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Ultrasonographic evaluation of the urinary tract diseases in dogs and its correlation with other diagnostic procedures

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Abstract
The objective of the present study was to evaluate the urinary tract diseases of dogs by ultrasonography and to correlate that with other diagnostic procedures. A total of 800 cases presented to the Teaching Veterinary Clinical Complex during the period from June 2017 to May 2018. Thirty-five dogs out of 800 were suspected for urinary tract diseases based on history and clinical signs. All the suspected animals were subjected to ultrasonography and other diagnostic procedures like radiography, haemato-biochemical analysis and urinalysis. Cystitis (22.86%, 8/35) and urolithiasis (11.42%, 4/35) were the major findings noticed in the present study. In ultrasonography, the inflamed thickened wall was visible with the distinction of different layers of the urinary bladder wall in case of cystitis. The cystoliths were visible as hyperechoic structures with distal acoustic shadow and appeared as a bright echogenic area. Radiographic examination revealed mucosal irregularity decreased with increasing bladder distension in cystitis cases and the presence of radiopaque masses in the urinary bladder. The haemato-biochemical analysis revealed significant (p<0.05) decrease in haemoglobin and significant (p<0.05) increase in neutrophils count, blood urea nitrogen and creatinine levels. In urinalysis, an increase in specific gravity, pH and presence of leukocytes, erythrocytes, protein, blood, urobilinogen and crystals noticed. On critical analysis of the above mentioned diagnostic procedures, it was observed that there was interrelationship among the different diagnostic methods for urinary tract diseases of dogs. It was observed that ultrasonography (91.67%) was the best diagnostic method for urinary tract diseases followed by haemato-biochemical analysis (66.67%), radiographic examination (50.00%) and urinalysis (41.67%). The results of the present study indicated that ultrasonography is more sensitive than radiography in diagnosing urinary tract diseases.

Keywords: Urinary tract, dogs, ultrasonography, urinalysis, radiography, sensitive

Introduction
The ultrasound imaging technique is a safe diagnostic tool for both patients and operating personals in veterinary practice with minimal biological hazards [1]. Assessment of the urinary tract with ultrasound has become a routine diagnostic practice in veterinary medicine [2]. Urinary ultrasonography offers outstanding diagnostic techniques when conventional radiographic assessment fails to reach a final diagnosis [3]. Generally, the radiographic technique is used to diagnose the conditions of cystic calculi, but it becomes challenging when urinary stones are radiolucent [3]. Ultrasonography is often recommended as the first diagnostic imaging modality in patients with haematuria or dysuria. Ultrasonography provides various information regarding the capacity of the urinary bladder, changes in bladder outline and wall thickness, identification of mural and luminal masses and also identify the extrinsic lesions which causing changes in bladder shape. Urinary tract infection of dog is a common problem in Mizoram but its diagnosis is sometimes complicated due to improper diagnosis. The modern diagnostic imaging techniques available for small animal practice include computed tomography, magnetic resonance imaging and scintigraphy. The extent of their use may be limited by availability, cost and expertise. Hence, veterinary clinicians have been depending on traditional diagnostic procedures. Each of the methods of investigation has its advantages and disadvantages and there is a dire need to use two or more tests in a single case. A bird's eye view on the available literature reveals that there are very few reports, about comprehensive studies on comparative usage of various investigative procedures for

diagnosing urinary disorders in dogs. Keeping these points in view, the objective of the present study was to evaluate the urinary tract diseases of dogs by ultrasonography and to correlate that with other diagnostic procedures.

Materials and Methods

Study area and selection of animals

The study was conducted in Teaching Veterinary Clinical Complex (TVCC), College of Veterinary Sciences and Animal Husbandry, Central Agricultural University, Selesih, Aizawl, Mizoram and State Veterinary Dispensary, Khatla, Aizawl, Mizoram. A total of 800 dogs were examined and age, sex, breed and history were recorded for 12 months from June 2017 to May 2018. Selection of animals was done based on history and correlating clinical findings such as haematuria, dribbling of urine, dysuria and pollakiuria.

Ultrasonographic examination

For scanning of the urinary bladder, the ventral pelvic region of the animal was shaved properly and positioned in dorsal and lateral recumbency. The US machine used for this study was MyLab40 vet (Esaote, Italy), digital doppler ultrasound. The images were acquired with a 5-8 MHz two-dimensional curvilinear transducer.

Radiographic examination

Abdominal radiographs were taken using Digital X-ray Machine (Siemen). Radiographs were taken by keeping the dog in a lateral or dorso-ventral position. Digital images were processed by using computed radiography (CR) System and interpreted accordingly.

Collection of blood samples

The blood samples (approximately 4.0 ml) were collected from each dog by venipuncture of cephalic vein in K2-EDTA (dipotassium ethylenediaminetetraacetic acid) and clot activator containing vials. Approximately, 1.0 ml of the blood sample was used for haematology and rest 3.0 ml of the blood sample was allowed to clot and centrifuged at 200×g for 10 min to separate serum and stored at −20 °C till analysis of serum biochemistry. Six healthy animals were taken as a control group for comparison.

Haematology

The haemoglobin (Hb), total erythrocyte count (TEC), total leukocyte count (TLC), packed cell volume (PCV) and differential leukocyte count (DLC) were measured using semi-automated blood cell counter (MS4e).

Serum biochemical parameters

Total protein, albumin, globulin, blood urea nitrogen (BUN) and creatinine levels in serum were estimated by using dry chemistry auto analyzer (Automated Fuji Dri-chem blood analyzer, Japan).

Urinalysis

The urine samples from affected dogs were was collected by direct method or urinary bladder catheterization and compared with healthy control. The urine samples in eppendorf tubes were centrifuged at 1500 rpm for 5 minutes. The supernatant was removed and the sediment was suspended in the remaining volume of urine. The samples were examined by microscopy for the presence of red blood cells, epithelial cells, leukocytes, casts, crystals, bacteria and yeast cells as per the method described by Lattimer *et al.* [4]

Statistical analysis

The results were analyzed using t-independent test for comparing healthy and diseased groups [5].

Results and Discussion

During the study period, 35 dogs out of 800 were suspected of urinary tract diseases based on history and clinical signs. Cystitis (22.86%, 8/35) and urolithiasis (11.42%, 4/35) were the major findings of the study. The animals showed symptoms of change in urination patterns like increased or decreased frequency, dribbling of urine, straining to urinate, pain while urinating and blood in the urine. These findings are compatible with signs observed by Sharma and Shrestha [6]. Haematuria indicated damage caused by uroliths to the urinary bladder and urethra [7]. Dennis *et al.* [8] stated that bladder haemorrhage may occur secondary to trauma, cystitis, cystic calculi or cystic neoplasm, and it is essential to distinguish between such causes.

Ultrasonographic examination

In cystitis, the urinary bladder wall was diffusely thickened and hyperechoic with an irregular mucosal margin. Urine was echogenic giving a swirling effect (Fig. 1- 4). These results coincided with Rajkumar and Ansar [9] who also observed diffuse bladder wall thickening with a hyperechoic wall and irregular mucosal surface in cystitis cases. In all the cases of cystolithiasis, calculi were visible as hyperechoic structures on a dark background of anechoic urine with distinct acoustic shadowing. Thickening of the urinary bladder was also observed in some cases (Fig. 5-6). Cystic and urethral calculi with dilated lumina and clear acoustic shadowing were noticed in the present study and similar findings were also reported by Konwar *et al.* [10]. Ultrasonography has a potential value in diagnosing urolithiasis [11]. Contrary to the findings of the present study, Nyland *et al.* [12] opined that identification of urinary calculi by ultrasonography is sometimes difficult since the intensity of acoustic shadowing varies depending upon the machine used and the transducer frequency used.

Radiographic examination

Computed radiographic examination of lateral and ventrodorsal pelvis revealed mucosal irregularity decreased with increasing bladder distension in cystitis cases (Fig.7) and the presence of radiopaque struvite masses in the urinary bladder (Fig.8) except in one dog where the crystals were found to be urate and are not clearly visible in the radiograph as they are radiolucent. Bumin and Soylu [13] suggested that simultaneous examination of dogs using radiography and ultrasonography helped diagnose cystic calculi. Survey radiographs showed the presence of a radio-opaque mass located in the bladder, while ultrasound scans revealed a hyperechoic mass in the bladder surrounded by anechoic urine. Ultrasound offers a better imaging modality due to the visualization of urinary crystals which cannot be detected on radiologic examination [14].

Haematology and serum biochemical parameters

Haematological analysis revealed significant (p<0.05) decrease in Hb and significant (p<0.05) increase in neutrophils and monocytes count as compared to healthy dogs (Table 1). Similar findings of anaemia and decreased levels of

packed cell volume were also observed by Bradea *et al.* [15]. However, Mesquita *et al.* [16] observed normal haematological parameters in various disorders of the urinary system. Similarly, serum biochemical analysis revealed significant (p<0.05) increase in BUN and creatinine levels as compared to healthy dogs (Table 1). These results agreed with Uma *et al.* [17] and Sharma and Shrestha [6]. Increased BUN and creatinine in urinary problem might be due to decreased glomerular filtration rate which caused by pre-renal causes, renal parenchymal disease, or post-renal causes [18].

Urinalysis

Qualitative and microscopic analysis of urine revealed abnormal colour, increase in specific gravity and pH, presence of leukocytes, erythrocytes, protein, blood, urobilinogen and crystals in affected dogs and such findings were absent in healthy control (Table 2). In cystitis, the urine becomes turbid due to presence of desquamated epithelial cells of the bladder in the urine whereas in other cases haemorrhages in the bladder may lead to haemorrhagic cystitis [19]. Increased specific gravity might be due to high urinary protein concentration [20]. Alkaline urine might be due to the presence of urease-producing bacteria, which break down urea to ammonia, resulting in alkaline urine [20]. Observed proteinuria in the present study might be due to inflammation of urinary tract [21] which was in agreement with Cetin *et al.* [22]. Proteinuria is also associated with the rate of progression of diseases and inflammation of the urinary tract as suggested by Raila *et al.* [23]. The findings of urate crystals observed in this present study might be due to oxidation of uric acid to allantoin, as a result, accumulation of uric acid in plasma and urine, which can lead to the formation of urate crystals. The result is in agreement with the observations made by Archer [21].

Correlation of ultrasonography with other diagnostic procedure

On critical analysis of the above mentioned diagnostic procedures, it was observed that there was interrelationship among the different diagnostic methods for urinary tract diseases of dogs (Table 3). It was observed that ultrasonography (91.67%) was the best diagnostic method for urinary tract diseases followed by haemato-biochemical analysis (66.67%), radiography examination (50.00%) and urinalysis (41.67%). The accurate diagnosis of urinary tract disease solely based on clinical signs is impossible and this is in agreement Maddison and Syme [24] who stated that urinary disease is a relatively common problem in canine medicine and may be associated with a wide and often confusing range of clinical signs. The clinical picture, haemato-biochemical, radiographical and urinalysis can help in the diagnosis of urinary affection, whereas ultrasonography determines accurate nature of such disease.

Table 1: Haemato-biochemical alterations in dogs affected with urinary tract diseases

Parameters	Affected dogs (n=12)	Healthy (n=6)	t-independent test
TEC (cells ×10^6/µL)	4.18±0.55	6.95±0.41	0.021*
Hb (g/dL)	9.23±1.82	13.63±0.36	0.005*
PCV (%)	37.63±1. 71	42.77±3.90	0.383
TLC (cells ×10^3/µL)	20.85±3.19	12.62±0.75	0.094
Neutrophils (%)	76.78±3.58	70.17±2.55	0.024*
Lymphocytes (%)	18.66±3.56	22.17±2.40	0.523
Monocytes (%)	3.13±0.33	6.17±1.76	0.032*
Eosinophils (%)	1.42±0.38	0.67±0.33	0.222
Total Protein (g/dL)	5.39±0.46	5.53±0.40	0.846
Albumin (g/dL)	2.13±0.22	2.83±0.22	0.064
Globulin (g/dL)	6.07±2.93	2.7±0.21	0.436
BUN (mg/dL)	34.63±10.99	10.08±2.28	0.031*
Creatinine (mg/dL)	6.717±2.53	0.97±0.09	0.033*

*P<0.05; probability levels that were significantly different from mean ± SEM in the healthy dogs

Table 2: Urinalysis of dogs affected with urinary tract diseases

Parameters	Healthy dogs (n=6)	Dogs with urinary tract disease (n=12)
Colour	Yellow	Brownish red
Turbidity	Clear	Mild turbid
Specific gravity	1.015±0.07	1.034±0.09
pH (mean±SE)	7.00±0.05	7.37±0.08
Glucose	Negative	Positive
Ketone	Negative	Negative
Leukocyte	Negative	Positive
Bilirubin	Trace to 1+	Trace to 1+
Blood	Negative	Positive
Protein	Trace	More
Urobilinogen	Negative	Positive
Crystals	Negative	Positive

Table 3: Correlation of ultrasonographic examination with other diagnostic procedure

Diagnostic procedure	No of cases showed Positive out of 12 cases	Percentage (%)
Urinalysis	05	41.67
Haemato-biochemical analysis	08	66.67
Radiography	06	50.00
Ultrasonography	11	91.66

Fig 1: Well-distended urinary bladder with irregular and hyperechoic wall

Fig 3: Sonogram showing an increase in the thickness of the bladder wall, corrugation and presence hyperechoic sediments in urine

Fig 2: Distended urinary bladder, the distinction of the wall layer is visible and the wall thickness measures 0.33 cm

Fig 4: Sonogram showing severe thickening of the urinary bladder wall

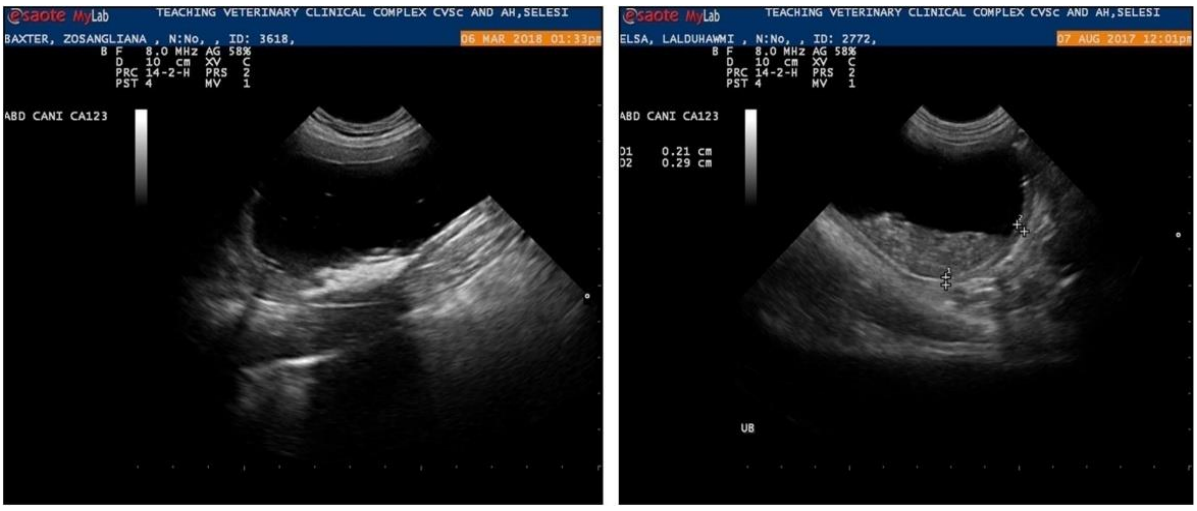

Fig 5, 6: Cystoliths visible as hyperechoic structures with distal acoustic shadow

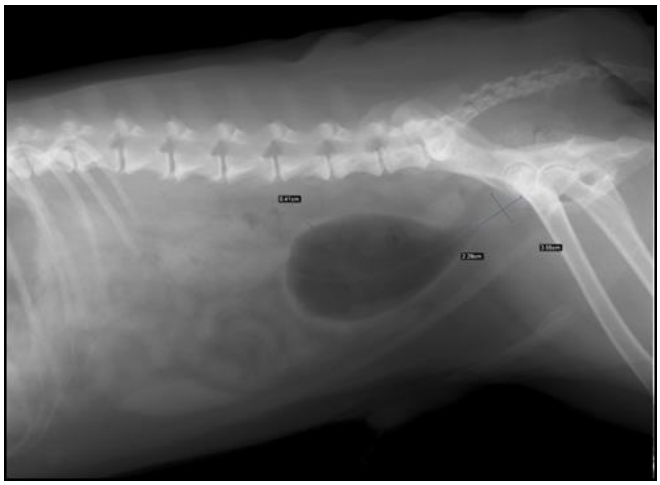

Fig 7: Cystitis with mucosal irregularity decreased with increasing bladder distension

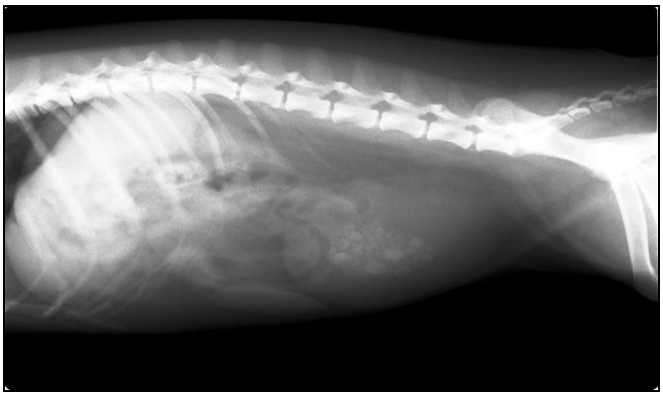

Fig 8: Presence of struvite crystals in the urinary bladder

Conclusion

It can be concluded that ultrasonography is a more accurate technique in diagnosing cystitis and cystic calculi. Plain radiography is conclusive only to limited instances like urolithiasis. In many instances, they are complementary to each other. Haemato-biochemical profile and urinalysis can be used to assess the severity of the disease, besides adding to diagnosis.

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