TRADITION AND MODERNITY IN VETERINARY MEDICINE

Online First

Published online: August 22, 2019

PROGNOSTIC AND DIAGNOSTIC VALUES OF ACUTE PHASE PROTEINS (APPS) AND ULTRASONOGRAPHY IN EXPERIMENTALLY INDUCED BACTERIAL CYSTITIS IN DOGS.

Hany Hassan[1*], Ahmed Zaghawa[2], Mahmoud Aly[1], Ahmed Kamr[1], Mohamed Nayel[2], Mostafa Abd El Gaber Mohamed[3], Ali abdelazeim[1] and Nehal Elgamasy[1].

[1] Department of Animal Medicine and Infectious Diseases (Animal Medicine), Faculty of Veterinary Medicine, University of Sadat City, Egypt.
[2]Department of Animal Medicine and Infectious Diseases (Infectious Diseases), Faculty of Veterinary Medicine, University of Sadat City, Egypt.
[3]Department of Animal Pathology, Faculty of Veterinary Medicine, University of Sadat City, Egypt.

*** email:** Hanyhassan1959@gmail.com

ABSTRACT

The aim of the study is the further use of ultrasound and acute phase proteins in diagnosis of bacterial cystitis in dogs. The present research was performed on 15 dogs apparently healthy, their weight were ranged from 20±0.5 Kg BW. Divided into 2 groups, Group (1): contained 10 dogs subjected to experimentally induce bacterial cystitis by pathogenic strains of *Staphylococcus aureus* and Group (2): contained 5 dogs act as control group. The diseased dogs showed inappetance, abdominal pain, pollakiuria, stranguria, arched back, lethargy and depression, compared to the control group which was were very active, in good physical condition and had normal appetite. The biochemical alteration included no significant change in kidney functions as serum creatinine, BUN and uric acid. Significant increase in serum haptoglobin, SAA from the 3rd day after induction till the end of experiment. There is significant decrease in serum total protein and albumin from the 3rd day till the end of experiment, compared to the control group. Urine analysis illustrated alkaline pH, negative glycosuria, and proteinuria, compared to the control group. Ultrasound imaging showed increase of bladder wall echogenicity, decrease in circumscribed anechoic area represented the urine which appear hyperechoic and contain suspended material which represents cellular debris, irregular bladder mucosa these changes at the 3rd day till the 15th day, compared to the control group. Macroscopic findings of dogs' urinary bladder showed diffuse thickening of the bladder wall and haemorrhage of dogs with induced bacterial cystitis. Microscopically, urinary bladder showed destruction and desquamation of transitional epithelium in the lumen of the urinary bladder. The lamina propria and submucosa showed haemorrhages and congested blood vessels.

Key words: Dogs; *Staphylococcus aureus*; Cystitis, Acute phase proteins, Ultrasonography

INTRODUCTION

Cystitis is the common disease of the urinary bladder caused by bacterial infection in dogs (Ling 2000). Cystitis is more frequent in female than in males, and also in older aged dogs (Ling et al., 2001). The causes of cystitis in dogs are likely multifactorial as cystic calculi, tumour, and some

Online First

Published online: August 22, 2019

nervous and endocrinological disorders (Primovic 2002). The most common isolated bacterium from dogs with cystitis was *Escherichia coli*, followed by *Staphylococcus spp*., *Proteus spp.*, *Streptococcus spp*., *Klebsiella spp*., *Enterobacter spp.*, and *Pseudomonas spp.* (Tilley and Smith 2004). The recorded signs of bacterial cystitis in dogs are frequent with straining before and during urination with voiding a little bit amount of urine each time. Sometime unconscious release of urine is happened. Also bloody urine, pyrexia, dullness, abdominal pain, laziness and anorexia (Langston 2011).

The biochemical measurement of serum samples of dogs suffered from by bacterial cystitis showed no significance difference in creatinine, urea and the uric acid values but physical examination of the infected urine showed turbidity and red coloration (Jasim 2012). Ultrasound was one of the most successful method of non-invasive diagnosis method used in cystitis especially the bacterial one in dogs, so the aim of study to make further diagnosis of the bacteria cystitis with ultrasonography and discover some novel biomarkers may help us in the future for diagnosis of bacterial cystitis Leoci et al (2015).

MATERIALS AND METHODS

Animals

A total number of fifteen male dogs has been selected for this study, the weight of dogs were 20±0.5 Kg BW. All dogs were managed, housed and sacrificed according to the guidelines of the institutional animal care and use committee (IACUC), Faculty of Veterinary Medicine, University of Sadat City. Dogs were dewormed by injection of ivermectine 1% and were repeated after 2 weeks. During this period, periodic clinical and laboratory examinations were performed according to Houston (2000). They were fed on a diet composed of meat, bones and bread twice daily with free access of sufficient tap water. The animals were placed in separated metal cages and kept under the same environmental, nutritional and hygienic condition throughout the duration of experiment. All animals were apparently healthy with no evidence of urinary tract infection or inflammation based on clinical, physical examination, as well as, serum biochemistry analysis, urine analysis, urinary bladder and kidney ultrasonography. Dogs were subjected to complete deworming after a period of adaptation. Data concerned with competent history, clinical findings, and the medical record for each animal was recorded. The present study was carried at Veterinary hospital of Faculty of Veterinary Medicine, University of Sadat City. These animals were allocated into two main groups as following (Group 1: Included 10 adult dogs that were subjected to experimentally induce bacterial cystitis. As follow Experimental bacterial cystitis was induced by modifications of previously described techniques according to (Bagley et al., 1991). The urinary bladder of 10 dogs of this group was emptied by cystocentesis, followed by irritation of the bladder mucosa using 5 ml of 2.5% turpentine oil were instilled into the urinary bladder this solution was retained for 10 minutes and then removed. The urinary bladder was subsequently rinsed with three successive 50 ml of sterile saline solution before instilling of 1 ml of the broth containing (Staphylococcus aureus) pathogenic strain as shown in (Fig 1,2). Urine samples were collected by cystocentesis guided by ultrasound after inoculation. Samples were evaluated using urinalysis by urine strip. All dogs were evaluated by clinical, physical examination, urine analysis, biochemical changes and

Online First

Published online: August 22, 2019

ultrasonographic images before and after injection at days 0 day , 3rd, 6th, 9th, 12th, 15th day and Group 2 Included Five adult dogs that were considered as control group).

Ultrasonographic examination of the urinary bladder

Prior to beginning the examination, the hair was clipped and ultrasonic gel was applied on the skin. The bladder was examined when it was distended with urine. To evaluate the urinary bladder keep the transducers positioned in long axis to the animal, and move it caudal to a concentrations between the last 2 mammary chains, According to Huynh and Berry (2016).

Biochemical analysis

Serum urea concentrations (mg/dl), serum uric acid concentrations (mg/dl), serum creatinine concentrations (mg/dl), serum albumin concentrations (g/dl), serum total proteins concentrations (g/dl), serum cholesterol concentrations (mg/dl) and serum triglercride concentrations (mg/dl) were measured according to the guidelines of the company kits. Haptoglobin concentrations (g/dl) and serum amyloid A were determined by ELISA kits according to the company guidelines.

Pathological analysis

Urinary bladder of each necropsied dog was carefully examined by naked eye for detection of any gross lesions. Following complete necropsy of sacrificed animals; fresh specimens were collected from different sites of the urinary bladder and immediately were preserved in 10% neutral buffered formalin. These specimens were processed through the conventional Paraffin embedded technique (dehydration through ascending grades of ethyle alcohol, cleared in different changes of xylene and embedded in paraffin wax at 60 c° paraffin blocks were prepared and cut by microtome into sections of about 5 microns. The paraffin sections were stained by haematoxylin and eosin (H&E) according to the method described by McDuffie et al., (2013).

Statistical analysis

Data obtained were statically analysed by one way ANOVA between three groups. Data were analysed by SPSS-software. Values were expressed as mean ± standard error, significance was set at $P< 0.05$, using the methods of Norman and Baily (1997). Receiver Operating Characteristic (ROC) curve was designed using Graph Pad Prism 8.

Fig 1. Induction of bacterial cystitis guided by Ultrasound.

Online First

Published online: August 22, 2019

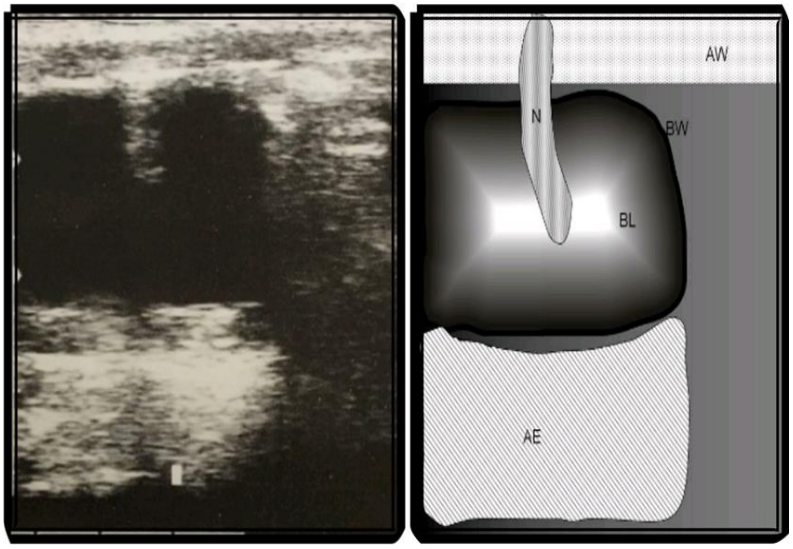

Fig 2. Ultrasonogram and schematic representation of urinary bladder in dogs during bacterial cystitis induction. Ultrasonogram and schematic representation of the urinary bladder at 0 day during time of instillation of bacterial colony in urinary bladder by a metallic needle showed large circumscribed anechoic area represent urinary bladder lumen filled by urine, inside this area appeared a long hyperechoic line represent metallic needle surrounded by very thin hyperechoic line represented urinary bladder wall.

RESULTS

Clinical symptoms in dogs with experimentally induced bacterial cystitis

Just starting injection of turpentine oil, all dogs suffered from restlessness, licking on the abdominal and urethral regions with attempts to urination with passage of urine. Then following intravesicular instillation of bacterial pathogen, all of the above mentioned signs were increased in severity especially the abdominal pain, pollakiuria (voiding small quantity of urine with increased frequency), stranguria (frequent difficult and painful urination accompanied by abdominal pain), as well as arched back, abdominal pain, restlessness, decreased appetite lethargy and depression, compared to the apparently healthy dogs of the control group were very active, in good physical condition and had normal appetite. Concerning physical examination of this group it was noticed that the body temperature was significantly increased with no significant changes noticed in heart rate.

Biochemical analysis of dogs with experimentally induced bacterial cystitis in comparison with control dogs

Concerning to the concentrations of serum creatinine, serum urea nitrogen and uric acid in induced bacterial cystitis, there was no significant ($P>0.05$) changes after induction compared to control group during the experiment (Table 1). There is a significant ($P<0.05$) decrease in serum total protein and albumin in bacterial cystitis in comparison to control group at the 3rd day and reduction continued in highly significant manner ($P<0.05$) at the 9th day post. (Table 2). The concentrations of SAA and haptoglobinin this group of induced bacterial cystitis showed significant increase ($P<0.05$) at the 3th day after induction in this group compared with the control group until the end of the experiment (Table 3). Serum amyloid A and haptoglobin was associated with severity of disease ($P<0.001$) as shown in Fig 3. Urine analysis of dogs with induced bacterial cystitis using

Online First

Published online: August 22, 2019

urine strip showed absence of glucosuria, alkaline pH (8) and proteinuria compared to the control group.

Table 1. Kidney function testes in dogs with experiment bacterial cysitis and control group at different time points.

Time point	Urea mg/dl		Creatinine mg/dl		Uric Acid mg/dl	
	Control	Cystitis	Control	Cystitis	Control	Cystitis
0 Day	37.9±0.2[a]	38.2±0.1[a]	1.1±0.1[a]	1±0.1[a]	4.2±0.1[a]	4.5±0.4[a]
3Day	38.2±0.4 [a]	41±03 [a]	0.9±0.1 [a]	1.1±0.2 [a]	4.2±0.4[a]	4±0.2[a]
6 Day	38.5±0.3 [a]	40.2±0.1 [a]	0.6±0. 08 [a]	1.2±0.1[a]	4.0±0.4[a]	4.2±0.2[a]
9 Day	37.9±0.2[a]	38.1±0.1[a]	1.01±0.1[a]	1±0.1[a]	4.1±0.1[a]	4.4±0.4[a]
12Day	38.5±0.4 [a]	41.3±03 [a]	0.9±0.1 [a]	1.1±0.2[a]	4.2±0.4[a]	4±0.2[a]
15Day	38.2±0.3 [a]	40.1±0.1 [a]	1.1±0. 08 [a]	1.1±0.1[a]	4.1±0.4[a]	4.1±0.2[a]

Data were presented as means ± standard error (S.E). Mean value with different superscript letters in the same row were significantly different at (P<0.05).

Table 2. Serum Protein Profile in dogs with experiment bacterial cysitis and control group at different time points.

Time point	Total Protein (g/dl)		Albumin (g/dl)		Globulin (g/dl)	
	Control	Cystitis	Control	Cystitis	Control	Cystitis
0 Day	7.4±0.2 [a]	7.1±0.2 [a]	4.5±0.3 [a]	4.1±0.3 [a]	2.9±0.1[a]	3±0.2[a]
3 Day	7.2±0.08 [a]	6.6±0.3[b]	4.4±0.09 [a]	3.7±0.2 [b]	2.8±0.07[a]	2.9±0.3[a]
6 Day	6.8±0.2 [a]	6.4±0.2[b]	4.1 ±0.1 [a]	3.3±0.1[b]	2.7±0.3[a]	3.1±0.4[a]
9 Day	6.9±0.08 [a]	5.1±0.1 [b]	4.1 ±0.1 [a]	2.4±0.1 [b]	2.8±0.3[a]	2.7±0.4[b]
12 Day	6.8±0.09 [a]	4.5±0.4 [b]	4.3 ±0.4 [a]	2.1±0.2 [b]	2.5±0.02[a]	2.4±0.05[b]
15 Day	6.9±0.2 [a]	3.7±0.2 [b]	4.1±0.3 [a]	1.7±0.3 [b]	2.8±0.2[a]	2±0.03[b]

Data were presented as means ± standard error (S.E). Mean value with different superscript letters in the same row were significantly different at (P<0.05).

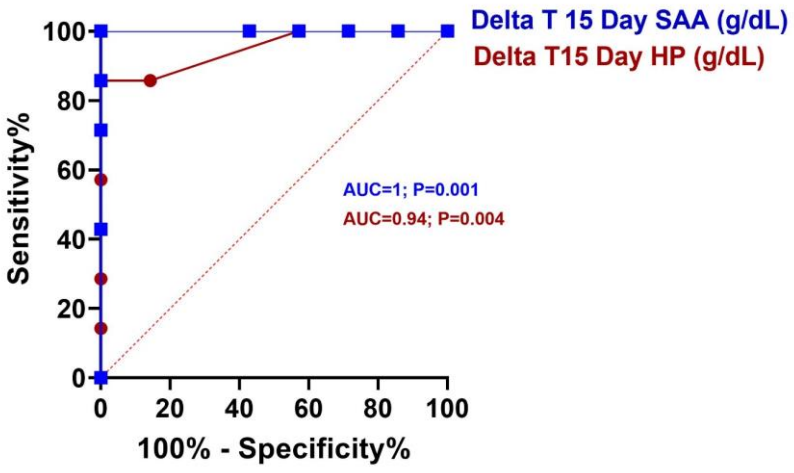

Fig. 3. ROC curve analysis of association of SAA and HP with severity of disease. Delta T15 was calculated between Day 0 and Day 15. SAA and HP concentrations were associated with severity of acute cystitis (P<0.05)

Online First

Published online: August 22, 2019

Ultrasonographic image of urinary bladder in dogs of with bacterial cystitis and in control group

For examination of the urinary bladder, the animals were placed in dorsal recumbency, urinary bladder is scanned between the last two mammary chains, using 5 MHZ transducers. As showed in Fig. 4 (A, B, C). Urinary bladder of dogs (A) within control group showed large circumscribed anechoic area represent urinary bladder lumen filled by urine and surrounded by very thin hyperechoic line represented urinary bladder wall. Urinary bladder at 3rd day (B) after induction of bacterial cystitis showed moderate circumscribed anechoic area represent urinary bladder lumen filled by urine and surrounded by hyperechoic area represented increase the thickness of urinary bladder wall. Urinary bladder at 6th day (C) in dogs with bacterial cystitis showed decrease in circumscribed anechoic area which represents the urinary bladder lumen filled by urine and surrounded by more hyperechoic area represented increase the thickness of urinary bladder wall, also the mucosa appear irregular, the urine appear hyperechoic and contain suspended material which represents cellular debris. AW=Abdominal Wall, BL=Bladder Lumen, BW=Bladder Wall and AE=Acoustic Enhancement.

Fig. 4 A (A, B, C): Ultrasonogram and schematic representation of urinary bladder in dogs from control group and with bacterial cysitis. A.) Urinary bladder of dogs within control group showed large circumscribed anechoic area represent urinary bladder lumen filled by urine and surrounded by very thin hyperechoic line represented urinary bladder wall. B.) Urinary bladder at 3rd day after induction of bacterial cystitis showed moderate circumscribed anechoic area represent urinary bladder lumen filled by urine and surrounded by hyperechoic area represented increase the thickness of urinary bladder wall. C.) Urinary bladder at 6th day in dogs with bacterial cystitis showed decrease in circumscribed anechoic area which represents the urinary bladder lumen filled by urine and surrounded by more hyperechoic area represented increase the thickness of urinary bladder wall, also the mucosa appear irregular, the urine appear hyperechoic and contain suspended material which represents cellular debris. AW=Abdominal Wall, BL=Bladder Lumen, BW=Bladder Wall and AE=Acoustic Enhancement.

Online First

Published online: August 22, 2019

Fig. 5 (A, B,C): Ultrasonogram and schematic representation of urinary bladder in dogs with bacterial cystitis at 9th, 12th, 15 days after induction. A) Urinary bladder at 9th day in dogs with bacterial cystitis showed more decrease in the circumscribed anechoic area which represents the urinary bladder lumen filled by urine and surrounded by more hyperechoic area represented increase the thickness of urinary bladder wall, the mucosa of urinary bladder appear irregular the urine appear hyperechoic and contain suspended material which represents cellular debris. B.) at 12th day in dogs with bacterial cystitis showed severe decrease in the circumscribed anechoic area which represent the urinary bladder lumen filled by urine and surrounded by large hyperechoic area represented increase the thickness of urinary bladder wall, also the mucosa appear more irregular, the urine appear hyperechoic and contain suspended material which represents cellular debris. C.) Urinary bladder at 15th day after the time of induction of bacterial cystitis showed very small circumscribed anechoic areas which represent the urinary bladder lumen filled by urine and surrounded by very large hyperechoic area represented increase the thickness of urinary bladder wall. AW=Abdominal Wall, BL=Bladder Lumen, BW=Bladder Wall and AE=Acoustic Enhancement.

Fig. 5 (A,B,C): Ultrasonogram and schematic representation of urinary bladder in dogs with bacterial cystitis at 9th, 12th,15 days after induction. A) Urinary bladder at 9th day in dogs with bacterial cystitis showed more decrease in the circumscribed anechoic area which represents the urinary bladder lumen filled by urine and surrounded by more hyperechoic area represented increase the thickness of urinary bladder wall, the mucosa of urinary bladder appear irregular the urine appear hyperechoic and contain suspended material which represents cellular debris. B.) at 12th day in dogs with bacterial cystitis showed sever decrease in the circumscribed anechoic area which represent the urinary bladder lumen filled by urine and surrounded by large hyperechoic area represented increase the thickness of urinary bladder wall, also the mucosa appear more irregular, the urine appear hyperechoic and contain suspended material which represents cellular debris. C.) Urinary bladder at 15th day after the time of induction of bacterial cystitis showed very small circumscribed anechoic areas which represent the urinary bladder lumen filled by urine and surrounded by very large hyperechoic area represented increase the thickness of urinary bladder wall. AW=Abdominal Wall, BL=Bladder Lumen, BW =Bladder Wall and AE=Acoustic Enhancement.

Online First

Published online: August 22, 2019

Histopathological examination

Macroscopic findings in control group of normal dog's urinary bladder showed normal bladder mucosa as shown in Fig (6-A) compared to the dogs with bacterial cystitis and macroscopic appearance showed diffuse thickening of the bladder wall and hemorrhage as showed in Fig (6-B). Microscopical examination of urinary bladder of dog from (group 2) showed destruction and desquamation of transitional epithelium in the lumen of the urinary bladder. The lamina propria and submucosa showed haemorrhages and congested blood vessels. There were high numbers of neutrophils infiltration in the wall of urinary bladder (Fig. 7 A, B, C &D).

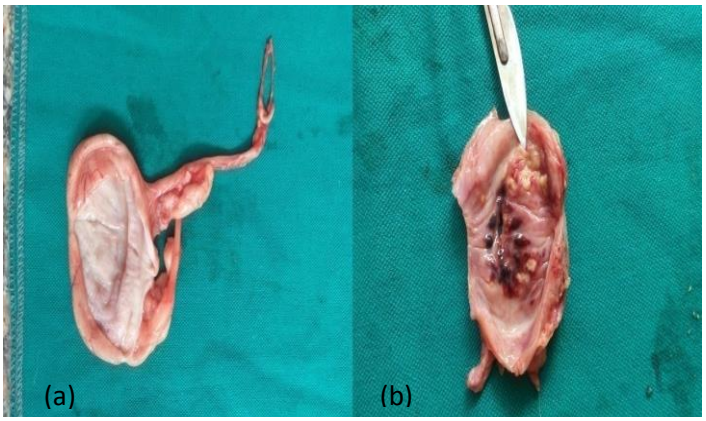

Fig 6 (A,B): Macroscopic findings of the urinary bladder of dogs in control group (A) compared to urinary bladder of dogs with cystitis group (B). (A) Macroscopic appearance of normal urinary bladder of dogs with normal mucosa. (B)Macroscopic appearance of urinary bladder with cystitis showed diffuse thickening of the bladder wall and hemorrhages.

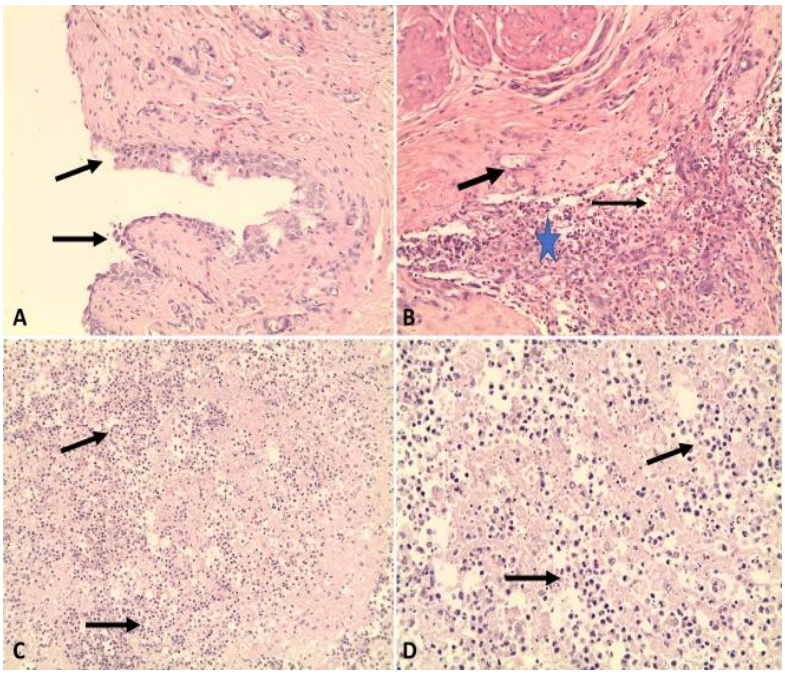

Fig. 7 (A,B,C,D): Postmortem histopathologic findings of urinary bladder in dog with induced bacterial cystitis. A. Urinary bladder of dog from (group 2) showed destruction and desquamation of transitional epithelium (arrow) (H&E x10). B. Urinary bladder of dog from (group 2) showed mononuclear cells infiltration (star), hemorrhages (thin arrow) and congested blood vessels (thick arrow)(H&E x10). C. Urinary bladder of dog from (group 2) showed high number of neutrophils infiltration (arrow) (H&E x10). D. Urinary bladder of dog from (group 2) showed high number of neutrophils infiltration (arrow) (H&E x20).

Online First

Published online: August 22, 2019

DISCUSSION

In the present study, the clinical pictures revealed licking of abdominal region, arched back, abdominal pain, restlessness, stranguria - difficulty in urination, in which the urine is passed only drop by drop with pain and tenesmus, pollakiuria – increased urinary frequency, haematuria, dogs with cystitis tend to have small bladders and may show pain/discomfort on palpation of the caudal abdomen as regard with, Jasim (2012) and Sturgess (2016). In addition to clinical findings in dogs within the group (2) showed unremarkable physical examination, except for the body temperature was increased significantly after induction with the bacterial colony within few days and non-significant increase in heart rate similar to results was reported by Bailiff et al (2005)and Jasim (2012).

Concerning serum creatinine and serum urea nitrogen concentrations in group of induced bacterial cystitis there was no significant ($P>0.05$) changes after induction compared to control group as reported by Rebar et al. (2004) non-significant changes in serum BUN and creatinine concentrations indicate that is present in case of bacterial cystitis, this results also indicated by Jasim (2012).

The uric acid serum concentrations showed no significant changes ($P>0.05$) during period of induction in group of induced bacterial cystitis compared to the control group, this results reported by Smith (1996), who mentioned that in most mammalian species uric acid (UA) is the end-point of purine metabolism in the liver most mammals, and in dogs in particular, the UA is then decarboxylated producing allantoin, which is water soluble and can be excreted by the kidneys in dogs, Smith (1996), the uric acid values showed no difference in German shepherd dog with lower urinary tract affections, this result also indicated by Jasim (2012), Serum concentrations of urea in group of induced there was no significant changes in dogs after induction of bacterial cystitis reported by Hill et al. (2011).

Concerning serum biochemical tests, serum total protein showed significant decrease ($P<0.05$) post infection in group (2) at the 3rd day and reduction continued in highly significant manner ($P<0.05$) at the 9th day post induction as recorded by Schreiber et al (1982) who attributed that decrease serum total protein occurred in acute inflammation.

Moreover serum albumin showed significant decrease ($P<0.05$) post infection at the 3rd day and reduction continued in highly significant manner ($P<0.05$) at the 9th day post induction as recorded by Vaden et al., 2009) and Jain et al. (2011), who documented that serum albumin is the major negative acute phase protein and its synthesis may be markedly reduced during the acute phase response.

Estimation of SAA concentrations in this group of induced bacterial cystitis showed significant increase ($P<0.05$) at the 6th day after induction in this group compared with the control group as proved by Michelle et al. (2014), who recorded that SAA was useful as diagnostic markers which show marked increases in concentration of systemic inflammation in dogs and this result also affirmed by Ceron et al (2005). Another positive acute phase protein estimated in this study was haptoglobin and showed significant increase ($P<0.05$) in group (2) after induction this was happened at the 6th day after induction as reported by Eckersall (2008) who mentioned that haptoglobin is considered a positive AAP in sick dogs. Increasing in the acute phase of the inflammation, this also mentioned by Mischke and Eckersall (2005).

Online First

Published online: August 22, 2019

Of interest, urine analysis in group (2) using urine strip revealed alkaline PH (8) of urine, as proved by Rebar et al. (2004), Chew and Dibartola (2004), KuKanich (2011) and Rizzi (2014), who attributed the high urine pH (8.0) is compatible with infection by a urease-producing organism as Staphylococcus aureus, urea is hydrolysed to ammonium and carbonate ions. The carbonate ions bind hydrogen ions and remove them from solution resulting in more alkaline urine, also indicate negative glycosuria and proteinuria by Parrah et al (2013) who recorded that proteinuria occurred in renal diseases this result also affirmed by Chew and Dibartola(2004).

Histopathology in dogs within bacterial cystitis microscopically examination of urinary bladder showed destruction and desquamation of transitional epithelium in the lumen of the urinary bladder. The lamina propria and submucosa showed haemorrhages and congested blood vessels. There were high numbers of neutrophils infiltration in the wall of urinary bladder as documented by Gelberg (2010), also this results proved by Bailiff (2005).

With regard to ultrasound of urinary bladder of dogs with bacterial cysitis in dogs within the control group proved that the urinary bladder is normally anechoic, the normal distended bladder is a hollow organ, pear-shaped structure with a thin wall and anechoic contents this was matching with the results proved by Mannion and Lang (2006) and Huynh and Berry (2016) who reported that mean bladder wall thickness increased significantly with decreasing bladder distention.

Concerning ultrasound image of urinary bladder represented in showed ultra sonogram and schematic representation of the urinary bladder at 0 day at the time of instillation of turpentine oil and bacterial colony in urinary bladder by a metallic needle and showed large circumscribed anechoic area represent urinary bladder lumen filled by urine and inside this area long hyperechoic line represent metallic needle surrounded by very thin hyperechoic line represented urinary bladder wall. Ultrasonographic changes occurred in urinary bladder in group of dogs induced bacterial cystitis as shown we found at the 3rd day the moderate circumscribed anechoic area represent urinary bladder lumen filled by urine and surrounded by hyperechoic area represented increase the thickness of urinary bladder wall as proved by Kandula et al (2017). By time at 6th day as illustrated after the time of induction of bacterial cystitis and showed decrease in the circumscribed anechoic area which represent the urinary bladder lumen filled by urine and surrounded by large hyperechoic area represented increase the thickness of urinary bladder wall and irregular bladder mucosa as illustrated by Armbrust and Grauer (2015), as well as found the urine appear heteroechoic due suspended material which represents the cellular debris in the urinary bladder as documented by Kandula et al (2017). At the 9th day the urinary bladder showed more decrease in the circumscribed anchoic area which represents the urinary bladder lumen filled by urine surrounded by more hyperechoic area represented increase in bladder wall thickness and the irregular bladder mucosa became more prominent as proved by Ghanem (2013) Kandula (2017). At the 12th day after induction of bacterial cystitis in dogs the ultrasonogram and schematic representation of the urinary bladder showed sever decrease in the circumscribed anechoic areas which represent the urinary bladder lumen filled by urine and surrounded by large hyperechoic area represented increase the thickness of urinary bladder wall and severe irregularity in bladder mucosa, the urine appear heteroechoic and contain suspended material as proved by Seo et al (2012), Armbrust and Grauer (2015) and Kandula (2017). At the 15th day after the time of induction of bacterial cystitis showed a very small circumscribed anechoic areas which represented by increase in thickness of urinary bladder and severe irregularity in bladder mucosa , also proved by Mannion and Lang (2006), Seo et al (2012), Armbrust and Grauer (2015) and Kandula (2017).

Online First

Published online: August 22, 2019

In conclusions, bacterial cystitis is associated with biochemical alterations in acute phase proteins especially serum amyloid A and haptoglobin which can be used as a diagnostic biomarker for acute cystitis in dogs. Ultrasound imaging is a useful diagnostic equipment of acute cystitis in dogs.

ACKNOWLEDGMENTS

Our grateful thanks to all veterinarian and technical staff at the Faculty of Veterinary Medicine, of the University of Sadat city for their support in this study.

CONFLICT OF INTEREST

The authors declared that no conflict of interest

REFERENCES

1. Armbrust, L. and Grauer, G.F. (2015): Imaging the Urinary Tract. cliniciansbrief.com.
2. Bagley, R.S.; Center, S.A.; Lewis, R.M.; Shin, S.; Dougherty, S.A.; Randolph, J.F. Erb, H. (1991): The effect of experimental cystitis and iatrogenic blood contamination on the urine protein/creatine ratio in the dog. J Vet Intern Med. 1991 Mar-Apr; 5(2):66-70.
3. Bailiff, N.L.; Westropp, J.L; Jang, S.S.and Ling, G.V. (2005) Corynebacterium urealyticum urinary tract infection in dogs and cats: 7 cases (1996–2003), JAVMA, Vol 226, No. 10, May 15, 2005.
4. Cerón, J.J.; Eckersall, P.D.and Subiela, S.M. (2005): Acute phase proteins in dogs and cats: current knowledge and future perspectives. Vet Clin Pathol.2005; 34:85–99.
5. Chew, D.J and. Dibartola, S.P. (2004): Interpretation of Canine and Feline Urinalysis. Clinical handbook series. Published by The Gloyd Group, Inc.Wilmington, and Delaware. ISBN 0-9678005-2-8, PP 16-19.
6. Eckersall, P.D. (2008): Proteins, Proteomics and the Dysproteinemias. In: Kaneko, JJ. Harvey, JW. Bruss, M.L.. Clinical biochemistry of domestic animals. 6th ed. Burlington: Academic Press, 2008. p. 117- 155.
7. Gelberg, H.B. (2010):Urinary Bladder Mass in a Dog, Veterinary Pathology 47(1) 181-184, The American College of Veterinary Pathologists 2010 Reprints and permission: http://www.sagepub.com/journalsPermissions.nav.
8. Ghanem, S.Y.A. (2013): Sonographic imaging of internal organs of canines as an aid to diagnosis. Cairo University, Faculty of Veterinary Medicine.
9. Hill, JM.; Leisewitz, A L.and Goddard, A. (2011): The utility of uric acid assay in dogs as an indicator of functional hepatic mass. Journal of the South African Veterinary Association (2011) 82(2): 86–93.
10. Houston, D.M. (2000): Clinical examination of dogs and cats. In: Radostits, O.M.; Mayhew, I.G.; and Houston, D.M.: Veterinary Clinical Examination and Diagnosis. W.B. Saunders, China, pp.125-138.

Online First

Published online: August 22, 2019

11. Huynh. And Berry, C. R. (2016): The urinary tract: urinary bladder & urethra. Today's veterinary practice Small Animal Abdominal ultrasonography. tvpjournal.com.september/October 2016.

12. Jain, S.; Gautam, V. and Naseem S (2011): Acute phase proteins: As diagnostic tool. Journal of Pharmacy and BioalliedSciences 3, 118–127.

13. Jasim, H.M. (2012): Hematological, biochemical and urinanalysis for the diagnosis of urinary tract infection in German Shepherd dog. Bas.J.Vet.Res.Vol.11, No2.

14. Kandula, S.; Karlapudi, S.K. and Nagaraj, P. (2017): Cultural studies of urine from cystitis dogs". The Pharma Innovation Journal; 6(8): 247-250.

15. KuKanich, K.S. (2011): Manging of urinary tract infection. Consultant on Call /NAVC, clinician's Brief / August 2011.

16. Mannion, P.and Lang, J. (2006): Ultrasonography of the Urinary and Genital System of the Dog and Cat, Iranian Journal of Veterinary Surgery.

17. McDuffie,J.E.; Gao,J.; Ma,J.; David, La.; Bittner,A. Sonee,M.; Wagoner,M. and Snook,S. (2013): Novel genomic biomarkers for acute gentamicin nephrotoxicity in dog http://dx.doi.org/10.4236/ojmip.2013.33018.

18. Michelle, B.; Langhorn, C. R.; Goddard A.; Andreasen,E.B.; Tvarijonaviciute,E.M.A.; Kirpensteijn, J.; Jakobsen, S.; Persson, F. and Hansen,M.K. (2014): Comparison of serum amyloid A and C-reactive protein as diagnostic markers of systemic inflammation in dogs" CVJ / VOL 55 / February 2014.

19. Mischke, R. and Eckersall, P.D. (2005): Changes in creative protein and haptoglobin in dogs with lymphatic neoplasm". In: International Colloquium on Animal Acute Phase Protein, 5th ed. 2005, p.35.

20. Parrah ,J. D.; Moulvi, B. A.; Gazi,M.A.; Makhdoomi, D.M.; Athar, H.; Din, M.U.; Dar, S. and Mir, A.Q. (2013): Importance of urinalysis in veterinary practice – A review, Vet World 6(9): 640-646, doi: 10.14202/vetworld.2013.640-646.

21. Rebar, A.H.; Boon, G.D. and John A. Christian, J.A. (2004): Biochemical Profiling in the Dog and Cat. Published by The Gloyd Group, Inc.Wilmington, and Delaware. ISBN 0-9678005-4-4, pp 27-35.

22. Rizzi, T.E. (2014): Urinalysis in Companion animals Part 2: Evaluation of Urine Chemistry & Sediment, May/June 2014 Today's Veterinary Practice.

23. Schreiber, G.; Howlettf, G.; Nagashima, M.; Millership, A.; artin, H.M.; Urban, J. and Kotlerg, L. (1982): The Acute Phase Response of Plasma Protein Synthesis during Experimental Inflammation, The Journal of Biological Chemistry. 257, No 17, Issue of September 10, pp. 10271-10277, 1982.

24. Seo, K.W.; Lee ,J.B.; Ahn,J.O.; Lee,H.W.; Hwang,C.Y.; Youn,H.Y.; Lee,C.W.(2012): C-reactive protein as an indicator of inflammatory responses to experimentally induced cystitis in dogs. J. Vet. Sci. (2012), 13(2), 179-185, http://dx.doi.org/10.4142/jvs.2012.13.2.179.

Online First

Published online: August 22, 2019

25. Smith, S. T. (1996): Non-protein Nitrogen". In Bishop, Duben-Engelkirk J.L, Foden F.P (Eds) Clinical chemistry: Principles, procedures and correlations. Lippincott-Raven Publishers, Philadelphia: 348–350.

26. Sturgess, K. (2016): A multimodal approach to feline and canine cystitis management. https://www.vettimes.co.uk.

27. Vaden, S.L.; Knoll, J.S.; Smith, S.W.K. and Tilley, L.P.(2009): Protein electrophoresis. In: S.L. Vaden, J.S. Knoll, S.W.K. Smith, and L.P. Tilley (eds.) Blackwell's five-minute veterinary consult: laboratory tests and diagnostic procedures. Wiley-Blackwell, Ames, IA, USA, pp. 501-503.

28. Norman, T.J. and Baily, M.A. (1997): Statistical Methods in Biology. 3rd. Cambridge University Press.

29. Langston, C.E. (2011): Cystitis in Dogs, Saunders

30. Leoci, R.; Aiudi, G. Silvestre, F.; Lissner, E.A.; Marino. and Lacalandra,G.M.(2015): Therapeutic Ultrasound as a Potential Male Dog Contraceptive: Determination of the Most Effective Application Protocol" reproduction in domestic animal.

31. Ling, G.V. (2000): Bacterial infections of the urinary tract. Editors Ettinger, S.J., Feldman, E.C. Textbook of Veterinary Internal Medicine. Diseases of the Dog and Cat. Philadelphia, U.S.A., W.B.Saunders Company, pp. 1678-1686, 2000.

32. Ling, G.V.; Norris, C.R.; Franti, C.E.; Eisele, P.H.; Johnsonn, D.L.; Ruby, A.L. and Jang, S.S.(2001): Interrelations of organism prevalence, specimen collection method, and host age, sex and breed among 8,354 canine urinary tract infections (1969-1995). J. Vet. Intern. Med. 2001; 15: 341-347.

33. Primovic,D.(2002): Acute cystitis, http//Petplace.netscape.com/articles/artprinter Friendly.asp?conID=12478, 2002 .

34. Tilley, L.P. and Smith, Jr. F.W.K. (2004): The 5-Minute Veterinary Consult-Canine and Feline. 3rd Edition, Lippincott Williams & Wilkins, Philadelphia, 768-769.