STUDIES ON THE INCIDENCE OF FELINE URINARY SYSTEM AFFECTIONS

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ABSTRACT

The present study was aimed to record the incidence of various urinary system affections in cats both retrospectively and prospectively. The two-year retrospective study recorded 118 cats presented with various surgical affections, among which, majority were found to have fractures (22%) followed by urinary system affections (18.6%). Prospective study for a seven-month period recorded a total of 91 cats presented with different surgical affections in which cases presented with urinary system affections were the highest (23%). Among various urinary system affections, cystitis was the predominant affection in both retrospective and prospective studies accounting for 45.4% and 52.4%, respectively. In both studies, Persian breed tom cats aged less than two years were predominantly affected. Struvite were more abundantly formed in the urine of cats along with amorphous crystals and calcium oxalate crystals, which was observed microscopically.

Keywords: Cats, urinary system affections, incidence study, persian breed, tom cats.

Introduction

Domestication of cats was dated back to centuries; however, in recent years, rearing of cats had gained popularity, leading to a proportional rise in health concerns (Rochlitz, 2009). Cats are being presented to the clinics with various ailments like fractures, wounds, herniations, ocular disorders, tumours, pyometra, dystocia, urinary system affections and for elective surgeries like ovario-hysterectomy, castration, etc (Rodrigues *et al.,* 2022). Among these various ailments, cats were quite often diagnosed with urinary system affections comprised of hydronephrosis (Udainiya *et al.,* 2018), polycystic kidneys, urolithiasis, interstitial cystitis (Ebrahim *et al.,* 2019), transitional cell carcinoma (Griffin *et al.,* 2020), uroperitoneum (Aumann *et al.,* 1998) and urethral plugs (Jackson, 1971). The incidence of urinary system affections was also higher as per the studies of Bennour *et al*. (2014) and Farghali *et al*. (2020), who reported 39.5 % and 23 %, respectively.

Most of the cats presented to the clinics with urinary tract affections were typically middle-aged, overweight, which had sedentary lifestyle, fed on dry diets (Gunn – Moore, 2003) and reside in provocative environment like multi pet household which induce stress (Buffington, 2011). Cats were found to be suffering from various conditions like polycystic kidney disease (Nivy *et al.,* 2015), hydronephrosis (Udainiya *et al.,* 2018), nephroliths, ureteroliths (Lulich *et al.,* 2016), ureteral strictures (Griffin, 2020), ureteral avulsion (Aumann *et al.,* 1998), cystoliths, cystitis, feline lower urinary tract disease (FLUTD) (Williams, 2009), etc.

In cats, urolithiasis means not only the formation of solid calculi but also production of sandy and matrix plugs which were not of calculi-like composition (Jackson, 1971). Urethral plugs or urethroliths could fully obstruct urethra resulting in a condition called as blocked cat (Williams, 2009), necessitating emergency veterinary consultation. The calculi or plugs in cats were mostly made of struvite and calcium oxalate (Houston and Moore, 2009). The term, feline lower urinary tract disease (FLUTD) cumulatively denotes the disease processes of urinary bladder and/or urethra, which is a persistent issue in small animal practice and especially in tom cats (Abdel–Saeed *et al*., 2021). Urethral plugs occur with the similar frequency as that of uroliths and they are of significant importance as they also result in urethral obstruction. Although, there are numerous conditions which lead to signs of FLUTD, most of the cases are idiopathic, hence termed as feline idiopathic cystitis (FIC). Transitional cell carcinomas were the most common cystic neoplasms in cats which occur either as primary tumours or secondary to chronic inflammation (Gunn–Moore, 2003).

Materials and Methods

The cats presented to Department of Veterinary Surgery and Radiology, NTR College of Veterinary Science, Gannavaram, Andhra Pradesh with various urinary system affections requiring surgical intervention were recorded prospectively from May, 2022 to December, 2022 and retrospectively for the last two years (2020-21 and 2021-22). The collected data was screened to know the various surgical affections in cats and overall incidence of urinary system affections and categorized accordingly i.e., affections of kidney and ureter, urinary bladder and urethra; types of urinary calculi; Detailed age-wise (0-2, 2-4, 4-6, 6-8 and above 8 years), sex-wise (male or female) and breed-wise incidence of the urinary system affections was recorded and analyzed to draw conclusions.

Results and Discussion

A. Retrospective study

1. Incidence of surgical affections in cats

During the two year retrospective study, 118 cats were registered at the Department of Veterinary Surgery and Radiology with various surgical affections. Majority of them

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were diagnosed with fractures of different bones (n=26; 22%) followed by urinary system affections (n = 22; 18.64%), different types of wounds, elective spaying, acute spinal injury, colonic impaction, ocular affections, elective castration, other orthopaedic affections, hernias, abscess, intussusceptions, rectal prolapse, limb amputation, etc (Table 1).

Table 1: Retrospective incidence of surgical affections in cats (n = 118).

S. No.	Affections	No. of cats	Percentage
1.	Fractures	26	22.03%
2.	Urinary system affections	22	18.64%
3.	Wounds	22	18.64%
4.	Ovario-hysterectomy	11	9.32%
5.	Acute spinal injury	8	6.8%
6.	Colonic impaction	5	4.23%
7.	Ocular affections	4	3.38%
8.	Other orthopaedic affections	4	3.38%
9.	Castration	3	2.54%
10.	Ottitis externa	2	1.7%
11.	Hernia	2	1.7%
12.	Abscess	2	1.7%
13.	Caesarean section	1	0.84%
14.	Cellulitis	1	0.84%
15.	Limb amputation	1	0.84%
16.	Intussusception	1	0.84%
17.	Rectal prolapse	1	0.84%
18.	Gingivitis	1	0.84%
19.	Foreign body ingestion – laryngeal obstruction	1	0.84%
	Total	118	

2. Incidence of urinary system affections in cats

Among 22 cats presented with urinary system affections, cystitis (45.4%) was the predominant clinical condition recorded followed by urethral plugs, sludge in urine, cystoliths etc and no ureteral affections were recorded in that period. Multiple clinical manifestations were observed in many cats. Lower urinary tract (urinary bladder and urethra) affections were predominant compared to upper urinary tract (kidney, renal pelvis and ureter) (Table 2). Cystitis, hydronephrosis, sludge in bladder, urethral plugs and urethritis were identified in cats with severely distended urinary bladder.

3. Age, sex and breed-wise incidence

Group of cats aged less than four years were mostly recorded with urinary system affections that too the cats less than two years (n = 12; 54.5%) were highly prone to FLUT. Sex-wise, male cats (n = 20; 90.1%) clearly outnumbered the females (n = 02; 9.1%) in the urinary system affections. Breed-wise, the incidence was found to be higher in Persian (n = 16; 72.7%) followed by domestic short hair and non-descript breeds. The calculi/crystaluria related issues were prevalent in males (Table 3).

Table 3: Retrospective breed, sex and age-wise incidence of urinary system affections in cats (n = 22)

S. No.	Category		No. of cats	Percentage
1.	Breed	Persian	16	72.7%
		Domestic Short Hair	04	8.1%
		Non-descript	02	9.1%
2.	Sex	Male	20	90.1%
		Female	02	9.1%
3.	Age	0 – 2 years	12	54.5%
		2 – 4 years	08	36.5%
		4 – 6 years	01	4.5%
		6 – 8 years	01	4.5%
		Above 8 years	Nil	Nil

B. Prospective study

1. Incidence of surgical affections

The detailed prospective study was carried out for a seven month period from May, 2022 to December, 2022, in which a total of 91 cases were registered with various surgical affections. Among which, majority numbers (n=21; 23.07%) were presented with urinary system affections followed by colonic impaction, elective spaying, fractures, ocular affections and different types of wounds etc. In this study also, no ureteral affections were recorded. Cystitis outnumbered the list with 11 cases (52.38%) followed by sludge in the urine and urinary bladder, urethral plugs, hydronephrosis etc (Table 4).

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2. Incidence of urinary system affections

The lower urinary attract affections were more compared to the upper. Four cases of hydronephrosis were recorded. Further, the urinary bladder suffered a lot in all cases which showed symptoms of urinary system affections (cystitis and sludge in bladder) (Table 5). Cystoliths were retrieved by cystotomy in two Persian cats. In one cat, the

Table 2: Retrospective detailed incidence of urinary system affections in cats

S. No	Part of urinary system	Affection	No. of cats affected (%)	Sex		Age (Years)					Breed		
				Male	Female	0 – 2	2 – 4	4 – 6	6 – 8	> 8	DSH	Persian	ND
1.	Kidney	Hydronephrosis	5 (22.7)	5	-	3	2	-	-	-	1	4	-
		Renal cyst	1 (4.54)	1	-	1	-	-	-	-	-	1	-
2.	Ureter	-	0	0	0	0	0	0	0	0	0	0	0
3.	Urinary bladder	Cystitis	10 (45.4)	9	1	7	2	-	1	-	2	7	1
		Cystolithiasis	4 (18.18)	4	-	3	1	-	-	-	-	4	-
		Sludge	5 (22.7)	3	2	2	2	1	-	-	1	3	1
		Blood clots	3 (13.63)	3	-	1	2	-	-	-	1	2	-
4.	Urethra	Urethral plugs	6 (27.27)	6	-	4	1	-	1	-	1	5	-
		Urethritis	3 (13.63)	3	-	2	1	-	-	-	-	3	-

Values in parenthesis are in percentage, DSH – Domestic short hair, ND – Non-descript

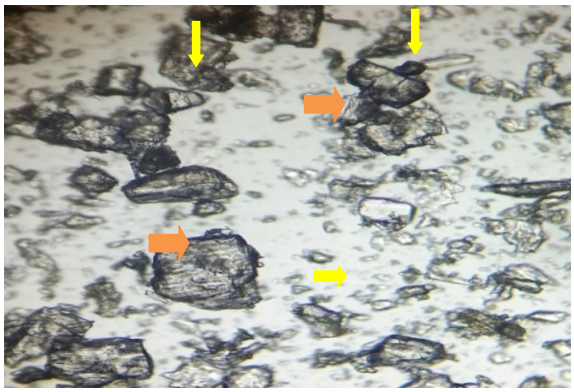


Fig. 1: Photomicrograph showing presence of coffin shaped struvite crystals (yellow arrows) and amorphous crystals (brown arrow) collected from solitary large calculus

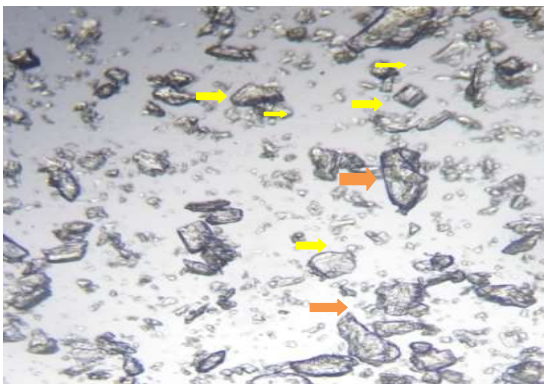


Fig. 2: Photomicrograph showing presence of struvite crystals (yellow arrows) and amorphous crystals (brown arrow) collected from small calculi

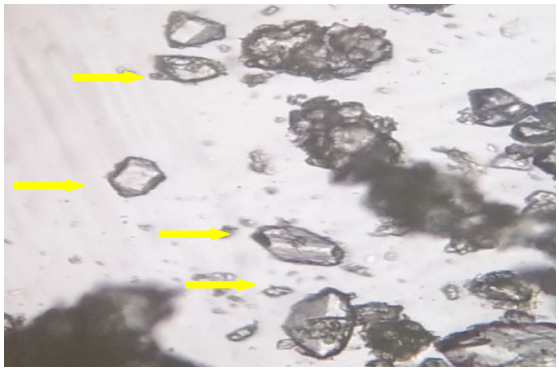


Fig. 3: Photomicrograph showing presence of rhomboid shaped calcium oxalate dihydrate crystal (yellow arrow) observed in an urethral plug

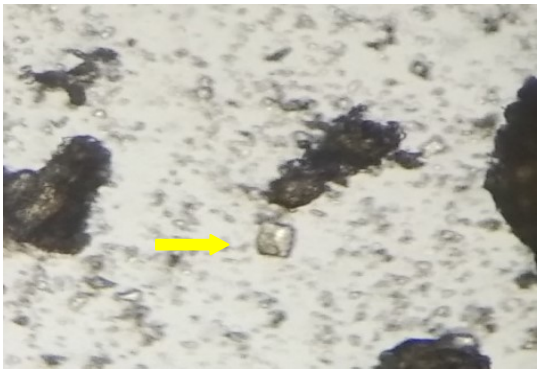


Fig. 4: Photomicrograph showing presence of coffin shaped struvite crystals (yellow arrows) observed in an urethral Plug

solitary large calculus was composed more of struvite that showed characteristic coffin shape or long cylindrical crystals with a triangular tip and many amorphous crystals (Fig. 1). In another cat, the two small cystic calculi retrieved were also composed of struvite and amorphous crystals (Fig. 2). The urethral plugs were retrieved in six (28.6%) Persian breed tom cats aged less than four years and two cats (9.52%) showed urethritis which showed hyperaemic tip of urethra. The plugs were composed mainly of struvite crystals apart from numerous amorphous crystals (Fig. 3). Calcium oxalate dihydrate crystals were also observed in the plugs identified by their rhomboid shape (Fig. 4).

3. Age, sex and breed–wise incidence

Cats aged less than two years (n=12; 57.14%) were mostly recorded with urinary system affections. Sex-wise, the incidence was found to be higher in tom cats (n=20; 95.2%) compared to queen cats. Persian breed tom cats (n=19; 90.5%) were found to be more affected followed by domestic short hair breed and non-descript type (Table 6).

Felines were being presented to the clinics with various surgical issues, among which urinary system was one of the most vulnerable components to various diseases (Sharun *et al.,* 2021). Lower urinary tract diseases top the list among the most frequently reported concerns by pet owners. Unhealthy ambience, bedding abnormalities and dry diets were the factors contributing to these abnormalities (Gunn-Moore, 2003). Retrospective study revealed that fractures were the most common affections with an incidence rate of 22 per cent which was closer to that of Bennour *et al.* (2014) who reported 39.5% incidence of fractures. In the prospective study, urinary system affections emerged as the most predominant with 23 per cent incidence which was similar to the findings of Farghali *et al.* (2020) who documented a 16.7% incidence of urinary system affections in cats.

Out of a total of 91 cases, almost 25 per cent of the cases were presented with lower urinary tract diseases. In contrast to this, Gunn-Moore (2003) and Balbinot *et al.* (2015) recorded 1% and 4.8% incidence of FLUTD, respectively. The overall increase in the rate can be attributed to the growing trend of cat rearing, complete reliance on commercial diets and lack of knowledge of rearing pure bred cats. In numerous cats, polycystic kidney was an incidental finding (Beck and Lavelle, 2001) and heritable in nature (Ebrahim *et al.,* 2019), however, the anamnesis could not trace the familial origin. The incidence of cystitis was high both in retrospective (45%) and prospective studies (57%). Similar to this, Buffington *et al.* (1996) diagnosed idiopathic cystitis in 53% of cats. Cystoliths were detected in only 9.5 per cent of the cases thus depicting less incidence of urolithiasis in cats which was agreement with

Table 4: Prospective incidence of surgical affections in cats (n = 91)

S. No	Affection	No. of cats affected (%)	Sex		Age					Breed		
			M	F	0-2	2-4	4-6	6-8	>8	DSH	Persian	ND
1.	Urinary system affections	21 (23.07)	20	1	12	4	3	2	0	2	19	-
2.	Colonic impaction	8 (8.79)	7	1	6	-	2	-	-	1	6	1
3.	Elective spaying	8 (8.79)	-	8	5	2	-	1	-	4	2	2
4.	Fractures	8 (8.79)	3	5	7	-	1	-	-	1	2	5
5.	Ocular affections	8 (8.79)	6	2	8	-	-	-	-	3	1	4
6.	Wounds	8 (8.79)	6	2	6	2	-	-	-	2	2	4
7.	Acute spinal injury	6 (6.59)	4	2	5	1	-	-	-	2	1	3
8.	Herniations	6 (6.59)	3	3	6	-	-	-	-	2	2	2
9.	Dystocia – caesarean	3 (3.29)	-	3	2	1	-	-	-	-	2	1
10.	Sprain	3 (3.29)	1	2	3	-	-	-	-	1	-	2
11.	Cellulitis	2 (2.19)	1	1	2	-	-	-	-	1	1	-
12.	Pyometra – OHE	2 (2.19)	-	2	-	1	1	-	-	-	1	1
13.	Abscess	1 (1.09)	-	1	1	-	-	-	-	-	1	-
14.	Aural haematoma	1 (1.09)	1	-	1	-	-	-	-	-	-	1
15.	Elbow luxation	1 (1.09)	1	-	-	1	-	-	-	-	1	-
16.	Elective castration	1 (1.09)	1	-	1	-	-	-	-	1	-	-
17.	Hip dysplasia	1 (1.09)	-	1	1	-	-	-	-	-	-	1
18.	Limb amputation	1 (1.09)	1	-	1	-	-	-	-	1	-	-
19.	Paraplegia	1 (1.09)	1	-	1	-	-	-	-	1	-	-
20.	Uterine prolapse	1 (1.09)	-	1	1	-	-	-	-	-	1	-

Values in parenthesis are percentages; DSH – Domestic short hair, ND – Non-descript

Houston and Moore (2009) who reported lower incidence (22%) in cats compared to dogs (78%). Further, Sharun *et al.* (2021) reported very low incidence of obstructive urolithiasis i.e., 1.03 per cent in cats. Prospectively, 38 per cent and retrospectively, 40 per cent of the cases were identified with urethral affections which were similar to the incidence findings of Neves *et al.* (2011) with 39% of obstructed urethra cases.

The nature of calculi was determined based on the appearance of crystals and their shapes, as outlined by Chew *et al.* (2010). The present study revealed struvite calculi in 80 per cent of the cases and calcium oxalate in 20 per cent which was in accordance to the studies of Buffington *et al.* (1996), Lekcharoensuk *et al.* (2000), Osborne *et al.* (2009) and Neri *et al.* (2016), who also reported the presence of both struvite and calcium oxalate calculi, while, Kruger *et al.* (1991) exclusively found struvite calculi in cats with urolithiasis. On the contrary, Houston *et al.* (2016) recorded 50.1% incidence of calcium oxalate, 40% struvite and 4.4% urate calculi in cats. Struvite calculi were formed in alkaline urine and various factors that result in alkaline urine were discussed *viz.,* diets containing 0.75 per cent or 1 per cent magnesium carbonate (Lewis *et al.,* 1978), a

Table 5: Prospective detailed incidence of urinary system affections in cats (n = 21):

S. No	Part of urinary system	Affection	No. of cats affected (%)	Sex		Age					Breed	
				M	F	0-2	2-4	4-6	6-8	>8	DSH	Persian
1.	Kidney	Hydronephrosis	4 (19.04)	4	-	3	1	-	-	-	1	3
		Renal cyst	2 (9.52)	2	-	1	-	1	-	-	-	2
		Pyelonephritis	1 (4.76)	1	-	1	-	-	-	-	-	1
2.	Ureter	-	0	0	0	0	0	0	0	0	0	0
3.	Urinary bladder	Cystitis	12 (57.14)	11	1	8	-	2	2	-	1	11
		Cystolithiasis	2 (9.52)	2	-	2	-	-	-	-	-	2
		Sludge	11 (52.38)	11	-	7	1	2	1	-	1	10
		Blood clots	5 (23.8)	5	-	5	-	-	-	-	1	4
4.	Urethra	Urethral plugs	6 (28.6)	6	-	3	2	-	1	-	-	6
		Urethritis	2 (9.52)	2	-	2	-	-	-	-	-	2

Table 6: Prospective breed, sex and age wise incidence of urinary system affections in cats (n = 21)

S.No.	Category		No. of cats	Percentage
1.	Breed	Persian	19	90.47
		Domestic Short Hair	02	9.52
2.	Sex	Male	20	95.23
		Female	01	4.8
3.	Age	0 – 2 years	12	57.14
		2 – 4 years	04	19.04
		4 – 6 years	03	14.28
		6 – 8 years	02	9.52
		Above 8 years	Nil	Nil

substantial meal that caused temporary alkalinisation of the urine (Finke and Litzenberger, 1992), consumption of multiple split meals (10-20 meals over a 24 hour period) containing high protein and low acid content simultaneously low potassium (DiBartola and Buffington, 1993).

Present study revealed preponderance of urinary system affections in Persian breed cats compared to domestic short hair and non-descript cats contradicting the observations of Ebrahim *et al.* (2019), who stated that mixed breed cats were most prone to urinary affections than pure bred cats. Renal cysts were observed only in Persian breed in the present study which was similar to the findings of Eaton *et al.* (1997), Beck and Lavelle (2001) and Nivy *et al.* (2015), possibly due to the predisposition of Persian breed cats to the inherited disorder of PKD (Ebrahim *et al.,* 2019). The cystoliths and urethral plugs composed of struvite were solely identified in Persian breed which was comparable to the findings of Hesse *et al.* (2012). It was observed that FLUTD predominantly occurred in Persian breed cats (Gunn–Moore, 2003 and Abdel-Saeed *et al.,* 2021) whereas Neri *et al.* (2016) diagnosed FLUTD in only two Persian breeds out of 26 cats (7.7%). The variations in breed-wise incidence could be attributed to prevalence of rearing particular breed in this geographical area. All the animals having urinary system affections were males except one, which was in accordance with the studies of Reche *et al.* (1998), which could be due to anatomically narrower urethra in males than females (Abdel - Saeed *et al.,* 2021) and frequent catheterization for relieving urethral obstruction (Malouin, 2010).

In the present study, both prospective (57.14%) and retrospective (54.5%) studies revealed that, cats less than two years were most commonly affected and overall, cats below four years were at higher risk of getting urinary system affections. This finding was closer to that of Neri *et al.* (2016) and Abdel - Saeed *et al.* (2021). Contradictory to these results, Nikousefat *et al.* (2018) asserted that the urinary tract infections were rare in young cats. The cats under this study also had restricted outdoor access and lived in multi animal household which predisposed cats to FLUTD as enlisted by Lund *et al.* (2015) like age, physical environment, diet type, feeding, cohabitation with other cats and limited access to water. These signs were attributed to inflammation of the urinary tract resultant of obstructive process and prolonged time of obstruction (Neri *et al.,* 2016) leading to increased intra-tubular hydrostatic pressure and decreasing the glomerular filtration rate (Joseph *et al.,* 1996).

Conclusion

Fractures and urinary system affections were recorded to be the most predominant affections presented in retrospective and prospective study respectively. Cystitis outnumbered the list of urinary tract affections in both the studies. Persian breed tom cats aged less than two years were mostly at risk. It was noticed that all the cats were maintained on commercial diets, hence, it may be concluded that the dry or canned diet may be the predisposing cause for developing this condition as they contain magnesium.

Conflict of interest

The authors declare no conflict of interest.

References

Abdel - Saeed H, Reem RT and Farag HS (2021) Diagnostic and epidemiological studies on obstructive feline lower urinary tract disease (FLUTD) with special reference to anatomical findings in Egyptian tom cats. *Bulg. J. Vet. Med.* **24** (3): 383-394.

Aumann M, Worth LT and Drobatz KJ (1998) Uroperitoneum in cats: 26 cases (1986-1995). *J. Am. Anim. Hosp. Assoc*. **34** (4):315-324.

Balbinot PDZ, Viana JA, Bevilaqua PD and Silva PSA (2015) Feline lower urinary tract disease:prevalence characterization and case control study in cats between 1994 and 2004. *Ceres*. **53** (310):645-653.

Beck C and Lavelle RB (2001) Feline polycystic kidney disease in Persian and other cats:a prospective study using ultrasonography. *Aust. Vet. J*. **79** (3):181-184.

Bennour EM, Abushhiwa MA, Ben Ali L, Sawesi OK, Marzok MA, Abuargob OM and El – Khodery S (2014) A retrospective study on appendicular fractures in dogs and cats in Tripoli – Libya. *J. Vet. Adv.* **4** (3):425-431.

Buffington CT, Dennis JC and DiBartola SP (1996) Interstitial cystitis in cats. *Vet. Clin. North Am. Small Anim. Pract.* **26** (2):317-326.

Buffington CT (2011) Idiopathic cystitis in domestic cats - beyond the lower urinary tract. *J. Vet. Intern. Med*. **25** (4):784-796.

Chew DJ, DiBartola SP and Schenck P (Eds.) (2010) Urinalysis. In: Canine and feline nephrology and urology, 2nd ed., Elsevier Saunders, St. Louis, Missouri, USA. pp. 1-31.

DiBartola SP and Buffington CA (1993) Feline urologic syndrome. In: *Textbook of Small Animal Surgery*. Slatter D H (ed.). 2nd ed., Saunders, Philadelphia, Pennsylvania, pp. 1473-1487.

Eaton KA, Biller DS, DiBartola SP, Radin MJ and Wellman ML (1997) Autosomal dominant polycystic kidney disease in Persian and Persian-cross cats. *Vet. Pathol.* **34** (2):117-126.

Ebrahim ZK, Gameaa SM, Metwally AM and Elsayed MS (2019) Ultrasonographic examination as a diagnostic aid in some urinary affections in cats. *Alexandria J. Vet. Sci*. **63** (1):10 - 17.

Farghali HA, Senna NA, Khattab MS and Shalaby RK I (2020) Prevalence of most common feline genital surgical affections in teaching veterinary hospital, Cairo university, Egypt and different pet clinics. *Adv. Anim. Vet. Sci*. **8** (7):709-719.

Finke MD and Litzenberger BA (1992) Effect of food intake on urine pH in cats. *J. Small Anim. Pract*. **33** (6):261-265.

Griffin MA, Culp WT, Giuffrida MA, Ellis P, Tuohy J, Perry JA and Kent MS (2020) Lower urinary tract transitional cell carcinoma in cats:clinical findings, treatments, and outcomes in 118 cases. *J. Vet. Intern. Med*. **34**(1):274-282.

Griffin S (2020) Feline abdominal ultrasonography:what's normal? what's abnormal? The kidneys and perinephric space. *J. Feline Med. Surg.* **22** (5):409-427.

Gunn – Moore DA (2003) Feline lower urinary tract disease. *J. Feline Med. Surg*. **5** (2):133-138.

Hesse A, Orzekowsky H, Frenk M and Neiger R (2012) Epidemiological data of urinary stones in cats between 1981 and 2008. Tierarztliche Praxis. Ausgabe K, Kleintiere/ Heimtiere. *Vet. Med. J.* Edition K, Small/Companion Animals), **40**(2):95-101.

Houston DM and Moore AE (2009) Canine and feline urolithiasis:examination of over 50,000 urolith submissions to the Canadian veterinary urolith centre from 1998 to 2008. *Can. Vet. J*. **50** (12):1263-1268.

Houston DM, Vanstone NP, Moore AE, Weese HE and Weese JS (2016) Evaluation of 21,426 feline bladder urolith submissions to the Canadian Veterinary Urolith Centre (1998–2014). *Can. Vet. J*. **57** (2):196-201.

Jackson OF (1971) The treatment and subsequent prevention of struvite urolithiasis in cats. *J. Small Anim. Pract*. **12** (10):555-568.

Joseph WB, Delmar RF, David JP, Cari AO, Jeanne AB and Scott AB (1996) Pathophysiology of urethral obstruction. *Vet. Clin. North Am.:Small Anim. Pract*. **26** (2):255-264.

Kruger JM, Osborne CA, Goyal SM, Wickstrom SL, Johnston GR, Fletcher TF and Brown PA (1991) Clinical evaluation of cats with lower urinary tract disease. *J. Am. Vet. Med. Assoc*. **199** (2):211-216.

Lekcharoensuk C, Lulich JP, Osborne CA, Koehler LA, Ulrich LK, Carpenter KA and Swanson LL (2000) Association between patient-related factors and risk of calcium oxalate and magnesium ammonium phosphate urolithiasis in cats. *J. Am. Vet. Med. Assoc*. **217** (4):520-525.

Lewis LD, Chow FH, Taton GF and Hamar DW (1978) Effect of various dietary mineral concentrations on the occurrence of feline urolithiasis. *J. Am. Vet. Med. Assoc*. **172** (5):559-563.

Lulich JP, Berent AC, Adams LG, Westropp JL, Bartges JW and Osborne CA (2016) American College of Veterinary Internal Medicine (ACVIM) small animal consensus recommendations on the treatment and prevention of uroliths in dogs and cats. *J. Vet. Intern. Med*. **30** (5):1564-1574.

Lund HS, Skogtun G, Sorum H and Eggertsdottir AV (2015) Antimicrobial susceptibility in bacterial isolates from Norwegian cats with lower urinary tract disease. *J. Feline Med. Surg*. **17** (6):507-515.

Malouin A (2010) Urologic Emergencies:Ureter, Bladder, Urethra, GN, and CRF. In: *Feline emergency and critical care medicine*. Drobatz K J and Costello M F (eds.). 1st ed., Wiley – Blackwell, USA, pp. 281-302.

Neri AM, de Araujo Machado LH, Okamoto PTCG, Filippi MG, Takahira RK, Melchert A and Lourenco MLG (2016) Routine screening examinations in attendance of cats with obstructive lower urinary tract disease. *Top. Companion Anim. Med.* **31** (4):140-145.

Neves L, Wanderley MC and Pazzini J (2011) Urinary tract disease in cats (*Felis catus domesticus*, Linnaeus, 1758) consulted in veterinary clinics in the region of Ribeirao Preto – SP, *Nucleus Animalium*, **3** (1):115-136.

Nikousefat Z, Hashemnia M, Javdani M and Ghashghaii A (2018) Obstructive bacterial cystitis following cystotomy in a Persian cat. *Vet. Res. Forum*. **9** (2):199-203.

Nivy R, Lyons LA, Aroch I and Segev G (2015) Polycystic kidney disease in four British shorthair cats with successful treatment of bacterial cyst infection. *J. Small Anim. Pract*. **56** (9):585-589.

Osborne C A, Lulich J P, Kruger J M, Ulrich L K and Koehler L A

(2009) Analysis of 4,51,891 canine uroliths, feline uroliths and feline urethral plugs from 1981 to 2007:perspectives from the Minnesota Urolith Center. *Vet. Clin. North Am. Small Anim. Pract*. **39** (1):183-197.

Reche Jr A, Hagiwara MK and Mamizuka E (1998) Clinical study of lower urinary tract disease of domestic cats of Sao Paulo. *Braz. J. Vet. Res. Anim. Sci*. **35** (2):69-74.

Rochlitz I (2009) Basic requirements for good behavioral health and welfare in cats. In: *BSAVA manual of canine and feline behavioral medicine*, BSAVA Library, Gloucester, England, pp. 35-48.

Rodrigues NM, Borges TB, Leitzke AVS, Dantas SSB, Merlini NB, Belettini ST and Quessada AM (2022) Surgical procedures in cats in a teaching veterinary hospital. *Res. Soc. Dev*. **11** (6):e2011628685.

Sharun K, Manjusha KM, Kumar R, Pawde AM, Malik YP, Kinjavdekar P, Maiti SK and Amarpal (2021) Prevalence of obstructive urolithiasis in domestic animals:an interplay between seasonal predisposition and dietary imbalance. *Iraqi J. Vet. Sci*. **35** (2):227-232.

Udainiya S, Tiwari A, Singh B, Roy K, Gupta DK and Raikwar A (2018) Feline hydronephrosis:a case report. *J. Entomol. Zool. Stud*. **6** (6):404-406.

Williams J (2009) Surgical management of blocked cats:which approach and when? *J. Feline Med. Surg*. **11** (1):14-22.