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Original Research Article
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MONITORING THE INFLAMMATORY PROCESS OF FELINE LOWER URINARY TRACT DISEASE

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Abstract: This study aimed to compare the hemato-biochemical parameters in cats suffered from FLUTD with those of healthy cats, and to evaluate the inflammatory process by measuring serum amyloid A, alpha-1-Acid glycoprotein, and plasma fibrinogen concentrations. Cats frequently suffer from feline lower urinary tract disease (FLUTD), which causes acute renal failure, electrolyte buildup, and acid-base imbalance. Acute-phase proteins can be used to monitor the inflammatory processes of feline lower urinary tract disease.

The present study included thirty cats of both sexes, nine cats defined as clinically healthy cats and 21 cats with signs of idiopathic cystitis and/ or urethral obstruction for up to 24 hours were defined as cat with FLUTD group. Blood samples were collected from cephalic vein for hematological, biochemical assays and the measurement of acute-phase protein concentrations, including SAA, AGP, and fibrinogen. Serum SAA and AGP were measured using commercial ELISA kits.

In cats with FLUTD, the total white blood cell count, neutrophils, and platelets count increased significantly, as did the mean values of hematological and biochemical indices. However, there was a significant decrease in the mean value of red blood cells, hemoglobin, and PCV. Blood urea nitrogen, creatinine, total proteins, albumin, potassium, and phosphorus levels all increased significantly, while sodium and chloride levels decreased significantly. When compared to clinically healthy cats, plasma fibrinogen, serum alpha-1- acid glycoprotein, and serum amyloid A levels were significantly higher in cats with FLUTD. There was a significant positive correlation between the concentrations of acute phase proteins biomarkers (SAA, AGP, and fibrinogen) and blood urea nitrogen and creatinine. It is concluded that, in cats with FLUTD, serum amyloid A, AGP, and fibrinogen could be employed as an indicator of inflammatory processes.

Key words: FLUTD; serum smyloid A; AGP; fibrinogen; feline

Introduction

Feline lower urinary tract disease (FLUTD) is a common disease of feline that causes urinary bladder and urethral dysfunction (1-3). FLUTD is a multifactorial condition that includes feline idiopathic cystitis, urolithiasis, urinary tract infection (2). It is characterized by several changes in the structure and function of the urinary bladder and urethra that obstruct urine flow (4). It could be related to sterile inflammation, which causes acid-base imbalance, electrolyte accumulation, and acute renal impairment (3, 5).

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Feline lower urinary tract disease primarily affects inactive, obese male cats that eat dry cat diet and drink little water (6). Owner of cats with FLUTD commonly observe signs of bloody urine (hematuria), straining during urination (stranguria), difficult in urination (dysuria), urinary house soiling (periuria) which are common clinical manifestations of the disease. As well, animal exhibits clinical symptoms of azotemia, such as anorexia, emesis, weakness, dehydration, depression, stupor, hypothermia, acidosis with hyperventilation, bradycardia, and finally death, if the obstruction is not removed within 36–48 hours. (1, 7, 8).

Lower urinary tract disease is diagnosed based on the physical examinations, blood and

urine tests, radiography, and abdominal ultrasonography of the urinary bladder and urethra. If no specific cause is found, the disease is classified as idiopathic cystitis (1, 9-11).

In veterinary medicine, acute phase proteins (APP), which are biomarkers of tissue damage caused by inflammation, assist with therapy monitoring and prognosis (3) and can be used to identify a wide range of illnesses, including infectious, immune-mediated, and inflammatory diseases (12).

In response to inflammation, the APP concentrations can either increase (positive APP) or decrease (negative APP) (13). Positive APP can be divided into two categories: the first category includes APP that increases 10–1000 times in humans or 10–100 times in domestic animals when there is inflammation, such as C-reactive protein (CRP) and serum amyloid A (SAA), and the second category includes APP that increases 2–10 times when there is an inflammatory response, such as haptoglobin and alpha-globulins. Fibrinogen, on the other hand, is a minor acute-phase protein. In healthy animals, plasma fibrinogen is constant, but when an inflammatory condition is acute, hepatocytes release large amounts of fibrinogen. While, negative APP concentration decreases in response to inflammation, such as albumin (14). In cats, the primary APPs are SAA, alpha-1-acid glycoprotein (AGP), and fibrinogen. SAA, alpha-1-acid glycoprotein and fibrinogen concentrations have been linked to inflammatory diseases (15, 16).

Therefore, the goal of this study was to compare the hemato-biochemical parameters in cats suffered from FLUTD with those of healthy cats. Additionally, to evaluate the inflammatory process in cat with FLUTD by measuring the serum amyloid A, alpha-1-Acid glycoprotein, and plasma fibrinogen concentrations in healthy and FLUTD cats.

Material and methods

Animals and selection criteria

The present study was performed on cats admitted to a private pet's clinic and shelters in Sharkia Governorate, Egypt. The data collected from cats that were used in the current study have been permitted by the owner through signing a consent form. Because this study did not include any experimental work, approval from the Zagazig University Institutional Animal Care and Use Committee (ZU-IACUC) was not required.

A total of 30 cats were selected to participate in this research. Of which, nine cats were selected as a control group based on absence of urinary tract diseases, normal physical examination, CBC, and serum biochemistry results. Inclusion criteria for cats with FLUTD comprised clinical findings of hematuria, stranguria, periuria and dysuria, idiopathic cystitis and/ or urethral obstruction for up to 24 hours. Diseased cats must not receive any prior medical treatments. All cats were subjected to physical and ultrasound examinations upon admission. Age, breed, sex, urination abnormalities are the signalment that were collected from cats included in the present study.

Samples collection and analysis

Blood samples were collected from cephalic vein for hematological, biochemical assays and the measurement of acute-phase protein concentrations, including SAA, AGP, and fibrinogen. The first blood sample (5 ml) was collected on an ethylenediaminetetraacetic acid (EDTA) tube for determination of hematological parameters. After that plasma harvested and used for fibrinogen assessments. A second blood sample (5 ml) was collected without anticoagulant, clotted at room temperature for 20 min, centrifuged at 3000 rpm for 10 min using Megafuge 3.0R (*Thermo Fisher Scientific GmbH, 63303 Dreieich, Germany*), and then the clear serum samples were harvested for determining the biochemical parameters, AGP and SAA concentrations.

Hematological parameters were measured by hematological analyzer (Sysmex XN1000 analyzer, *USA*) as previously described by standard methods (17).

The biochemical measurements were applied using Beckman AU5800 analyzer (*Beckman Coulter, California, USA*). The method was performed according to the manufacturer's instructions using standard methods (17). Results were compared with normal reference values according to Latimer (18).

Plasma fibrinogen was determined using an automated coagulation analyzer (*STA Compact; Roche Diagnostics*) (19). While serum SAA and AGP

were measured using commercial kits Cat Serum Amyloid A ELISA (*Life Diagnostics®, USA*), with 1:400, 1:800, and 1:2500 dilutions to determine serum concentration of SAA; and Cat Alpha-1-Acid Glycoprotein ELISA (*Life Diagnostics, West Chester, PA, USA*), with 1:40 000 dilution to determine serum AGP concentrations and the measurements were applied according to the manufacturer's instructions. Results were compared with normal reference values according to Ceron, Eckersall (15).

Ultrasonography examination

Ultrasonographic examination of the kidneys and urinary bladder was performed in sagittal and transverse planes using a 3.5 MHz convex transducer (DUS60VET, Edan®, EDANUSA Co., China).

Statistical analysis

All data were statistically analyzed using SPSS Statistics® 22.0 (*Version 22.0, Armonk, NY: IBM Corp*). Descriptive statistics (mean and standard error) were calculated. The data were tested for normal distribution using *Shapiro Wilks W Test* and were found normally distributed. The obtained results were analyzed using one-way ANOVA test, all data are listed as mean ± SE. Differences between parameters were tested for significance at probability level of $p<0.05$. Pearson correlation was used for estimating the relationship between the concentration of total protein, albumin, urea and creatinine and SAA, AGP and plasma fibrinogen concentrations in healthy and FLUTD cats.

Results

Signalment

The current study comprised a total of 30 cats, from which 21 cats of different ages (7 to 12 years old) and breeds (14 Baladi, 5 Shirazi and 2 cross breed) met the inclusion criteria and diagnosed as FLUTD. While, the remaining 9 were healthy cats with an age range from 7 to 12 years old and breeds (3 Baladi, 3 Shirazi and 3 cross breed) met the inclusion criteria where it showed no signs of urinary tract disorders and the physical examination was normal. FLUTD was most commonly detected in male cats (85.5 %), while, female cats (14.5 %) (Table 1).

Clinical findings

The most common clinical indicators in cats with FLUTD, based on clinical assessment, are anorexia (85.7 %), lethargy (61.9 %), vomiting (28.5 %), dehydration (66.6 %), dysuria and strangulation (100 %) (Table 1), dehydration status was based on sunken eyes and skin fold test.

Cats with FLUTD had a significant increase in the mean body temperature of 39.6 ± 0.32 °C, respiratory rate of 46 ± 4 breaths per minute and heart rate of 200 ± 20 per minute ($p<0.05$) compared to clinically healthy cats (38.7 ± 0.6 °C, 29 ± 3 breaths per minute, 130 ± 10 per minute), respectively (Table 2).

Hematological and biochemical findings

The mean values of hematological and biochemical indices in Cats with FLUTD are summarized in Table (3 and 4). Complete blood count in cats with FLUTD showed a significant increase in the total white blood cell count (12.6 ± 0.15), neutrophils (69.59 ± 0.12) and platelets count (243.2 ± 16.08). While, a significant decrease in the mean value of red blood cells (5.37 ± 0.08), hemoglobin (8.3 ± 0.48) and PCV (28.6 ± 0.85) compared to clinically healthy cats (Table 3).

A highly significant increase ($p<0.01$) in the serum activities of AST (60.8 ± 8.44), ALT (49.8 ± 4.6), blood glucose (122.2 ± 10.5), blood urea nitrogen (38.33 ± 0.26) and blood creatinine (13.07 ± 2.41) in cats with FLUTD compared to clinically healthy cats. In addition, there was a significant increase ($p<0.05$) in the mean values of serum total proteins (9.23 ± 0.26), albumin (4.51 ± 0.33) and creatine kinase (387 ± 11.5) in cats with FLUTD compared to clinically healthy cats (Table 4).

Blood electrolytes showed significant decrease ($p<0.05$) in sodium (135.02 ± 0.07), chloride (101 ± 6.3) while there was a significant increase in the mean values of potassium (5.73 ± 0.37) and phosphorus (15.42 ± 0.79) in cats with FLUTD compared to clinically healthy cats (Table 4).

The measurements of serum alpha-1- acid glycoprotein and serum amyloid A levels as

well as plasma fibrinogen concentration were significantly increased (1.42 ± 0.17, 34.14 ± 16.12 and 283.42±12.1, respectively) in cats with FLUTD compared to clinically healthy cats (Table 5).

The relationship between the acute phase proteins concentrations (AGP, SAA and Fibrinogen) and total protein, albumin, BUN and creatinine in cats with FLUTD were recorded in Table (6). The results showed significant positive correlation between AGP, SAA and fibrinogen concentration (r = 0.726, r = 0.618, respectively) as well the correlation between SAA and AGP showed moderate positive correlation (r = 0.580) (Figure 1).

Total protein, albumin, blood urea nitrogen and creatinine showed a strong positive correlation with AGP (r = 0.843, r = 0.690, r = 0.881, r = 0.778, respectively) (Figure 2). As well a strong positive correlation with plasma fibrinogen (r = 0.857, r = 0.793, r = 0.938, r = 0.905, respectively) (Figure 3).

Total protein, albumin, creatinine showed a moderate positive correlation with SAA (r =0.490, r = 0.267, r = 0.368, respectively) whereas a strong positive correlation between blood urea nitrogen and SAA (r = 0.653) (Figure 4).

Ultrasonographic findings:

The ultrasonographic examination revealed a distended urinary bladder with the presence of anechoic fluid inside it, the wall was severely distended and an acoustic shadowing is observed next to the bladder (Figure 5). Kidneys in some cases revealed a polycystic kidney appeared severely distended with anechoic fluid (Figure 6).

Table 1: Signalment and clinical findings of healthy and FLUTD cats included in the present study, the results are ex-pressed as absolute number and their percentages [n (%)]

	Healthy cats (n = 9)	**Cats with FLUTD (n = 21)**
Age (years)		
<7	---	---
7-9	5 (55.6 %)	13 (61.9 %)
10-12	4 (44.4 %)	8 (38.1 %)
Sex (n)		
Intact male	3 (33 %)	15 (71.5 %)
Castrated male	3 (33 %)	3 (14 %)
Intact female	2 (22 %)	2 (9.5 %)
Spayed female	1 (11 %)	1 (5 %)
Breed (n)		
Baladi Cats	3 (33 %)	14 (66.5 %)
Shirazi Cats	3 (33 %)	5 (24 %)
Cross breed	3 (33 %)	2 (9.5 %)
Clinical Signs		
Anorexia	None	18 (85.7 %)
Lethargy	None	13 (61.9 %)
Vomiting	None	6 (28.5 %)
Dehydration	None	14 (66.6 %)
Dysuria, Stranguria	None	21 (100 %)
Urethral obstruction	None	17 (80.9 %)
Distended bladder	None	17 (80.9 %)

Table 2: Clinical observations in healthy and FLUTD cats included in the present study, the results are expressed as Mean±S.E.

Parameters	Healthy cats(n = 9)	Cats with FLUTD(n = 21)
Rectal temperature (°C)	38.7±0.6[b]	39.6±0.3[a]
Respiratory rate (breaths/min)	29±3[b]	46±4[a]
Heart rate (beats/min)	130±10[b]	200±20[a]

a, b: means within the same column with different superscripts differ significantly (P<0.05).

Table 3: Hematological findings in healthy and FLUTD cats included in the present study. The results are expressed as Mean±S.E.

	Healthy cats (n=9)	Cats with FLUTD (n=21)
Hb (g/dl)	12.1±0.14[a]	8.3±0.48[b]
PCV (%)	38.43±0.26[a]	28.6±0.85[b]
RBCs (10^6 /µl)	8.54±0.27[a]	5.37±0.08[b]
WBCs ($10^3/mm^3$)	6.61±0.32[b]	12.6±0.15[a]
Neutrophil (%)	56.98±1.27[b]	69.59±0.12[a]
Lymphocyte (%)	38.27±0.07[a]	35.02±0.24[a]
Eosinophil (%)	6.39±0.03[a]	8.42±0.12[a]
Monocyte (%)	1.71±0.02[a]	1.52±0.01[a]
Platelets ($10^3/mm^3$)	158.33±3.5[b]	243.2±16.08[a]

a, b: means within the same column with different superscripts differ significantly (P<0.05).

Table 4: Biochemical findings in healthy and FLUTD cats included in the present study. The results are expressed as Mean ± S.E.

	Healthy cats (n=9)	Cats with FLUTD (n=21)
Total protein (g/dl)	6.51±0.09[b]	9.23±0.26[a]
Albumin (g/dl)	3.3±0.14[b]	4.51±0.33[a]
Globulin (g/dl)	3.21±0.18[a]	4.72±0.39[a]
BUN (mmol/l)	8.63±0.03[b]	38.33±0.26[a]
Creatinine (mg/dl)	1.48±0.08[b]	13.07±2.41[a]
CK (U/l)	93.44±4.35[b]	387±11.5[a]
ALT (U/l)	29.11±0.53[b]	49.8±4.6[a]
AST (U/l)	22.1±1.4[b]	60.8±8.44[a]
Na (mmol/L)	152.7±0.46[a]	135.02±0.07[b]
K (mmol/L)	4.35±0.01[b]	5.73±0.37[a]
Cl (mmol/L)	121.1±0.97[a]	101±6.3[b]
Glucose (mg/dl)	74.7±2.5 [b]	122.2±10.5[a]
Phosphorous (mg/dl)	4.3±0.29 [b]	15.42±0.79[a]

a, b: means within the same column with different superscripts differ significantly (P<0.05).

Table 5: Serum SAA, AGP and Fibrinogen concentrations in healthy and FLUTD cats included in the present study. The results are expressed as Mean ± S.E.

	Healthy cats(n = 9)	Cats with FLUTD(n = 21)
AGP (mg/ml)	0.61 ± 0.02[b]	1.42 ± 0.17[a]
SAA (µg/ml)	0.42 ± 0.05[b]	34.14 ± 16.12[a]
Fibrinogen (g/l)	199.8 ± 0.56[b]	283.42 ± 12.1[a]

a, b: means within the same column with different superscripts differ significantly (P<0.05).

Table 6: Correlation results between blood variables; total protein, albumin, urea and creatinine and SAA, AGP and plasma fibrinogen concentrations in healthy and FLUTD cats included in the present study (Pearson correlation analysis)

Parameters	AGP	SAA	Fibrinogen	TP	Albumin	BUN	Creatinine
AGP		0.580*	0.726**	0.843**	0.690**	0.881**	0.778**
SAA			0.618*	0.490	0.267	0.653*	0.368
Fibrinogen			1	0.857**	0.793**	0.938**	0.905**
TP				1	0.728**	0.959**	0.832**
Albumin					1	0.753**	0.804**
BUN						1	0.881**
Creatinine							1

SAA, serum amyloid A; AGP, alpha-1-acid glycoprotein; TP, total protein; BUN, blood urea nitrogen; * P < 0.05 and **P < 0.01

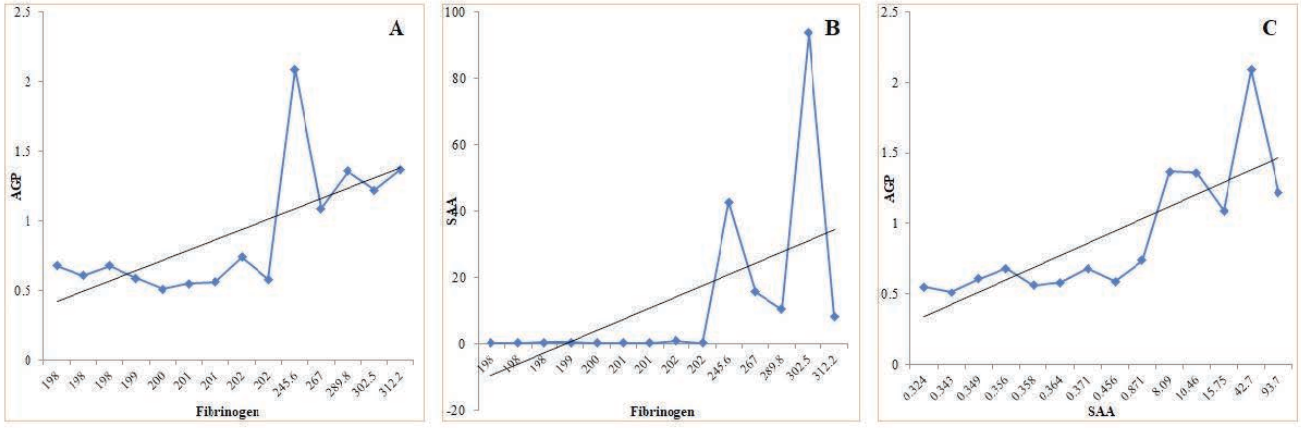

Figure 1: Correlation analysis graph between acute phase proteins (AGP – SAA and fibrinogen). (A) positive correlation between AGP and fibrinogen (r = 0.726). (B) positive correlation between SAA and fibrinogen (r = 0.618). (C) positive correlation between SAA and AGP (r = 0.580).

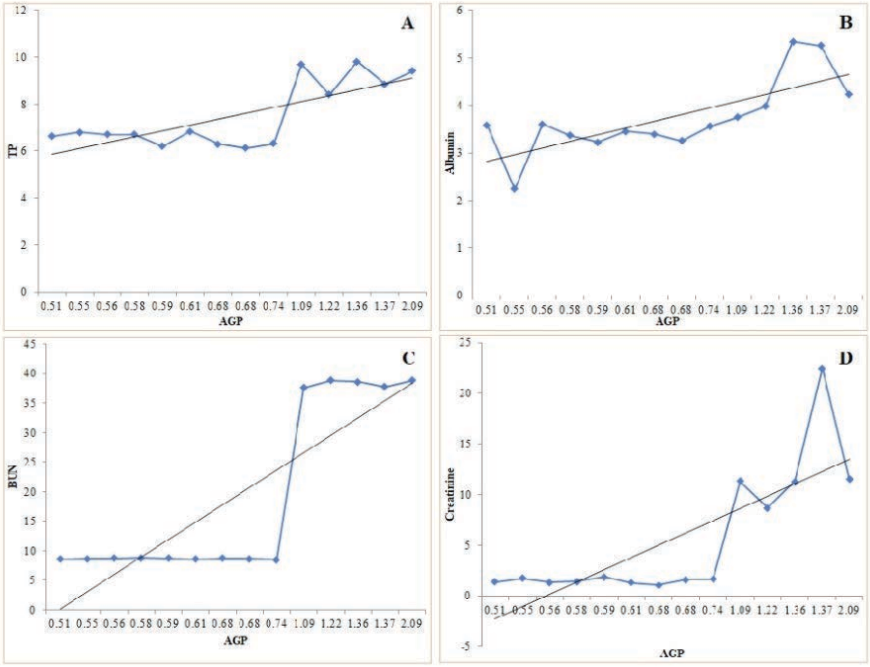

Figure 2: Correlation analysis graph between total protein, albumin, blood urea nitrogen, creatinine and AGP. (A) strong positive correlation between AGP and total protein (r = 0.843). (B) strong positive correlation between AGP and albumin (r = 0.690). (C) strong positive correlation between AGP and blood urea nitrogen (r = 0.881). (D) strong positive correlation between AGP and creatinine (r = 0.778)

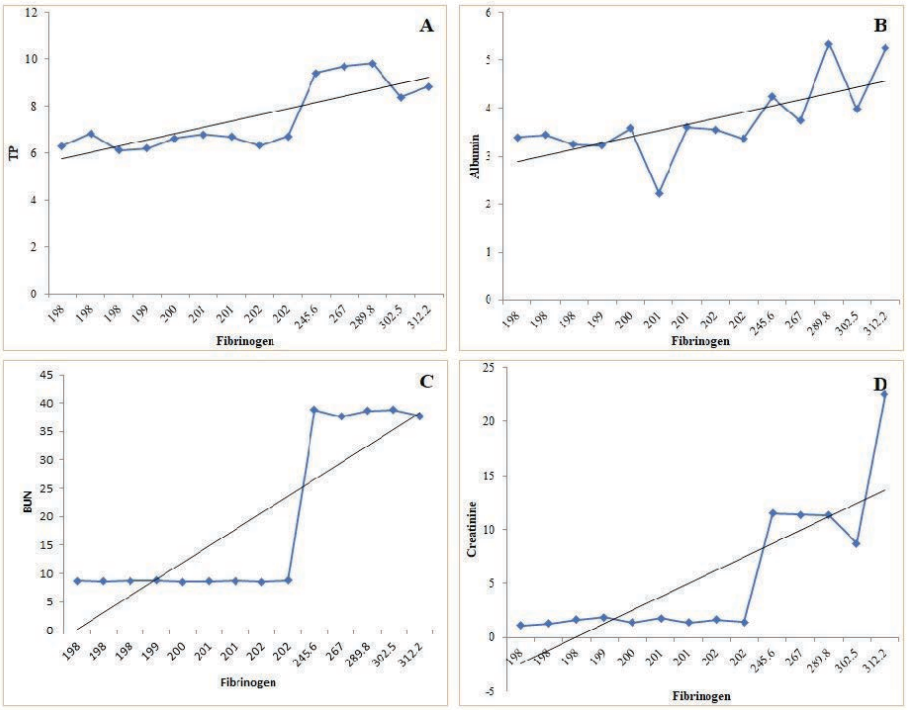

Figure 3: Correlation analysis graph between total protein, albumin, blood urea nitrogen, creatinine and fibrinogen. (A) strong positive correlation between fibrinogen and total protein (r = 0.857). (B) strong positive correlation between fibrinogen and albumin (r = 0.793). (C) strong positive correlation between fibrinogen and blood urea nitrogen (r = 0.938). (D) strong positive correlation between fibrinogen and creatinine (r = 0.905)

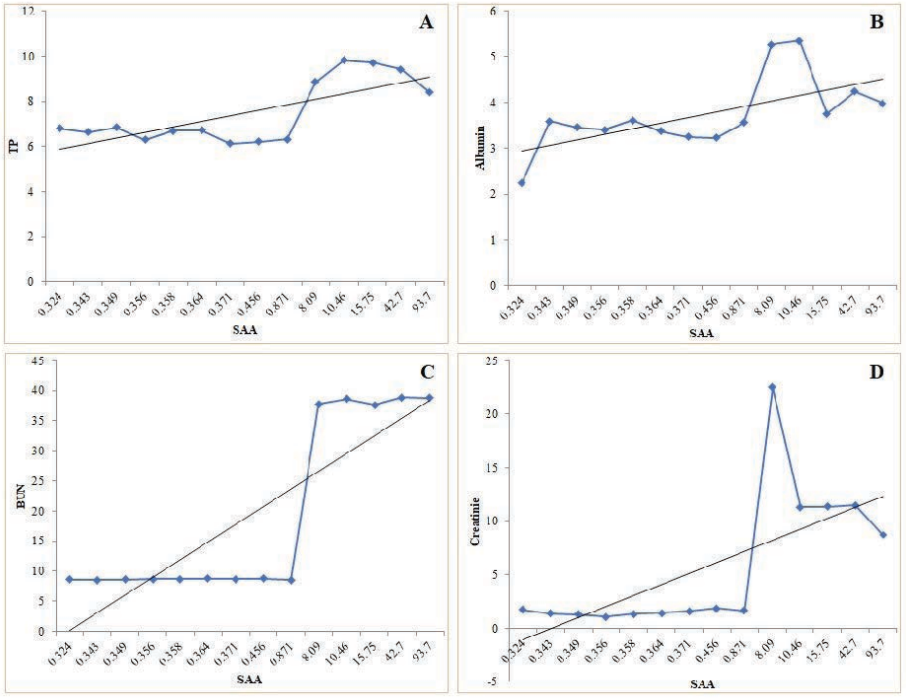

Figure 4: Correlation analysis graph between total protein, albumin, blood urea nitrogen, creatinine and SAA. (A) moder-ate positive correlation between SAA and total protein (r = 0.490). (B) moderate positive correlation between SAA and albumin (r = 0.267). (C) strong positive correlation between SAA and blood urea nitrogen (r = 0.653). (D) moderate positive correlation between SAA and creatinine (r = 0.368)

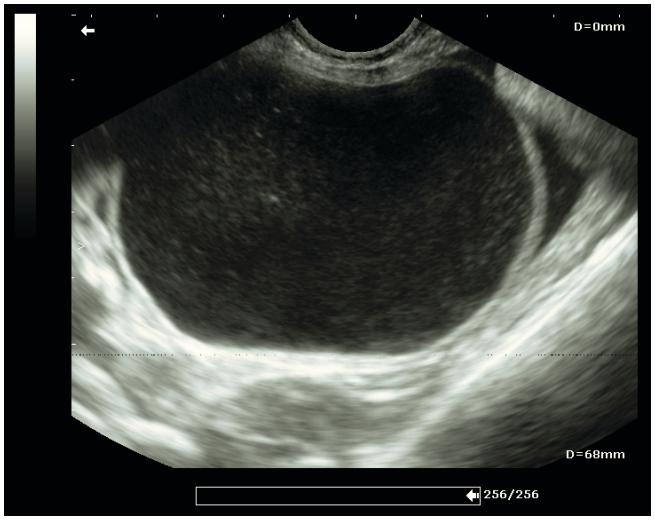

Figure 5: ultrasonography of the urinary bladder in a cat suffered from distended urinary bladder with signs of FLUTD. The image was obtained from the most caudo-ventral part of the abdomen

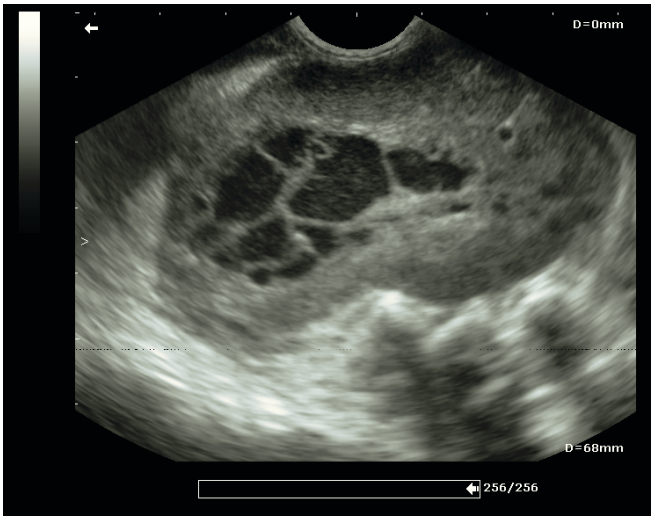

Figure 6: ultrasonography of the kidney in a cat suffered from distended urinary bladder with signs of FLUTD. The image was obtained from behind the lumbar vertebrae. The image showed polycystic kidney lobules due to the stasis of urine in the urinary bladder.

Discussion

Feline lower urinary tract disease is a common feline disease that characterized by several changes in the structure and function of the urinary bladder and urethra (2, 3). For daily use in the clinic, there is an increased need for rapid diagnostic, easily accessible, reliable, and low-cost assays for monitoring and early detection of renal inflammation during FLUTD. Several biomarkers have proven to be useful in the diagnosis of FLUTD in cats. The true power of these biomarkers is found in their ability to detect kidney damage or injury, as well as active pathological changes, at an early stage. Based on data collected from private pet clinics and shelters in Sharkia governorate, 21 cats were diagnosed with FLUTD in the current study based on ultrasonographic examination. FLUTD was more commonly found in male cats (85.5 %) and was associated with significant increases in mean body temperature, mean respiratory rate, and mean heart rate. Clinical examination revealed the following clinical findings; anorexia, lethargy, vomiting, dehydration, dysuria, and strangulation.

The obtained results were in agreement with previous findings reported by Kochan and Simsek (20)**,** who observed that the most clinical signs appeared as pain (100 %), stranguria (81.57 %), pollakiuria (73.68 %), obstruction (60.52 %), hematuria (50.0 %) and periuria (28.9%). Whereas, Nururrozi, Yanuartono (2) reported that the clinical signs associated with the disease were stranguria 45.3 %, hematuria 40.4 %, pollakiuria 11.9 %, dysuria 6.0 % and periuria 3.2 %.

The mean values of hematological and biochemical indices in healthy group and Cats with FLUTD group were tested for statistically difference. Mean values of hematological parameters showed a significant increase in the total white blood cell count, neutrophils and platelets count, while, a significant decrease in the mean of red blood cell counts, hemoglobin and PCV compared to clinically healthy cats. The findings are consistent with a previous study by Paraš, Paraš (21), who observed a significant decrease in erythrocytes in a group of cats suffering from renal failure especially in complete urinary obstruction. With the explanation that kidney load affected the poor stimulation of erythropoietin, the number of erythrocytes in this group of cats is lower than in the control group. Authors provide similar data, demonstrating that renal failure affects erythropoiesis and decreases erythrocyte-related hematological parameters such as PCV and hemoglobin (22).

The mean value of leukocytes and neutrophils, on the other hand, increased in cats with FLUTD compared to clinically healthy cats, due to intoxication and inflammatory kidney processes caused by renal insufficiency (23).

In fact, the rise in pressure within the renal pelvis and ureter reduces renal blood flow and

glomerular filtration rate, resulting in acute kidney damage. As a result, FLUTD is the most common and significant cause of acute kidney damage. The main biochemical changes in the current study were significant increase in the mean values of blood urea nitrogen and blood creatinine, total proteins, albumin, creatine kinase, blood glucose, serum AST, ALT, potassium and phosphorus concentrations in cats with FLUTD, while a significant decrease in sodium and chloride values compared to clinically healthy cats. The biochemical alterations in cats with FLUTD is related to the systemic inflammation induced by the lower urinary tract obstruction which supported by a previous literature by Chiu, Adler (24), Chen, Avital (25), Ceren, Gülten (26). Additionally, electrolytic and acid-base imbalances result from reduced glomerular filtration rates caused by a blockage in the flow of urine (3).

Phosphorus is freely filtered by the glomeruli, its concentration is heavily influenced by the glomerular filtration rate (GFR), and a drop in GFR will result in a proportional increase in serum phosphorous concentration (27). Hyperphosphatemia may cause soft tissue mineralization (including the kidneys), potentially contributing to the progression of chronic kidney disease and influencing the likelihood of survival (24, 26).

Blood urea nitrogen and blood creatinine revealed highly significant increase in cats with FLUTD and the obtained results were in agreement with a previous study by Chen, Avital (25), who reported that serum creatinine and blood urea nitrogen concentrations were associated with a worse short-term outcome, as expected given that they all reflect the severity of the injury. Additionally, blood creatinine and blood urea nitrogen levels increased five-fold in cats with renal disease, indicating impaired kidney function and poor blood filtration in a previous study by Mizutani, Takeuchi (28), Ceren, Gülten (26).

The primary acute-phase proteins that are positive in felines are SAA and AGP, which can help with the monitoring of inflammation in cats with FLUTD (4). The measurements of serum alpha-1- acid glycoprotein and serum amyloid A levels were significantly increased; as well plasma fibrinogen concentration was a highly significant increase in cats with FLUTD compared to clinically healthy cats. The obtained results were in line with the observations of Dinallo, Giuffrida (3), who observed that serum amyloid A, AGP and plasma fibrinogen concentrations significantly higher in FLUTD cats compared with clinically healthy cats at the time of examination, which were consistent with earlier research by Paltrinieri (13), Ceron, Eckersall (15), who argued that feline fibrinogen is a positive acute-phase protein that responds to inflammation in cats with FLUTD. As well, Sasaki, Ma (29) observed increased SAA concentrations in cats with urethral obstruction which peaked 24 hours after obstruction. Additionally, cats undergoing surgery for urinary diversion had higher serum AGP concentrations, according to Kajikawa, Furuta (30). Therefore, assessing the inflammatory profiles and clinical recoveries of cats with FLUTD based on these acute phase protein responses.

In the current study the results showed that total protein, albumin, creatinine showed a significant positive correlation with SAA, AGP and plasma fibrinogen, supporting the findings of Lannergard, Friman (31), Dinallo, Giuffrida (3) who found high APPs concentrations in cats with FLUTD. APPs concentrations rise as a result of severe systemic inflammatory reactions in which blood flow is reduced and inflammatory mediators (proinflammatory cytokines) are released, which is enough to activate hepatocytes and cause muscle spasms, edema, and pain (4).

Conclusions

It is concluded that, FLUTD is a most common disease affecting cats especially male cats. Diseased cats usually presented with signs of bloody urine, dysuria, stranguria and periuria. In addition, acute-phase proteins like SAA, AGP, and fibrinogen can be used as biological biomarkers to evaluate systemic inflammatory processes and aid in the monitoring of cats with FLUTD.

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ples and shared in study design. Tarek Shety, developed the idea and collected the literature, analyzed data and wrote and revised the manuscript. All authors read and approved the final manuscript.

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