The liver: role in health and disease in small animals

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Samantha Frogley RVN, looks at the essentials of liver function in healthy animals as well as the effects of associated disease on body systems

Summary

THE liver has many functions in healthy animals and, when diseased, there can be multiple consequences. Finding a diagnosis can be a complex process in liver disease cases.

The nurse should be aware of the steps taken to discover the underlying cause. The nursing care required for these patients can be considerable and the use of diet and nutraceuticals may play a role.

Key words

liver disease, hepatocytes, veterinary anatomy, cat, dog

THE liver is the largest gland in the body and is located in the cranial abdomen. It is a major organ and has many functions. The liver is made up of several lobes and in the centre lays the falciform ligament, which is left over from fetal blood vessels, but is of no significance in adult animals (Aspinall and Cappello, 2007).

The primary cells of the liver are called hepatocytes, but many other types of cells, including endothelial cells, Kupffer's cells (part of the immune system) and hepatic stellate cells (involved with production of fibrous tissue), are also contained in the gland.

The anatomy of the liver differs between cats and dogs. For the understanding of one of the conditions discussed in this article, it is worth noting dogs have two separate ducts: a pancreatic duct and a bile duct. In cats, however, the bile duct joins the pancreatic duct. This may allow the reflux and mixing of gastric secretion with both pancreatic secretions and bile (Sant, 2013).

Functions of the liver

Carbohydrate metabolism

• Glucose is used for energy within the body. Glucose is stored in the liver as glycogen under the action of insulin, which is secreted by the pancreas. When energy is required the glycogen is broken down by glucagon, also secreted by the pancreas.

Protein metabolism

• Formation of plasma proteins – for example, albumin, fibrinogen, prothrombin and globulins.

• Regulation of amino acids. The liver uses amino acids to build proteins; any amino acids that are not essential may be converted into more useful ones – a process called transamination.

• Production of urea. Excess amino acids cannot be stored and are converted to ammonia and then urea – a process called deamination.

Fat metabolism

• Fatty acids and glycerol are converted by the liver into phospholipids and cholesterol. The phospholipids are used to build cell membranes and cholesterol is used for bile salts. Excess fat is then stored in deposits around the body.

Formation of bile

• Bile is used for digestion and stored in the gall bladder.

Destruction of old red blood cells

• Once red blood cells are destroyed, the haemoglobin is excreted as bilirubin in the bile. Impairment in bile excretion can lead to jaundice (Sant, 2013).

Storage of vitamins

• Vitamins including A, D, E and K are stored in the liver.

Storage of iron Thermoregulation Detoxification of certain substances

As evidenced above, in healthy cats and dogs the liver plays a major role in many body functions and it is easy to see how liver disease can have many negative consequences for the patient.

Differential diagnoses/investigations

Signs of liver damage include anorexia, lethargy, jaundice, vomiting, diarrhoea and weight loss. Cranial abdominal pain or ascites may be noted, and neurological symptoms due to hepatic encephalopathy may also be reported. Significant liver disease may be present before clinical signs appear, as the liver has a large reserve capacity (Dunn and Baines, 2003).

Blood work

• This is likely to show an elevation in liver enzymes, a marker of liver damage. Liver enzyme concentrations do not, however, give any indication of liver function. Markers of liver function on routine biochemistry profiles include albumin, urea and cholesterol concentrations. More sensitive tests for liver function include bile acid stimulation. The history, physical examination and blood work may lead to a suspected abnormality of the liver, but further understanding of the disease process is likely to require imaging and sampling. Making a diagnosis of the type of liver disease is important to enable correct treatment, planning and prognostication.

Abdominal ultrasound

• This will allow assessment of liver size, shape and echotexture. Other pertinent abnormalities may be identified within the abdomen during this procedure – such as gall bladder disease or the presence of abdominal effusion.

Fine-needle aspirates (FNAs)

• These are typically performed under ultrasound guidance and may be performed on a conscious or mildly sedated patient. FNAs obtain a cytology sample, and do not allow assessment of liver architecture. The correlation between cytology and histopathology results can be variable depending on the disease (Sant, 2013) – for example, correlation in inflammatory disease can be less than 50 per cent (Wang et al, 2004).

Tru-Cut liver biopsy

• Typically this is carried out under ultrasound guidance with the use of sedation or anaesthesia. A tissue sample is obtained, which may give an idea of liver architecture, but is still relatively small so samples must be obtained from all representative areas of the liver (Sant, 2013).

Biopsy via laparoscopy or laparotomy

• These samples are generally larger than Tru-Cut samples and may allow a more detailed analysis (Sant, 2013). Impression smears may also be made and aspiration of bile from the bilary tract may be sent away for culture during the procedure (Sant, 2013).

Nursing considerations

From a nursing point of view, the function of the liver within the clotting cascade is of importance. Liver disease may cause coagulation problems (Dunn, 2010). The liver produces many of the proteins involved in the clotting process (clotting factors, prothrombin and fibrinogen among others). The clotting process is known as the clotting cascade (see box out).

Therefore, if liver disease is known or suspected, care must be taken when performing venepuncture and peripheral vessels should be used. Performing clotting times will help highlight problems and it is recommended these be carried out prior to any type of biopsy (Sant, 2013). If a coagulopathy is detected, treatment may be required to address it. Treatments include vitamin K administration and transfusion with fresh frozen plasma. The presence of a coagulopathy due to liver disease is a concerning finding (Dunn and Baines, 2003).

Equally important is the fact many of these patients present anorexic and with weight loss – therefore, tempting them to eat will be a nursing goal. This may include warming food and spending time encouraging them to eat.

If these attempts are unsuccessful the clinician may consider the placement of an oesophagostomy or naso-oesphageal feeding tube to provide enteral nutrition (Gajanayake and Chan, 2009), depending on the coagulation profile results. It may be avoided if a coagulopathy is detected. The clinician may want to try to improve the patient's coagulation status prior to placement. An oesophageal feeding tube is preferable to a naso-oesophageal tube as it may be used longer term and allows higher volumes of food to be administered. Oesophageal tubes are also considered to have fewer complications than gastrostomy tubes (Scherk and Center, 2010). Patients may be sent home with an oesophageal tube in place provided there is good communication between the client and the practice.

Syringe feeding can be stressful for the patient and often doesn't provide a long-term solution for anorexic animals (Lumbis and Chann, 2008).

Naso-oesophageal feeding tubes may prove an effective method of meeting a patient's nutritional requirements, but they are less well tolerated, and the narrow diameter may limit the type of diet used.

Examples of liver disease

Hepatic lipidosis (mainly seen in cats)

Hepatic lipidosis is the accumulation of fat in the cytoplasm of the hepatocytes. It is associated with acute hepatic failure (Murphy and Warman, 2007).

Typically, hepatic lipidosis is seen in obese cats that have had a recent stressful event, causing anorexia. This may include a change of diet. Obese cats are more prone to the condition because overnutrition augments hepatic fat accumulation. When these cats become inappetent, fatty acids are released from their peripheral adipose stores. This release of fat challenges the liver's ability to use and disperse the additional fat (Murphy and Warman, 2007). Hepatic lipidosis is treatable and rarely recurrs, but may require weeks to months of nutritional support and nursing care (Scherk and Center, 2010). Maintaining a healthy weight is key to promoting good liver health and preventing the accumulation of hepatic fat.

Cholangitis complex

Cholangitis (more recently referred to as cholangiohepatitis) is inflammation of the bilary system and liver. It is the most common primary hepatic disorder in felines (Harvey, 2009). There are two main forms of cholangitis: neutrophilic cholangitis and lymphocytic cholangitis. Neutrophilic cholangitis is thought to be caused by an ascending infection of the biliary tract, stemming from the intestines (Harvey, 2009). Feline anatomy is thought to predispose to developing this condition (Harvey, 2009). Pancreatitis and/or inflammatory bowel disease may occur alongside neutrophilic cholangitis (Sant, 2013) and may predispose to it.

Lymphocytic cholangitis is thought to be immune-mediated; however, the aetiology is not known (Harvey, 2009).

Portosystemic shunt

A portosystemic shunt (PSS) is a congenital malformation within the blood supply to the liver (Cappello and Aspinall, 2009). Blood coming from the digestive system is shunted from the portal circulation, around the liver effectively bypassing it. Portosystemic shunting can be detected with blood tests, such as bile acid stimulation tests.

The implication of PSS is that toxins, such as ammonia, which would typically be removed by the liver, can accumulate in the systemic circulation leading to clinical signs including stunted growth and neurological symptoms (hepatic encephalopathy).

Portosystemic shunts can be both intrahepatic and extrahepatic. Further diagnostics, such as ultrasound and a portovenogram, will determine the shunt location. Congenital portosystemic shunts may be treated medically or surgically.

Neoplasia

Neoplasia can occur in the liver either as a primary disease or due to metastases. The liver is a common site of metastases due to its rich blood supply.

Toxic hepatopathies

Liver disease can be caused by a number of toxins. These include blue-green algae, copper accumulation, paracetamol and some other medications (Dunn and Baines, 2003).

Some infectious diseases, such as canine hepatitis virus or leptospirosis, may also cause liver disease.

Supplements and diet

There are many diets designed to support the liver during disease and carry on supporting the liver afterwards. Most food companies will have a specially formulated liver diet.

These diets mainly have reduced protein content, but the protein that is included is of high biological value. Liver diets are designed so they are easy for the liver to handle, and protein is restricted (Dunn and Baines, 2003).

When supporting animals with hepatic disease, the following points should be considered when selecting a diet (Lumbis and Chan, 2008). The diet should:

• support protein synthesis;

• maintain optimal bodyweight;

• decrease protein catabolism;

• slow disease progression;

• support liver regeneration; and

• encourage the patient to eat.

Current thinking is that animals with hepatic encephalopathy should be fed a hepatic diet and, crucially, cats with hepatic lipidosis must be fed a low fat diet, which may not always be a liver diet. A low fat, high fibre diet maybe more beneficial.

Some supplements are said to support the liver and also aid detoxification – for example,

ursodeoxycholic acid. This improves bile flow and displaces toxic bile acids. By doing so it is protective of hepatocytes.

S-adenosylmethionine (SAMe) may also be used in liver disease cases. It is an anti-inflammatory membrane stabiliser and also an antioxidant. These actions help support the liver (Sant, 2013). Although in most instances the use of SAMe is speculative, in paracetamol toxicity it has been demonstrated to be beneficial. Some nutraceuticals also contain milk thistle (silymarin) which, although not proven, may help protein synthesis and have antioxidant effects (Harvey, 2009).

Conclusions

In conclusion, a healthy liver plays many important roles in the body and, when it is diseased, many problems result. There are many causes of liver disease and a specific diagnosis can be important to make decisions about treatment and prognosis. The use of diet can play a role and good nursing care is crucial to the recovery of these patients. This includes grooming, encouraging them to eat and ensuring adequate nutrition is provided, along with an awareness of the disease as well as general nursing care.

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The clotting cascade

1. Platelets adhere to the damaged blood vessels and to each other to form a seal. These platelets release an enzyme called thromboplastin.

2. If thromboplastin and calcium ions are present the plasma protein prothrombin is converted to thrombin (vitamin K is required for this).

3. Thrombin then converts the plasma protein fibrinogen into a mesh of insoluble fibres, called fibrin (calcium is required).

4. The fibrin fibres then form a clot over the damaged area.

Figure 1. A cat receiving an oesphagostomy tube feed.

Figure 2 (above). Equipment preparation for a Tru-Cut liver biopsy.Figure 3 (right). Performing a Tru-Cut liver biopsy.

Figure 3 (right). Performing a Tru-Cut liver biopsy.