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Ultrasonographic and radiographic evaluation of bacterial lower urinary tract infection (Cystitis) in geriatric dogs

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Abstract
The present study was carried out to investigate ultrasonographic and radiographic findings in bacterial lower bacterial urinary tract infection of geriatric dogs. The total number of adult dogs (>6 years) brought to the medicine outpatient ward of Veterinary Clinical Complex, College of Veterinary Science., Rajendranagar with various medical problems during the study period (January 2021 to April 2022) was 7280. Out of these total adult dogs, 620 were geriatric, and out of which, 184 dogs that were showing the clinical signs indicative of bacterial lower urinary tract infection (Cystitis), such as haematuria, pollakiuria, stranguria, dysuria, periuria, abdominal pain, foul smelling urine, depression, loss of appetite and anuria etc., were taken up for detailed study. 134 geriatric dogs that were diagnosed with bacterial lower urinary tract infection (Cystitis) included for study. The ultrasonographic and radiographic changes recorded in bacterial lower urinary tract infection recognize a high degree of specificity in accordance with the type and degree of the medical condition. Ultrasonographic changes in the urinary bladder of dogs which had positive cultures included, thickened urinary bladder wall, sediments on the floor of bladder, echogenic swirls within the bladder and two dogs showed ovoid nodular mass with short stalk in bladder**.** In the present study, thickness of distended urinary bladder wall was 3 mm to 18 mm in dogs with BLUTI. In dogs with polypoid cystitis, pneumocystography revealed irregular filling defects which are protruding from thickened bladder wall towards the centre of urinary bladder.

Keywords: Bacterial lower urinary tract infection, Ultasonography, Radiography, geriatric dogs

1. Introduction
Urinary tract infection (UTI) refers to the microbial colonization of the urine or of any urinary tract organ. Urinary tract infection (UTI) of bacterial origin is the most common infectious disease of dogs, affecting 14 per cent of all dogs during their lifetime. Most UTIs are the result of ascending bacteria from rectal or fecal contamination or from the distal urogenital tract. The infection is more prevalent in older dogs with a median age of 9 years (Greene, 2012, Wong *et al.*, 2015) [1, 2]. Bacterial urinary tract infections can be classified as simple or uncomplicated, which is a sporadic bacterial infection of the urinary tract in an otherwise healthy individual with normal urinary tract anatomy and function, and it does not occur more frequently than every 4 to 6 months, and complicated, which is defined as a urinary tract infection (UTI) that occurs in the presence of an anatomic or functional abnormality or a comorbidity that may predispose the patient to persistent infection, recurrent infection or treatment failure. Common comorbidities of complicated UTI include diabetes mellitus, chronic kidney disease (CKD), urolithiasis, immune suppression etc. (Wood, 2017) [3]. The clinical expression and specific ultrasonographic evaluation of urinary bladder diseases in dogs comprise an obvious and constant professional challenge for the veterinary clinician. The ultrasonographic changes recorded in urinary bladder diseases recognize a high degree of specificity in accordance with the type and degree of the medical condition. (Yogeshpriya *et al.*, 2014, Biasibetti *et al.* 2019) [4, 5]. The ultrasound diagnosis allows the identification and understanding of the parietal elements and any changes especially correlated with the uniform/non-uniform thickening which can be easily diagnosed in accordance with the position, echogenicity changes or echo structure. In such cases, the presence and degree of micturition disturbances and correlated urine abnormalities allow to diagnose the various urinary bladder diseases. The ultrasound examination confirms the presumed diagnosis based on the accurate results about the bladder topography, type and quantity of the content (Corpuscular elements in suspension and/or in

sediment, stones and clots), degree of distension, identification of mural and luminal masses, parietal tonus, wall thickness, uniformity and ratio of the parietal constituents. The advantages offered by the accuracy and non-invasiveness of the ultrasound examination makes it a recommended valuable harmonising method of diagnosis for urinary bladder changes in the dog. Bumin and Soylu (2000) [6] suggested that simultaneous examination of dogs using ultrasonography and radiography was more helpful for diagnosing bladder abnormalities. The present research was conducted to evaluate USG and radiography changes in bacterial lower urinary tract infection (Cystitis) in geriatric dogs.

2. Materials and Methods

Geriatric dogs that were showing the clinical signs indicative of bacterial lower urinary tract infection, such as haematuria, pollakiuria, stranguria, dysuria, periuria, abdominal pain, foul smelling urine, depression, loss of appetite and anuria etc., were taken up for detailed study. Ultrasonographic examination was performed using a Z5 Vet Mindray ultrasound machine. Kidneys, urinary bladder and urethra were evaluated ultrasonographically. Variable frequency 2.0-5.0 MHz convex array and 7.0-12.0 MHz linear array transducers were used for scanning ventro lateral abdominal area. Morphology of kidney and urinary bladder was evaluated by abdominal ultrasonography as per the procedure described by Nyland *et al.* (2002) [7]. The abdomen was prepared by clipping the hairs and acoustic coupling gel was applied on to the skin. The kidneys were initially examined from the ventral abdomen with the animal in dorsal recumbency. Left kidney is easier to visualize because of its more caudal position and acoustic window was provided by the spleen. The cranial position of dog's right kidney within rib cage makes high quality images possible when evaluated through the right 11^{th} or 12^{th} intercostal space. Urinary bladder was also examined in dorsal recumbency. The transducer placed on the caudoventral abdomen, to one side of the penis or prepuce cranial to the pubis in females. Plain lateral or negative contrast (pneumocystogram) radiographs of abdomen were taken to visualize the urinary bladder and urethra. For peumocystography, animal was positioned right lateral recumbence on the radiographic table. For catheterization of urethra, infant feeding tube of relevant size was used in both male and female dogs. Then room air was injected into the bladder with the help of 30 mL syringe till appropriate distention of bladder was achieved. Immediately radiograph was taken on lateral and ventrodorsal view of caudal abdomen. After taking the radiograph, the abdomen was gently pressed to facilitate the expression of air from the bladder. This procedure helps in evaluation of bladder lumen or any tumour, diverticula, and radiolucent calculi which are detectable through routine survey radiography. (Atalan *et al.*, 1999) [8].

3. Results

Dogs suspected with bacterial lower urinary tract infection is subjected to ultrasonographic examination of the abdomen involving both upper and lower urinary tracts in order to rule out the disorders associated with complete urinary tract. In dogs with BUTI, the ultrasonographic examination of kidney revealed normal appearance with respect to shape, size and echogenicity. Ultrasonographic changes in the urinary bladder of dogs which had positive cultures (BLUTI) included, thickened urinary bladder wall in 72 (53.73%) dogs, sediments on the floor of bladder in 48 (35.82%) dogs, echogenic swirls within the bladder in 12 (8.96%) dogs, and two dogs (1.49%) showed ovoid nodular mass with short stalk in bladder. Dogs with ovoid nodular mass in bladder underwent surgical cystotomy to evaluate the urinary bladder and to obtain tissue samples for histopathology that were confirmed as polypoid cystitis by histopathological studies. Bladder wall thickness in a fully distended bladder was approximately 1 to 2 mm in apparently healthy animals. In the present study, thickness of distended urinary bladder wall was 3 mm to 18 mm in dogs with BLUTI. The details are shown in table 1 and fig. 1 to 5. Radiographic evaluation of bacterial lower urinary tract disease suspected dogs was carried out to study the plain and contrast pneumocystographic abnormalities. Radiological examination of the geriatric dogs with bacterial LUTI did not reveal any detectable changes on survey abdominal radiography. In dogs with polypoid cystitis, pneumocystography revealed irregular filling defects which are protruding from thickened bladder wall towards the centre of urinary bladder (Fig.6).

Table 1: Ultrasonographic changes in bacterial LUTI

Sl. No.	Sonographic changes	No. of animals (n=134)	Percent (%)
1	Thickening of the urinary bladder wall	72	53.73
2	Sediments on the floor of bladder	48	35.82
3	Echogenic swirls within the bladder	12	8.96
4	Ovoid nodular mass in bladder	2	1.49

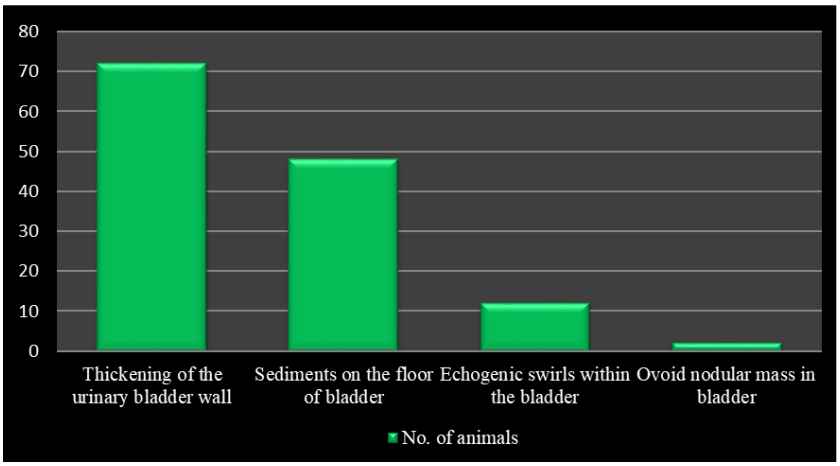

Fig 1: Ultrasonographic changes in bacterial LUTI (n=134)

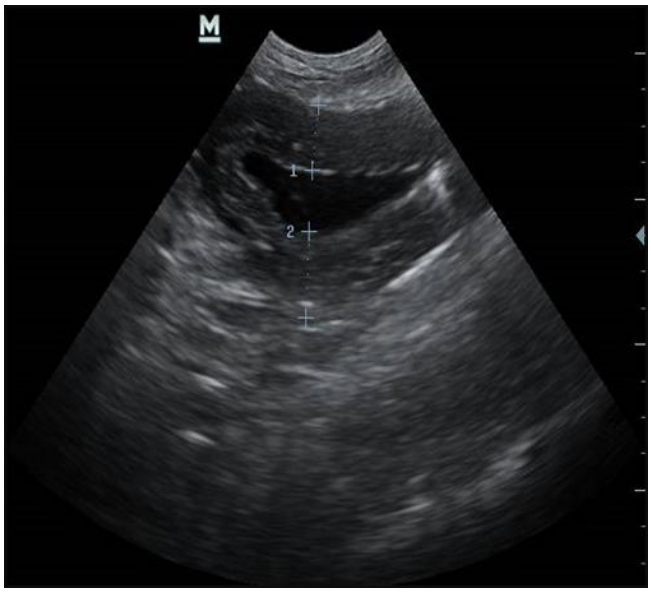

Fig 2: Ultrasound image of bladder showing hyperechoeic irregular surface and thickened wall in adog with cystitis (BLUTI)

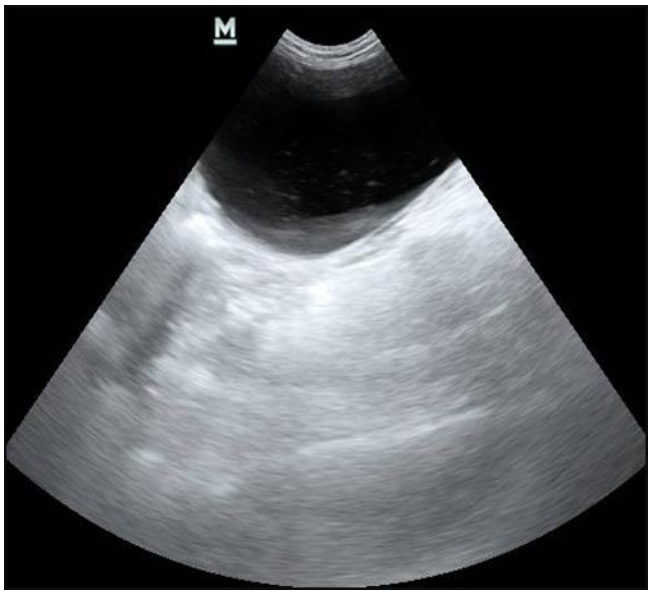

Fig 3: Hyperechoeic sediment on the ventral floor of the bladder

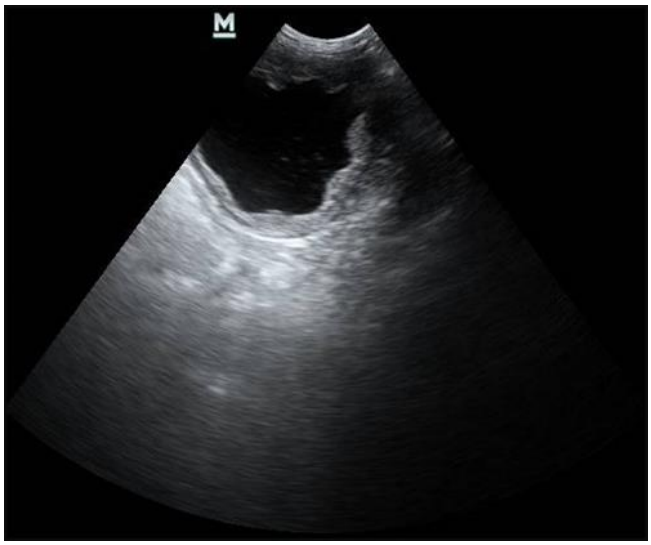

Fig 4: Ultrasound image of a cystitis bladder showing irregular, thick wall along with hyperechoeic swirls in the bladder lumen

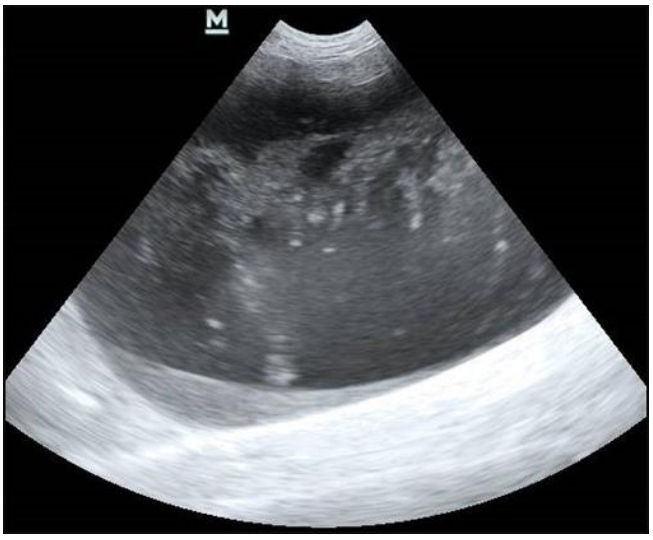

Fig 5: Ultrasound image showing ovoid nodular mass with a stalk in the bladder (Polypoid cystitis). Also note the presence of echogenic debris

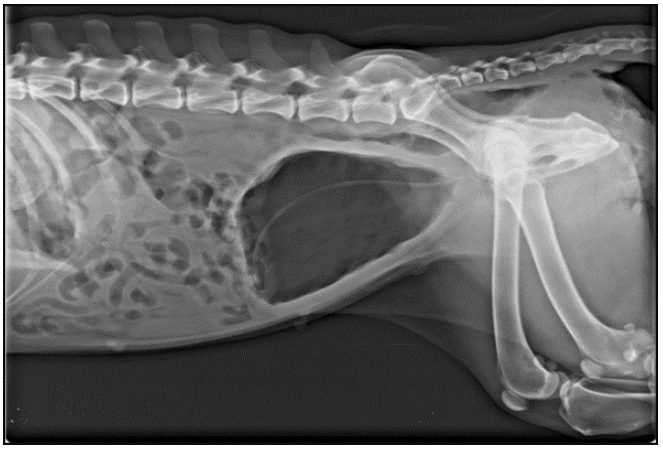

Fig 6: Pneumocystography showing irregular filling deffects into centre of bladder (Polypoid cystitis)

4. Discussion

In the present study, dogs suspected with bacterial lower urinary tract infection is subjected to ultrasonographic examination of lower urinary tract including kidneys in order to rule out the involvement of upper urinary tract. The ultrasonographic examination of kidney revealed normal appearance with respect to shape, size and echogenicity in all cases. Ultrasonographic changes in the urinary bladder of dogs with positive cultures (BUTI) include, thickened urinary bladder wall in 72 dogs, sediments in ventral aspect of bladder in 48 dogs, echogenic swirls within the bladder in 12 dogs, 2 dogs showed ovoid nodular mass in bladder. Bladder wall thickness in a fully distended bladder was approximately 1 to 2 mm in apparently healthy animals. In a non-distended bladder, evaluation of bladder wall thickness requires subjective evaluation according to the amount of distension. Mean bladder wall thickness as 2.3 mm in minimally distended bladder, 1.6 mm in mildly distended bladder and 1.4 mm in moderately distended bladder. Mean bladder wall thickness increased significantly with increasing body weight and with decreasing bladder distension (Mantis and lamb, 2008 and Yogeshpriya *et al.*, 2018) [9, 10]. Chronic cystitis causes wall thickening that is usually most pronounced

cranioventral, but in severe cases it can become generalized. Cystitis most commonly causes widespread irregular hypoechoic thickening of the urinary bladder wall. In the present study, thickness of urinary bladder wall was 3 mm to 18 mm in 60 dogs with BLUTI (cystitis) and in remaining dogs (74) with UTI the thickness of the bladder wall was <2 mm. In dogs with BUTI, the observed thickness of urinary bladder wall was > 2 mm in diameter as opined by Mantis and lamb (2008) [9]. Yogeshpriya *et al.* (2018) [10] opined that cystitis was recognized by a diffuse thickening of the bladder wall. Similar findings were observed in dogs with cystitis by Dinesh *et al.* (2015) [11], Rajkumar and Ansar Kamran (2016) [12], Srikanth *et al.* (2017) [13], Biasibetti *et al.* (2019) [5] and Lippi *et al.* (2019) [14], Due to damage of mucosal defence barrier of bladder due to infection and leading to inflammation causing increase in the thickness of bladder mucosa. These changes might be related to leukocyte infiltration and haemorrhage in all the layers of the bladder wall (Boston and Singh, 2014) [15]. Hyperechoic sediments on the floor of bladder were observed in 48 dogs. These sediments suggest cellular debris and sludge in the bladder formed during inflammation, when disturbed, it moved as a cloud and resettled in dependent part of the bladder. This is in accordance with the observation made by Srikanth *et al.* (2017) [13] in their study on Ultrasonographic examination dogs with cystitis. Echogenic swirls or swirling effect, which is caused by presence of blood cells or high protein content in the urine of infected animals with BLUTI (cystitis) within the bladder was seen in 12 dogs. Kealy *et al.* (2010) [16] and Lippi *et al.* (2019) [14] also observed swirling effect in bladder of dogs with BUTI. 2 dogs showed ovoid nodular mass with in bladder. These two dogs underwent surgical Cystotomy and tissue samples were collected and processed for histopathological study and were confirmed as polypoid cystitis. These Ultrasonographical findings are in agreement with the reports of Takiguchi and Inaba (2005) [17] and Nandini *et al.* (2016) [18] who observed similar sonographic findings in polypoid cystitis. In dogs with polypoid cystitis, pneumocystography revealed irregular filling defects which were protruding from thickened bladder wall towards the centre of urinary bladder, which may be due to presence of mucosal projections into the lumen of urinary bladder. The findings are in agreement with authors Martinez *et al.* (2003) [19] and Takiguchi and Inaba (2005) [17] who explained polypoid cystitis seen as multiple, irregular filling defects projecting into the positive contrast pool, arising from the thickened cranioventral bladder wall.

5. Conclusion

It is concluded that ultrasonography is often recommended as the first diagnostic imaging modality in patients with hematuria or dysuria. It can provide information relative to the capacity of the urinary bladder, changes in bladder outline and in wall thickness, identification of luminal and mural masses, and identification of extrinsic lesions that may displace the bladder wall causing changes in its shape. Ultrasonography allows an evaluation of the entire urinary tract (except distal urethra) in both gender dogs.

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