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RESEARCH ARTICLE

Ultrasonographic Diagnosis of Liver and Gallbladder Surgical Affections in Dogs and Cats

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Abstract

In the present study a total number of 26 dogs and 16 cats have been examined and diagnosed ultrasonographically with liver and gallbladder surgical affections. In dogs, it was found that the most liver and gallbladder affections were liver tumors 16 cases out of 26 affected dogs with an incidence rate of 61.5%. in the second level were cholecystitis 6 out of 26 with a rate of 23.1%, then liver abscess 3 cases (11.5%) and 1 case with gallbladder polyp (3.8%). While in cats, cholecystitis, cholangiohepatitis, mucocele and bile duct obstruction were 10 cases out of the 16 diagnosed cats with an incidence rate of 62.5%, then the rest were liver tumors 2 cases (12.5%), liver abscess, liver cyst, gallbladder rupture and bile duct stones 1 case each.

The sonographic picture, cytological and histopathological findings as well as the surgical treatment were described and discussed.

Introduction

Several hepatic disorders are found in dogs and cats and cause focal, multifocal or diffuse parenchymal alterations. The evaluation of the liver must include several parameters: liver size and contour, parenchymal echogenicity and ultrasound- beam attenuation as well as the distribution of abnormalities. Although some of these disorders have characteristic ultrasonographic features, most changes are not pathognomonic of one particular process **(d'Anjou, 2008).** The parenchymal echogenicity can be increased, decreased or unaffected. The disorder can also affect the parenchymal uniformity and distort the hepatic margin. It can appear heterogenous or contains hypoechoic or hyperechoic nodular foci. Hepatomegaly is expected in most types of diffuse neoplasia, although its size can vary with th**e** level of infiltration. Lymphoma can involve the liver without detectable ultrasonographic changes or causes diffuse parenchymal hypoechogenicity, hyperechogenicity or mixed echogenicity with or without hypoechoic nodules **(Whiteley et al., 1989 and Lamb et al., 1991).** However, the liver is considered to be the common target for metastasis, mainly through the portal system, which drains most of the abdominal structures. On the other hand, clinical evidence of gallbladder diseases may not be present. The diagnosis of cholecystitis on the basis of wall thickening should be made with caution **(Spaulding, 1993)**.

Ultrasonography has become an important investigative tool in assessing icteric dogs and cats with biliary obstruction **(Nyland and Gillett, 1982).** Therefore, the aim of the present study is to evaluate the efficacy of ultrasonography for diagnosis of different liver and gallbladder surgical affections as well as to survey such diseases.

Materials and Methods:

In the course of this study a total number of 26 dogs and 16 cats were examined ultrasonographically for diagnosis of different liver and gallbladder surgical affections. These animals were admitted to the small animal clinic, Justus - Liebig University, Giessen, Germany during the period from 2008 to 2010.

Ultrasonography was performed using a real-time ultrasound machine (Powervision 8000, SSA-390A; Toshiba) with an 8 to 12 MHz linear transducer and 5-7 MHz convex transducer and (LOGIQ 9 General Electric (GE) - USA) equipped with M7C (4-7 MHz) convex transducer and M12 L (9-12 MHz) linear array transducer. The ventral abdominal wall was clipped and acoustic gel (Sonogel; Bad Camberg) was applied. The entire abdomen was examined ultrasonographically while the animal was in dorsal recumbency.

Percutaneous ultrasound-guided aspiration biopsies were performed using either a 22 gauge spinal needle or a 20 gauge needle. The microcore automated biopsy was performed using a 18 gauge Tru-Cut-like needle, assisted by an automated biopsy gun. Fine - needle aspiration biopsy (FNAB) were also performed.
Specimens were preserved and were sent to Pathology Department for examination and diagnosis.

Partial lobectomy of one liver lobe was indicated and performed with a 4.8 TA (Thoraco-abdominal) stapler. Also cholecystectomy was indicated in some cases and performed through double ligature of its neck at the level of the cystic duct with its resection in-between the ligatures.

Results:

In this work a total number of 26 dogs and 16 cats have been examined and diagnosed with liver and gallbladder surgical affections.

Through the assessment of the affected cases, it was found that the breed, sex, and weight did not play any role in the incidence of these pathologies or surgical affections**.** 7 out of 26 cases were of mixed breed and the other 16 different breeds were recorded among the rest 19 dogs. 15 out of 26 were female of which 11 were castrated. Considering the age the affected cases were ranged from 2 to 14 years. Animals affected with liver tumors, cholecystitis and gallbladder mucocele were of old ages.

In cats the most breed encountered was the European Shorthair 14 out of 16, also 7 out of 16 cats were males, all of them were also castrated. Moreover, the incidence of these cases has no any relation with the weight of the animals. They weighted between 1.7 to 6.8 kg.

In dogs, it was found that the most liver and gallbladder affections were liver tumors, 16 cases out of 26 with an incidence rate of 61.5%. In the second level were cholecystitis 6 out of 26 with a rate of 23.1%, then liver abscess 3 cases (11.5%) and 1 case with gallbladder polyp (3.8%). While in cats, cholecystitis, cholangiohepatitis, mucocele and bile duct obstruction were 10 cases out of the 16 diagnosed animals with an incidence rate of 62.5%. then the rest were liver tumors 2 cases (12.5%), liver abscess 1 case, liver cyst 1 case, gallbladder rupture 1 case and bile duct stones 1 case.

Liver affections

1. Abscesses

A total numbers of 3 dogs and one cat had liver abscess. In ultrasonographic examination of 2 animals it was able to see anechoic fluid contents surrounded with hyperechoic region suspected to be gas and pus in the right liver lobe (Fig.1). Exploratory laparotomy demonstrated cavities with pus and necrotizing right liver lobe (Fig. 2 A & B). These dogs were euthanized on table. The abscess in the third dog appeared as heterogeneous mass in the liver and of about 7.5x6.5 cm (Fig. 3). In the cat there was a diffuse hypoechoic area with indistinct boundary indicating purulent hepatitis, no surgery was adopted. The cat was euthanized.

2. Tumors

In the course of this study there were a total numbers of 16 dogs and 2 cats. These were ultrasonographically diagnosed with suspicion of liver tumors, of these cases one dog demonstrated ruptured liver tumor which appeared with mixed echogenicity and heterogenous hypo- and hyperechoic masses with unclear margins (Figs.4 & 5).
Biopsy of the liver mass and the histopathological examination revealed fibrosarcoma. The dog was euthanized.

Another dog with ruptured liver tumor demonstrated a heterogenous mass with mixed echogenicity (anechoic to hyperechoic) (Fig. 6). This mass was aspirated for cytological examination and showed ruptured hepatocellular carcinoma. The dog was euthanized.

The circumscribed tumor nodules in 10 dogs with a size from 0.53 to 2 cm and reached to 7x7 cm or more were heterogeneous masses with a hypoechoic areas sometimes in the left or right margins of liver lobes (Fig.7 & 8). The rest of the liver tissue was normal.

Partial lobectomy of left lateral liver lobe included this round swelling was indicated. A 4,8 mm TA (Thoraco- Abdominal) Stapler was used for the operation.
The part of the excised lobe was histopathologically examined and revealed a hepatocellular adenoma.

One dog demonstrated heterogenous masses of different sizes and reached to 10 cm in size with mixed echogenicity from anechoic to hyperechoic. The liver parenchyma was highly inhomogenous and sometimes with multiple rounded hypoechoic masses. The same ultrasonographic finding was manifested in cats. In the rest 3 dogs demonstrated mixed echogenicity with distorted liver shape and contour. Generally hepatocellular carcinoma, adenoma and fibrosarcoma were manifested histopathologically.

3. Liver cyst

A liver cyst was diagnosed in one cat. It was manifested as an anechoic round structure in the liver parenchyma with distal acoustic enhancement (Fig. 9).

Gallbladder

In this study 7 dogs and 12 cats were diagnosed with suspicion for gallbladder and biliary tract affections.

1. Cholecystitis, Cholangiohepatitis, and Bile Duct Obstruction

A total numbers of 6 dogs and 10 cats suffered Cholecystitis and/or cholangiohepatitis with bile duct obstruction were examined ultrasonographically and demonstrated hyperechoic and large liver. The liver parenchyma was interspersed with multifocal small hypoechoic nodules. The gallbladder wall has hyperechoic areas and irregular structures that protrude into the lumen (Fig.10). Blood flow was only in the wall detectable. The cytology of the liver shows moderate hydropic degeneration, as well as a mild intracytoplasmic deposition of lipofuscin (age-related changes).

Severe distension of the gallbladder was seen ultrasonographically in a dog as large anechoic sac inside the liver with distal acoustic enhancement (Fig.11 A). Exploratory laparotomy was done for manual evacuation of the severely distended gallbladder that occurred due to adhesion at this area (Fig.11 B).

The characteristic ultrasonographic picture of the disease in cats demonstrated dilated gallbladder with anechoic fluid (bile) with dilated cystic and bile ducts (Fig. 12).

In other cats there were cystic anechoic sacs with hyperechoic walls diagnosed as dilated bile ducts inside the liver (Fig.13).

The ultrasonographic picture in cat showed an anechoic tubular structure inside the pancreas (dilated about 2mm) (Fig.14) and diagnosed as pancreatic duodenal duct which occurred in case of cholangiohepatitis and pancreatitis. Also the common bile duct is dilated (6 mm) (Fig.15). Cytological examination revealed purulent cholecystitis.

The ultrasonographic picture in a cat demonstrated hypoechoic rounded structure opens inside the duodenum and of prominent inner wall (5.5mm). It is diagnosed as prominent duodenal papilla in case of cholangiohepatitis and pancreatitis. (Fig. 16)

2. Gallbladder Mucocele

In this study 3 dogs were suspected of having mucocele. There was distension of the gallbladder seen with hyperechoic materials with cavitations and anechoic regions in one dog (Fig.17 A). While the other two dogs demonstrated the typical shape of the kiwi fruit (Fig. 17 B).

The gallbladder was resected (Fig.18 A & B) at the level of cystic duct with a double ligature. Fibrosponge was placed in gallbladder fossa to control bleeding. Abdominal drain was inserted to check the tightness of the ligature. The cytological picture of the liver demonstrated a very mild hydropic degeneration and a mild intracytoplasmic deposition of lipofuscin.

3. Gallbladder mass or polyp

In one dog the gallbladder revealed a hyperechoic protrusion from its inner wall with the dimension of 7 x 7 mm without a distal acoustic shadowing (Fig. 19). This mass could be a polyp or malignant neoplasia. Cholecystectomy operation and cytology to the sample was indicated but the owner refused.

4. Gallbladder rupture

There was one cat which had a gallbladder rupture. This cat was severely traumatized through a car accident. Ultrasound examination revealed gallbladder rupture that appeared as small contracted and shrinked hyperechoic structure with a diameter of 9 mm. Anechoic fluid between liver lobes was seen. Cholecystectomy was done (Fig. 20 and 21 A&B).

5. Bile duct stones

In this work there was one cat demonstrated bile duct stones. The ultrasonographic picture shows a hyperechoic structures with distal shadowing inside the liver around the hyperechoic wall of the bile ducts. Also hyperechoic round structures were seen at the area of the duodenum and common bile duct with distal shadowing (Fig. 22 A & B). Laparotomy was done and the duodenum, common bile duct as well as the gallbladder were opened for removal of the bile duct stone. The pathway of the duct was checked by 3 French catheter (Fig. 23 A- E). After closure of the choledochotomy the gallbladder and the duodenum were lavaged as well as the abdominal cavity with sterile normal saline solution.

Fig. 1: Liver abscess ultrasound longitudinal scan in a dog showing right liver lobe with anechoic fluid (F) and necrotic tissues with gas of hyperechoic shadowing (S)

Fig. 2: A&B Surgery: liver lobe (A) appeared necrotic and with abscess in the excised lobe (B)

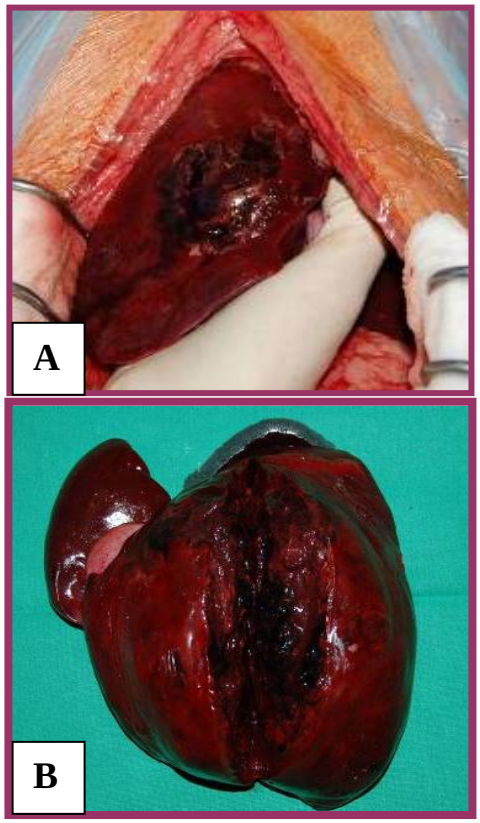


Fig. 3: Liver abscess ultrasound longitudinal scan in a dog showing heterogenous swelling in liver, it was about 7.5x6.5 cm in size.

Fig. 4: Ruptured liver tumor in a dog, ultrasound longitudinal scan appeared with mixed echogenicity and heterogenous hypo - and hyperechoic masses (arrow).

Fig. 5: Surgery in a dog showing ruptured liver tumor

Fig. 6: Liver carcinoma, ultrasound longitudinal scan in a dog showing a heterogenous mass of mixed echogenicity.

Fig. 7: Hepatocellular adenoma Ultrasound longitudinal scan in a dog showing circumscribed mass (7x7 cm) heterogeneous with hypoechoic area in the left margin of liver lobe.

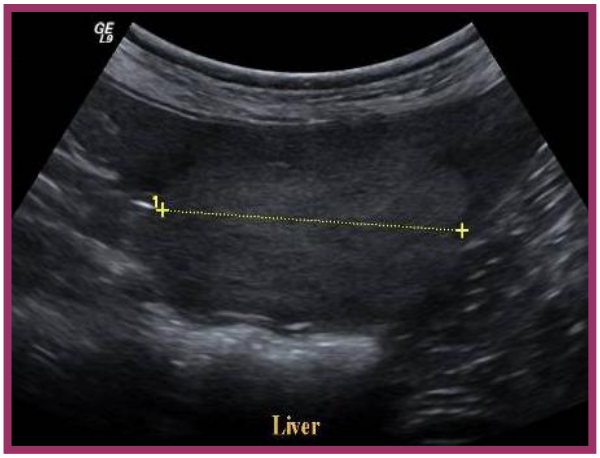


Fig. 8: Surgery in the same dog showing a mass in the left lateral hepatic lobe (arrow).

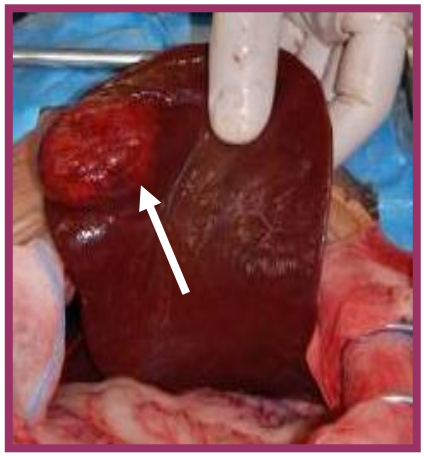


Fig. 9: Liver cyst, ultrasound longitudinal scan in a cat showing the liver cyst 0.79 cm appeared as anechoic structure with distal enhancement (arrow) in the parenchyma.

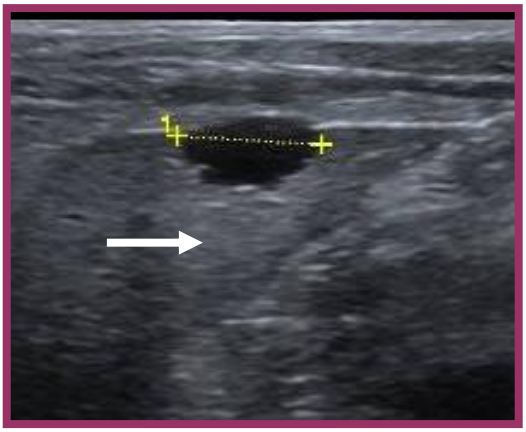


Fig. 10: Cholecystitis: ultrasound cross scan in a dog showing gallbladder wall hyperechoic areas and irregular structures that protrude into the lumen. Decreased blood flow was only detectable in the wall by Doppler ultrasound.

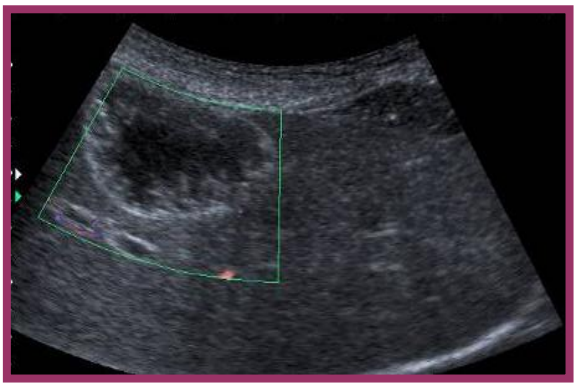
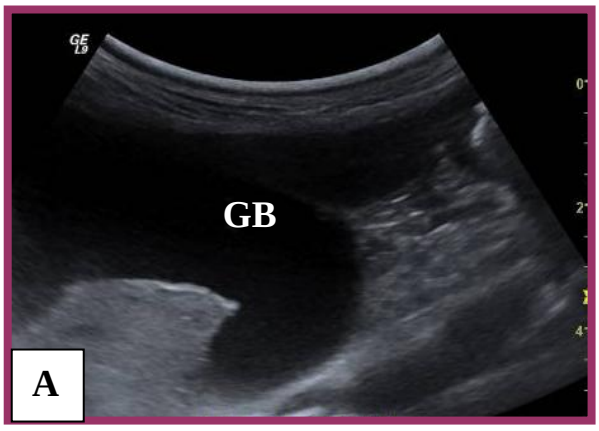


Fig. 11 A: Ultrasound longitudinal scan in a dog showing severely distended gall bladder as large anechoic distended sac (GB)

B. Surgery (arrow) showed the distended gallbladder.



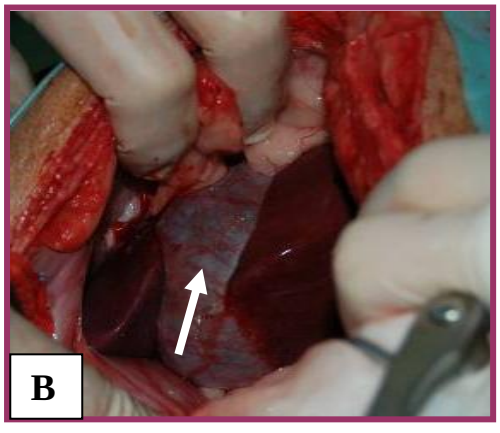


Fig. 12: Ultrasound cross scan in a cat anechoic sacs with hyperechoic walls diagnosed as distended gallbladder (GB), cystic duct (C) and dilated bile ducts (BD) inside the liver parenchyma. In this case Doppler was done to differentiate hepatic blood vessel

Fig. 13: Ultrasound cross scan in a cat showing dilated bile duct (BD). Doppler was done to exclude hepatic blood vessels

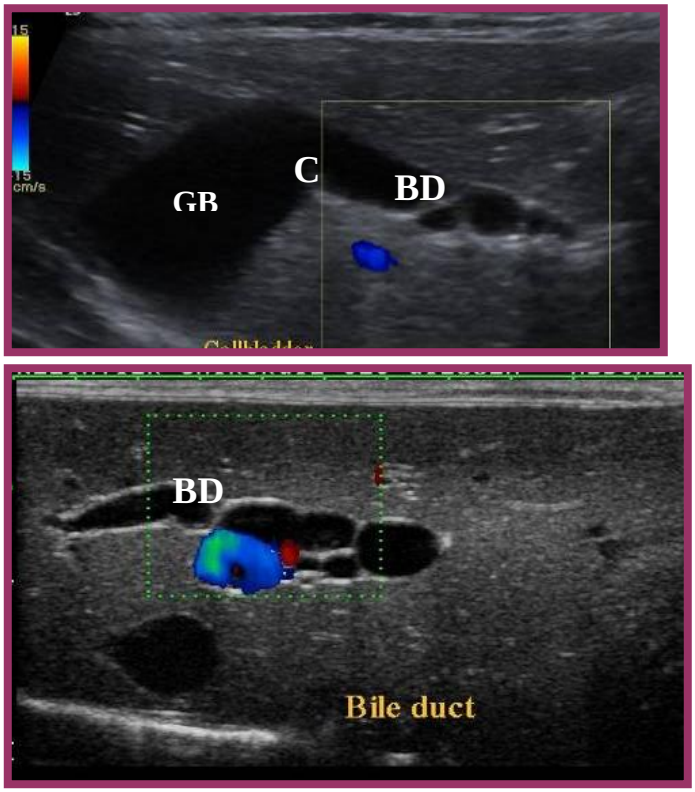


Fig. 14: Ultrasound longitudinal scan in a cat demonstrated anechoic tubular structure inside the pancreas (pancreatic duodenal duct)

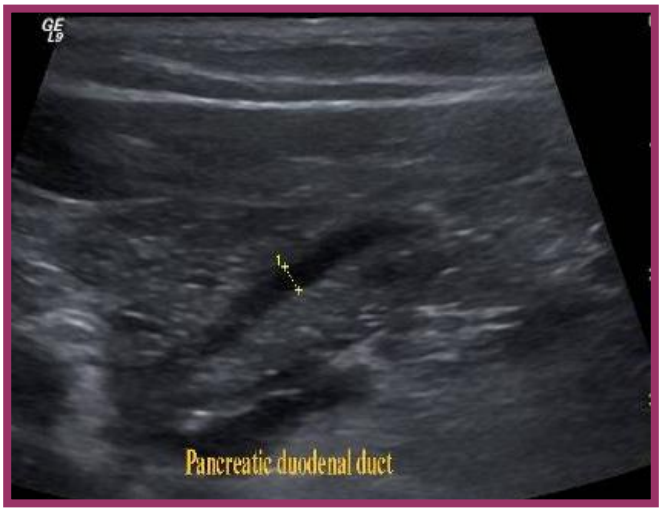


Fig. 15: Ultrasound longitudinal scan in a cat demonstrated anechoic, dilated tubular structure inside the pancreas (6mm) (arrow) which opens in the duodenum (D) and diagnosed as common bile duct in case of cholangiohepatitis and pancreatitis

Fig. 16: Ultrasound cross scan in a cat demonstrated hypoechoic rounded structure (A) opens inside the duodenum and is prominent in the inner wall (5.5 mm) and diagnosed as prominent duodenal papilla in case of cholangiohepatitis and pancreatitis

Fig. 17 A: Gallbladder mucocele, ultrasound cross scan in a dog gallbladder is distended with hyperechoic materials with cavitations and anechoic regions. In B: The gallbladder revealed the typical kiwi fruit shape.

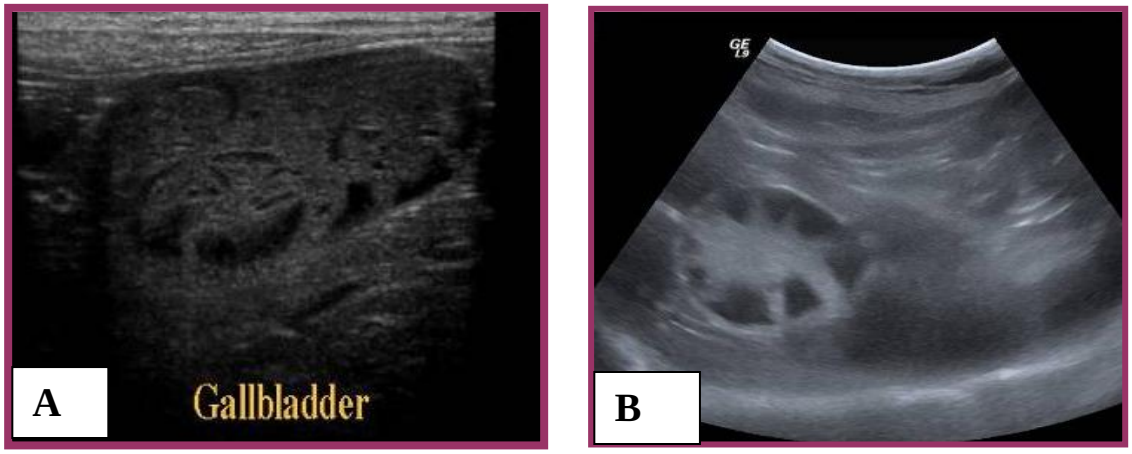


Fig. 18 A&B: Macroscopy of the gallbladder mucocele in a dog.
Gallbladder after resection appears large and with thick viscous green colour bile.

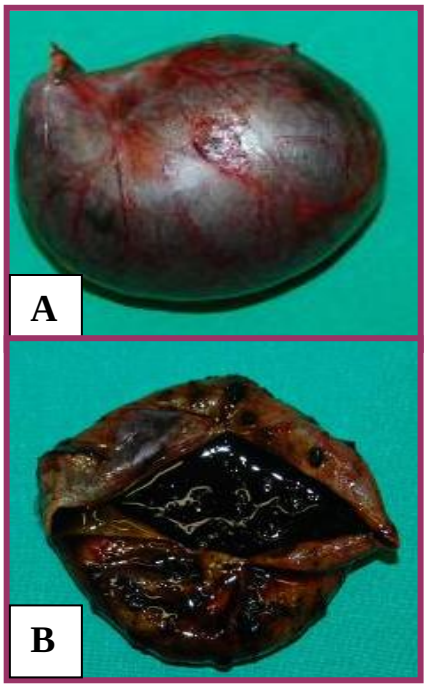


Fig. 19: Gallbladder polyp, ultrasound cross scan in a dog. Gallbladder showed a hyperechoic mass from its inner wall (7 x 7 mm) without distal acoustic shadowing. Liver (L).

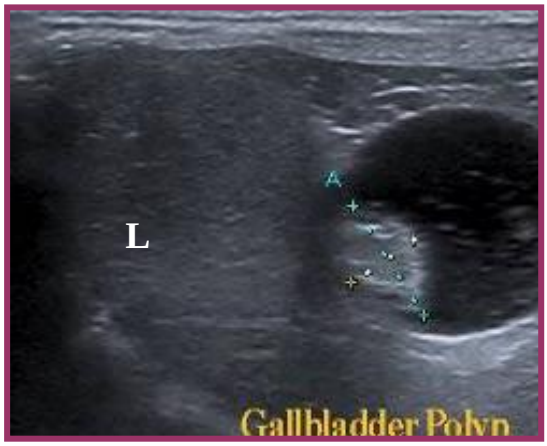


Fig. 20: Ruptured gallbladder, ultrasound cross scan in a cat. Gallbladder appears as a small contracted and shrinked hyperechoic structure (9mm) without fluid (arrow).

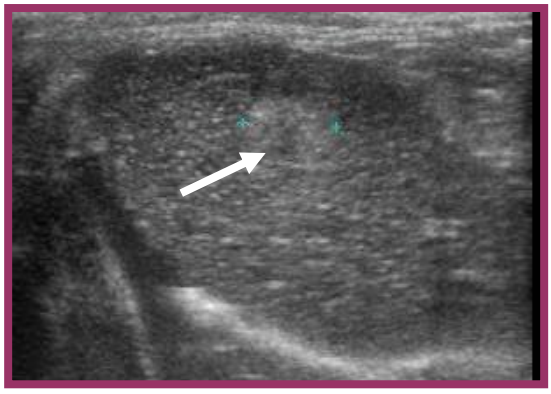


Fig. 21 A&B: Surgery in the same cat A: Gallbladder is shrinked and ruptured (arrow) yellowish fluid in the abdomen was seen.
B: Gallbladder after excision.

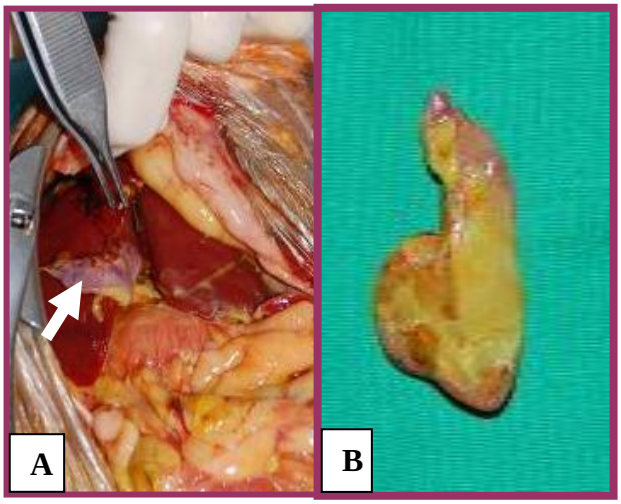


Fig. 22 A&B: Bile duct stones, ultrasound longitudinal scan in a cat showing a hyperechoic structures with distal shadowing in the liver (arrow) around the hyperechoic wall of the bile ducts, there are hyperechoic round structure at the area of the duodenum and common bile duct with distal shadowing.
BD: Bile duct.
CBD: Common Bile Duct.
SH: distal shadowing.
Stone represented with the arrow.

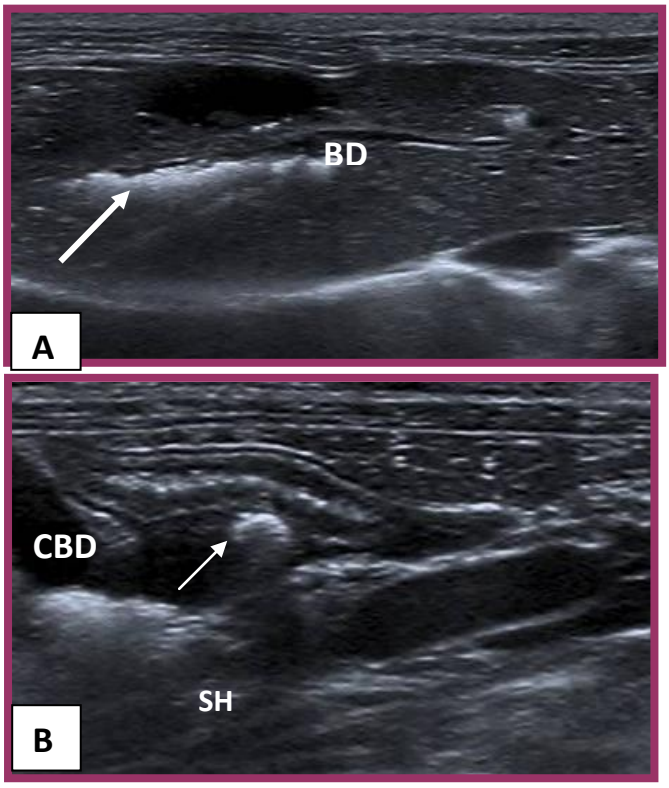
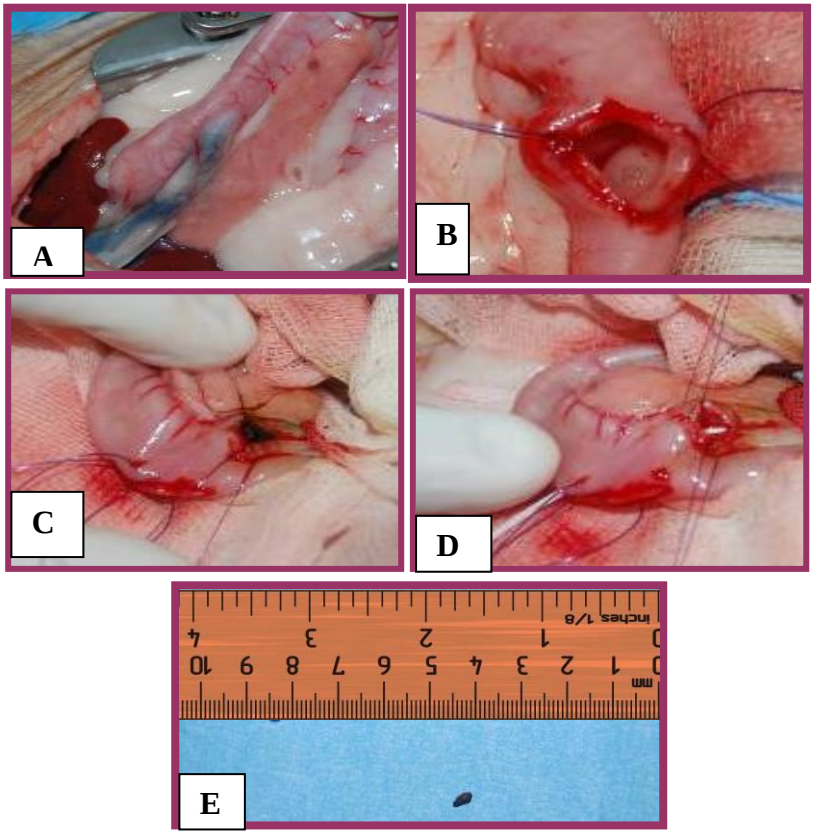


Fig. 23 A&B&C&D: Surgery:
A: Dilated and bluish congested common bile duct that ends in the descending duodenum
B: Opening the duodenum to see the duodenal papilla and locate the stone.
C: Location of the stone after opening of the common bile duct
D: Passing a 3 French catheter through duodenal opening into duodenal papilla to common bile duct to check the free pathway.
E: Stone (3mm) after removal



Discussion:

The diagnosed cases (3 dogs and 1 cat) suspected to be **liver abscesses and diffuse purulent hepatitis** demonstrated ultrasonographically anechoic fluid contents surrounded with hyperechoic region and shadowing suspected to be gas and pus. The abscess itself appeared as a heterogenous mass in the liver parenchyma. Exploratory laparotomy demonstrated cavities with pus and necrotizing liver lobe. The heterogenous mass reached the size of 7.5 x 6.5 cm. Purulent microorganisms were bacteriologically isolated of which Staphyococcus, E. Coli and Enterococcus. In the cat there was a diffuse hypoechoic area with indistinct boundary indicating purulent hepatitis which is confirmed bacteriologically. This sonographic image is not in accordance with that described with **Schwarz et al., (1998)** who demonstrated more common solitary lesions greater than 3 cm than multiple ones. The abscesses were mainly poorly echogenic lesions due to the fluid and pus content.

On the other hand, interpretation of focal liver parenchymal lesions is always a challenging problem for the ultrasonographer as they rarely pathognomonic of a special disease as also emphasized by **Faverrani et al., (2006).**

Liver tumors were suspected in 16 dogs and 2 cats and constituted the most encountered sonographically diagnosed surgical affection in the liver. Two cases were with ruptured tumors appeared with mixed echogenicity and heterogenous hypo and hyperechogenic mass with unclear margins. Other cases revealed multiple rounded hypoechoic and hyperechoic masses with inhomogenous parenchyma. Others manifested large circumscribed masses of 7 x 7 cm or more heterogenous with a hypoechoic area. The diagnosis was confirmed with biopsy and histopathological examination. Fibrosarcoma and hepatocellular carcinoma were predominant. Partial lobectomy or euthanization was adopted according to the condition and invasion of the tumors. In cats, the diffuse hypoechoic area with indistinct boundary indicated diffuse purulent hepatitis. The cats were euthanized.

These ultrasonographic findings are in agreement to great extent with those of 2nd and 3rd patterns described by **Nyland (1984)** who concluded also that ultrasound is helpful for diagnosis and staging of canine lymphosarcoma with liver involvement and is useful for monitoring the response to chemotherapy. Also our results are supported with that described by **Kneissl et al (1997) and Irausquin et al (2008)** who demonstrated ultrasonographic hypoechoic hepatic parenchyma and therefore suspected neoplasia and identified histopathologically as well as surgically. In general, it could be concluded that diffuse liver changes are more challenging to be detected than focal lesions. Also primary liver tumours could not be differentiated from secondary ones. Moreover, there is no specific ultrasonographic feature for individual tumour type. Also benign tumours could not be differentiated from malignant ones. Only the biopsy and histopathological examinations are determining. These findings are in agreement with these emphasized by **Nisenbaum and Rowling (1995); Nyland et al., (2002): Faverzani et al., (2006), and Penninck, (2008).** As a very rare case, **liver cyst** was diagnosed in one cat which did not manifested any clinical abnormalities. It was manifested as anechoic round structure in the liver parenchyma with distal acoustic enhancement. These cysts are unharmful and could be encountered in different organs without any clinical manifestations. Also **Thiel et al (2005)** diagnosed with sonography a congenital liver cyst in a cat in the size of a child head and connected with all liver lobes. The cyst wall was partially surgically resected with omentalization which helped in minimizing the duration of surgical healing.

Cholecystitis, Cholangiohepatitis and Bile Duct Obstruction were diagnosed in 6 dogs and 10 cats and constituted the most encountered affection in cats. These finding is not in agreement with **Kelly et al (1975), Zawie and Garvey (1984), Neer (1992) and Smith et al (1998)** who considered the condition to be uncommon in cats and attributed its cause to tumors and inflammation of the common bile duct, pancreas or duodenum and cholelithiasis. The diagnosed cases demonstrated hyperechoic and enlarged liver. Its parenchyma was interspersed with multifocal small hypoechoic nodules. The gallbladder wall revealed hyperechoic areas and irregular structures protrude into the lumen. In dogs, severe distension of the gallbladder was seen ultrasonographically, as large anechoic sac inside the liver with distal acoustic enhancement. While in cats, the gallbladder was also dilated with anechoic fluid (bile). This is with dilated cystic and bile ducts or with hyperechoic walls which is diagnosed as dilated bile duct inside the liver. Although, a dilated description of ultrasonographic changes associated with extrahepatic biliary obstruction in cats are not available **(Gaillot et al., 2007).** A common bile duct diameter of 5 mm or more is considered to be dilated and supportive of extrahepatic biliary obstruction as also supported by **Leveille (1996).** The same was demonstrated in our cases as the common bile duct reached to 6 mm. Also a gallbladder wall thickness greater than 1 mm is considered to be an accurated sign of gallbladder disease as also supported by **Hittmair et al (2001) and Gaillot et al., (2007).** Although **Spaulding (1993)** demonstrated the thickness of the gallbladder wall to be 2 – 3 mm. In our cases, the gallbladder wall thickness of 2 mm is indicative for gallbladder affection. In accordance with other data, the results support common bile duct diameter being a useful indicator for extrahepatic biliary obstruction in cats **(Nyland and Gillett, 1982 and Leveille, 1996).** In conclusion, a cat with a common bile duct diameter below 5 mm indicating hyperplasia that prevented normal bile flow into the common bile duct and gallbladder.

Hydropic degeneration of the liver tissue with the deposition of lipofuscin pigment could be attributed to cholecystitis, cholangiohepatitis and gallbladder mucocele, these are age related changes as these were mainly diagnosed in old aged animals.

A Mucocele is defined as the distension of a cavity by an in appropriate accumulation of mucous **(Dorland medical dictionary, 1994).** Other terms used included inspissated bile, mucinous hyperplasia, cystic hyperplasia, mucinous cysts, mucosal cysts, cystic mucinous hypertrophy, mucinous cholecystitis and cystic glandular cholecystitis **(Kovatch et al, 1965, Reindel and Evans, 1987, Thornburg, 1988 and Fossum and Willard, 1995).**

The three diagnosed cases with **gallbladder Mucocele** revealed distension of the gallbladder with hyperechoic materials, cavitations and anechoic regions in two cases. In agreement with these findings, **Besso et al., (2000)** characterized mucocele ultrasonographically in combination with the appearance of the stellate or finely striated bile patterns like the typical kiwi fruit shape as demonstrated in the third case and differ from biliary sludge. A finding which is considered to be pathognomonic for gallbladder mucocele. However the gallbladder wall thickness and wall appearance were variable and non specific. Pericholecystic hyperechoic fat or fluid were suggestive of but not diagnostic for a gallbladder rupture. Cholecystectomy was also the appropriate treatment for mucoceles as described in the present study.

Gallbladder mass or polyp was ultrasonographically revealed as hyperechoic protrusion from its inner wall. It was in the diameter of 7 mm without distal acoustic shadowing. This finding is considered to be pathognomonic.

Gallbladder rupture is revealed ultrasonographically as a small contracted and shrinked hyperechoic structure with a diameter of 9 mm. Also anechoic fluid was seen between liver lobes, the same findings as described by **Broemel et al., (1998)**.

Bile duct stones were demonstrated as hyperechoic content with distal shadowing inside the liver parenchyma around the hyperechoic wall of the bile ducts indicating mineralized choleliths. Also hyperechoic round structures were seen at the duodenum and common bile duct with distal shadowing as also described by **Gaillot et al. (2007).** On the other hand **Neer (1992) and Smith et al (1998)** attributed the cause of extrahepatic biliary obstruction in cats to tumors and inflammation of the common bile duct, pancreas or duodenum and choledocholithiasis, which formed of calcium carbonate or palmitate or of amorphous blugs of bile salts and cholesterol as analysed by **Gaillot et al., (2007).**

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