Studies on Feline lower Urinary Tract Disease in Egypt Cat Population
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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 aureus (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.

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

INTRODUCTION

Feline lower urinary tract disease (FLUTD) is a term that includes urethral and/or bladder disorders (Sævik 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°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).

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

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 peruria (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

<table>
<thead>
<tr>
<th>Clinical signs</th>
<th>All cats</th>
<th>FIC</th>
<th>UTI</th>
<th>Urethral plugs</th>
<th>Urolithiasis</th>
<th>Neoplasm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>56 (100%)</td>
<td>19</td>
<td>8</td>
<td>6</td>
<td>21 (37.5%)</td>
<td>2 (3.6%)</td>
</tr>
<tr>
<td>Hematuria</td>
<td>26 (46.4%)</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>13 (61.9%)</td>
<td>2 (100%)</td>
</tr>
<tr>
<td>Stranguria</td>
<td>19 (33.9%)</td>
<td>6</td>
<td>5</td>
<td>0</td>
<td>8 (38.0%)</td>
<td>2 (100%)</td>
</tr>
<tr>
<td>Pollikuria</td>
<td>12 (21.4%)</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4 (19.0%)</td>
<td>0.0</td>
</tr>
<tr>
<td>Periuria</td>
<td>3 (5.3%)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1 (4.7%)</td>
<td>0.0</td>
</tr>
<tr>
<td>Urethral obstruction</td>
<td>24 (42.8%)</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>14 (66.6%)</td>
<td>2 (100%)</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>FIC (19) 33.9%</th>
<th>U plugs (6) 10.7%</th>
<th>UTI (8) 14.2%</th>
<th>Urolithiasis (21) 37.5%</th>
<th>Neoplasm (2) 3.5%</th>
<th>Total 56</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine color</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>5 (26.3%)</td>
<td>0</td>
<td>1 (12.5%)</td>
<td>0</td>
<td>6 (10.7%)</td>
<td>24</td>
<td>0.05</td>
</tr>
<tr>
<td>Dark Yellow</td>
<td>9 (47.3%)</td>
<td>2 (33.3%)</td>
<td>5 (62.5%)</td>
<td>8 (38.0%)</td>
<td></td>
<td>24</td>
<td>0.05</td>
</tr>
<tr>
<td>Bloody</td>
<td>5 (26.3%)</td>
<td>4 (66.6%)</td>
<td>2 (25%)</td>
<td>13 (61.9%)</td>
<td>2 (100%)</td>
<td>26</td>
<td>0.05</td>
</tr>
<tr>
<td>Urine pH</td>
<td>7.9±1.59</td>
<td>6.1±2.02</td>
<td>6.6±2.22</td>
<td>7.22±1.89</td>
<td>5.45±0.64</td>
<td>0.137</td>
<td></td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.01±0.007</td>
<td>1.017±0.004</td>
<td>1.02±0.015</td>
<td>1.017±0.004</td>
<td>1.02±0.004</td>
<td>0.382</td>
<td></td>
</tr>
<tr>
<td>Leucocytes/HPF</td>
<td>11.38±7.35</td>
<td>13.67±11.89</td>
<td>25.42±15.3</td>
<td>20.53±10.02</td>
<td>14.5±3.54</td>
<td>0.054</td>
<td></td>
</tr>
<tr>
<td>RBCs/HPF</td>
<td>59.42±41.2</td>
<td>48.17±45.88</td>
<td>53.5±49.75</td>
<td>78.44±35.7</td>
<td>56.0±41.01</td>
<td>0.424</td>
<td></td>
</tr>
<tr>
<td>WBCs 10³ cells/ul</td>
<td>50.94±8.5*</td>
<td>31.24±6.5*</td>
<td>56.0±6.4*</td>
<td>27.3±12.5</td>
<td>20.4±8.7</td>
<td>0.051</td>
<td></td>
</tr>
<tr>
<td>Crystals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triple Phosphate</td>
<td>5 (26.3%)</td>
<td>6 (100%)</td>
<td>2 (25%)</td>
<td>13 (61.9%)</td>
<td>1 (50%)</td>
<td>29</td>
<td>0.01</td>
</tr>
<tr>
<td>Ammonium urates</td>
<td>1 (5.2%)</td>
<td>0</td>
<td>0</td>
<td>5 (23.8%)</td>
<td>1 (50%)</td>
<td>7</td>
<td>0.125</td>
</tr>
<tr>
<td>Ca Oxalate</td>
<td>6 (31.5%)</td>
<td>0</td>
<td>0</td>
<td>3 (14.2%)</td>
<td>0.0</td>
<td>9</td>
<td>0.16</td>
</tr>
<tr>
<td>Amorphous Phosphate</td>
<td>13 (68.4%)</td>
<td>4 (66.6%)</td>
<td>5 (62.5%)</td>
<td>15 (71.4%)</td>
<td>1 (50%)</td>
<td>37</td>
<td>0.01</td>
</tr>
<tr>
<td>Amorphous Urate</td>
<td>5 (26.3%)</td>
<td>1 (16.6%)</td>
<td>1 (12.5%)</td>
<td>5 (23.8%)</td>
<td>1 (50.0%)</td>
<td>13</td>
<td>0.23</td>
</tr>
</tbody>
</table>

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 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 aureus* 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

<table>
<thead>
<tr>
<th>Parameters</th>
<th>FIC</th>
<th>U plugs</th>
<th>UTI</th>
<th>Urolithiasis</th>
<th>Neoplasia</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean± SD</td>
<td>Mean± SD</td>
<td>Mean± SD</td>
<td>Mean± SD</td>
<td>Mean± SD</td>
<td></td>
</tr>
<tr>
<td>BUN (mg/dl)</td>
<td>26.0±21.52</td>
<td>56.38±22.39</td>
<td>24.91±15.83*</td>
<td>60.41±56.98*</td>
<td>26.95±28.35</td>
<td>0.01</td>
</tr>
<tr>
<td>Creatinine mg/dl</td>
<td>1.61±0.77</td>
<td>2.95±1.02</td>
<td>1.57±0.78</td>
<td>4.69±4.62</td>
<td>4.65±3.04</td>
<td>0.01</td>
</tr>
</tbody>
</table>

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 indoor 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, pollakiuria and peruria in the current study were consistent with the previous studies (Saevik et al., 2011, Okafor et al., 2019). The incidence rate of urolithiasis 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 (Lister 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, Kopency 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
The results obtained from the study of Gunn (2004) indicated 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.

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; Lewis-Kojrjs 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 other studies was 14.2% in the present study. 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 Staphylococcus species (37.5%) in the present study. Similar findings have been reported (Passmore et al., 2008; Teichmann-Knorn et al., 2018; Ataya et al., 2023). Urose produced by Staphylococcus aureus produces an enzyme that 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 aureus (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.

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Conflict of interests

The author declares no conflict of interests.

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