

Diagnostic evaluation of ultrasonography in canine hepatobiliary and urinary disorders

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Received: 5 January 2010; Accepted: 20 November 2010

Key words: Cystoliths, Hepatobiliary disorders, Ultrasonography, Urinary disorders

Ultrasound is considered as a safe procedure for the patient, the operator and nearby personnel and non-invasive allowing it to be performed in any location without the need for specific safety precautions (Preston and Shaw 2001). Hepatobiliary and urinary disorders are quite common in dogs. Abdominal ultrasonography seems to be of much diagnostic assistance for identifying various abdominal disorders in particular to the abnormalities of the liver parenchyma, biliary tract, vascular system and urinary system. However, a comparative evaluation of ultrasonography with serum biochemistry and radiography is needed. The present study was, therefore undertaken to compare the diagnostic ability of clinical, ultrasonography, serum biochemistry and radiography in hepatobiliary and urinary disorders in dogs.

The study was conducted in the institutes Referral Veterinary Polyclinic during December 2009 to May 2010. Based on the history and clinical signs 48 dogs referred at the polyclinic were suspected to be having abdominal disorders. Out of which 36 and 12 dogs were diagnosed ultrasonographically to have hepatobiliary and urinary disorders, respectively, formed the material for the present study. 10 Apparently healthy dogs (10) brought for vaccination or regular check up were also included as a control group for comparison. Clinical examination was performed employing routine standard procedures. Abdominal ultrasonography was performed with Sonosite 600 M machine using 2.5–5.0 MHz transducer. Sick anorectic dogs were not subjected to fasting prior to sonographic examination. Cranio-ventral abdominal hairs were shaved and acoustic coupling gel was applied liberally before sonography. Dogs were gently restrained in dorsal

recumbency by holding the forelimbs and hind limbs. No anesthesia or chemical restraint was used. Scanning was performed for liver, gall bladder, kidneys and urinary bladder as per the standard procedure described by Nyland *et al.* (2002).

Total serum protein, serum albumin, serum bilirubin, ALT, ALP and GGT for hepatobiliary disorders and BUN, serum Creatinine and ALP for urinary disorders were estimated colorimetrically using reagent kits. Abdominal radiography was performed employing standard procedure.

The clinical signs/symptoms recorded in dogs with hepatobiliary disorders included depression and dullness (25), inappetence/anorexia (30), vomiting (18), diarrhoea (11), melena (5), ascites (21), abdominal pain (9), pedal odema (4), icterus (3), swollen lymph nodes (7), cough (5), dyspnoea (3) and dogs with urinary disorders showed depression and dullness (8), inappetence/anorexia (10), vomiting (3), polyuria/polydipsia (11), anuria (1) and anaemia (10). The clinical findings in respect to all the dogs for average values of rectal temperature ($101.4 \pm 0.8^\circ\text{F}$), heart rate (98 ± 20 bpm) and respiratory rate (26 ± 8 /minute) were found normal. On abdominal palpation, six dogs were suspected for hepatomegaly, two for splenomegaly and eighteen dogs showed abdominal fluid thrill on tactile percussion. Apart from these signs epistaxis and ataxia for few seconds was noticed in one dog. These clinical signs were extremely variable and vague related to gastrointestinal and neurological symptoms (Holt *et al.* 1995) commonly seen in hepatopathies depending on the etiology and the extent of liver damage (Sharma *et al.* 2001). However, jaundice and melena were observed in chronic active hepatitis (Center 1995). Mc Grotty (2008) opined that clinical signs can be variable and depend on stage of renal disease but may include polyuria and polydipsia, decreased appetite, weight loss and depression. A progressive non-regenerative anaemia commonly develops in animals with chronic kidney disease secondary to shortened red blood cell life span, erythropoietin deficiency and intestinal blood loss.

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The ultrasonographic examination of liver of apparently healthy control dogs revealed uniform coarsely granular echotexture with visible portal vein and pear shaped, anechoic vesicular gall bladder (Fig. 1-6). Liver was found equal to or slightly more echogenic than the right kidney cortex, whereas, slightly hypoechoic than the spleen as also reported by Nyland *et al.* (2002). Portal veins had hyperechoic walls and the hepatic veins anechoic walls, whereas, both intra and extra hepatic biliary ducts could not be visualized as described by Lamb (1990) for normal canine liver. Ultrasonographic identification of the liver lobes and sub lobes was not clear.

As per the severity and ultrasonographic features of hepatobiliary disorders, 4 different forms of hepatopathies noted as follows, viz. acute hepatopathies, chronic hepatitis, cholecystitis and hepatosplenomegaly (Table 1). Six dogs showed reduced parenchymal echogenicity with enhanced visualization of portal vessels suggestive of acute hepatitis. Liver echogenicity is usually normal in cases of acute hepatitis, but it may be decreased with enhancement of periportal echoes (Biller *et al.* 1992). In 3 dogs the liver parenchyma revealed multifocal hypoechoic lesion suggestive of focal necrosis, which were in agreement with Lamb (1990) and in 1 dog lesions suggestive of lymphoma, confirmed later by fine-needle aspiration cytology from lymph nodes.

Diffuse hyperechoic liver parenchymas with less distinct portal vessels associated with peritoneal fluid accumulation (ascites) were noticed in 9 dogs diagnosed as chronic hepatitis which was in agreement with the findings of Varshney and Hoque (2002). Four dogs were diagnosed to have hepatic cirrhosis as evidenced by hyperechoic 'bright' small liver with irregular margins as reported by Cartee (1981). Irregular margins and hyperechogenicity was due to fibrosis which occurs in chronic cases of hepatitis. Focal increases in hepatic echogenicity due to fibrosis or dystrophic calcification are also possible (Nyland and Mattoon 2002). Sludge was detected in 3 dogs which was associated with anorexia and chronic hepatitis. Nyland *et al.* (2002) opined that sediment might be related to biliary stasis from fasting or illness, but sometimes can be seen in healthy, non-fasting animals.

Cholecystitis was diagnosed in 7 dogs which had increased echogenicity of the wall with thickening ranging from 2.9 to 3.7 mm. Spaulding (1993) opined that wall thickness is diagnosed when the wall is thicker than 3–3.5 mm. Increased echogenicity or hyperechoic thickening of gall bladder wall is usually consistent finding in cholecystitis. But the presence or absence of cholelithiasis and the character of biliary sludge are variable (Nyland and Mattoon 2002). Increased echogenicity or hyperechoic thickening of gall bladder wall with or without an irregular muscular contour, in addition to cholecystitis has been associated with cystic hypertrophy of mucous producing glands of mucosa, a normal aging change in older dogs (Lamb 1995, Burk and Ackerman 1996) and biliary neoplasia (Lamb 1995). Gall bladder wall thickening

in ascites and congestive heart failure was considered due to hypoalbuminemia, which consequently affects plasma colloid oncotic pressure causing edema of the wall. Pain was detected in the gallbladder region during scanning in 2 dogs which was referred as the sonographic (Murphy sign) characteristic of acute cholecystitis (Ralls *et al.* 1982).

The spleen was markedly enlarged with uniformly reduced parenchymal echogenicity in 4 dogs along with hepatomegaly. This abnormal but non-specific splenic pattern was associated with haemoprotozoan infection (Ehrlichiosis in 1 dog and *Hepatozoon canis* infection in 2 dogs) as evidenced by the blood smear examination. Nyland and Mattoon (2002) were of the view that acute systemic infectious or inflammatory diseases may cause secondary splenomegaly and hepatomegaly with normal to reduced echogenicity which was observed in this study.

Ultrasonographically the left kidney was found in close contact with the greater curvature of the stomach at its anterior margin and the spleen at its dorso-medial aspect. Often the spleen is found ventral to the left kidney, providing an ideal acoustic window. The right kidney was found in close proximity with the caudate liver lobe cranially. Sagittal scanning of renal sonogram showed 3 distinct zones, viz. a bright central echo-complex representing the renal sinus and peripelvic fat, a hypoechoic region surrounding the pelvis representing renal medulla, and outer zone of intermediate echogenicity, the renal cortex. Renal medulla is hypoechoic relative to that of surrounding renal cortex as also reported by Konde *et al.* (1984). Both the kidneys were found equal in size and the left kidney was sonographically easily detectable in comparison to the right kidney. The urinary bladder was easily recognized in the ventral pubic area as an anechoic vesicular structure distended with urine providing an acoustic window as also reported by Voros *et al.* (1995). The bladder wall was also easily recognized as a hyperechoic thin line ranging from 1–2 mm thick. It is ideally suited for sonographic examination because of its superficial position and its fluid contents so that little attenuation of the sound beam occurs (Barr 1990). On the basis of organ involved and ultrasonographic observations, cases of urinary disorders were differentiated as renal abnormalities, cystitis and cystic calculi.

Out of 12 dogs diagnosed for urinary disorders 7 dogs had renal abnormalities such as glomerulonephritis (3), renal cysts (1), hydronephrosis (1) and chronic renal failure (2). Ultrasonographic findings in these cases were more echogenic renal cortex as compared to the liver suggestive of nephritis, cyst visualized as solitary, round to ovoid structure with echo-free contents, smooth and sharply demarcated thin walls and chronic renal failure as evidenced by poor visualization of the corticomedullary junction and internal renal architecture. The sonographic features of simple cysts include a round to ovoid contour, echo-free contents, smooth and sharply demarcated thin walls with a

Table 1. Mean±SE values of different biochemical parameters in control and in different types of hepatobiliary disorders

Group	Total protein (gm/dl)	Albumin (gm/dl)	A: G ratio	Total bilirubin (mg/dl)	Direct bilirubin (mg/dl)	ALT (IU/L)	ALP (U/L)	GGT (U/L)
Control (n=10)	5.8±0.42	2.670 ^a ±0.197	1.16±0.26	0.77±0.09	0.51±0.05	90.593 ^{ab} ±11.585	80.416±6.69	4.727 ^a ±0.516
Acute hepatopathies (n=12)	6.28±0.24	2.488±0.165	0.77±0.14	1.95±0.93	1.32±0.72	86.149 ^a ±15.909	64.036±12.02	5.229 ^a ±0.580
Chronic hepatitis (n=13)	5.05±0.42	2.044 ^b ±0.214	1.45±0.63	2.08±1.19	1.43±0.89	63.49 ^a ±9.292	76.668±18.83	5.927 ^a ±1.509
Cholecystitis (n=7)	5.94±0.33	2.091±0.125	0.57±0.16	1.49±0.16	1.03±0.16	57.611 ^a ±10.639	73.423±22.304	12.159 ^b ±0.712
Hepatosplenomegaly (n=4)	6.17±0.45	2.523±0.118	0.75±0.12	1.05±0.09	0.75±0.11	147.805 ^b ±22.205	92.278±13.57	5.190 ^a ±0.761

Means with different superscripts in the same column differ significantly (P < 0.05).

distinct far-wall border, and strong distal echo enhancement as observed in one dog (Konde 1985). Hydronephrosis was seen in a dog which had urethral obstruction as suggested by the greatest degree of pelvic dilatation (Felaki *et al.* 1995). Three dogs revealed thickened wall with corrugations in urinary bladder which had increased echogenicity suggestive of cystitis. Voros *et al.* (1997) reported that chronic cystitis causes wall thickening that is usually most pronounced cranioventrally, but it can become generalized in severe cases. One dog showed hyperechoic foci inside the bladder suggestive of calculi along with cystitis. A 10 years old non-descript male dog revealed focal hyperechoic radiolucent calculi with acoustic shadow. Radio-opaque or radiolucent calculi are detected as hyperechoic focal echogenicities that shadow in the dependent portion of the bladder (Cartee *et al.* 1980, Biller *et al.* 1990). The amount of shadowing varies with the composition and compactness of the calculus, its location with respect to the focal zone and the ultrasound frequency used. In most cases repositioning the animal and imaging the bladder in multiple planes will distinguish fibrosis or calcification from calculi, blood clots, sediments or gas bubbles (Nyland and Mattoon 2002).

The mean values of total protein, albumin and A: G ratios were within the normal range when compared to control values as suggested by Kaneko *et al.* (2008) except insignificant hypoproteinemia and significant hypoalbuminemia in chronic hepatitis group. Sevelius (1995) reported that total albumin levels were markedly decreased in chronic progressive hepatitis with high sensitivity, indicating that hypoalbuminemia is an important marker of chronic inflammatory liver disease, when other causes of protein losing disorders were ruled out. The reduction in total protein in chronic hepatitis without statistical significance could be attributed to hypoalbuminemia as evident from the study.

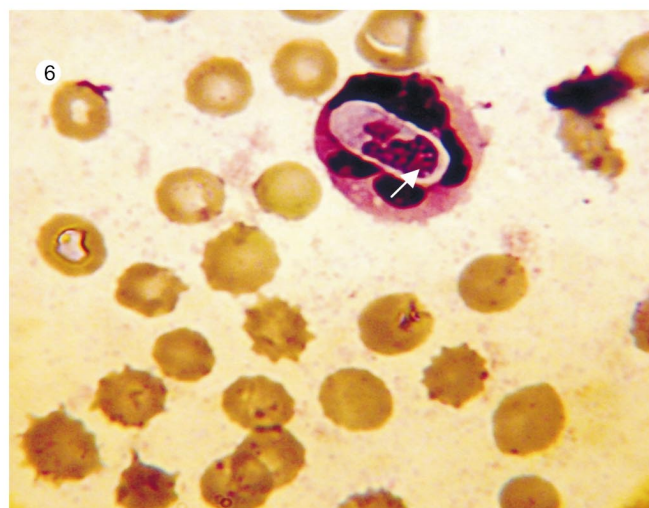
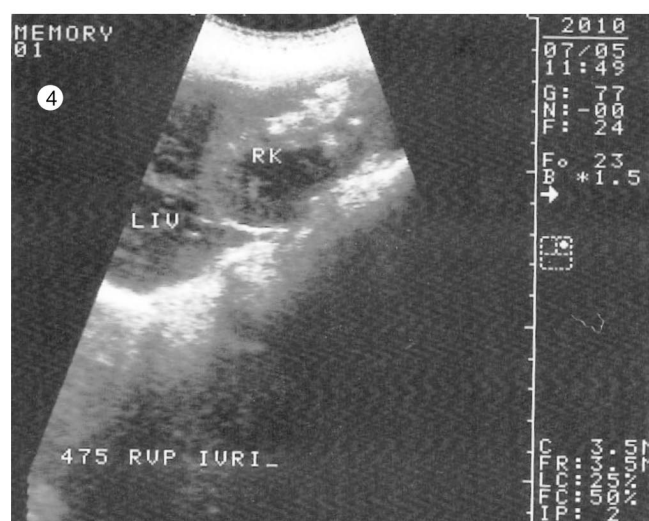
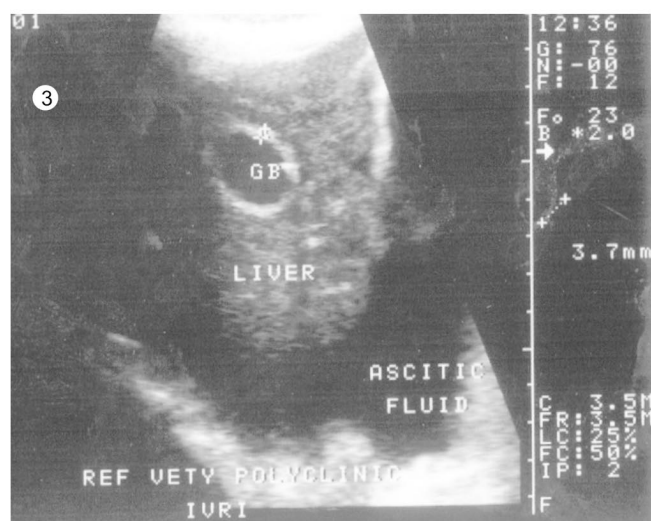
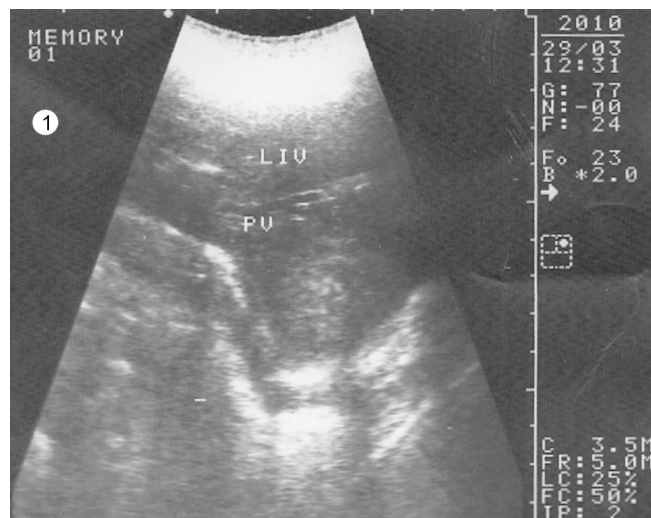
It was noticed that there was considerable increase in the total and direct bilirubin levels in all groups when compared to the control group, though nonsignificant. Among the

groups chronic hepatitis group showed increase in total bilirubin level compared with the others. The bilirubin increased due to disturbances in the balance between rates of production, metabolism and excretion of this dye caused by altered hepatic function (Kaneko *et al.* 2008). There was no significant difference in ALT values of different groups when compared with control group. Fuentealba *et al.* (1997) and Center (2007) stated that short half life of the enzyme and a single insult to liver could result in high ALT values that soon returned to normal which was seen in this study. Kaneko *et al.* (2008) postulated normal value of ALP in dogs to be ranging from 20–156 U/L. No statistically significant difference was observed among the different groups of the present study. However 2 dogs with cholestasis and bile duct obstruction showed greater activity of ALP. High serum ALP is considered a sensitive marker for cholestasis in most mammalian species including dogs (Solter *et al.* 1994). Tennant (1997) was of the view that increased synthesis of ALP might be due to extrahepatic bile duct obstruction or intrahepatic cholestasis. A nonsignificant elevation of GGT values in different groups when compared with the control was observed. But the cholecystitis group showed significant increase in GGT values as compared with control and other groups (Table 1). GGT is considered as a serum marker primarily for diseases of the hepatobiliary

Table 2. Mean±SE values of different biochemical parameters in control and in different types of urinary disorders

Group	BUN (mg/dl)	Creatinine (mg/dl)	ALP (U/L)
Control (n=8)	17.29 ^a ±1.81	1.33 ^a ±0.17	76.30 ^a ±6.76
Renal disorders (n=7)	44.64 ^b ±6.64	3.19 ^{ab} ±0.74	141.503 ^b ±23.2
Cystitis/cystoliths (n=5)	41.09 ^b ±8.95	5.29 ^b ±0.92	97.24 ^b ±42.31

Means with different superscripts in the same column differ significantly (P < 0.05).



Figs 1–6. Sonogram showing: 1. normal canine liver with uniform coarse granular echotexture and visible portal vein; 2. a small hyperechoic “bright” liver with irregular margins surrounded by ascitic fluid indicating cirrhosis; 3. cholecystitis showing thickened gall bladder wall (3.7 mm); 4. chronic renal failure or end-stage kidney showing loss of corticomedullary definition; 5. radiolucent hyperechoic calculi (arrow) with acoustic shadow (AS). 6. Photomicrograph of *Hepatozoon canis* gamont in a neutrophil (arrow, Leishman staining, 100×).

system associated with cholestasis (Braun *et al.* 1983) as also noticed in this study.

Significant increase in both blood urea nitrogen (BUN) and creatinine levels was noticed in urinary disorders (Table 2). This might be due to the renal abnormalities and the urinary retention due to obstruction which is in agreement with others (Gleadhill 1994, Kaneko *et al.* 2008). Significant increase in ALP levels were noticed in renal disorders group when compared with control and cystitis/cystoliths group. A non-significant increase was noticed in cystitis/cystoliths group when compared with the control group.

Abdominal radiography of 3 dogs with hepatobiliary disorder and 2 dogs with urinary disorders (cystic calculi) did not provide any useful information. The ability of ultrasound to distinguish fluid from soft tissue and differentiate between soft tissues based on their composition makes it better suited than radiography for examining soft tissue structures (Nyland and Mattoon 2002). Ultrasound therefore provides a non-invasive effective alternative to many radiographic contrast procedures although the 2 techniques should still be considered as complimentary. Ultrasound may also often provide information that previously was only available through exploratory laparotomy (King 2006). In many cases, ultrasonography has replaced radiography as the initial imaging procedure in screening for liver diseases (Koyama 2004). Ultrasonography is most suitable for diagnosing and locating the site of both radiopaque and radiolucent calculi in the urinary system whereas radiography only detects the radiopaque calculi (Cartee *et al.* 1980). Koyama (2004) was of the view that ultrasound imaging is usually one of the first studies performed to assess the kidneys because of important anatomic information concerning the size, shape, and internal architecture that can be obtained even in the presence of impaired renal function or abdominal fluid.

Routine urine examination in 5 dogs revealed presence of epithelial cast, crystals and few pus cells. Blood smears from dogs with liver and splenic enlargement were examined for blood protozoa infection, in which 1 dog was positive for *Ehrlichia canis* and 2 dogs was positive for *Hepatozoon canis*. These findings were in agreement with Baneth (2006) and Mark Neer and Harrus (2006). Microscopic detection of gamonts in peripheral blood smears is the most frequently used diagnostic test. The hepatitis is associated with developing meronts within the liver and their associated neutrophilic and mononuclear inflammation (Kearns 2009). Based on the study it was concluded that ultrasonographically the incidences of hepatobiliary and urinary disorders were more, with the clinical signs were relatively vague and variable in nature. Ultrasonography served as a valuable aid in diagnosing and differentiating hepatobiliary and urinary disorders especially cirrhosis, renal failure, cystitis, cystoliths and hepato-splenomegaly compared to serum biochemistry and radiography.

SUMMARY

In the present study a comparative evaluation was made between clinical signs, ultrasonography, serum biochemistry and radiology for diagnosis of hepatobiliary and urinary disorders in dogs. The normal ultrasonographic appearances were studied for liver, gall bladder, kidneys and urinary bladder and the observations were compared with diseased group. The findings were also correlated with the blood biochemical alterations, viz. albumin, ALT, GGT, BUN and creatinine along with plain radiography. The study indicated that ultrasonographically the incidences of hepatobiliary and urinary disorders were more, with the clinical signs were relatively vague and variable in nature. Ultrasonography served as a valuable aid in diagnosing and differentiating hepatobiliary and urinary disorders especially cirrhosis, renal failure, cystitis, cystoliths and hepato-splenomegaly compared to serum biochemistry and radiography.

ACKNOWLEDGEMENTS

We extend our sincere thanks to Director and Joint Director, IVRI, Izatnagar, for extending all facilities and also to ICAR for providing Junior Research Fellowship to the first author.

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