagnostic FLUTD groups (Table 3).

Table 3: Description of urinalysis and sediment findings in cats diagnosed with feline lower urinary tract disease (FLUTD) in Egypt using chi squared test.

Parameters		FIC (19)33.9%	U plugs (6)10.7%	UTI (8) 14.2%	Urolithiasis (21) 37.5%	Neoplasm (2) 3.5%	Total 56	P value
Urine color	yellow	5(26.3%)	0.0	1(12.5%)	0.0		6(10.7%)	
	Dark Yellow	9 (47.3%)	2 (33.3%)	5(62.5%)	8(38.0%)		24 (42.8%)	
	Bloody	5 (26.3%)	4 (66.6%)	2 (25%)	13 (61.9%)	2(100%)	26(46.4%)	0.05
Urine pH		7.9±1.59 4.4- 9.0	6.17±2.02 4.5-9.0	6.6±2.22 4.2-9.0	7.22±1.89 4.5-9.0	5.45±0.64 5.0- 5.9		0.137
Specific Gravity		1.018±0.007 1.012-1.046	1.017±0.004 1.012-1.022	1.024±0.015 1.014-1.060	1.017±0.004 1.014-1.025	1.020±0.000 1.020		0.382
Leucocytes/HPF		11.38±7.35 1.0-27	13.67±11.89 1- 35	25.42±15.3* 4.0-65	20.53±10.02* 5.0-42	14.5±3.54 12-17		0.054
RBCs/HPF		59.42±41.2 5.0-100	48.17±45.88 5.0-100	53.5±49.75 3.0-100	78.44±35.7 3.0-100	56.0±41.01 27- 85		0.424
WBCs 10^3cells/ul		50.9±8.5* 8.3-343.0	31.2±6.5* 21.3-37.9	56.0±6.4* 12.4-188	27.3±12.5 18.8-55.0	20.4±8.7 14.2-26.6		0.051
Crystals	Triple Phosphate	5 (26.3%)	6 (100%)	2 (25%)	13 (61.9%)	1 (50%)	29(51.7%)	0.01
	Ammonium urates	1 (5.2%)	0.0	0.0	5 (23.8%)	1 (50%)	7(12.5%)	
	Ca Oxalate	6 (31.5%)	0.0	0.0	3 (14.2%)	0.0	9 (16.0%)	
Amorphous Phosphate		13 (68.4%)	4 (66.6%)	5 (62.5%)	15 (71.4%)	1 (50%)	37 (66.0%)	0.01
Amorphous Urates		5 (26.3%)	1 (16.6%)	1 (12.5%)	5 (23.8%)	1 (50.0%)	13 (23.2%)	

Significant at (P<0.05)
Feline Idiopathic cystitis (FIC); Urethral plugs (U plugs); Urinary tract infection (UTI).

Stone analysis revealed calcium oxalate uroliths were identified in 2/8, struvite uroliths in 1/8, mixed calcium oxalate and struvite uroliths in 2/8, mixed calcium oxalate and urates stones in 2/8, calcium phosphate uroliths in 1/8. Consequently, calcium oxalate composed of 62.5% of bladder stones while struvite stone formed 50% and ammonium urate stone (25%) (Fig.5).

a) Pure calcium oxalate stones. Hard brownish irregular stones and acidic.

b) Mixed calcium oxalate and urate Stones. Yellowish irregular multiple stones

c) Calcium phosphate stone. Hard granulated irregular and alkaline.

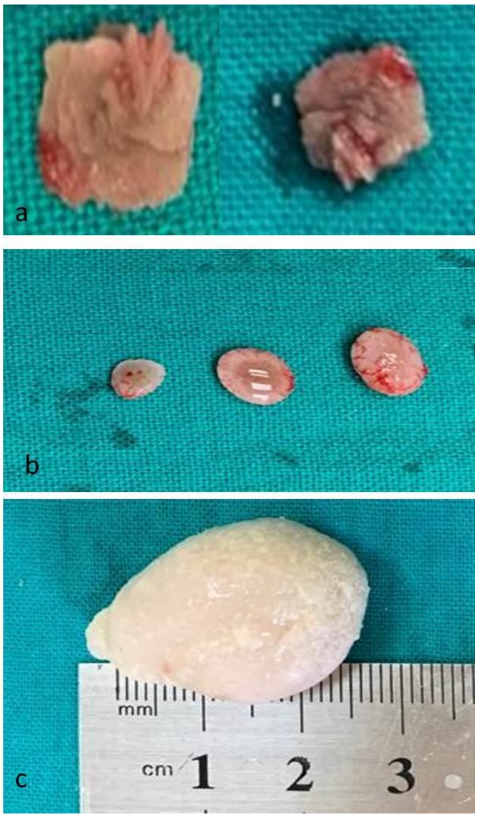

Fig.5: The different types and shapes of cystic calculi obtained after surgical cystotomy.

A positive urine bacterial culture was found in 8 cats (14.5%) that were subsequently diagnosed with urinary tract infection (UTI). The bacterial isolates identified were *Escherichia coli* 3/8 (37.5%), *Staphylococcus aurous 3/8 (37.5%) and Proteus species 2/8 (25%)*. The serum BUN (mg/dl) and creatinine (mg/dl) in diagnostic FLUTD cats had significantly (P<0.05) increased in urolithiasis (60.4 ± 56.3) mg/dl and (4.69±1.7) mg/dl respectively, and urethral plugs (56.3± 22.0) and (2.95 ±1.02) mg/dl respectively (Table 4).

Table 4: Serum biochemical analysis of FLUTD diagnostic groups in Egypt

Parameters	FIC	U plugs	UTI	Urolithiasis	Neoplasia	P value
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	
BUN (mg/dl)	26.0±21.52 11-81	56.38±22.39 3.5-57	24.91±15.83* 1.53- 44	60.41±56.98* 10-209	26.95±28.35 6.9-47	0.01
Creatinine mg/dl)	1.61±0.77 0.91-3.7	2.95±1.02 0.9- 3.4	1.57±0.78 0.3- 2.3	4.69±4.62 1.1-17.3	4.65±3.04 2.5-6.8	0.01

Significant at (P<0.05).Feline Idiopathic cystitis (FIC); Urethral plugs (U plugs); Urinary tract infection (UTI).

DISCUSSION

The most common findings were urolithiasis (37.5%) and feline idiopathic cystitis (FIC) (33.9%). These findings contradict the previous reports, which indicate FIC is the most frequent cause of FLUTD, followed by urolithiasis (**Da Rosa *et al.*, 2018; Piyarungsri *et al.*, 2020**). Urinary bladder neoplasia was (3.5%) the less common cause of FLUTD. Similar findings were reported (**Gerber *et al.*, 2005**).

In the present study, male cats (87.5%) were more affected by FLUTD than female cats. The same has been reported (**Hribova *et al.*, 2020; Remichi *et al.*, 2020; Ataya *et al.*, 2023).** This might be attributed to the long and narrow urethra in males (**Saevik *et al.*, 2011; Segev *et al.*, 2011**). On the other hand, older female cats in this study had a higher UTI (57.1%) due to a shorter and wider urethra (**Litster *et al.*, 2009**). The current study revealed that most cats with FLUTD were sexually intact. **Reche *et al.*,**

(1998) reported that reproductive status is not a major risk factor for FLUTD development. In contrast, (**Leckharoensuk *et al.,* 2001; Remichi *et al.,* 2020)** found that neutered male cats are more susceptible to FLUTD than sexually intact males which may be attributed to weight gain and inhibition of urethral growth (**Gama *et al.,* 2009**).

Persian cats were the most affected breed with FLUTD in this study. Furthermore, the Persian breed represented the highest percentage of obstructive urolithiasis (39.5%). Similar results have been reported by (**Mendoza-López *et al.,* 2019; Abdel-Saeed *et al.,* 2021**) and this could be due to genetic predisposition **(Lew- Kojrys *et al.,* 2017)**. As well as the Persian breed being preferred for keeping among most Egyptian residents. In contrast, **Appel *et al.,* (2010**) pointed out the presence of a genetic association between the Egyptian Mau breed and urolithiasis.

Previously, the risk factors for urolithiasis formation were overweight, a lower water intake, the use of a litter box, a lower activity level, and an in-door lifestyle (**Cameron *et al.,* 2004; Dorsch *et al.,* 2014**). These conditions predispose the animal to urine stasis and saturation and increase the risk of stone formation and urinary tract infections (**Cleroux *et al.,* 2017**).

In the present study, cats with an average body weight of approximately 6.0 kg have been reported to have been associated with urolithiasis and urinary bladder tumors. Obese cats have a higher susceptibility to FLUTD development (**Gerber *et al.,* 2008; Lew-Kojrys *et al.,* 2017**). **Piyarungsri *et al.* (2020**) reported that obese cats may be less active, drink less water and void urine less frequently.

In the present study, all cats were strictly indoors and consumed dry foods. Dry diet is considered an important risk factor for FLUTD and urolithiasis formation as it influences urinary pH (**Gomes *et al.,* 2018; Lund *et al.,* 2019**). The dried industrialized food, including cereals, tends to alkalinize the urine and predisposes to the formation of struvite crystals (**Skoch *et al.,* 1991**).

The mean age of the cat population with FLUTD in Egypt was 4.8± 1.26 years compares closely with the mean ages reported in other studies. It was 5.1 years in the USA (**Buffington *et al.,* 1997**) and 5.6 years in Norway (**Saevik *et al.,* 2011**). The mean age of cats with UTI and neoplasia was 7.9 years and 8.4 years respectively, which is higher than previously reported literature (**Saevik *et al.,* 2011; Dorsch *et al.,* 2014**). A strong correlation was found between increased age and the prevalence of urinary tract infection (UTI) (**Mendoza- Lepoz *et al.,* 2019; Hribova *et al.,* 2020**).

The clinical signs of haematuria, stranguria, pollikuria and periuria in the current study were consistent with the previous studies (**saevik *et al.,* 2011, Okafor *et al.,* 2019**). The incidence rate of urolthiasis was high (37.5%) in cat population in Egypt. Meanwhile, the incidence rate of urolithiasis decreased in European countries **(Lew- Kojrys *et al.,* 2017; Hribova *et al.,* 2020**). This study revealed urethral obstruction (66.6%), hematuria (61.9%), stranguria (38.0%), and pollakiuria (19.0%), and these findings are similar to previous studies (**Dorsch *et al.,* 2014**). Marked hematuria was seen in cats with FLUTD (46.4%), and it was observed more in urolithiasis, urethral plugs and UTI diagnostic groups. The prevalence of hematuria was high in previous studies (**Saevik *et al.,* 2011; Dorsch *et al.,* 2014**) and attributed to urinary bladder bleeding due to inflammation, high pressure within the bladder and fewer causes due to cystocentesis and catheterization (**Segev *et al.,* 2011; Lew- Kojrys *et al.,* 2017**).

Pyuria was higher in urinary tract infection (25.42±15.3) and urolithiasis (20.53±10.02). Similar findings were also reported (**Litster *et al.,* 2009; Dorsch *et al.,* 2014**). Furthermore, this study documented no significant differences in the urine color, pH or specific gravity between the different FLUTD groups, which is in agreement with the results of **(Bailiff *et al.,* 2008**). Nevertheless, **Martinez- Ruzafa *et al.,* (2012**) reported that the specific gravity was significantly lower in the UTI group when compared to the other FLUTD groups.

Da Rosa *et al.,* (2018) reported that obesity increased mineral excretion in the urine. Similar observations have been observed in humans with large bodies: increased secretion of uric acid and oxalates in the urine and enhanced formation of calcium oxalate uroliths (**Taylor *et al.,* 2005**). Consequently, in our study, calcium oxalate was composed of 62.5% of bladder stones, while struvite formed 50% stones and ammonium urate (25%). The same has been reported (**Houston *et al.,* 2016**; **Mendoza- lopez *et al.,* 2019**). In contrast, **Kopecny *et al.,* (2021**) reported a significant decrease in the calcium oxalate-containing uroliths and an increase in the struvite-containing uroliths. **Albasan *et al.,* (2012); Houston *et al.,* (2016); Kopency *et al.,* (2021**) concluded that the formulation of commercial diets (highly acidified diets) designed to dissolve struvite uroliths and minimize struvite crystalluria resulted in decreased struvite and increased calcium oxalate uroliths. Furthermore, **Cannon *et al.,* (2007**) found that Persian breeds have an increased risk for calcium oxalate-containing uroliths. The same findings were noticed in this study.

Appel *et al.*, (2010) and Albasan *et al.*, (2012) reported that high concentrations of protein in the diet can lead to hyperuricosuria, hyperammonuria and aciduria, promoting the formation of reduced solubility crystals that can cause urate urolithiasis. The same findings have been observed in the present study.

FIC was commonly diagnosed in young and middle-aged cats **(**4.35±2.23) with increased body weight. Similar findings were documented (**Gunn-Moore 2003; Cameron *et al.*, 2004; Lew- Kojrys *et al.*, 2017**). Moreover, crystalluria of amorphous phosphate, urate and calcium oxalate were common in the present study. Consequently, the aggregate of crystalluria within the urinary tract and urine over-saturation with crystallogenic substances predispose to urolith formation (**Okafor *et al.*, 2019**). Urethral obstruction in cats with FIC was 10.2% in the present study. In this respect, **Kruger *et al.* (2009**) attributed urethral obstruction in cats with FIC to intraluminal accumulations of sloughed tissue, inflammatory cells, or red blood cells from inflammatory swelling of the urethra and urethral muscle spasm, in addition to the formation of matrix-crystalline urethral plugs (**Osborne *et al.*, 1992**).

The percentage of urethral plugs in the current investigations was 10.7%. A similar finding was reported in European cats (**Gerber *et al.*, 2005**). The cause of plug formation is still not completely known. The urinary tract infection (UTI) reported in the present study (14.2%) is in line with findings reported in other studies (**Bartges, 2004; Hribova *et al.*, 2020**). UTI has been diagnosed in only 1–3% of FLUTD cases in USA (**Kruger *et al.*, 1991**), whereas bacterial cystitis represented 8%–25% (**Nururrozi *et al.*, 2020**).

Escherichia coli were the most common isolates (37.5%), followed by *Staphyloccocus species* (37.5%) in the present study. Similar findings have been reported (**Passmore *et al.*, 2008; Teichmann-Knorrn *et al.*, 2018; Ataya *et al.*, 2023**). Urease produced by *Staphylococcus* alkalizes the urine and leads to struvite formation (**Litster *et al.*, 2007**). Consequently, a high percentage of amorphous phosphate crystalluria (66.6%) in cats with UTI confirmed that crystalluria is an important predisposing factor in obstructive FLUTD (**Hribova *et al.*, 2020**). Increased BUN and creatinine concentrations in obstructive FLUTD (urolithiasis and urethral plugs) were seen in this study. Postrenal azotemia is mostly diagnosed in cats who suffer complete or nearly complete obstruction at the bladder and/or urethra level (**Polzin *et al.*, 1996; Gerber *et al.*, 2005; Segev *et al.*, 2011**).

CONCLUSION

In conclusion, the most common FLUTD diagnosis was urolithiasis (37.5%), followed by feline idiopathic cystitis (FIC) (33.9%), bacterial urinary tract infection (UTI) (14.2%), urethral plugs (10.7%) and neoplasia (3.5%). Urethral obstruction (42.8%) was more frequent in cats with urolithiasis, urethral plugs and FIC. Persian male cats were highly susceptible to FLUTD. Cats with urolithiasis and neoplasia had higher body weights than other FLUTD groups. Stone analysis revealed calcium oxalate was composed of 62.5% of bladder stones while struvite stones formed 50% and ammonium urate (25%). The identified bacterial isolates were *Escherichia coli* (37.5%), *Staphylococcus aurous (37.5%) and Proteus species (25%)*. The results obtained from the study indicate that age, sex, breed, indoor confinement, and diet could increase the risk of developing FLUTD.

Funding

This research did not receive any funding from any agency

Conflict of interests

The author declares no conflict of interests

REFERENCES

ABDEL-SAEED, H., REEM, R.T., and FARAG, H.S., 2021. Diagnostic and epidemiological studies on obstructive feline lower urinary tract disease (flutd) with special reference to anatomical findings in Egyptian tomcats. Bulgarian Journal of Veterinary Medicine, 24(3), pp. 383 – 394. https://doi.org/10.15547/bjvm.2019-0096

ALBASAN, H., OSBORNE, C.A., LULICH, J.P., and LEKCHAROENSUK, C., 2012. Risk factors for urate uroliths in cats. Journal of the American Veterinary Medical Association, 240(7), pp. 842-847. https://doi.org/10.2460/javma.240.7.842

APPEL, S.L., HOUSTON, D.M., MOORE, A.E., and WEESE, J.S., 2010. Feline urate urolithiasis. The Canadian Veterinary Journal 51 (5), pp. 493. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2857427/

ATAYA, H.A., SOLIMAN, M.S., KAYAF, K.A.H., MAROUF, S., and AL-AMRY, K., 2023. Incidence, bacterial causes and antibiotic resistance patterns of urinary tract infection in pet animals. Journal of Applied Veterinary Sciences 8 (2), pp. 26-34. https://dx.doi.org/10.21608/ja vs.2023.179690.1199

BAILIFF, N.L., WESTROPP, J.L., NELSON, R.W., SYKES, J.E., OWENS, S.D., and KASS, P.H., 2008. Evaluation of urine specific gravity and urine sediment as risk factors for urinary tract infections in cats. Veterinary clinical pathology, 37(3), pp. 317-322. https://doi.org/10.1111/j.1939-165X.2008.00065.x

BARTGES, J.W. 2004. Diagnosis of urinary tract infections. The Veterinary Clinics of North America.

Small Animal Practice, 34(4), pp. 923-33. https://doi.org/10.1016/j.cvsm.2004.03.001

BUFFINGTON, C.A., CHEW, D.J., KENDALL, M.S., SCRIVANI, P.V., THOMPSON, S.B., BLAISDELL, J.L., and WOODWORTH, B.E., 1997. Clinical evaluation of cats with nonobstructive urinary tract diseases. Journal of the American Veterinary Medical Association, 210(1), pp.46-50. https://pubmed.ncbi.nlm.nih.gov/8977647/

CAMERON, M.E., CASEY, R.A., BRADSHAW, J.W.S., WARAN, N.K., and GUNN-MOORE, D.A., 2004. A study of environmental and behavioural factors that may be associated with feline idiopathic cystitis. Journal of Small Animal Practice, 45(3), pp.144-147. https://onlinelibrary.wiley.com/doi/10.1111/j.1748-5827.2004.tb00216.x

CANNON, A.B., WESTROPP, J.L., RUBY, A.L., and KASS, P.H., 2007. Evaluation of trends in urolith composition in cats: 5,230 cases (1985–2004). Journal of the American Veterinary Medical Association, 231(4), pp.570-576. https://avmajournals.avma.org/view/journals/javma/231/4/javma.231.4.570.xml

CLEROUX, A., ALEXANDER, K., BEAUCHAMP, G., and DUNN, M., 2017. Evaluation for association between urolithiasis and chronic kidney disease in cats. Journal of the American Veterinary Medical Association 250 (7), pp.770-774. https://doi.org/10.2460/javma.250.7.770

DA ROSA GOMES, V., ARIZA, P.C., BORGES, N.C., SCHULZ, F.J., and FIORAVANTI, M.C.S., 2018. Risk factors associated with feline urolithiasis. Veterinary Research Communications 42 (1), pp. 87-94. https://link.springer.com/article/10.1007/s11259-018-9710-8

DORSCH, R., REMER, C., SAUTER-LOUIS, C., and HARTMANN, K., 2014. Feline lower urinary tract disease in a German cat population. Tieraerztliche Praxis Ausgabe K: Kleintiere/Heimtiere, 42(04), pp. 231-239. https://www.thieme-connect.de/products/ejournals/abstract/10.1055/s-0038-1623769

DORSCH, R., TEICHMANN-KNORRN, S., and SJETNE LUND, H., 2019. Urinary tract infection and subclinical bacteriuria in cats: a clinical update. Journal of feline medicine and surgery, 21(11), pp.1023-1038. https://doi.org/10.1177/1098612X19880435

FORRESTER, S.D., and TOWELL, T.L., 2015. Feline idiopathic cystitis. Veterinary Clinics: Small Animal Practice, 45(4), pp. 783-806. https://doi.org/10.1016/j.cvsm.2015.02.007.

GAMA, R.O.G., FERNANDES, D.O., LIMA, C.C.V., and BARROUIN-MELO, S.M., 2009. Factors Related to the Occurrence of Feline Lower Urinary Tract Disease (FLUTD). In: The Proceedings of the 34th Congress of the World Small Animal Veterinary Association Online, 2009. Sao Paulo, Brazil, July 2009. https://www.vin.com/apputil/content/defaultadv1.aspx?pId=11290&catId=33324&id=4252806

GERBER, B., BORETTI, F.S., KLEY, S., LALUHA, P., MÜLLER, C., SIEBER, N., UNTERER, S., WENGER, M., FLÜCKIGER, M., GLAUS, T., and REUSCH, C.E., 2005. Evaluation of clinical signs and causes of lower urinary tract disease in European cats. Journal of Small Animal Practice, 46(12), pp. 571-577. https://doi.org/10.1111/j.1748-5827.2005.tb00288.x

GERBER, B., EICHENBERGER, S., and REUSCH, C.E., 2008. Guarded long-term prognosis in male cats with urethral obstruction. Journal of feline Medicine and Surgery, 10(1), pp. 16-23. https://doi.org/10.1016/j.jfms.2007.06.007

GOMES, V.D.R., ARIZA, P.C., BORGES, N.C., SCHULZ, F.J., and FIORAVANTI, M.C.S., 2018. Risk factors associated with feline urolithiasis. Veterinary research communications, 42, pp. 87-94. https://link.springer.com/article/10.1007/s11259-018-9710-

GOMES, V.R., ARIZA, P.C., SILVA, M.A.M., SCHULZ JR, F.J., OLIVEIRA, H.F., QUEIROZ, L.L., BORGES, N.C., BRAGATO, N., and FIORAVANTI, M.C.S., 2022. Mineral composition and clinical aspects of urolithiasis in cats in Brazil. Arquivo Brasileiro de Medicina Veterinária e Zootecnia, 74, pp.649-661. https://doi.org/10.1590/1678-4162-12545

GUNN-MOORE D. 2003: Feline lower urinary tract disease. Journal of feline Medicine and Surgery, 5, pp. 133-138. https://doi.org/10.1016/S1098-612X(02)00129-8

HOUSTON, D.M., VANSTONE, N.P., MOORE, A.E., WEESE, H.E., and WEESE, J.S., 2016. Evaluation of 21426 feline bladder urolith submissions to the Canadian Veterinary Urolith Centre (1998–2014). The Canadian Veterinary Journal, *57*(2), 196. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4713001/pdf/cvj_02_196.pdf

HŘIBOVÁ, B., CEPLECHA, V., ŘEHÁKOVÁ, K., PROKS, P., GABRIEL, V., KOHOUTOVÁ, L., and CRHA, M., 2020. Causes of lower urinary tract disease in Czech cat population. Acta Veterinaria Brno, 88(4), pp.433-441. https://doi.org/10.2754/avb201988040433

HUNPRASIT, V., PUSOONTHORNTHUM, P., KOEHLER, L., and LULICH, J.P., 2019. Epidemiologic evaluation of feline urolithiasis in Thailand from 2010 to 2017. The Thai Journal of Veterinary Medicine 49 (1), pp. 101-105. https://doi.org/10.56808/2985-1130.2968

KOPECNY, L., PALM, C.A., SEGEV, G., and WESTROPP, J.L., 2021. Urolithiasis in dogs: Evaluation of trends in urolith composition and risk factors (2006-2018). Journal of veterinary internal medicine, 35(3), pp.1406-1415. https://doi.org/10.2460/javma.236.2.193

KRUGER, J.M., OSBORNE, C.A., GOYAL, S.M., WICKSTROM, S.L., JOHNSTON, G.R., FLETCHER, T.F.,and BROWN, P.A., 1991. Clinical evaluation of cats with lower urinary tract disease. Journal of the American Veterinary Medical Association, 199(2), pp. 211-216. https://pubmed.ncbi.nlm.nih.gov/1653776/

KRUGER, J.M., OSBORNE, C.A., and LULICH, J.P., 2009. Changing paradigms of feline idiopathic cystitis. Veterinary Clinics of North America: Small Animal Practice, 39(1), pp. 15-40. https://doi.org/10.1016/j.cvsm.2008.09.008

LAMB, C.R., DIRRIG, H., and CORTELLINI, S., 2018. Comparison of ultrasonographic findings in cats with and without azotaemia. Journal of feline medicine and surgery, 20(10), pp. 948-954. https://doi.org/10.1177/1098612X17736657

LEKCHAROENSUK, C., OSBORNE, C.A., and LULICH, J.P., 2001. Epidemiologic study of risk factors for lower urinary tract diseases in cats. Journal of the American Veterinary Medical Association, 218(9), pp. 1429-1435. https://doi.org/10.2460/javma.2001.218.1429

LEW-KOJRYS, S., MIKULSKA-SKUPIEN, E., SNARSKA, A., KRYSTKIEWICZ, W., and POMIANOWSKI, A., 2017. Evaluation of clinical signs and causes of lower urinary tract disease in Polish cats. Veterinární medicína, 62(7), pp. 386-393. https://doi.org/10.17221/170/2016-VETMED

LITSTER, A., MOSS, S.M., HONNERY, M., REES, B., and TROTT, D.J., 2007. Prevalence of bacterial species in cats with clinical signs of lower urinary tract disease: recognition of Staphylococcus felis as a possible feline urinary tract pathogen. Veterinary Microbiology, 121(1-2), pp. 182-188. https://doi.org/10.1016/j.vetmic.2006.11.025

LITSTER, A., MOSS, S., PLATELL, J., and TROTT, D.J., 2009. Occult bacterial lower urinary tract infections in cats-urinalysis and culture findings. Veterinary Microbiology, 136(1-2), pp. 130-134. https://doi.org/10.1016/j.vetmic.2008.10.019

LUND, H.S., RIMSTAD, E., and EGGERTSDÓTTIR, A.V., 2012. Prevalence of viral infections in Norwegian cats with and without feline lower urinary tract disease. Journal of feline medicine and surgery, 14(12), pp. 895-899. https://doi.org/10.1177/1098612X12459644

LUND, H. S., and EGGERTSDÓTTIR, A. V., 2019. Recurrent episodes of feline lower urinary tract disease with different causes: possible clinical implications. Journal of feline medicine and surgery 21(6), pp. 590-594. https://doi.org/10.1177/1098612X18783839

MARTINEZ-RUZAFA, I., KRUGER, J. M., MILLER, R., SWENSON, C. L., BOLIN, C. A., and KANEENE, J. B., 2012. Clinical features and risk factors for development of urinary tract infections in cats. Journal of feline medicine and surgery 14 (10), pp. 729-740. https://doi.org/10.1177/1098612X12451372

MENDOZA-LÓPEZ, C. I., DEL-ANGEL-CARAZA, J., AKÉ-CHIÑAS, M. A., QUIJANO-HERNÁNDEZ, I. A., and BARBOSA-MIRELES, M. A., 2019. Epidemiology of feline urolithiasis in Mexico (2006–2017). Journal of Feline Medicine and Surgery Open Reports, 5(2), 2055116919885699. https://doi.org/10.1177/2055116919885699

NIKOUSEFAT, Z., HASHEMNIA, M., JAVDANI M., and GHASHGHAII, A., 2018. Obstructive bacterial cystitis following cystotomy in a Persian cat. Veterinary Research Forum, 9(2), pp. 199-203. https://doi.org/10.30466/vrf.2018.30822

NURURROZI, A., YANUARTONO, Y., SIVANANTHAN, P., and INDARJULIANTO, S., 2020. Evaluation of lower urinary tract disease in the Yogyakarta cat population, Indonesia. Veterinary World, 13(6), pp. 1182.www.doi.org/10.14202/vetworld.2020.1182-1186

NYE, A.K., and LUTHER, J.K., 2018. Feline Perineal Urethrostomy: A Review of Past and Present Literature. Topics in Companion Animal Medicine, 33(3), pp. 77-82. https://doi.org/10.1053/j.tcam.2018.07.002

OKAFOR, C.C., PEARL, D.L., BLOIS, S.L., LEFEBVRE, S.L., YANG, M., LUND, E.M., and DEWEY, C.E., 2019. Factors associated with hematuric struvite crystalluria in cats. Journal of feline medicine and surgery, 21(10), pp. 922-930. https://doi.org/10.1177/1098612X18809176

OSBORNE, C.A., KRUGER, J.P., LULICH, J.P., BARTGES, J.W., POLZIN, D.J., MOLITOR, T., BEAUCLAIR, K.D., and ONFFROY, J., 1992. Feline matrix-crystalline urethral plugs: a unifying hypothesis of causes. Journal of Small Animal Practice, 33(4), pp. 172-177. https://doi.org/10.1111/j.1748-5827.1992.tb01110.x

OSBORNE, C.A., JOHN, M.K., and JODY, P.L., 1996. Feline lower urinary tract disorders: definition of terms and concepts. Veterinary Clinics of North America: Small Animal Practice, 26(2), pp. 169-179. https://doi.org/10.1016/S0195-5616(96)50200-7

PASSMORE, C.A., SHERINGTON, J., and STEGEMANN, M.R., 2008. Efficacy and safety of cefovecin for the treatment of urinary tract infections in cats. Journal of Small Animal Practice, 49(6), pp. 295-301. https://doi.org/10.1111/j.1748-5827.2006.00231.x

PIYARUNGSRI, K., TANGTRONGSUP, S., THITARAM, N., LEKKLAR, P., and KITTINUNTASILP, A., 2020. Prevalence and risk factors of feline lower urinary tract disease in Chiang Mai, Thailand. Scientific Reports, 10(1), 196. https://doi.org/10.1038/s41598-019-56968-w

POLZIN, D. J., OSBORNE, C. A., and BARTGES, J. W., 1996. Management of post renal azotemia. Veterinary Clinics of North America: Small Animal Practice, 26(3), pp. 507-513. https://doi.org/10.1016/S0195-5616(96)50081-1

RECHE JR, A., HAGIWARA, M.K., and MAMIZUKA, E., 1998. Clinical study of lower urinary tract disease of domestic cats of São Paulo. Brazilian Journal of Veterinary Research and Animal Science, 35, pp. 69-74. https://doi.org/10.1590/S1413-95961998000200004

REMICHI, H., HANI, F.A., REBOUH, M., BENMOHAND, C., ZENAD, W., and BOUDJELLABA, S., 2020. Lower urinary tract lithiasis of cats in Algeria: Clinical and epidemiologic features. Veterinary World, 13(3), pp. 563-569. http://doi.org/10.14202/vetworld.2020.563-569

SÆVIK, B.K., TRANGERUD, C., OTTESEN, N., SØRUM, H., and EGGERTSDÓTTIR, A.V., 2011.

Causes of lower urinary tract disease in Norwegian cats. Journal of Feline Medicine and Surgery, 13(6), pp. 410-417. https://doi.org/10.1016/j.jfms.2010.12.012

SKOCH, E.R., CHANDLER, E.A., DOUGLAS, G.M., and RICHARDSON, D.P., 1991. Influence of diet on urine pH and the feline urological syndrome. Journal of Small Animal Practice, 32(8), pp. 413-419. https://doi.org/10.1093/jn/128.12.2753S

SEGEV, G., LIVNE, H., RANEN, E., and LAVY, E., 2011. Urethral obstruction in cats: predisposing factors, clinical, clinicopathological characteristics and prognosis. Journal of feline medicine and surgery, 13(2), 101-108. https://doi.org/10.1016/j.jfms.2010.10.006

TAYLOR, E.N., STAMPFER, M.J., and CURHAN, G.C., 2005. Obesity, weight gain, and the risk of kidney stones. Journal of American Medical Association 293 (4), pp. 455-462. https://doi.org/10.1001/jama.293.4.455

TEICHMANN-KNORRN, S., REESE, S., WOLF, G., HARTMANN, K., and DORSCH, R., 2018. Prevalence of feline urinary tract pathogens and antimicrobial resistance over five years. Veterinary Record 183 (1), pp. 21-21. https://doi.org/10.1136/vr.104440

How to cite this article:
Shimaa M. Ayoub, Mohamed B. Mostafa and Ahmed I. Abdelgalil, 2024. Studies on Feline lower Urinary Tract Disease in Egypt Cat Population. Journal of Applied Veterinary Sciences, 9 (1): 61-72.**DOI**:**https://dx.doi.org/10.21608/javs.2023.239423.1279**