



Ultrasonographic features of normal heart and liver in relation to diagnose pericarditis in bovine

ASHWANI KUMAR¹, NARINDER S SAINI², JITENDER MOHINDROO³ and NARESH K SOOD⁴

Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab 141 004 India

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ABSTRACT

The present study was conducted on 6 clinically healthy bovine and 55 adult female bovine (29 cows and 26 buffaloes) suffering from pericarditis. Ultrasonographic examination was performed from both right and left sides with convex or microconvex multifrequency (3.5 or 5.0 MHz) transducer in standing position. The pericardial effusions were seen from both right and left sides of heart at fourth and fifth ICS. Pericardial effusions were anechoic to hypoechoic with or without fibrin deposition in the pericardial sac in 74.6% animals or had a uniform echogenic texture in 25.4% animals suggestive of pus. Hepatic ultrasonography revealed congestion and marked hepatomegaly characterized by round liver margins. Caudal vena cava appeared persistently round and dilated. Portal vein was also dilated. Gall bladder was displaced with edematous and double walled appearance. Histopathology of ultrasound guided biopsy (USGB) and ultrasound guided fine needle aspiration biopsy (USG-FNAB) samples confirmed sinusoidal dilatation in all the animals along with chronic cholangiohepatitis, amyloidosis or chronic sepsis, purulent hepatitis, chronic active hepatitis and fatty liver. In conclusion ultrasonography is a reliable technique to describe nature and severity of the pericardial effusions to assess prognosis and outcome of the case.

Key words: Bovine, Congestion, Hepatomegaly, Histopathology, Pericarditis, Peritoneal effusions, Pleural effusions, Ultrasound guided biopsy

Traumatic pericarditis in bovine is usually associated with perforation of potential metallic foreign bodies through the reticulum and diaphragm into pericardial sac (Ramakrishna 1993, Radostits *et al.* 2007). Trauma to pericardium initiates inflammation. Accumulation of exudates due to inflammation and formation of adhesions causes cardiac tamponade which leads to right side heart failure, systemic congestion and toxemia (Ramakrishna 1993, Radostits *et al.* 2007). The affected animals generally showed variable clinical signs which depends upon the severity of disease, individual sensitivity and the species of the animal (Singh *et al.* 2006, Abdelaal *et al.* 2009, Braun 2009a). Hemato-biochemical and radiographic findings are usually non-specific and may mimic any pleural effusions or pleuritis and thoracic abscess etc. (Ramakrishna 1993, Radostits *et al.* 2007). Presently there are a few reports on the use of ultrasonography to evaluate heart in bovine and hepatomegaly has been reported to be associated with traumatic pericarditis (Braun 2009a). The present study was planned to describe ultrasonographic

features of heart in healthy and pericarditis affected bovine animals and histopathological changes in liver associated with pericarditis.

MATERIALS AND METHODS

All the clinically healthy (6) and pericarditis affected bovine (55) were prepared by hair clipping or shaving the entire right thoraco-abdominal wall starting flank to fourth intercostals space. On left side, area from seventh to fourth ICS was prepared for ultrasonographic examination. Ultrasonography was done by moving transducer dorso-ventrally at each intercostal space starting from right flank to fourth intercostal space in the standing position using multifrequency (3.5 to 5.0 MHz) convex or microconvex transducers.

Ultrasonography of the heart was performed from both, left and right, sides as per Braun *et al.* (2001). During ultrasonographic examination, any abnormal fluid density in the thoracic cavity including in the pericardial sac were noted. Subjective evaluation of the cardiac contractions was also done. Cranio-ventral abdominal region from right left and post-xiphoid region was scanned to visualize reticular contractions, peritoneal effusions and changes in spleen. Ultrasound guided pericardiocentesis was carried out in cases

Present address: ^{1,5}Assistant Professor, ²Professor-cum-Head, ³Associate Professor, Department of Veterinary Surgery and Radiology; ⁴Professor-cum-Head, Department of Veterinary Pathology, College of Veterinary Science.

showing increased fluid in pericardial sac and it was subjected to microscopic examination.

Liver was evaluated, ultrasonographically, to assess its size and echotexture. Caudal vena cava and portal vein were scanned to note their size, shape and diameter. Caudal vena cava and portal veins were identified as described by Braun (2009b). Ultrasonographic examination of gall bladder was done to assess its location, wall thickness and echotexture.

The ultrasound guided biopsy (USGB) and ultrasound guided fine needle aspiration biopsy (USG-FNAB) of liver was carried out randomly on 7 animals (4 buffaloes and 3 cows) and 3 cows respectively, in standing position. For USGB the instrument used was Bard Max core disposable biopsy gun (Fig. 1), which was resterilized before every use. The size of the needle was 16G with 16 cm in length. The length of sample notch was 1.8 cm and depth of the penetration was 22 mm.



Fig. 1. Core disposable biopsy instrument

Before taking USGB the local anesthesia (2% lignocaine, 10–15 ml) was achieved at the site of biopsy followed by aseptic preparation of the skin area by scrubbing with savlon and povidone iodine solutions. The biopsy was taken with free hand technique as per Singh *et al.* (2009). The procedure was performed by a single examiner by holding the ultrasound transducer in the left hand and the biopsy gun in the right hand. A stab incision on the skin was made with 11 no. surgical blade. Biopsy gun was loaded and the needle was pierced through the skin and subcutaneous tissues while being visualized on the monitor. Biopsy of the liver at desired site was made. In freehand technique, entry of the needle of the biopsy gun was at an oblique angle to the transducer depending upon the depth and location of the lesion. One or two liver biopsy samples were collected. After removal of the biopsy instrument, a post biopsy scan was done to check haemorrhage. The liver biopsy samples were immediately stored in 10% buffered formalin for histopathological analysis using H&E stain.

The USG-FNAB of liver was done using a 20–22G needle attached to a 10 ml disposable syringe as per Singh *et al.* (2009). The transducer was placed on the liver and the needle was advanced slightly oblique to the long axis of transducer through the skin. When the needle entered in the hepatic parenchyma, moderate and rapidly repeated suction (approximately 3–6 times) was applied to the syringe plunger while the needle was moved within the lesion or hepatic parenchyma. After complete release of the suction, the syringe along with needle was removed. Thin smears were

prepared on glass slides and evaluated cytologically for any abnormality using Leishman's stain.

Age, sex, species and reproductive status, brief history and clinical findings of appetite, defecation, tympany and brisket edema was recoded in animals diagnosed with pericarditis. Blood sample was collected in EDTA for estimation of hemoglobin, total and differential leukocyte count. Radiographic examination of the heart and caudal mediastinal region was also performed in lateral recumbency.

RESULTS AND DISCUSSION

In the present study, all 55 bovine (26 buffalo and 29 cows) suffering from hepatic congestion and pericarditis were adult females with a mean age of 6.23 ± 0.31 years. Among these 16 animals (7 cows and 9 buffaloes) were in advanced stage of pregnancy (>6 month of gestation) and 10 (3 cows and 7 buffaloes) had a history of recent calving of less than a month duration. High incidence of traumatic pericarditis in advanced pregnant or recently calved animals could be correlated to increased intra-abdominal pressure that might have pushed the potential metallic foreign bodies towards the thorax (Ramakrishna 1993). However, in the present study, majority of the animals (52.7%, $n=29$) were either non-pregnant or in early pregnancy or were in later stage of lactation indicating possibility of occurrence of pericarditis in animals at various stages of production and reproduction. Normal reticular contractions might also force the potential metallic foreign bodies to penetrate cranially into heart and lungs.

The 71% animals were anorectic for 1–4 weeks while remaining had a history of partial anorexia. Majority of the animals (69.1%) were passing scanty loose or hard faeces and 5.5% animals were not passing faeces while normal defecation was seen in 25.4% cases. Tympany was recorded only in 11% cases and brisket edema was present in 81.8% (27 cows and 18 buffaloes) cases. Similar but variable clinical signs in animals suffering from pericarditis were reported by various authors (Senna *et al.* 2003, Braun 2009a). However, there is a report of asymptomatic and sudden death of a buffalo having chronic pericarditis that had satisfactory productive and reproductive status before death (Singh *et al.* 2006). Signs of pain and systemic reaction were reported to be more pronounced in cows compared to buffaloes having traumatic reticulo-peritonitis and its sequele (Saleh *et al.* 2008, Abdelaal *et al.* 2009). Hematological examination revealed decreased Hb (8.63 ± 0.36 g/dL), leukocytosis ($17476 \pm 1751/\mu\text{L}$) with neutrophils $77.6 \pm 1.54\%$ as reported earlier (Ramprabhu *et al.* 2003). Hemato-biochemical findings in animals suffering from pericarditis are non-specific and are indicative of any suppurative or toxemic condition of the body (Radostits *et al.* 2007).

In the present study, lateral radiograph of animals suffering from pericarditis revealed poor visibility of diaphragmatic line, loss of cardiac silhouette and fluid density in the thoracic cavity as reported earlier (Misk and Semieka 2001, Braun

2009a). The presence of potential metallic foreign bodies in the thoracic cavity was observed in 51% animals only. Radiographically, a foreign body may not be visible because thick radiodense exudates or adhesions may obscure a foreign body or it might get migrate back and fall into the reticulum (Ramakrishna 1993, Braun 2009a). Penetration of potential metallic (Ramakrishna 1993, Radostits *et al.* 2007) or non-metallic foreign bodies (Krishnamurthy *et al.* 1998) were reportedly caused traumatic reticulo-pericarditis. Traumatic pericarditis was also reported in association with reticular diaphragmatic hernia in buffaloes (Saini *et al.* 2000).

Ultrasonographic examination

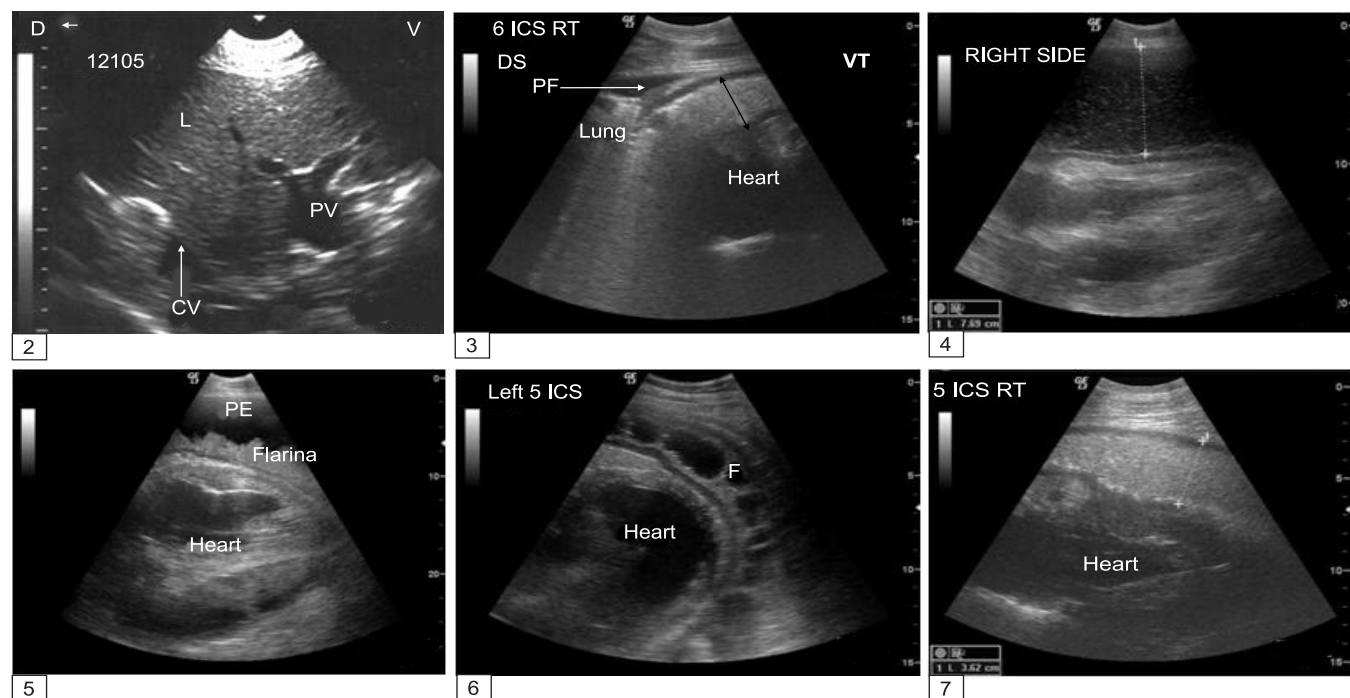
Normal heart was visualized close to the thoracic wall from both right and left sides in all the animals with no apparent fluid density in pericardial sac. From right side, heart was scanned in between the lung lobes from a narrow window at fourth ICS only while for scanning of heart from left side a larger window was available at fifth and fourth ICS in cows and buffaloes. Buffaloes being thick skinned and fatty in nature, scanning clarity was less in buffaloes compared to cows.

In clinically healthy bovine, normal liver was visualized ventral to lung when scanned dorso-ventrally at each intercostal space starting 12th to 6th ICS. Normal liver was

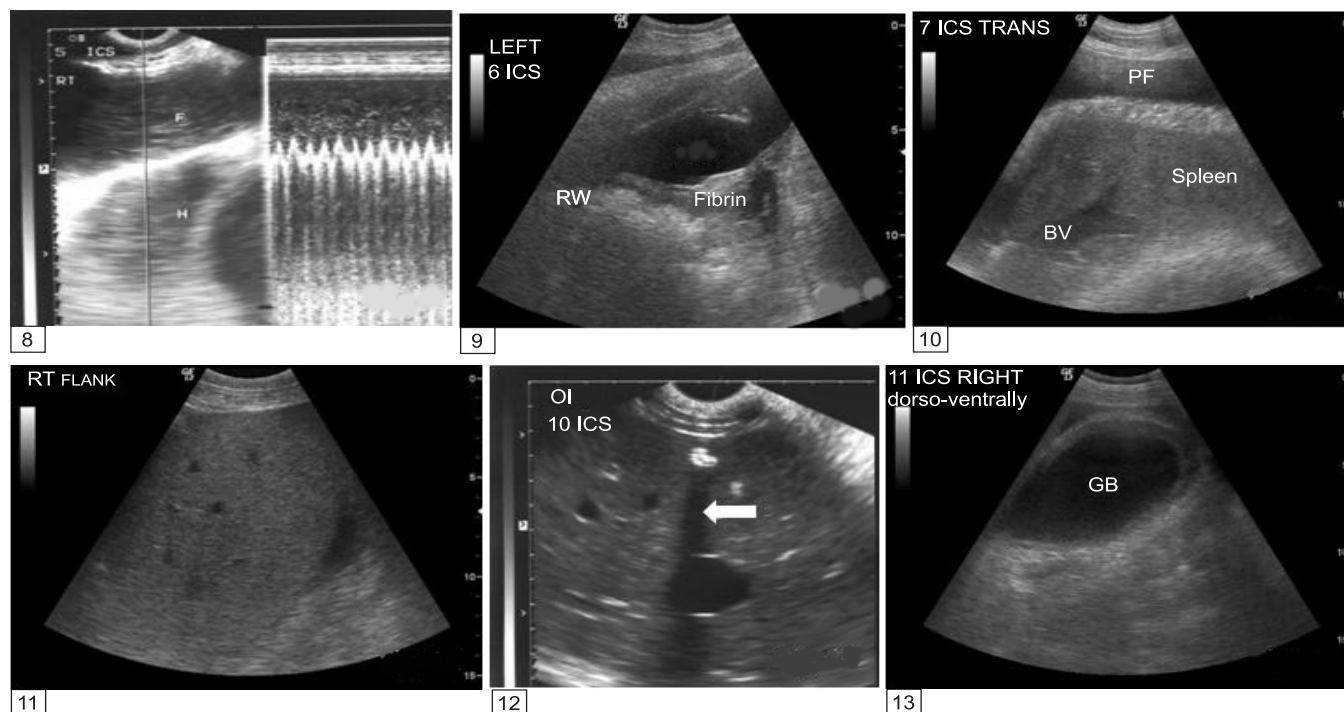
uniform and weakly echogenic in appearance approximately at the line joining right elbow and right hip bone. Braun (2009b) reported similar findings of scanning of liver within the rib cage i.e. up to 12th ICS. Vena cava was scanned dorsal and lateral to the portal vein (Fig. 2). Vena cava appeared triangular shaped with a mean diameter of 3.01 ± 0.1 cm while the portal vein was round with thick echogenic wall and mean diameter 2.82 ± 0.1 cm. Gall bladder was seen as a thin walled (3.66 ± 0.44 mm) sac like structure with anechoic contents at ninth and tenth ICS.

In animals diagnosed with pericarditis, heart appeared enlarged and was scanned over a larger area. A larger window at fifth and fourth ICS was available for visualizing pericardial effusions from both right and left sides. While scanning dorso-ventrally various structures such as pleural effusions, lung surface and presence of pericardial effusions were observed in real time B-mode. Pericardial sac with inflammatory exudates was easy to differentiate from pleural effusions due to localization of fluid column in pericardial sac around heart (Fig. 3).

In 93% cases, pericardial effusions were seen from both, right and left, sides of heart at fourth and fifth ICS. But in a few cases (n=4), heart appeared apparently normal from left side but pericardial effusions were seen from right side suggesting a need of evaluating heart from both sides for



Figs 2–7. Ultrasonound image showing portal vein (PV) giving multiple branches into liver (L) parenchyma. Vena cava (VC) is seen dorsal to portal vein. D (Dorsal), V (Ventral), **3.** Ultrasonographic image differentiating pleural fluid (PF) from fluid column in pericardial sac around heart (black double head arrow). DS (Dorsal), VT (Ventral). **4.** Ultrasonographic image showing anechoic with mixed hyperechoic contents in the pericardial effusions. Aspiration yielded foul smelling exudates. **5.** Ultrasonographic image showing anechoic pericardial effusions (PE) with fibrin deposition at epicardium. **6.** Ultrasonographic image showing echogenic fibrin strands in pericardial sac connecting epicardium and pericardium along with scanty amount of fluid indicating constrictive pericarditis. **7.** Ultrasonographic image showing uniform echogenic effusions indicating pus (double arrow) in the pericardial sac.



Figs. 8–13. **8.** Ultrasonographic image showing tachycardia and markedly reduced amplitude of cardiac contractions due to presence of pericardial effusions. F (fluid), H (heart). **9.** Ultrasonographic image showing thickened reticular wall (RW) with irregular contour and presence of peritoneal fluid with fibrin deposition. **10.** Ultrasonographic image showing dilatation of splenic blood vessels (BV) indicating congestion. Increased peritoneal fluid (PF) is also seen adjoining spleen. **11.** Ultrasonographic image showing scanning of liver parenchyma at right mid flank region (hepatomegaly) with round liver margins. **12.** Ultrasonographic image showing hyperchoic foci producing acoustic shadow (white arrow) in the hepatic parenchyma suggesting calcification. **13.** Ultrasonographic image showing thick or double walled appearance of gall bladder (GB).

proper diagnosis. In the present study, it was observed that the heart was dilated caudally and in a few cases pericardial effusions were seen even at sixth ICS in buffaloes ($n=3$). Pericardial effusions were anechoic to hypoechoic with or without fibrin deposition (Figs 4, 5) in the pericardial sac in 74.6% cases which yielded foul smelling fluid. In 2 buffaloes, echogenic fibrin strands were observed in pericardial sac between epicardium and pericardium along with scanty amount of fluid suggesting fibrinous or constrictive pericarditis (Fig. 6). In remaining animals (25.4%) pericardial effusions were of uniform hyperechoic texture (Fig. 7) which yielded thick pus on needle aspiration. Cited literature suggests presence of hypoechoic contents in pericardial sac corresponding to pus and suppurative pericarditis (Abdelaal *et al.* 2009, Braun 2009a) while echogenic bands between the hypoechoic thick pericardium represent fibrinous pericarditis (Abdelaal *et al.* 2009). The ultrasound guided needle aspiration of the pericardial sac helped to confirm the nature of the pericardial fluid. Cytological examination of the pericardial fluid revealed presence of bacteria and degenerated neutrophils suggestive of infection and inflammation.

The mean depth of the pericardial fluid column (from pericardium to epicardium) was 6.13 ± 0.57 cm (range 3 to

20 cm). The presence of pericardial effusions appeared to compress cardiac ventricles resulting in tachycardia and marked reduction in the amplitude of cardiac contractions was observed in B+M mode (Fig. 8). Reticular wall appeared irregular and thickened with reduced amplitude of the reticular contractions indicating reticulitis and reticular adhesions in all the animals diagnosed with pericarditis. Concurrent presence of excessive peritoneal fluid with fibrin (Fig. 9) and small amount of pleural fluid was also seen ultrasonographically, in all animals of the present study, suffering from pericarditis which corroborates to earlier findings (Braun 2009a). Presence of splenic congestion (Fig. 10), in the present study, could also be correlated to systemic congestion.

Hepatic ultrasonography revealed marked hepatomegaly in all the animals having pericarditis which was diagnosed based on scanning of liver beyond the 12th ICS. Ultrasonographically, congested liver was seen extending beyond rib cage up to right mid flank and ventrally along with rounding of the liver margins (Fig. 11). In a few cases ($n=6$) of the present study, single or multiple hyperchoic foci producing acoustic shadow were seen in the hepatic parenchyma (Fig. 12) during ultrasonographic examination which represented focal calcification. Gall bladder wall was



Fig. 14. Ultrasonographic image showing round appearance and dilatation of caudal vena cava (VC) and hepatic vein (HV).

thickened with a mean thickness of 11.31 ± 1.95 mm (range 7.3 to 18.4 mm) with double-walled appearance (Fig. 13) otherwise contents were normal. Gall bladder was displaced ventrally from its normal location and some times reaching abdominal floor ventro-laterally. In all the animals, ultrasonographically, caudal vena cava showed marked dilatation with round to oval appearance on cross section (Fig. 14) having a mean diameter of 4.82 ± 0.23 cm. On longitudinal view, swirling movements of blood could be appreciated on real time B-mode ultrasonogram. The portal vein was also dilated with a mean diameter of 4.20 ± 0.23 cm. Similar to the present study, hepatic changes such as marked hepatomegaly due to congestion and the caudal vena cava dilatation so that it appears round to oval instead of normally triangular in cross section has been reported to occur secondary to thrombosis (Braun *et al.* 2002) and in traumatic pericarditis (Braun 2009a). But in the present study, all animals suffering from pericarditis had hepatic congestion and hepatomegaly. Thickening of gall bladder wall due to edema has been reported in bovine patients having right side cardiac insufficiency due to any cause (Braun 2009b).

Histopathologically, hepatic congestion characterized by sinusoidal dilatation was confirmed in all the USGB samples which were related to systemic congestion due to right side heart failure. Other histopathological/cytological findings such as chronic cholangiohepatitis (n=3), chronic sepsis and amyloidosis (n=2), chronic active hepatitis (n=2), purulent hepatitis (n=2) and fatty liver (n=1) may occur depending upon the severity of the inflammatory process or sepsis. Johnson and Jamison (1984) diagnosed wide spread amyloid deposition in various organs like kidneys, liver, adrenal glands and spleen in dairy cows due to foci of inflammation related to traumatic reticuloperitonitis, traumatic pericarditis, salpingitis, mastitis and metritis. Histopathological findings, in the present study, indicate that systemic congestion associated with pericarditis and/or right side heart failure

resulted in marked hepatomegaly along with rounding and dilatation of the vena cava.

From the present study it is concluded that ultrasonography is a non-invasive tool to characterize nature and extent of pericardial effusions and thus helps to diagnose and assess prognosis. Ultrasonographically, heart should be evaluated from both left and right sides to diagnose pericardial effusions.

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