

Liver surgery

Hepatic surgery

Surgery of the liver is one of the more technically challenging areas in small animal surgery. Patients are often physiologically compromised, organs are highly vascular, access is poor because of limited mobility, and hepatic parenchyma is often friable and difficult to suture. Careful patient evaluation, preoperative management, knowledge of the complex anatomy and physiology, and flexibility to change plans intraoperatively can all reduce the associated risks.

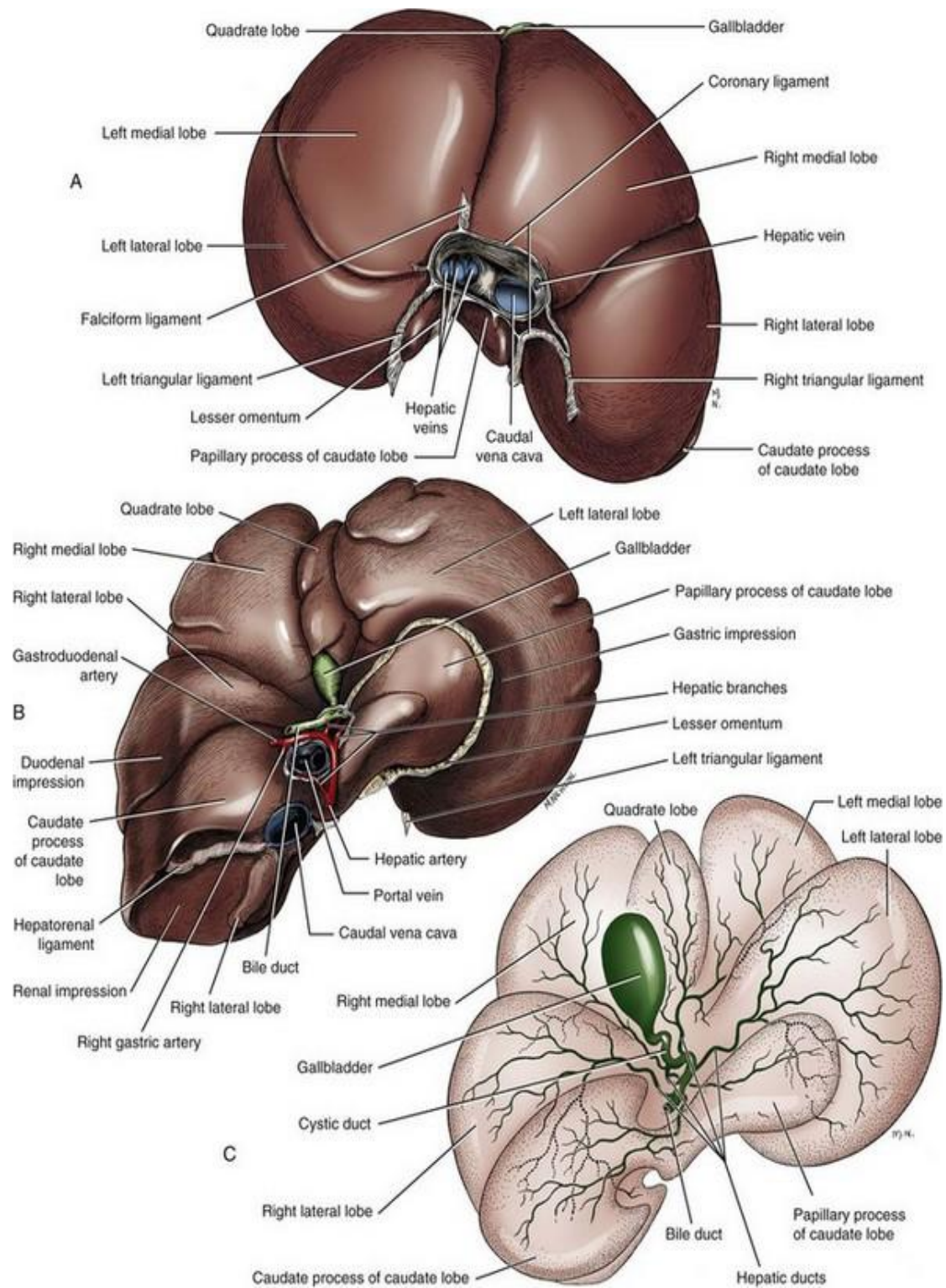
Anatomy

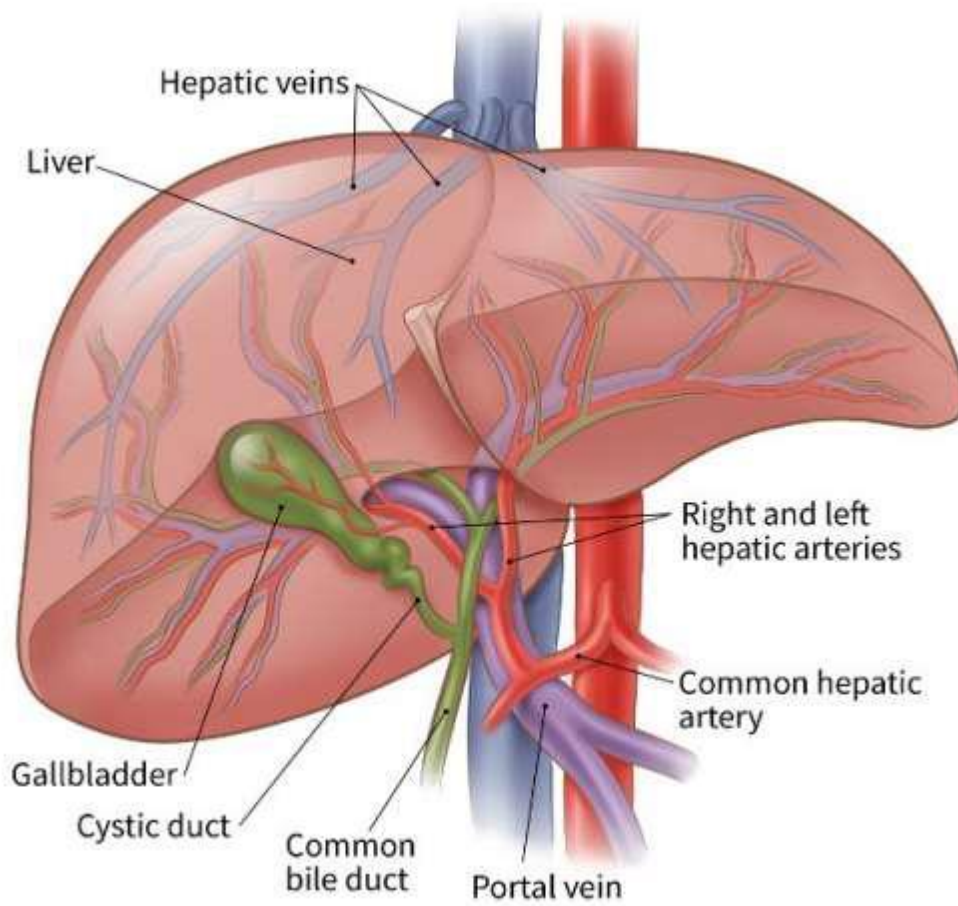
The liver, a brownish-red, friable organ, is the largest gland in the body. It is located in the cranial abdomen and is shaped to fit around neighboring structures — for example, its caudal surface is concave (to fit around the stomach), and its cranial surface curves with the diaphragm.¹ Most of the liver is encased in peritoneum. The liver consists of six lobes.² The lobes are separated into tiny hepatic lobules, which help filter blood through the liver.³ The hepatic cells (i.e., hepatocytes) line the lobules and radiate toward a central vein.³ As an animal ages, its liver atrophies; therefore, the liver in young animals weighs more than the liver in adult animals.¹ The liver has a unique venous system called the *hepatic portal system*, which receives both oxygenated and deoxygenated blood.⁴ All products of digestion are filtered through the liver,⁴ and approximately 80% of the blood that flows into the liver enters via the portal vein and originates from the stomach and intestines.³ The hepatocytes are nourished by this blood, which is rich in nutrients but not in oxygen.³ As the blood enters the lobules, plasma flows across the hepatocytes and filters into the central vein; the blood then travels from

the central vein into the hepatic vein and eventually into the caudal vena cava.⁵ As the blood is filtered through the liver, it passes through Kupffer cells, which help to remove bacteria. The hepatic artery supplies the remaining 20% of the blood to the liver. This blood, which is rich in both oxygen and nutrients, supports the high metabolic activity of the hepatocytes. The hepatocytes secrete hormones and bile, a yellowish-green digestive liquid. The bile is carried through channels of increasing size to the gallbladder and the common bile duct, which leads to the duodenum, where the bile is released.

Blood Supply

Blood supply to the liver comes from the hepatic artery, which is a branch of the celiac artery, and the portal vein. The hepatic artery provides approximately 20% of the blood volume and 50% of the oxygen supply; the portal vein supplies 80% of the blood flow and the remaining half of the oxygen supply. At the level of the porta hepatis, the hepatic artery usually branches into two to five branches that penetrate the different lobes of the liver. A right lateral branch usually supplies the caudate and right lateral lobes. A right middle branch usually supplies the right medial lobe, the dorsal part of the quadrate, and part of the left medial lobe. The left branch supplies the left lateral lobe, part of the quadrate lobe, and left medial lobe.





Surgical affections

Acute Liver Failure

Acute liver failure results in sudden loss of liver function, which is often associated with neurologic signs and clotting abnormalities. It can occur due to a sudden injury of a previously healthy liver or due to an additional insult to an already diseased liver. It is important to seek immediate veterinary care for treatment to support the liver until it can regenerate and compensate for the insult. Any underlying causes of the liver failure need to be identified and treated, if present. Make sure to tell your veterinarian about any medications your pet receives or any access your pet may have to poisons. Treatment may include intravenous fluids, diet changes, antibiotics, and certain liver medications. Another goal of therapy is to prevent or treat neurologic complications of liver failure.

Complications of Liver Disease

The liver has multiple functions, including removing many toxins from the bloodstream and producing blood clotting proteins. When it is not working properly, many other organs can be affected.

1- Hepatic Encephalopathy

Hepatic encephalopathy, a syndrome of neurologic problems caused by poor liver function, is seen in a number of liver diseases. While the development of this condition is not completely understood, failure of the liver to clear poisons from the bloodstream, changes in amino acid metabolism caused by the liver disease, and neurologic changes may act together to cause this disorder. Signs of hepatic encephalopathy include dullness, inability to respond to basic commands, circling, head pressing, aimless wandering, weakness, poor coordination, blindness, excessive drooling, behavior changes (e.g., aggression), dementia, collapse, seizures, and coma.

Treatment of hepatic encephalopathy is aimed at providing supportive care and rapidly reducing the poisons being produced by the digestive tract. Severely affected dogs can be comatose or semicomatose and should not be fed until their status improves. Treatment is likely to include intravenous fluids to correct dehydration and electrolyte (salt) imbalances. Enemas may be used to cleanse the intestines of ammonia

and other poisons, and to introduce nutrients that help decrease poison production. Medications to affect the bacterial populations in the gut may also be used to reduce the absorption of toxic products, such as ammonia. Once the dog has been stabilized, treatment is aimed at preventing recurrence. A protein-modified restricted diet may be prescribed. The signs of hepatic encephalopathy can be worsened by intestinal bleeding, infections, certain drugs (such as corticosteroids and sedatives), cancer, low blood sugar, fever, kidney disease, dehydration, and constipation. Your veterinarian may prescribe additional treatments to address these concerns.

2- Ascites

Ascites is a condition in which fluid collects in the abdomen. In patients with liver disease, ascites is caused by a combination of high blood pressure in the liver, low levels of protein in the blood, and an imbalance in sodium and water metabolism. The first step in the control of ascites is restriction of sodium in the dog's diet. However, sodium-restricted diets alone are often not sufficient, and diuretics (medications that promote loss of fluid by the kidneys) may also be needed. If ascites interferes with breathing, appetite, or comfort, fluid can be removed from the abdomen using a long needle in a process called abdominocentesis. Periodic abdominocentesis can also be used if ascites does not respond to treatment with medication.

3- Clotting Defects

Clotting defects occur in dogs with liver disease because the liver produces many of the proteins responsible for the clotting process. In addition, there can be decreased absorption of vitamins that aid in clotting from the digestive tract. Clotting problems can be treated using transfusions of blood or plasma to provide the necessary clotting factors. Heparin and vitamin K can also be administered to decrease or increase clotting ability. Your veterinarian will prescribe the treatment most appropriate for your pet, its overall condition, and blood type.

4- Bacterial Infections

Dogs with acute liver failure and long-standing liver disease are susceptible to bacterial infections. Your veterinarian will be alert to this possibility because signs of the liver disease itself (for example, fever or low blood sugar) can be similar to those of infection. One or more antibiotics may be necessary to adequately treat the types of bacteria associated with the infection.

5- Fibrosis

Fibrosis, the formation of fibrous scar tissue in the liver, can eventually lead to liver cirrhosis. Cirrhosis is a serious disease that disrupts liver function. However, fibrosis can sometimes be reversed or reduced by the use of appropriate medications. Your veterinarian can determine which, if any, of the available medications would be beneficial for your pet.

Portosystemic Shunts and Other Vessel Abnormalities

Portosystemic shunts have already been described as a congenital (inborn) defect. However, in some cases they can develop as a part of illness. In these instances they are called acquired shunts. They can be caused by high blood pressure in the vessels entering the liver. The diseased liver can be thought of as resisting blood flow into the organ. In this case, new blood vessels open to bypass the liver and connect to the blood system of the rest of the body, where the blood pressure is lower. It is as if the blood system were finding a detour around a traffic jam. Acquired shunts are usually seen in older animals and are more frequent in dogs than in cats.

Signs of an acquired shunt include excessive thirst, vomiting, and diarrhea. Fluid accumulation in the abdomen (ascites) is common. Affected dogs may also have neurologic signs (due to hepatic encephalopathy) that come and go. Laboratory tests can identify abnormalities associated with the underlying liver disease. Medical treatment of the disease to minimize the neurologic signs and fluid build-up in the abdomen can result in a favorable outlook for some dogs with this condition.

Poisons Affecting the Liver

Because of the liver's function in metabolizing drugs, some drugs have been associated with liver dysfunction in dogs. The specific signs and effects depend on the drug and dosage. In many cases your veterinarian will be aware of the potential for liver disease when prescribing these drugs and will monitor your dog for any signs of decreased or altered function.

Other substances that are toxic to the liver include heavy metals, certain herbicides, fungicides, insecticides, rodent poisons, aflatoxins (produced by mold), amanita mushrooms, cycad plants (Sago palm ornamental

plants for the yard and home), and blue-green algae. These can cause life-threatening liver damage.

If your dog has had an accidental overdose of a medication, has had an adverse reaction to a medication (even at the prescribed dose), or has eaten a poison, a veterinarian should be consulted immediately. If necessary, the veterinarian can take steps to minimize absorption of the drug or poison. Depending on the situation, the veterinarian may induce vomiting, administer activated charcoal, pump the animal's stomach, and/or administer an appropriate antitoxin.

Infectious Diseases of the Liver

Several types of infections may affect the liver, including viral, bacterial, fungal, and parasitic diseases.

Viral diseases of dogs associated with liver dysfunction include infectious canine hepatitis and canine herpesvirus. **Infectious canine hepatitis**, caused by canine adenovirus 1, can cause longterm inflammation and scarring of the liver in addition to causing death of liver tissue. Canine herpesvirus causes severe, often fatal liver disease in puppies.

Accidentally injecting an intranasal *Bordetella* vaccine into the skin instead of squirting it into the nose can result in liver damage in some dogs.

Leptospirosis is a bacterial infection, caused by *Leptospira interrogans*, that can cause liver disease. The diagnosis is usually made with a blood test or identification of the organism in urine or blood samples. Treatment includes supportive care and treatment with appropriate antibiotics. Special precautions are recommended when handling dogs suspected of leptospirosis, because this organism may also infect humans.

Other types of bacterial infections, such as those caused by *Clostridium piliforme* or *Mycobacterium* species, can cause liver damage. Infections in other parts of the body can invade into liver tissue and cause damage or dysfunction. Because the liver can help protect the body from bacterial infections, dogs with liver failure or with longterm liver disease are more susceptible to many types of bacterial infections.

The most common fungal infections associated with liver dysfunction are **coccidioidomycosis** and **histoplasmosis**. Signs of liver dysfunction include fluid accumulation in the abdomen (ascites), jaundice, and an enlarged liver. Histoplasmosis is generally treated with one or more

prescription antifungal drugs. Depending on the level of illness, the outlook for recovery may be poor. Coccidioidomycosis can be treated with the longterm (6 to 12 months) use of antifungal medications. However, relapses do sometimes occur, and life-long treatment may be necessary for some dogs.

Toxoplasmosis is a parasitic disease that can kill liver cells and cause sudden liver failure. Jaundice, fever, lethargy, vomiting, increased abdominal fluid, and diarrhea are seen in addition to signs of central nervous system, lung, or eye involvement. Liver disease associated with toxoplasmosis in dogs is most often seen in young dogs or those with a suppressed immune system. Some dogs with toxoplasmosis are also infected with canine distemper virus, in which case the disease is sudden in onset and rapidly fatal. Diagnosis can be difficult. Treatment usually involves appropriate antibiotics. The outlook for recovery depends on the severity of the illness.

Leishmaniosis is a potentially fatal disease caused by *Leishmania* species of protozoa. The disease affects multiple organs, including the liver. There are several drugs available for treatment, but they rarely cure the disease. Lifelong therapy may be necessary. The disease can pass to people, especially those with compromised immune systems. The outlook for severely affected dogs is poor.

Canine Chronic Hepatitis

Chronic hepatitis is a longterm inflammation of the liver. It is more common in dogs than in cats. Several breeds of dogs are predisposed to this condition, including Bedlington Terriers, Labrador Retrievers, Cocker Spaniels, Doberman Pinschers, Skye Terriers, Standard Poodles, Springer Spaniels, Chihuahuas, Maltese, and West Highland White Terriers. Although the cause can be determined in some cases of chronic hepatitis, in many cases the cause remains unknown. Copper and iron accumulation is often seen in dogs with chronic hepatitis. Other conditions that have been associated with chronic hepatitis include viral infection (such as infectious canine hepatitis), leptospirosis, exposure to certain chemicals or poisons, and drug toxicity.

Abnormal accumulations of copper can lead to copper-associated hepatopathy, one the most common causes of chronic hepatitis. Adding zinc to the diet may help to protect the liver by preventing the absorption of copper from the gut in these cases. Please see Liver for more information on copper-associated liver disease.

Depending on the signs, the cause (if known), and the breed and history of the dog, your veterinarian will determine the appropriate plan for treating and managing chronic hepatitis.

Canine Cholangiohepatitis

Liver inflammation can also occur due to infections around the biliary tract, which transports bile from inside the liver to the small intestine. These infections ascend from the intestinal tract, often due to slow movement of bile, gallstones, or other biliary tract disorders. The condition, called **cholangiohepatitis**, is rare in dogs. Antibiotics are needed to treat the infection, and surgery can be necessary, depending on the cause.

Endocrine Diseases Affecting the Liver

Several diseases involving the endocrine glands can cause liver problems in dogs. These diseases include diabetes mellitus, Cushing disease, and hyperthyroidism.

Dogs with **diabetes mellitus** can rarely have liver dysfunction associated with their disease. Diabetic dogs have an increased risk for inflammation of the pancreas (pancreatitis), which can lead to some types of liver disease. Some diabetic dogs will develop hepatocutaneous syndrome, which is often deadly. They can also have an increased risk of developing fatty degeneration of the liver because diabetes mellitus increases the metabolism and mobilization of lipids. Lipids include any of a group of water-soluble fats and fat-like chemical substances that are sources of fuel for the body. However, when too many lipids are deposited in the liver, the function of the organ is impaired. Insulin replacement may or may not correct this storage problem.

Dogs with **hyperadrenocorticism** are likely to develop changes in the liver similar to those seen in overdoses of cortico-steroids. These problems are controlled when the underlying disorder is treated. Liver changes can also be seen in dogs with hypothyroidism.

Liver Cysts and Nodular Hyperplasia

Liver cysts can be acquired (usually single cysts) or present at birth (usually multiple cysts). Congenital polycystic disease of the liver has been reported in Cairn Terriers, Bull Terriers, Beagles, and West Highland White Terriers. Occasionally, the cysts can become large and

cause abdominal swelling and other signs such as lethargy, vomiting, and excessive thirst. Your veterinarian may be able to feel masses in the abdomen that usually are not painful. Fluid may accumulate in the abdomen. The problem can be identified using x-rays or ultrasonography, although a definitive diagnosis is made by biopsy. Surgical removal of the cysts usually cures the condition.

Canine Vacuolar Hepatopathy

The liver produces and stores energy in the form of glycogen. Glycogen is released to help maintain blood sugar levels throughout the day. However, in dogs with **vacuolar hepatopathy**, abnormal amounts of glycogen accumulate within liver cells, distending them. It is a common liver syndrome that is typically revealed with the results of a liver tissue biopsy. The syndrome is often associated with excessive adrenal gland function (hyperadrenocorticism) or with longterm stress, illnesses, inflammation, or cancer. Certain drugs can also stimulate this syndrome. The presence of glycogen-distended liver cells may also be present in dogs with nodular hyperplasia and certain types of liver cancer. Veterinarians will determine and treat the underlying cause of these liver changes. They may also recommend a change in dog food, the addition of a vitamin supplement, or other treatments. A form of this syndrome is common in Scottish Terriers. Affected dogs of this breed can slowly or rapidly develop severe liver conditions, such as cirrhosis, liver cancer, or liver failure.

Nodular hyperplasia is a nonspreading, age-related condition in dogs. It does not usually cause disease or affect liver function. If it is detected, a biopsy may be needed to distinguish these changes from those caused by other serious liver diseases.

Hepatocutaneous Syndrome in Dogs

Hepatocutaneous syndrome is a rare, longterm, progressive disorder that affects both the liver and the skin. Affected dogs often have crusting sores on their lips, nose, footpad, ears, elbows, and around the eyes. Signs also include loss of appetite, weight loss, lethargy, and an increase in thirst and urination. The condition can occur in dogs with certain longterm diseases, such as diabetes mellitus and certain tumors, and the longterm use of certain drugs, such as phenobarbital. Your veterinarian may recommend a diet change and treatments for the skin sores. Other medications may also help some affected dogs, and underlying diseases need to be managed. Unfortunately, dogs often die from this condition.

Cancers of the Liver

Tumors that originate in the liver (called primary tumors) are less common than those caused by spread from another part in the body. Primary tumors are most often seen in animals more than 9 years old. These tumors can be either malignant or benign and may spread (metastasize) to other locations such as the lymph nodes, abdominal wall, and lungs.

Cancers that can spread to the liver include lymphoma, pancreatic cancer, mammary (breast) cancer, and many others. Metastatic tumors usually occur at multiple sites.

Signs can include a decreased appetite, lethargy, fever, excessive urination and thirst, vomiting, weight loss, jaundice, bleeding problems, hepatic encephalopathy (see above), enlarged liver, and fluid accumulation in the abdomen. Seizures may develop because of hepatic encephalopathy, low blood sugar, or the spread of cancer to the brain. An abdominal tumor may be found by your veterinarian during an examination or during an abdominal ultrasound. A biopsy is often needed for a definitive diagnosis. Sometimes a liver tumor can rupture and result in life-threatening internal bleeding. If a single liver lobe is involved, surgical removal of the involved lobe is often recommended. Chemotherapy may be effective for some other cancer types. The outlook is poor for primary liver tumors that involve multiple lobes because an effective treatment is not yet available.

Other Liver Diseases

Several other noninfectious chronic diseases may also affect the liver.

Glycogen Storage Disease

Glycogen is a form of stored sugar found in animals. It is converted to glucose when the body needs energy. Glycogen storage diseases are caused by a deficiency of certain enzymes and result in failure of glycogen to be released from cells. When this occurs, glycogen accumulates within the liver and other organs and is unavailable for conversion to glucose. The disease is inherited in certain breeds, including Malteses, German Shepherds, and Curly Coated Retrievers. Signs of this disorder include an enlarged liver, retarded growth, and weakness due to low blood sugar levels. Liver biopsies or genetic tests

are used for diagnosis. Treatment is based on signs of illness and includes frequent small meals of high-carbohydrate food. The outlook in most cases is poor, and most dogs with these diseases die at a young age.

Hepatic Amyloidosis

Amyloid is a protein that is not folded into the correct shape. Misfolded proteins clump together and cause damage by displacing normal cells. Amyloidosis is an inherited disease of Chinese Shar-Peis; however, the liver is not always affected. Longterm exposure to antigens, which can be associated with longterm infections, can also cause amyloidosis in the liver. Although some dogs may show no signs, typical signs include loss of appetite, excessive thirst and urination, fever, vomiting, jaundice, and an enlarged liver. Affected animals may collapse and have pale mucous membranes due to rupture of the liver and subsequent internal bleeding. Diagnosis is made by identifying amyloid deposits in liver biopsy samples. Drugs are available that may slow the progression of amyloidosis, but the outlook is poor, especially if the diagnosis is made late in the disease.

Diseases of the Gallbladder and Bile Duct

The liver secretes bile, a substance that assists with digestion and absorption of fats and with elimination of certain waste products from the body. Bile is stored in the gallbladder and is released into the small intestine through the bile duct.

Jaundice (a yellow tinge noticeable in the skin, mucous membranes, and eyes) is often the main sign of diseases of the gallbladder and bile duct. An exception is cancer of the gallbladder, which may not cause jaundice.

Gallbladder agenesis is the lack of a gallbladder from birth. Unless the bile ducts within the liver are also missing, the lack of a gallbladder doesn't cause any problems.

Biliary atresia is the lack of development of bile ducts within the liver and is uncommon. Affected dogs are jaundiced and unthrifty at a young age. The outlook is poor.

Cystic mucosal hyperplasia of the gallbladder is also known as cystic mucinous hypertrophy, cystic mucinous hyperplasia, and mucinous

cholecystitis. It is the development and growth of cysts filled with mucus in the gallbladder. It may be caused by treatment with steroid hormones, such as female reproductive hormones. An early stage of the disorder may be a condition known as gallbladder dysmotility.

Obstruction of the Bile Duct

Obstruction of the bile duct is associated with a number of conditions, including inflammation of the pancreas, gall bladder, or small intestines; foreign material in the intestine; cancer; and parasitic infections. Tissue swelling, inflammation, or fibrosis can cause compression of the bile duct. Diagnosis is based on laboratory tests, x-rays, and ultrasonography. Abdominal surgery is frequently necessary to diagnose and treat the obstruction. However, in dogs with pancreatitis, treatment will often relieve the obstruction. If this is not successful, surgery may be necessary. If gallstones are the cause of obstruction, the gallbladder may need to be removed. When cancer is present, surgery can provide some relief but is not a cure.

Inflammation of the Gallbladder (Cholecystitis)

Inflammation of the gallbladder (cholecystitis) can be caused by bacterial infections, cancer, trauma to the liver, gallbladder obstruction, or blood clots. In some cases, the wall of the gallbladder is damaged, and bile leaks into the abdomen causing severe abdominal infection and inflammation, which can be fatal. Loss of appetite, abdominal pain, jaundice, fever, and vomiting are common signs. The dog may be in a state of shock due to abdominal inflammation.

The inflammation can also spread to the surrounding branches of the bile duct and the liver. Diagnosis is based on blood tests and ultrasound findings and can be confirmed by biopsy for bacterial cultures and tissue analysis. Treatment usually consists of removal of the gallbladder and appropriate antibiotic medication to treat infection. The outlook is good if surgery and appropriate antibiotics are started early but is less favorable if diagnosis and treatment are delayed.

Gallbladder Mucocele in Dogs

A gallbladder mucocele is an abnormal accumulation of bile within the bile ducts that results in a bile duct obstruction. As it expands, the mucocele can lead to inflammation, tissue death, or rupture of the gallbladder. The condition may be inherited in some breeds, including

Shetland Sheepdogs. Underlying diseases can also predispose dogs to the condition. Some mildly affected dogs can improve with medications alone; however, most will require surgery to remove the gallbladder. Liver biopsies are often taken during surgery. Antibiotics are usually necessary for 4–6 weeks after surgery. Dogs with a ruptured gallbladder and blood poisoning may not survive, even with surgery.

Gallstones

Gallstones rarely cause disease. When it does occur, disease is usually seen in middle-aged to older dogs, and may be more common in small-breed dogs. Signs include vomiting, jaundice, loss of appetite, abdominal pain, fever, and discomfort after eating, but many dogs show no signs. Gallstones are diagnosed by ultrasonography. Because abdominal ultrasounds are being used more frequently, gallstones are being diagnosed more often in recent years. Medications, including antibiotics, can treat dogs with uncomplicated disease. Surgery to remove the stones is necessary if they are obstructing bile or causing cholecystitis. Removal of the gallbladder may also be necessary.

Rupture of the Gallbladder or Bile Duct

Rupture of the gallbladder or bile duct is most often due to gallstone obstruction, inflammation of the gallbladder, or blunt trauma. Rupture of the bile duct may also occur as a result of cancer or certain parasites. Rupture leads to leakage of bile into the abdomen, causing a serious condition called bile peritonitis, which may be fatal if the rupture is not repaired. Treatment includes surgery, which consists of placing a stent in the bile duct, removing the gallbladder, or connecting the gallbladder with the small intestine.

Diagnosis of liver diseases

- Ultrasonography and Doppler
- X-ray
- Liver inspiration needle
- CT scan and MRI

Common Hepatectomies

Each dog was sedated with acepromazine 0.1-0.5 mg/kg IM followed by ketamine 5 mg/kg and diazepam 0.25 mg/kg IV. General anesthesia was maintained with 2% inhaled isoflurane via endotracheal tube. Animals were placed in lithotomy, and midline incisions were used. After the liver was mobilized by dividing the coronary and triangular ligaments, dissection was carried to the level of the hepatic veins superiorly and the vena cava inferolaterally. The portal structures were identified within the hepatoduodenal ligament, and the portal vein branches to the left and right lobes were individually dissected free and encircled. The canine portal vein branches outside the hilar plate and the main left portal branch were easy to identify. The left main portal vein branch was dissected carefully into the liver parenchyma to preserve as much length as possible, controlled with a vascular clamp, and divided. Hepatic veins approaching the liver parenchyma tend to be shorter in dogs than humans. We carefully ligated the middle hepatic vein without narrowing the left hepatic vein. We then dissected the left hepatic vein into the liver parenchyma to provide as much length as possible. We controlled the dissection with a vascular clamp and divided the area sharply. We preserved the right hepatic vein to drain the remaining liver remnant. We then divided the liver parenchyma itself with the use of a LigaSure device (Covidien); we removed the quadrate lobe, left lateral lobe, left medial lobe, and papillary process of the caudate lobe. In order to complete the 90% hepatectomy model, we used the LigaSure device to remove the entire right medial lobe, the ventral and lateral portions of the right lateral lobe, and caudate processes of the caudate lobe. The remaining 10% of liver parenchyma included portions of the caudate lobe and the right lateral liver lobe encircling the vena cava. We preserved blood flow to this remnant through the right portal vein, right hepatic artery, and right bile ducts. The hepatic venous outflow was through the right hepatic vein and the direct branches of the remaining liver into the vena cava.

Surgical Risks Include:

1. Infection (less than 3%) which may require additional testing and medication at an additional cost.
2. Hemorrhage (during or after surgery) that may require a transfusion at additional cost
3. Low blood sugar
4. Infection

5. Liver enzyme or bile acid elevations that may require supportive care in the hospital
6. Pancreatitis
7. Incomplete resection if liver tumor