Hepatosonography and Computed Tomography in Feline

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ABSTRACT

Hepatic disease in cats is often treatable and has a favorable prognosis with early diagnosis. This study aimed to assess the liver status by using different diagnostic techniques including ultrasound, X-ray and CT and cross section anatomy. Twenty- nine mongrel cats of both sexes with age range (1-5 years) and weight range (1.5 –5kg) were used in this study**.** Cats were randomly divided into four groups. The 1st group had sixteen cats used for normal ultrasound study. The 2nd group has five cats used for cholecystography study by using urographin (R).The 3rd group had three cats used for CT examination and cross sections anatomy .The 4th group had five cats subjected to experimental ligation of common bile duct and Specimens were subjected to standardized processing and histopathological examination for yielding definitive diagnosis of hepatic affections. The liver of cats appeared as 6 lobes located into intrathoracic portion of the abdominal cavity.The hepatobiliary sonography was able to identify the normal structure of the biliary system, evaluate of hepatobiliary affections, clarify the character of hepatic damage and dysfunction and determine the possible primary causes of secondary hepatobiliary diseases. The CT images from this study are intended as a reference for clinical CT imaging studies of the liver of the cat and for interpreting lesions of the liver and associated structures. The serum biochemical database comprises of ALT, AST and bilirubin was significant increase in obstruction of common bile duct.

Keywords: Ultrasonography, feline, Liver and Computed Tomography.

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1. INTRODUCTION:

Ultrasonography is an excellent noninvasive way to evaluate liver parenchyma. It is particularly useful in differentiating focal from diffuse disease, cystic from solid masses and obstructive from non-obstructive icterus (Mayhew, 2006). The desirable virtues of less time consumption and noninvasive assessment of the detailed internal architecture of the liver and the adjacent structures, including the portal vein, established ultrasonography as the best choice technology, for identifying the various forms of hepatic disease in cats (Irausquin et al, 2008 and kealy, 2010). Pet animal is considered as any animal kept by human beings as a source of companionship and pleasure. Ultrasonography evolved as the paramount technique of diagnostic imaging for detecting the alteration in liver and gall bladder (Kealy, 2010 and Kumar, et al., 2012). Indications for hepatic ultrasound usually include elevated liver enzymes (ALT and AST), presence of free abdominal effusion and indicated for determining the extent of common bile duct obstruction in cases of hepatic neoplasia extrahepatic or intrahepatic obstruction (Ellison, 2011). Doppler imaging confirms the location of the suspicious vessels and direction of the blood flow within and can provide supportive evidence of intrahepatic portal hypertension by allowing the assessment of the speed and direction of

portal flow (Nyland and Mattoon 2007). Abdominal radiographs (lateral) and ventrodorsal view) are useful to evaluate the morphologic abnormalities in size, shape, position, and density (mineralization /radiolucencies) of the liver and presence of abdominal effusion (Olosson, 2008, Gaschen, 2009 and Kumar et al., 2012). It is difficult to evaluate the entire liver as much of the liver is silhouetted by the diaphragm, stomach and right kidney (kealy, 2012). Computed tomography (CT) is modalities routinely used to scan cross-sectional for various diseases in humans, and smaller versions are now manufactured for dedicated animal research CT provides radiography-based thin cross sectional images without disturbing internal structures (Rycke et al., 2004 and Irausquin et al., 2008). CT eliminates super imposition of structures and harmony improve quality resolution .CT has consider more diagnostic image for hepatobiliary evaluation especially biliary obstruction (Newell, et al., 1998). Biliary obstruction (BO) is a life-threatening condition with several etiologies that leads to numerous systemic physiologic derangements. It often presents as an emergency condition and causes significant morbidity and mortality in cats (Worley, et al, 2004 and Mayhew, 2006). When biliary drainage from the gallbladder is impaired; bile becomes inspissated or sludge-like. Biliary sludge is seen as thick bile during surgery and can vary from a highly viscid fluid to a semisolid material. Sludge is often mixed in consistency and may resemble tar (Cornejo and Webster, 2005). Biliary sludge is seen as an echogenic substance in the gallbladder. This highly viscous sludge can result in Common bile duct obstruction or exacerbate the effects of a partial CBD obstruction (Fogle and Bissett, 2005, Mayhew, 2006).The biliary obstruction progresses in cats are often lethargic and may have weight loss, anorexia, and a history of vomiting or diarrhea. A recent study documented anorexia and vomiting as the most common clinical signs reported (Kamonrat, 2001 and Mixti, 2006). Bilirubinuria may be the first abnormality noticed an experimental study in cats with acute EHBO demonstrated an initial increase in serum ALT, AST and bilirubin (Worley et al., 2004, Harran et al., 2011). The wall of gall bladder appears more hyper echoic which denoted the thickness of the wall. The bile appears as hypoechoic area with hyperechoic fine granules (Nyland and Mattoon 2007).

2. MATERIAL AND METHODS.

The present study carried out on 29mongerl cats of both sexes with age range (1—5years) and weight range (1.5 –5kg.)Cats were randomly divided into four groups. Group I include 16 cats used for normal ultrasound study with 5–8 MHz convex transducer or micro convex with alcohol application before water-soluble coupling gel (kealy, 2010). Group II includes 5cats for cholecystography study. Cats used for cholecystography study after intravenous injection of urographin (Tri-iodinated contrast medium (Iodine 76 %, Schering Co. USA) with dose rate o.2 ml/kg with the efficient factors for examination (80 cm focal film distance, 40MAs and 10Kv) (Kumar, et al, 2012). Group III included 3 cats for CT examination and cross sectional anatomy. Cats Positioned in a supine position during CT examination and transverse slices (5 mm) of the entire abdominal cavity were taken by using Toshiba–Asteion CT machine (Irausquin, et al, 2008). Group IV includes 5 cats subjected to experimental ligation of common bile duct. The cat was anesthetized by, ketamine Hcl (10 mg/kg, IM) and xylazine (1 mg/kg, IM). The ligation operation was performed by Kocher's incision. Antibiotic solution injects in peritoneum cavity (Epicephin0.5 gm/5ml solvent) (Ceftriaxone0.5gm EIPICO. Egypt) (Fogle, and Bissett, 2005). Serum samples were collected to determine ALT, AST enzymes and bilirubin activity before

ligation (control group), after 3days and after 7 days (Murray, 1984)

3. RESULTS

Ultrasound scanning of liver determined the anatomical structure of liver parenchyma which has a uniform low to medium echogenicity pattern (Fig.1). The gall bladder appeared as anechoic fluid-filled structures with thin echoic wall and tree of bile. Hepatic vein and hepatic artery appeared as anechoic fluid-filled structures within the hepatic parenchyma with more echogenicity of peripheral wall. The suitable transducer was 5–8 MHz convex or micro convex for examination of the liver and its structure in relation to neighboring organs. Moreover, locates on ventral abdomen shift to right side and the ultrasound direction of craniodorsal to explain the entire of the liver caudal to costal arch (Fig. 2). Doppler ultrasound determined the amount of blood enter and come out from the liver vesselswhich reflect the efficiency of the blood vessels of the liver and The color differs to red and blue according the direction of the blood velocity toward probe or away from it (Fig. 3). C.T examination and the anatomic cross sections determined the position of entire the liver that located in the epigastric region at the levels of the 8th thoracic vertebra till the first lumbar vertebrae and bordered by stomach, intestine, spleen and kidney (Fig.4A, 4B and Fig.5A, 5B). The caudal vena cava passes through the liver at the border while the aorta contacts to the vertebra near the liver. The two lungs appeared in the thoracic cavity around the liver and the diaphragm separate between them (Fig.6Aand 6B). The gall bladder locates the superficial groove on the right medial lobe of the liver under the quadrate lobe of the liver (Fig.7Aand 7B). Ascending colon, duodenum and jejunum appear around the liver at the 13th vertebra and the first lumber vertebra (Fig.8A, 8B and fig. 9A, 9B). Abdominal radiographs (lateral and ventrodorsal view) explained the liver was homogeneous density behind the diaphragm while the gall bladder appeared as a low-density circumstance area. The gallbladder fills by contrast media taken time longer than that time taken for the urinary bladder, the gall bladder appears as a high-density area on caudal border of the liver and the entire liver is situated into intrathoracic portion of the abdominal cavity (Fig.10). The cat's liver is collaboration of main 4 lobes (left lobe, right lobe, caudate lobe and quadrate lobe). Right and left lobes are divided into right medial lobe ,right lateral lobe , medial left lobe and lateral left lobe so the liver of feline appear 6 lobes .the gall bladder was located on liver fossa lies more superficially on the right medial lobe (Fig. 11A). The liver in cats engaged the level of the 8th to 10th thoracic vertebrae while the gall bladders located near the 8th inter costal space. An acute obstruction of common bile resulting in the gallbladder was destined; the amount of bile in the lumen is scanty, thickening of the gall bladder's wall and sharp edge of liver, which become rounded (Fig.11A, 11B and Fig. 12). The liver enzyme ALT and AST showed significant increase (Tablet 1). Histopathologically bile duct obstruction result in accumulation of bile pigment in interstitial space of hepatic cell (bile lakes) which gives yellow color between liver cells, hypotrophy of hepatocyte and infiltration inflammatory cells (Fig.13Aand 13B).

4. DISCUSSION

The feline liver consists of 6 lobes occupies the intrathoracic area of the abdomen and the gall bladder situated the superficial groove on right medial lobe of the liver under quadrate lobe (Breton, 2008 and Norwich, 2011).The result of this study was similar this and confirm by C.T examination compared with cross sections. Alcohol application before water- soluble

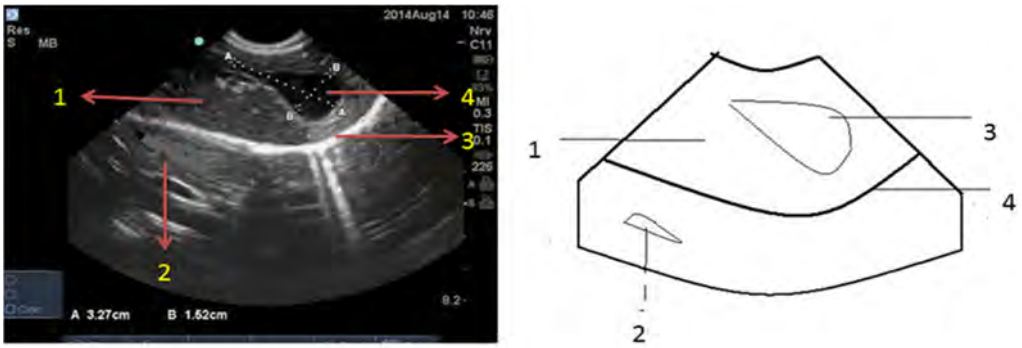


Fig (1):- An ultrasonographic image of adult cat is showing that the liver is course granules (1). Spleen is fine granule (2) .diaphragm was hyperechoic curved area (3). Acoustic shadow was the hyper echoic area extends behind gall bladder (4). The probe was placed caudal costal arch.

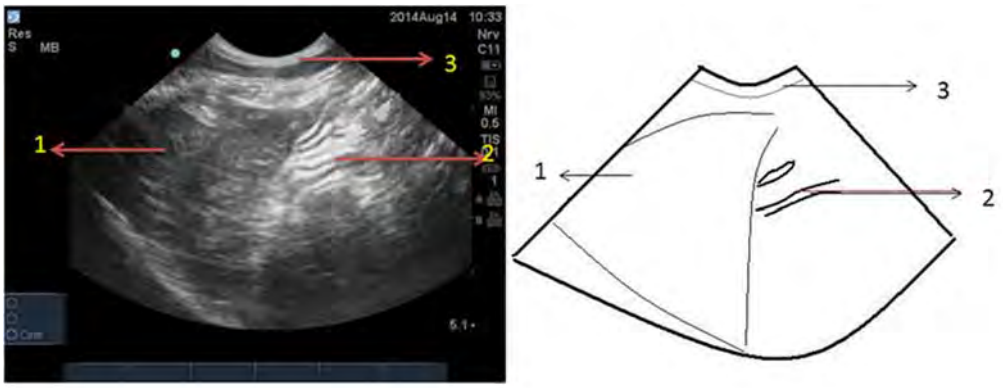


Fig (2):- An ultrasonographic image of adult cat showing the liver tissue (1) and intestine (2) with thickening of the wall that indicates enteritis and skin (3). The probe was placed caudal costal arch.

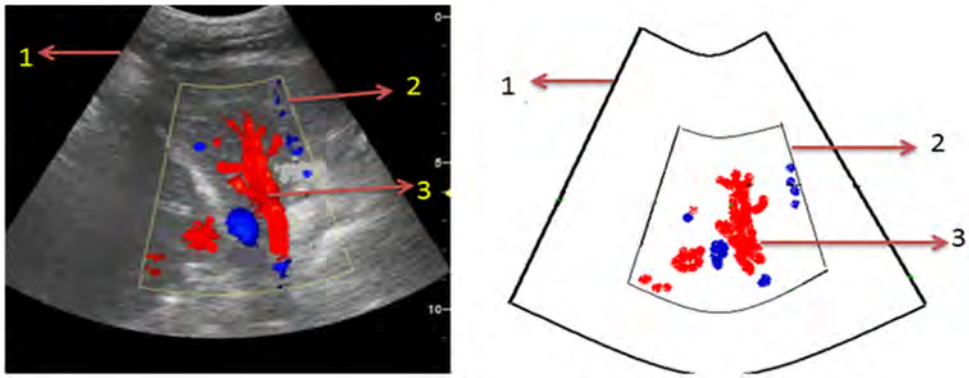


Fig (3):-Doppler ultrasonography of normal cat is showing that hepatic vessels appeared red and blue (1) ultrasound field (2) Doppler field. (3) Hepatic vessels. The probe was placed caudal to costal arch.

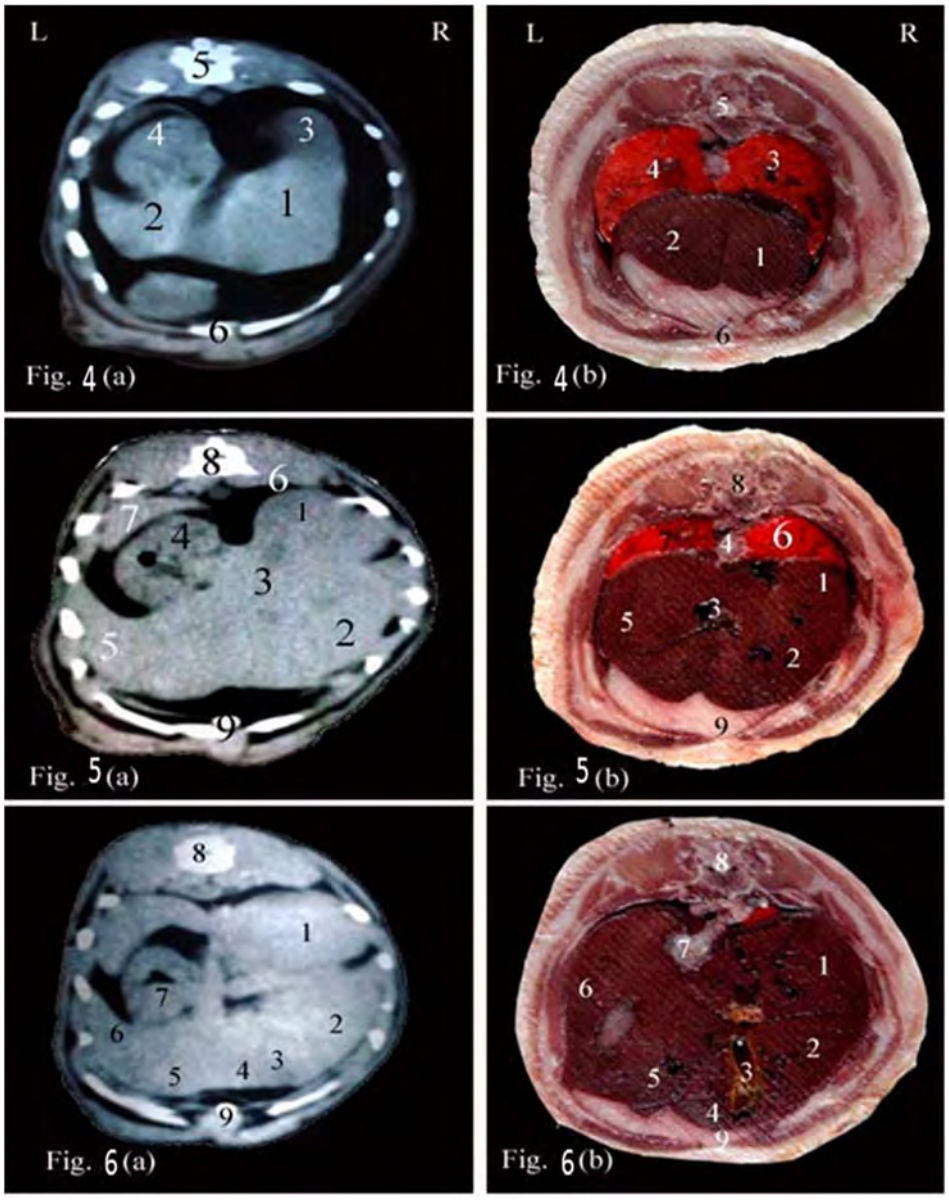


Fig. (4). (A) CT scan image and **(B)** anatomic cross-section of a clinically normal cat liver at level of the ninth thoracic vertebra. Caudal view, R, right, L left. (1) Right lobe of liver; (2) left lobe of liver; (3) right lung; (4) left lung; (5) Nine thoracic vertebra; (6) sternum.

Fig. (5). (A) CT scan image and **(B)** anatomic cross-section of a clinically normal cat liver at level of the tenth thoracic vertebra. Caudal view R. right, L. left. (1) Right lateral lobe of liver; (2) right medial lobe of liver; (3) portal vein; (4) esophagus ; (5) left lateral lobe of liver; (6) right lung; (7) left lung; (8) Tenth thoracic vertebra; (9) sternum.

Fig. (6). (A) CT scan image and **(B)** anatomic cross-section of a clinically normal cat liver at level of the eleven thoracic vertebra. Caudal view R, right, L left. (1) Right lateral lobe of liver; (2) right medial lobe of liver; (3) gallbladder; (4) Quadrate lobe of liver; (5) left medial lobe of liver; (6) left lateral lobe of liver; (7) esophagus; (8) Eleven thoracic vertebra; (9) sternum.

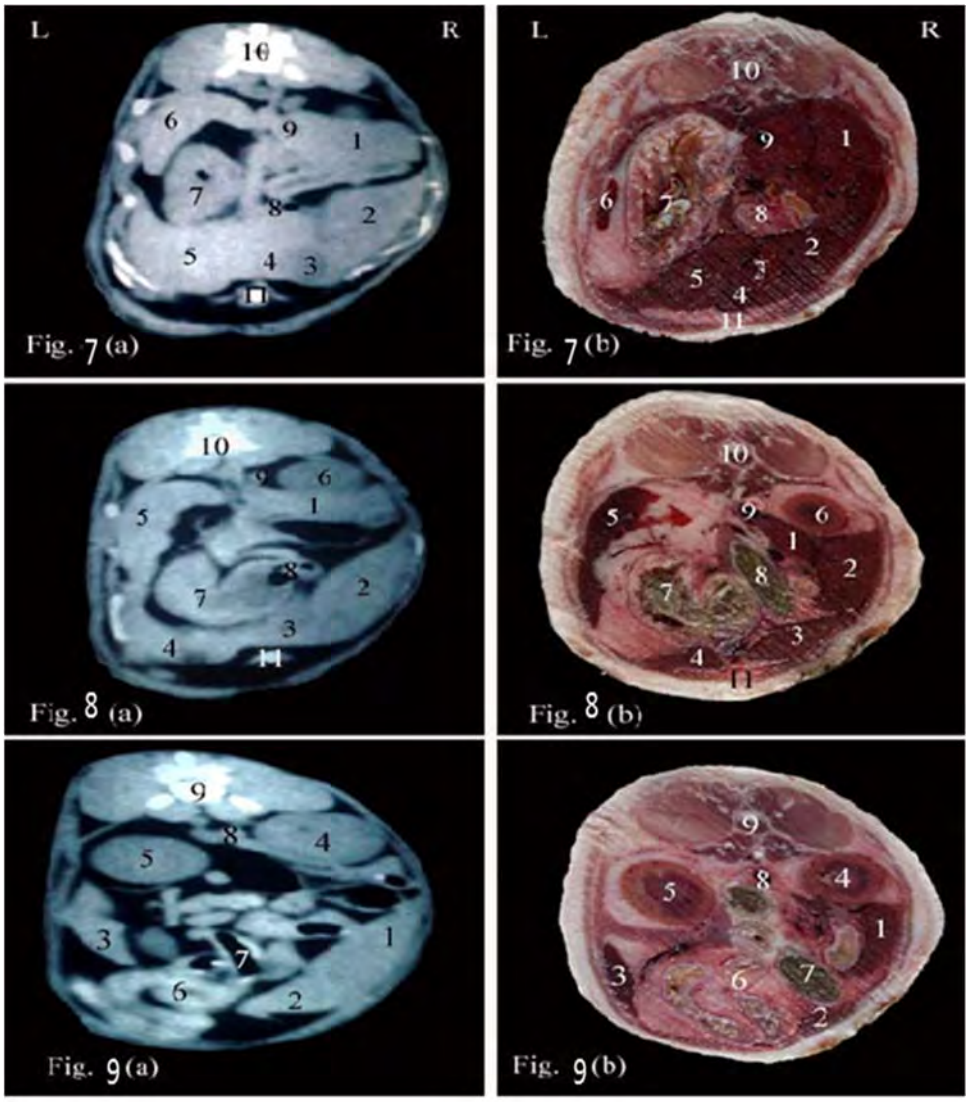
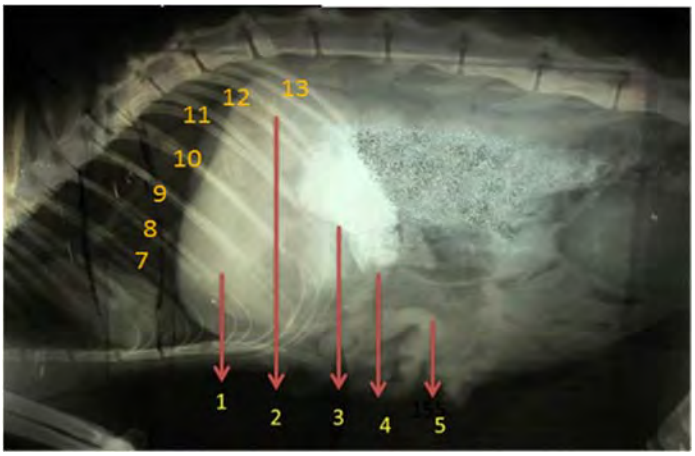


Fig. (7). (A) CT scan image and **(B)** anatomic cross-section of a clinically normal cat liver at level of the 12th thoracic vertebra. Caudal view R, right, L left. (1) Right lateral lobe of liver; (2) Right medial lobe of liver; (3) Gallbladder; (4) Quadrate lobe of liver; (5) left medial lobe of liver; (6) Spleen; (7) Stomach; (8) duodenum; (9) Caudal vena cava; (10) Twelve thoracic vertebra; (11) sternum.

Fig. (8). (A) CT scan image and **(B)** anatomic cross-section of a clinically normal cat liver at level of the 13th thoracic vertebra. Caudal view R, right, L left. (1) Right medial lobe of liver; (2) Right lateral lobe of liver; (3) left medial lobe of liver; (4) left lateral lobe of liver; (5) Spleen; (6) Right kidney; (7) Stomach; (8) Ascending colon; (9) Aorta; (10) 13 thoracic vertebra; (11) sternum.

Fig. (9). (A) CT scan image and **(B)** anatomic cross-section of a clinically normal cat liver at level of first lumbar vertebra. Caudal view R, right, L left. (1) Right lateral lobe of liver; (2) caudate lobe of liver;; (3) Spleen; (4) Right kidney; (5)Left kidney; (6) Jejunum; (7) Ascending colon; (8) Aorta; (9) First lumbar vertebra.

Fig (10): Radiography of cat showing the liver (1), the ribs (2) high density area at the caudal border of liver gallbladder (3),duodenum(4), and intestine(5).(ribs7,8,9,10,11,12and13)



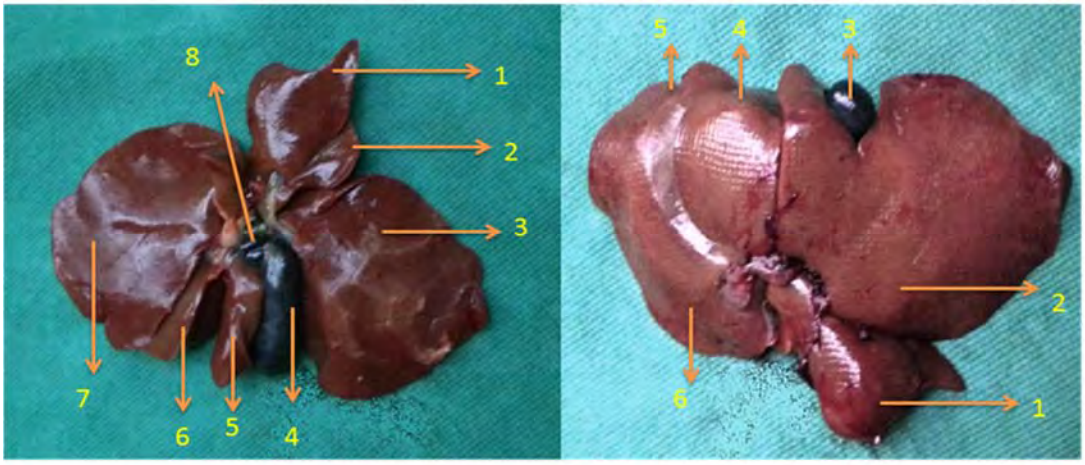


Fig. (11 A):-A gross examination of visceral surface show distended gall bladder and rounded edge of liver in male cat 4 years.(1-Cudate process 2-Rightlateral lobe 3- Right medial lobe. 4- Gall bladder. 5- Quadrate lobe. 6- Left medial lobe. 7-Left lateral lobe. 8- Distended bile duct.

Fig. (11 B) A gross examination of Parietal surface Show distended gall bladder which appear in the notch right lobe of the liver and rounded edge of liver in male cat 4 years. (1) Caudate Process. (2) Right medial lobe. (3) Gall bladder. (4) Quadrate lobe. (5) Left medial lobe. (6) Lateral left lobe.

Table (1): Mean ± S.E. of AST, ALT and Bilirubin in relation to time of death in 5 cats with ligation of common bile duct.

Time	AST	ALT	Bilirubin
Control(0day)	57.60b ±2.25	48.20 ±1.16	0.76 ±0.05
3 days post ligation	100.81a ±20.82	100.15 ±10.40	5.94 ±0.65
7 days post ligation	200.23a ±30.93	100.19 ±10.25	7.26 ±0.62

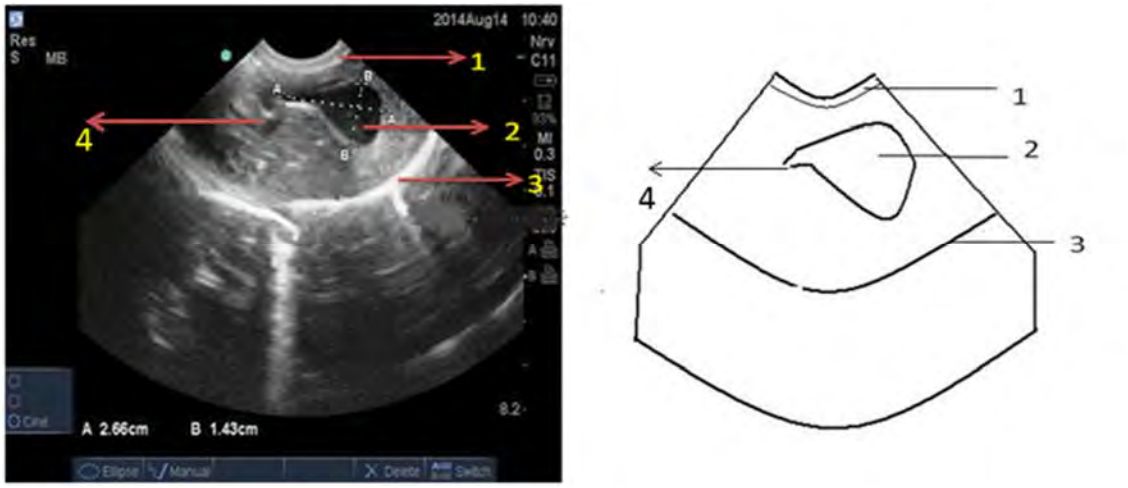


Fig (12):- ultrasonography of adult male cat is showing that the gall bladder is anechoic distance between A and B which form an increase in the size due to common bile obstruction. (1) Skin. (2) Gall bladder (3) Diaphragm. (4) Ligation site. The probe was placed caudal to the sternum.

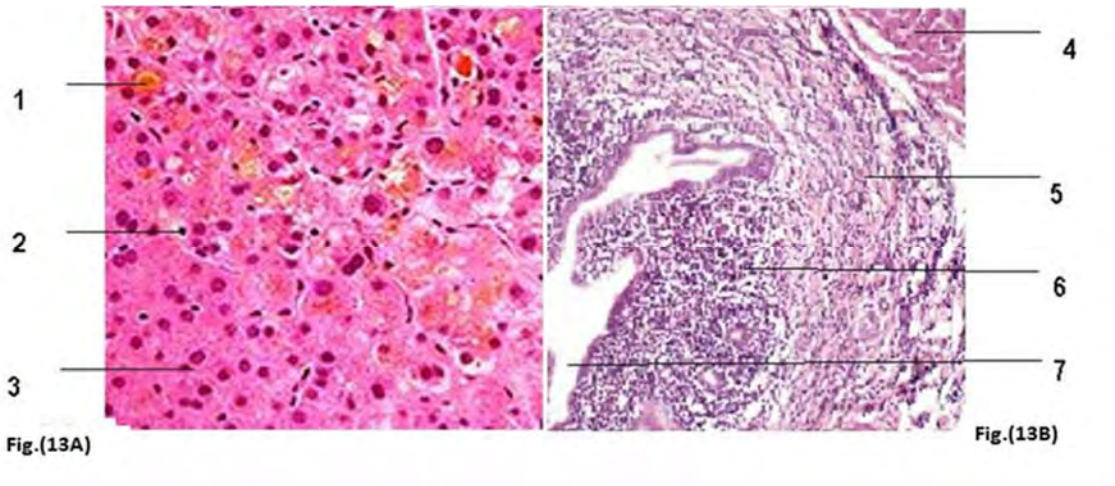


Fig. (13A): The histopathological changes due to ligations of common bile duct. There is a diffusion of bile pigment (1) between hypotrophy hepatic cells (2) Normal hepatic cells (3) (H&E).

Fig. (13B): The histopathological changes due to ligations of common bile duct. There is thickening of the wall of the gall bladder with well defined ductules. (4) Hepatic cells, (5) ductules. (6) Lymphocytic cell infiltration (7) lumen of gall bladder is narrow (H&E).

coupling gel in ultrasound examination provides more convenient and give excellent quality image (Cartee, 2000, Nyland and Mattoon, 2007 and Irausquin et al., 2008). Alcohol reduces the air bubble and greasy material between hair due to bad clipping or unclipping area. Linear and curved linear-array transducer can only use in cats (Baker 2009). The ideal transducer used in ultrasound examination of feline liver was convex and micro convex gives good quality ultrasound image from small window between costal cages. Liver parenchyma has a uniform low to medium echogenicity pattern and of the gall bladder with bile tree, portal vein; hepatic vein appeared as anechoic fluid-filled structures (Olsson 2005, Kealy 2010 and Støylen 2013). The liver appears homogenous echogenic structure with areas of low or anechoic parts. Doppler ultrasound determined the amount of blood which enter and come out from the liver vessels as well as the efficiency of the blood vessels of the liver as colored area determined the portal vein or hepatic vein (Mehraj et al., 2009 and Støylen 2013).The vascular of the liver appeared as colored according the way of vessel. Ultrasonography is the choicest technology, for identifying the various forms of hepatic disease in feline and the most popular medical imaging modality, owing to the low price per examination and its safety (Irausquin et al., 2008 and kealy 2010). Ultrasound consider rapid, safe, low cost per decision and more accurate in the liver rather than other images. The liver has homogeneous density behind the diaphragm covered by costal arch in the cranial portion of the abdomen in radiography (Samy et al., 2014). Diagnosis the case of biliary obstructions was rapid and accurate mandatory with ideal intervention. The Kocher's incision is the best way of ligation of common bile duct with elevation the quadrate lobe of the liver (Gourley, 1992 and Edwards, 2004). Ligation of common bile duct results in changes on the animal health, elevation of liver enzymes and biochemical of liver as AST, ALT and lead to death (Kamonrat, 2001). The cats were positioned in a supine position within the CT machine, Transverse slices (5 mm) of the entire abdominal cavity were obtained in axial mode, beginning at the cranial extent of the liver and ending at the level of the wings of the ileum (Rivero et al., 2005 and Irausquin et al., 2008). Suitable positioning of the animal given good details in the image of CT. accurate interpretation of CT images of the liver and gall bladder requires a meticulous of cross-sectional anatomy of that region to give realistic diagnosis (Rycke et al., 2005 and Rivero et al., 2005). Skillful person aware with information of the gross anatomy is required to locate the organs on CT image. The normal cat liver was a massive, homogeneous, soft tissue structure with normal attenuation. The right and left lobes of the liver were observed and the right and left lung appeared in the same (Rivero et al., 2005 and Irausquin et al., 2008). All soft tissue appears similar so location of liver can detect by cross section anatomy. In conclusion, the use of ultrasonography, radiography, CT and cholecystography provide topographic and ultra structural details of the feline liver that could be used as diagnostic and prognostic tools. In addition, the cross section anatomy helps in demonstrating the relationship of feline liver with the surrounding organs and tissue therefore; these techniques can used to evaluation the healthy status of the liver in cats but hepatosonography is the best tools to evaluation.

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