
بسم الله الرحمن
الرحيم

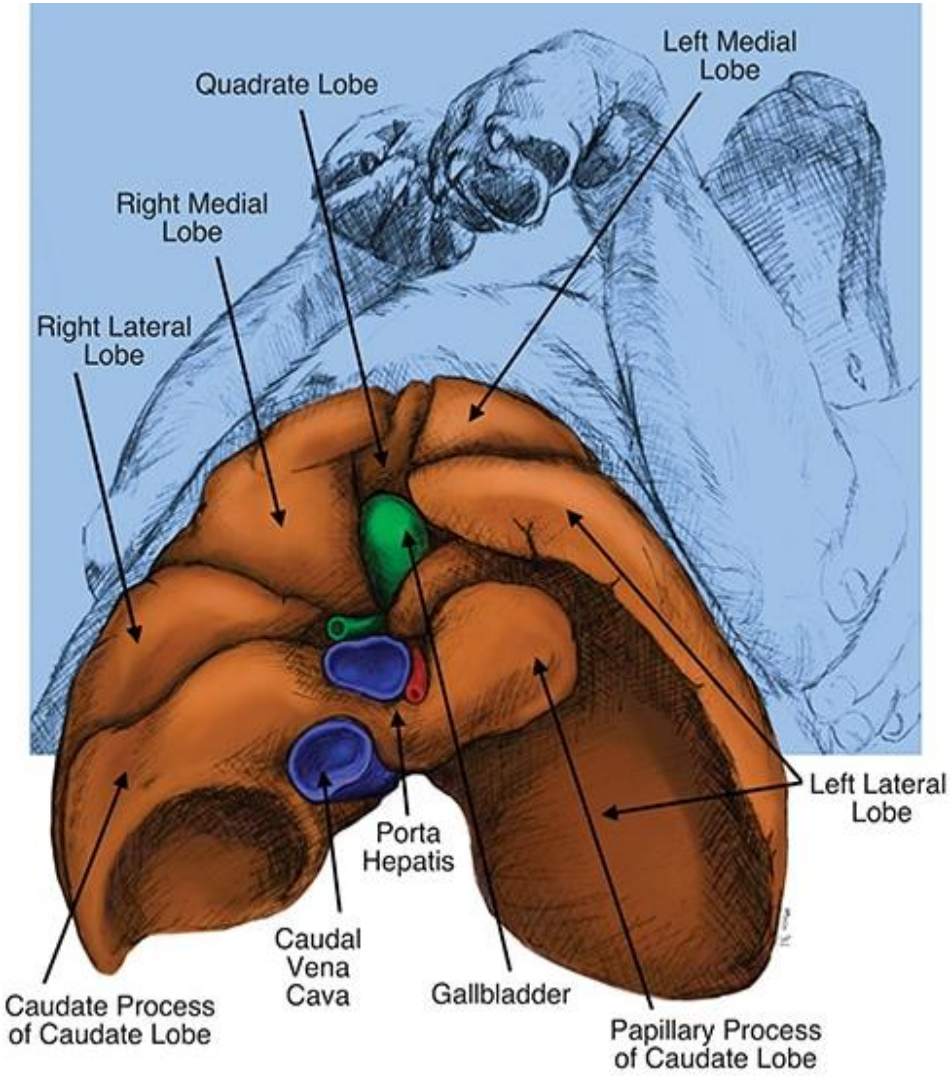
Surgery of Liver and Biliary System

By Dr. Rafid Majeed Naeem Alkhalifa

anatomy

Surgery of the liver and extrahepatic biliary tract is challenging areas in small animal surgery because : *organs are highly vascular, access is poor because of limited mobility, and hepatic parenchyma is often friable and difficult to suture.*

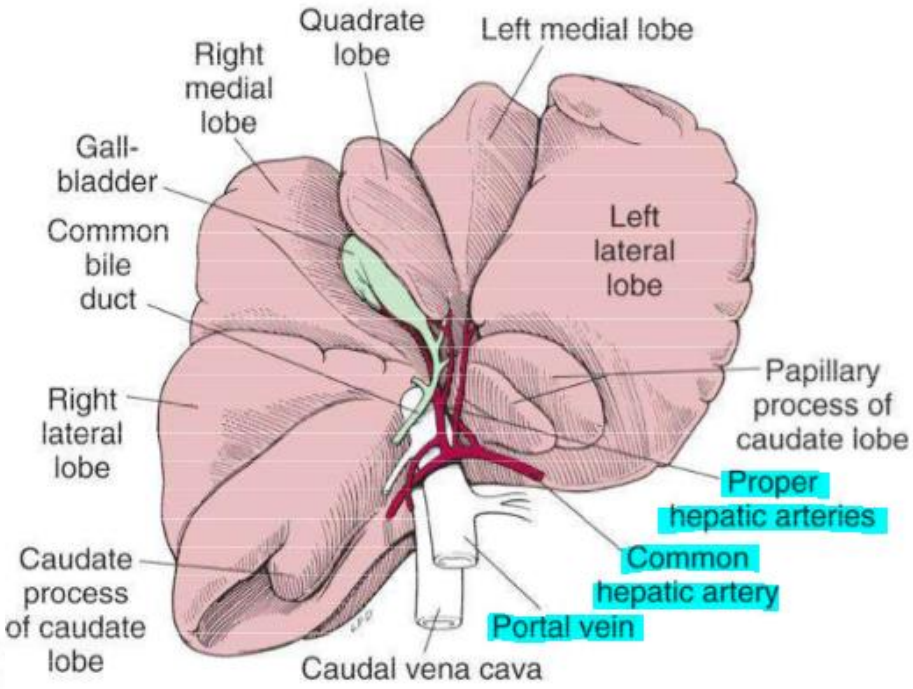
The liver is deeply fissured in dogs and cats, fissures allow the lobes to move over each other without risk of parenchymal fractures

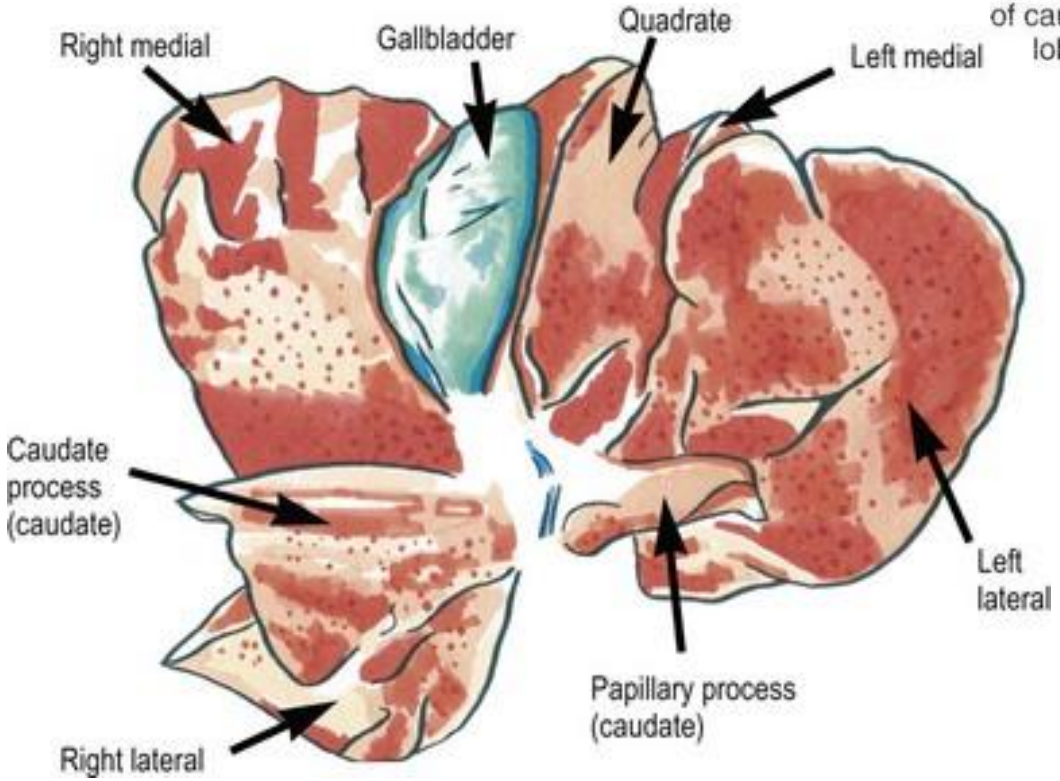


anatomy

The fissures subdivide the liver of dogs and cats into five lobes, four sublobes, and two processes.

The left lobe is the largest and is subdivided into the left lateral and left medial lobes.



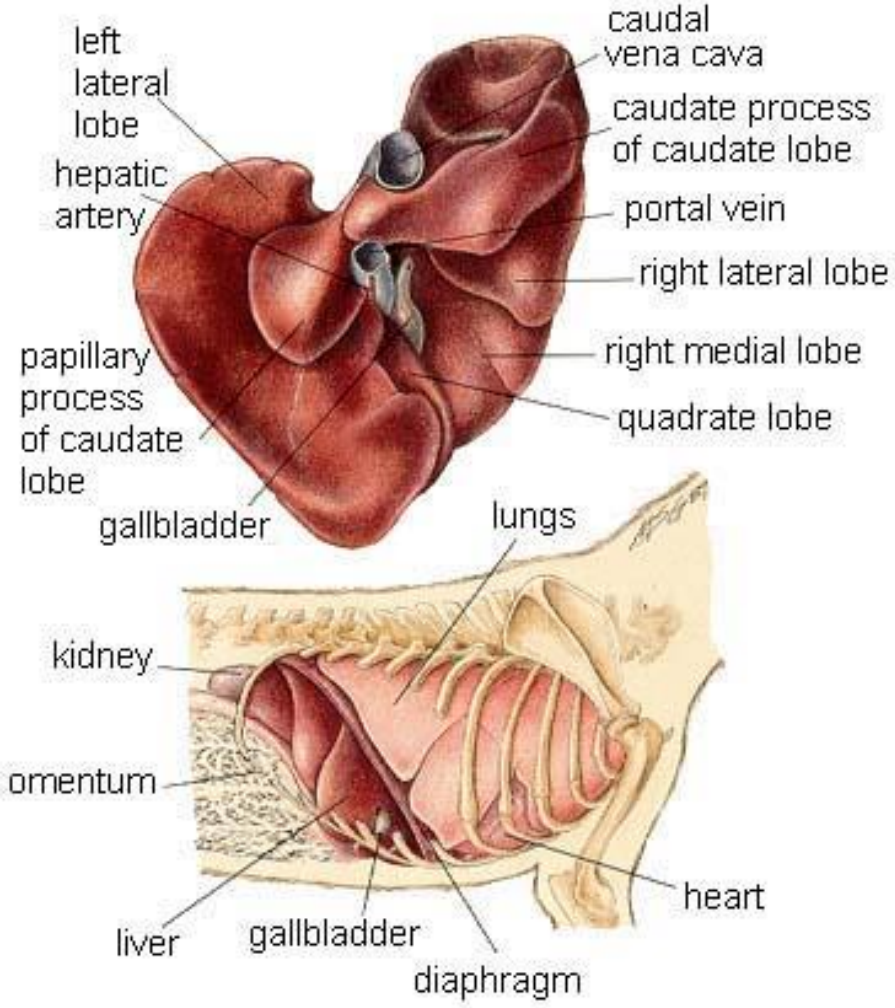


A substantial cleft separates the two portions of the left lobe, making surgical access to the bases of the left lateral and medial lobes less technically demanding compared with right side approaches

anatomy

A deep fissure also separates the left medial lobe from the quadrate lobe and extends from the porta hepatis almost all the way to the esophageal notch

The right lateral lobe is usually fused at its base with the caudate lobe, which is subdivided into the caudate and papillary processes.



<u>The caudate process is the most caudal part of the liver, usually extending to the level of the twelfth intercostal space</u>

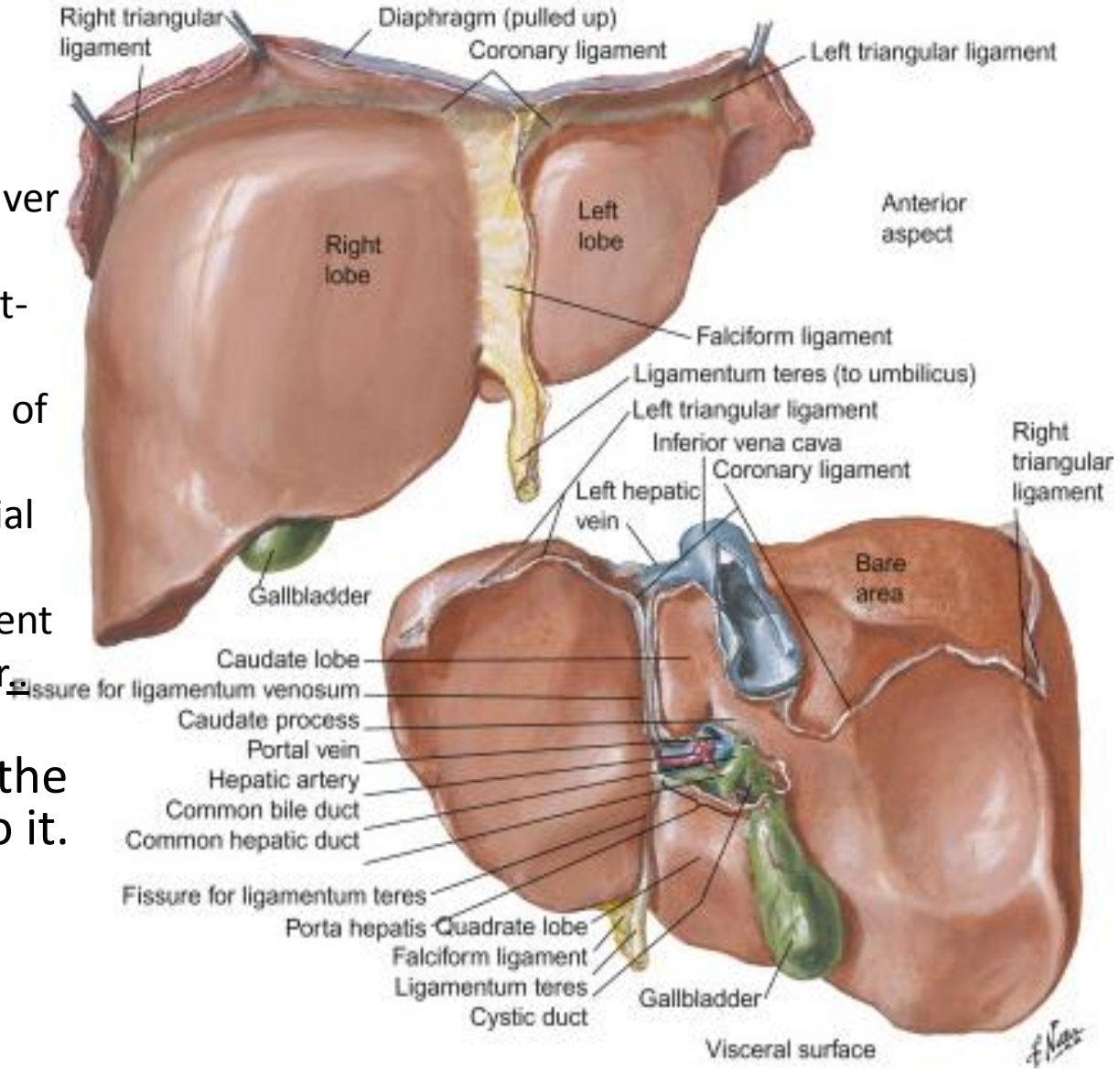
The papillary process extends toward the left side, crossing the midline, and is loosely covered by the lesser omentum.

Attachments

A coronary ligament attaches the liver to the diaphragm
the coronary ligament are two right-sided triangular ligaments, a larger one that fuses onto the dorsal part of the right lateral lobe and a smaller one that attaches to the right medial lobe.
a single left-sided triangular ligament attaches to the left lobe of the liver.

The vena cava runs through the liver and is firmly attached to it.

The hepatorenal ligament



The lesser omentum(as the hepatogastric ligament) and (as the hepatoduodenal ligament).

- The hepatorenal ligament attaches the caudate lobe of the liver to the right kidney.

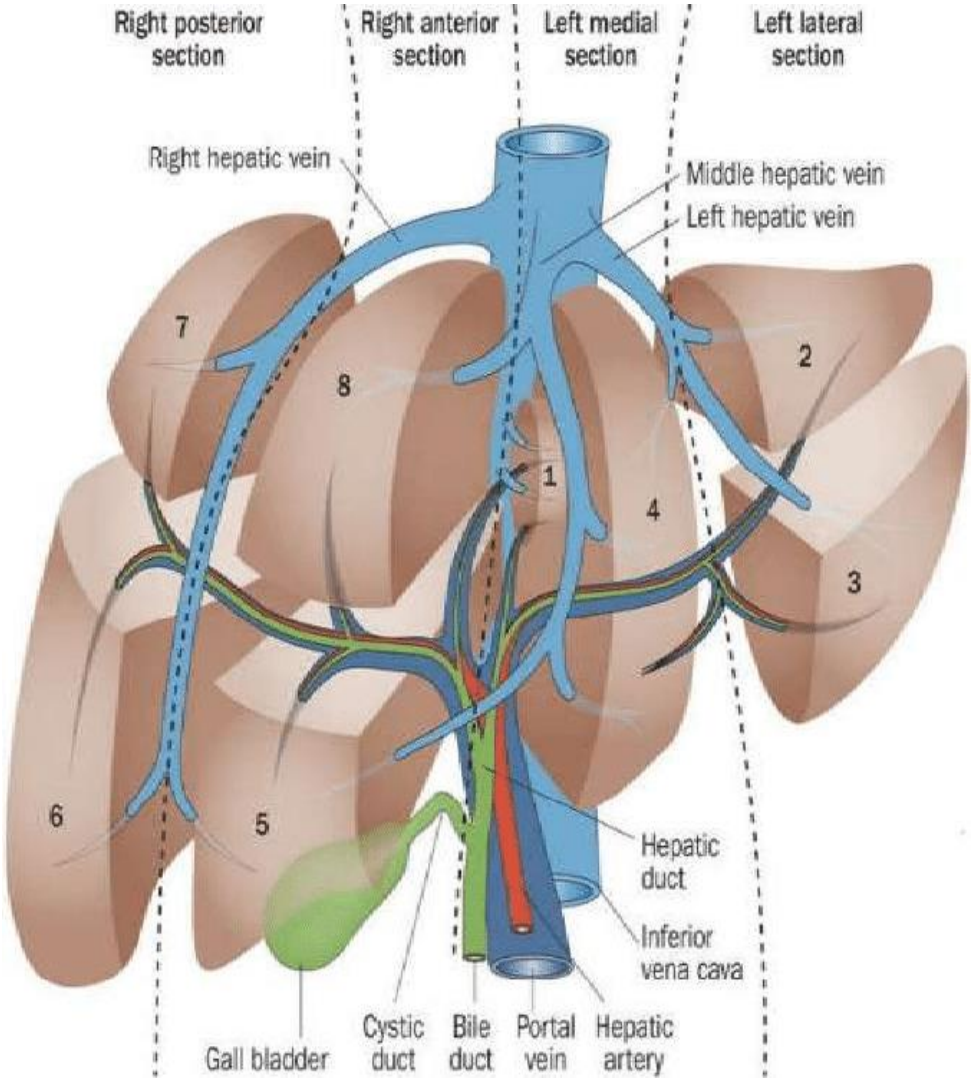
- The lesser omentum loosely surrounds the papillary process of the liver and attaches the liver in the region of the porta hepatis to the lesser curvature of the stomach (as the hepatogastric ligament) and the proximal duodenum (as the hepatoduodenal ligament).

Blood Supply

Blood supply to the liver comes from the hepatic artery, which is a branch of the celiac artery, and the portal vein.

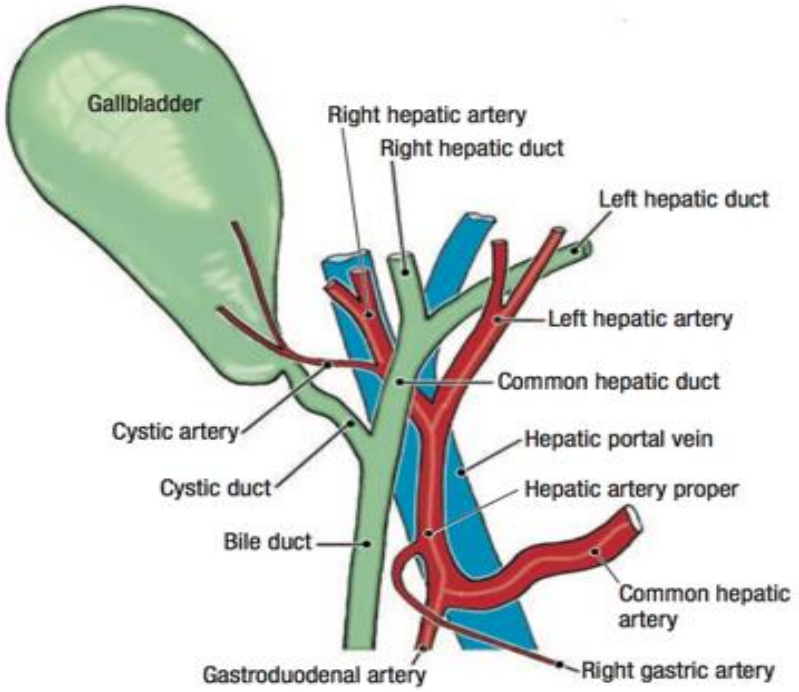
The hepatic artery provides approximately 20% of the blood volume and 50% of the oxygen supply; the portal vein supplies 80% of the blood flow and the remaining half of the oxygen supply.

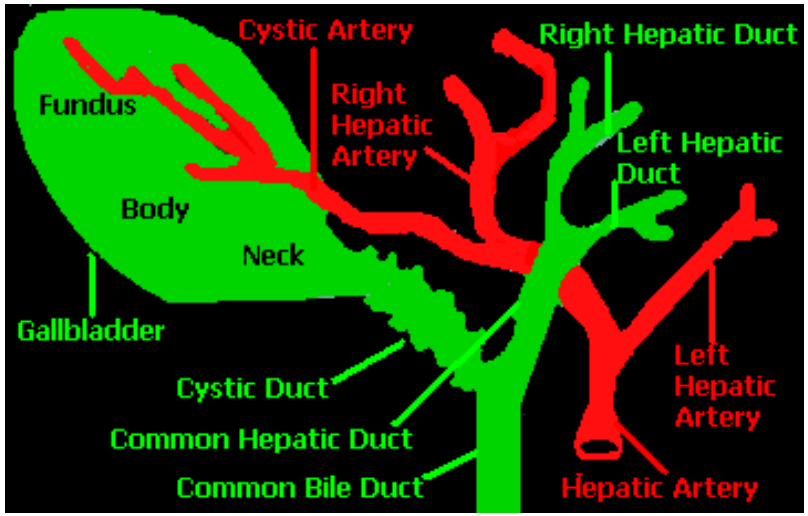
At the level of the porta hepatis, the hepatic artery usually branches into two to five branches that penetrate the different lobes of the liver.

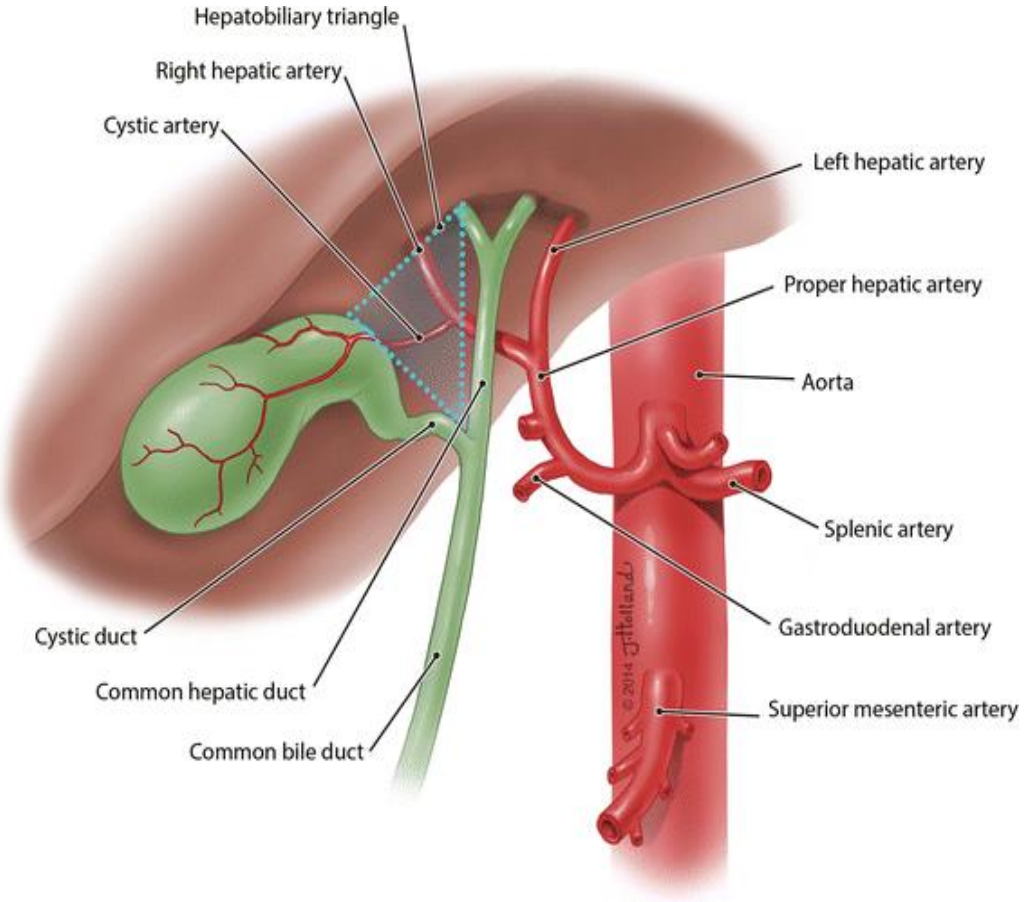


the gallbladder and bile duct

The cystic artery to the gallbladder is a branch of the left branch of the hepatic artery.

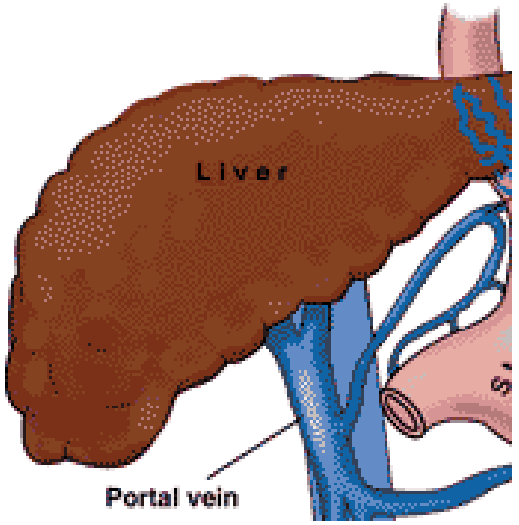




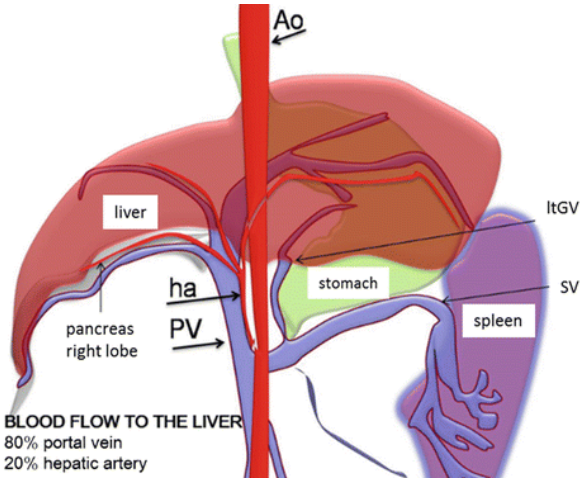


portal vein branchs

- **the canine portal vein** generally divides into a right and left main branch. The right branch supplies the caudate process and the right lateral lobe. The left branch usually gives off a central branch that supplies the right medial lobe and papillary process and then divides into the left lateral, left medial, and quadrate branches, which supply their respective lobes.

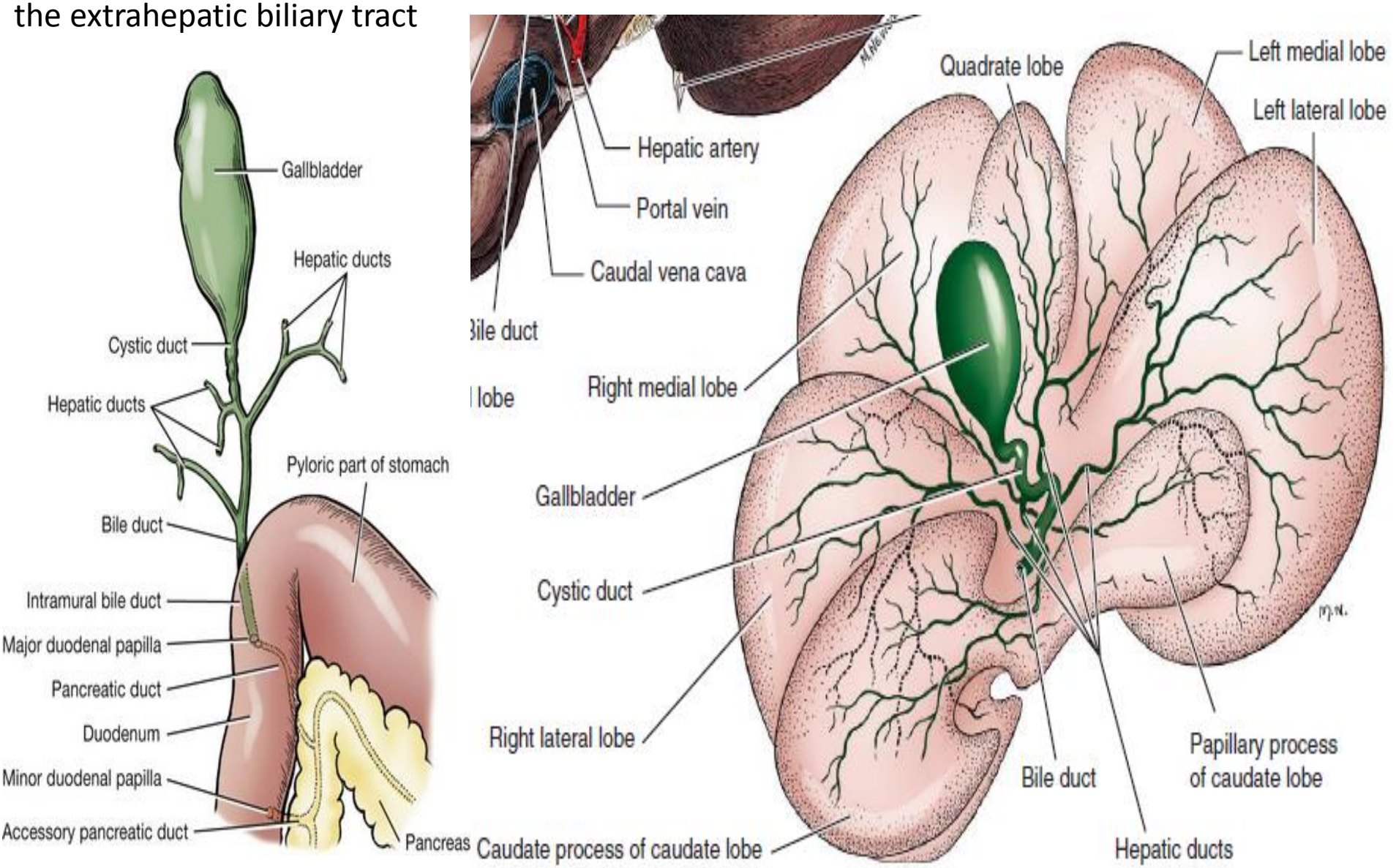


- In cats, there are usually three main branches—right, central, and left—that supply the relevant lobes of the right, central, and left divisions of the liver. Six to eight hepatic veins usually drain venous blood from the canine liver into the caudal vena cava



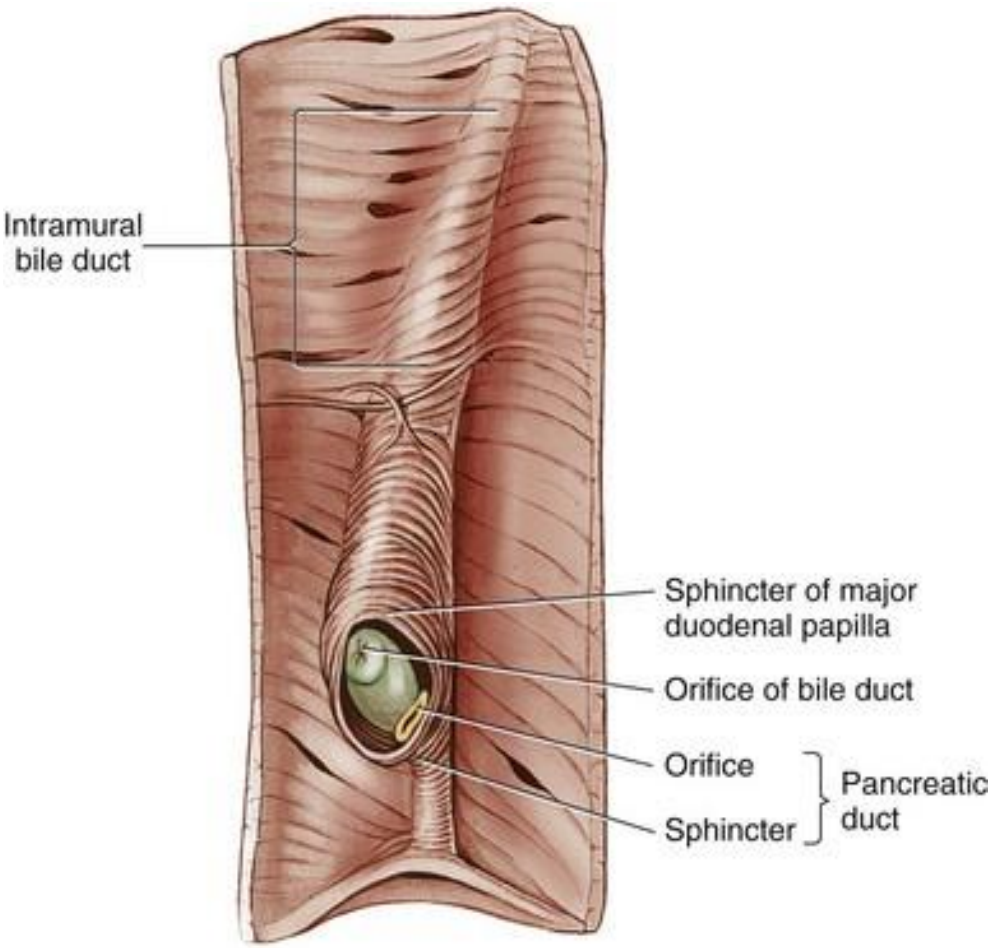
Biliary System

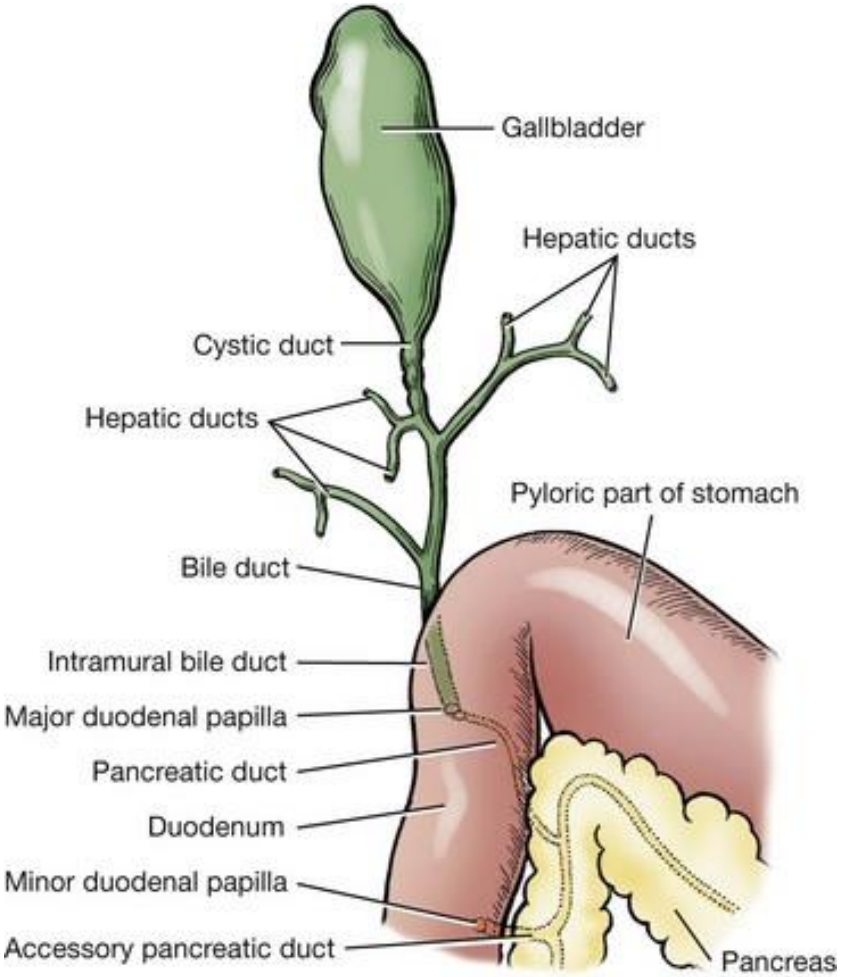
Within the liver, canaliculi drain bile into interlobular ducts. These converge further into lobar ducts that become known as *hepatic ducts* as they exit the liver parenchyma and form part of the extrahepatic biliary tract



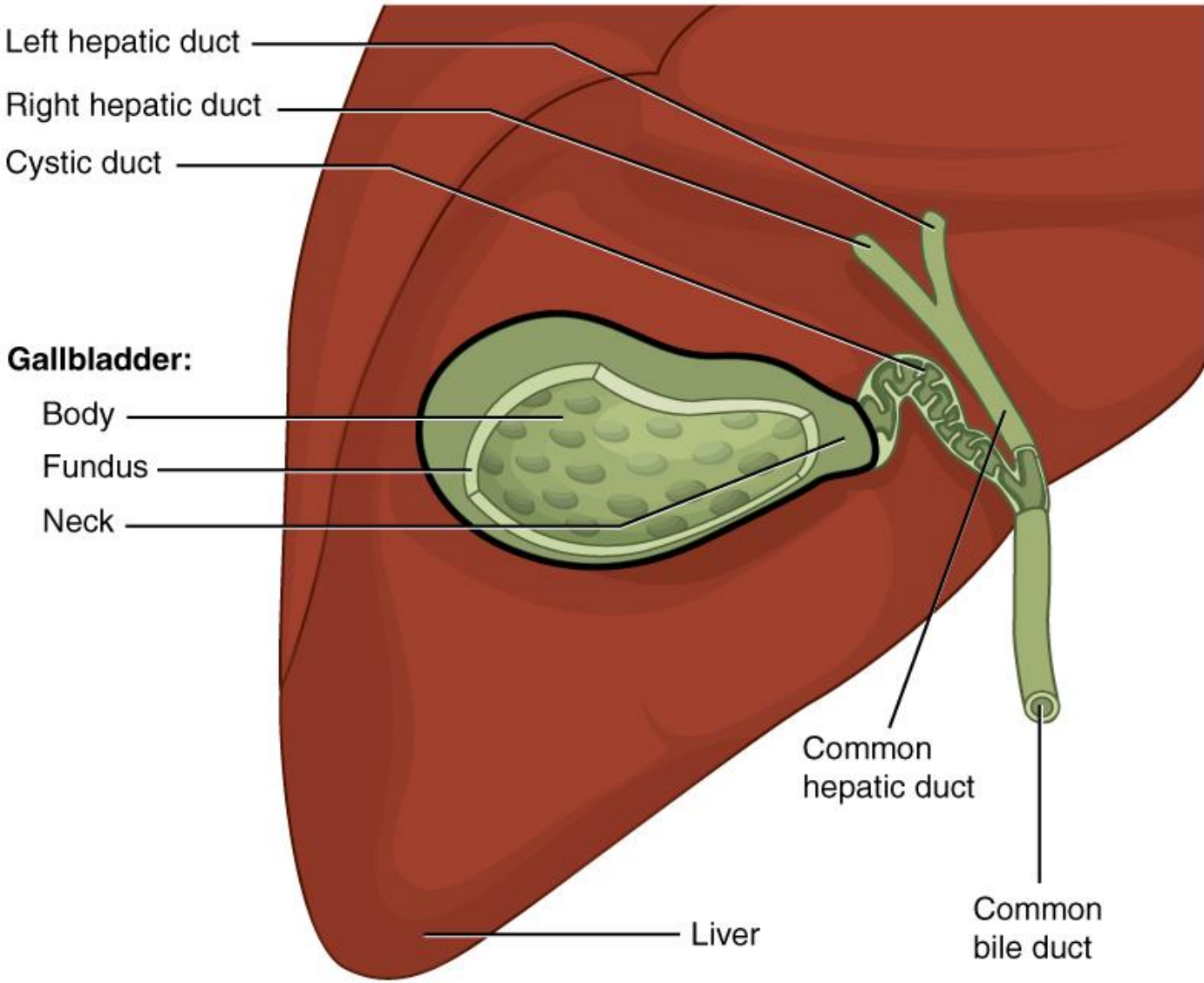
- The number of hepatic ducts in dogs varies from two to eight. Hepatic ducts converge to form the common bile duct, which enters the duodenum at the major duodenal papilla

- The point at which the first hepatic duct joins the cystic duct is the point at which the common bile duct commences.

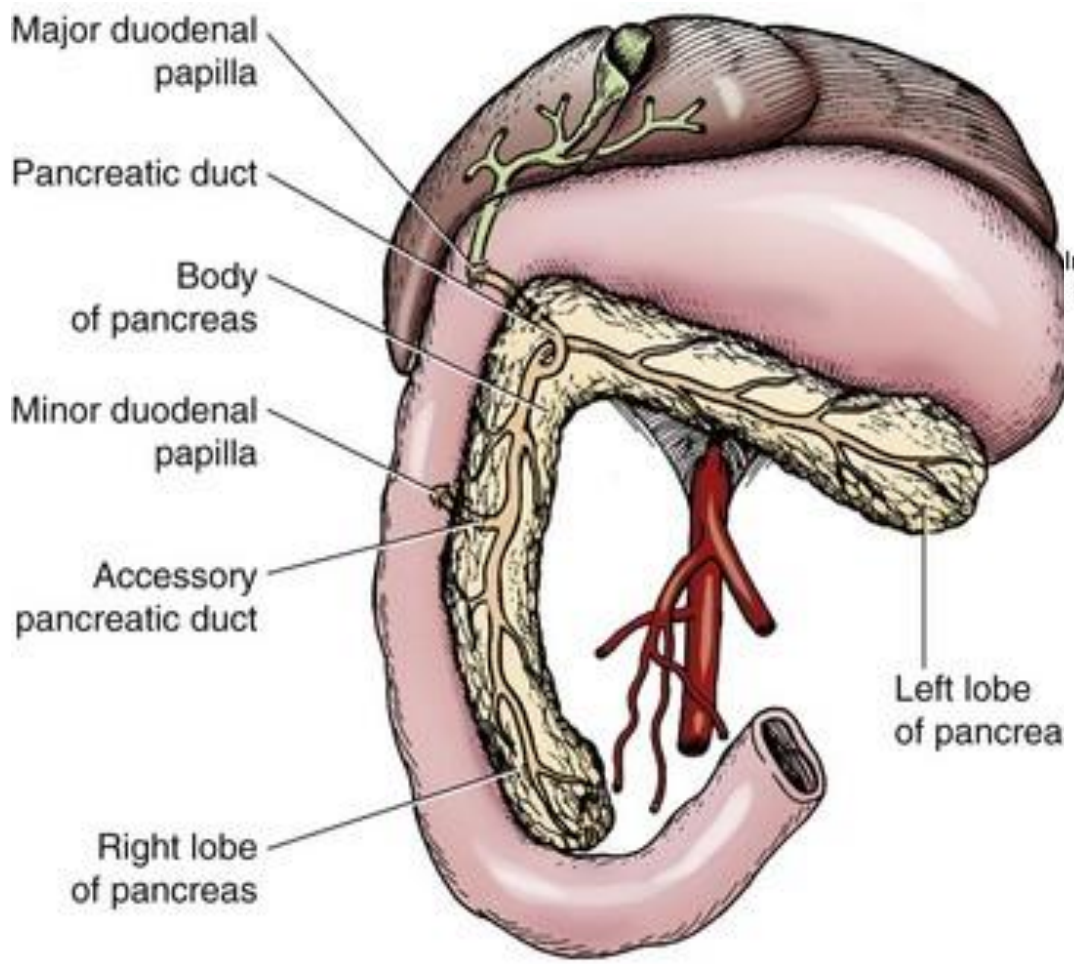


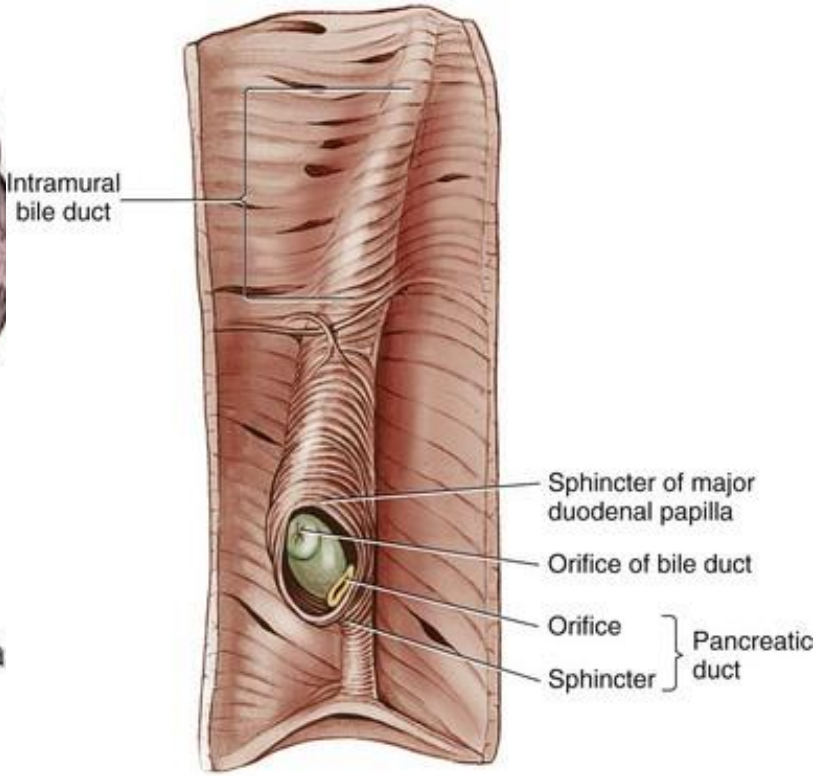


- The gallbladder stores and concentrates bile and excretes it into the intestinal tract.
- Bile first passes through the cystic duct and common bile duct before entering the duodenum through the sphincter of Oddi.



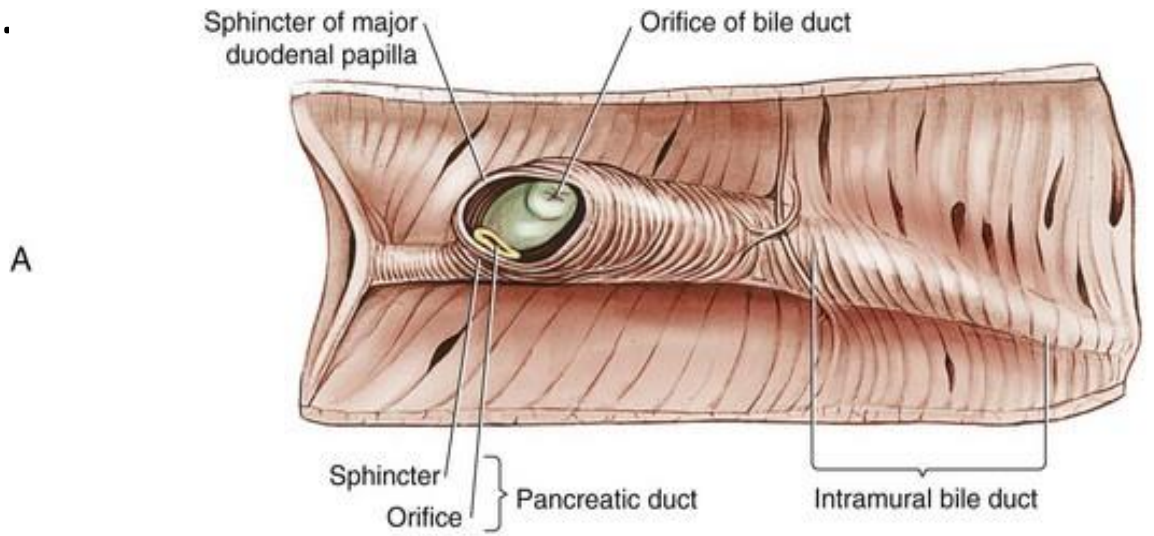
- The major duodenal papilla is a small, raised تلmound located on the mesenteric mucosal margin approximately 3 to 6 cm aboral to the pylorus.
- The location of the major duodenal papilla can be estimated by locating the point at which the distal common bile duct passes through the right limb of the pancreas to join the mesenteric aspect of the descending duodenum.

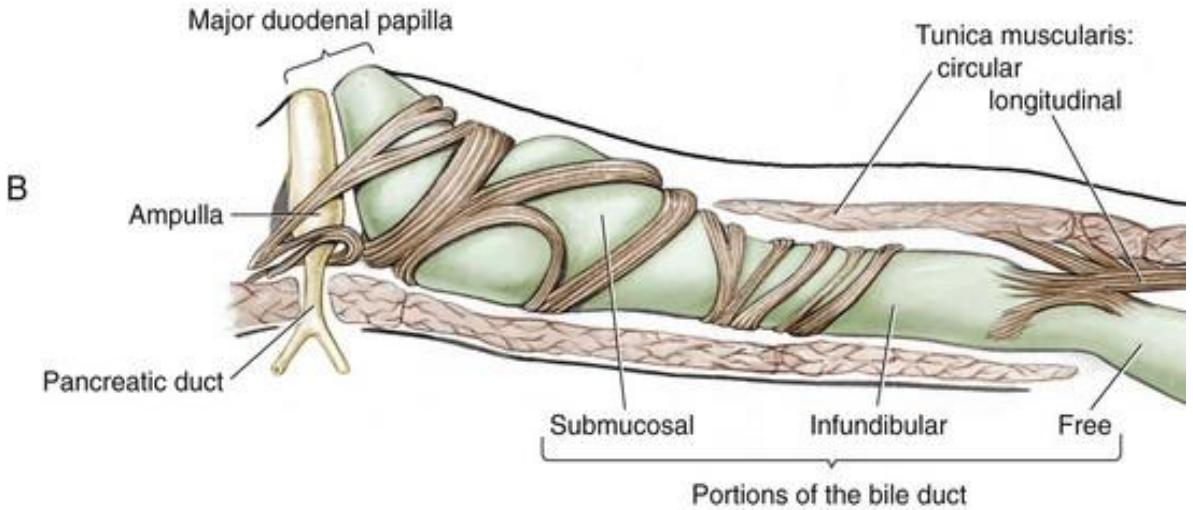




Species Differences

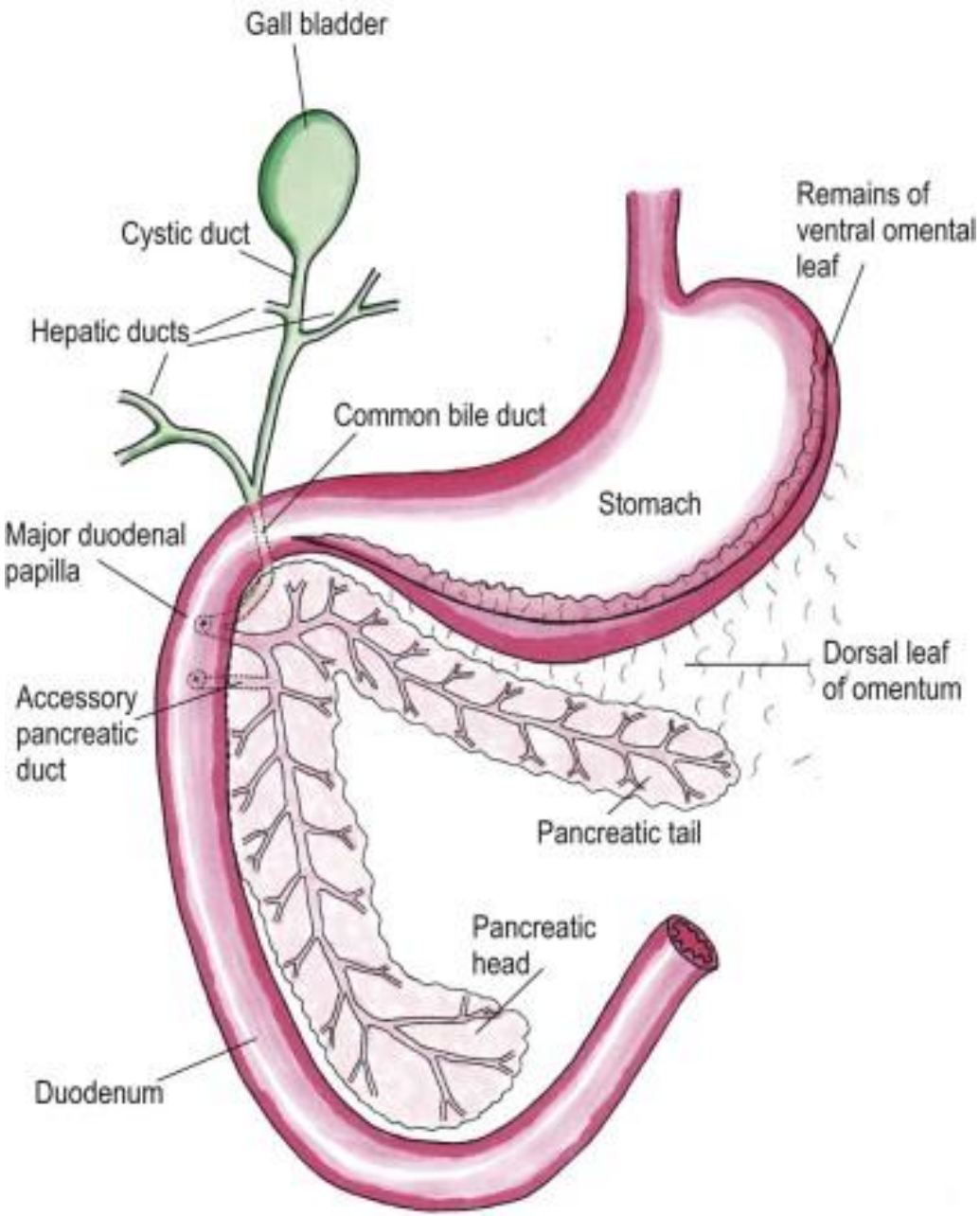
In dogs, the common bile duct enters the duodenum at the major duodenal papilla adjacent to, but not conjoined with, the pancreatic duct. Smooth muscle fibers surround the two ducts as they emerge into theduodenum, forming the sphincter of Oddi.





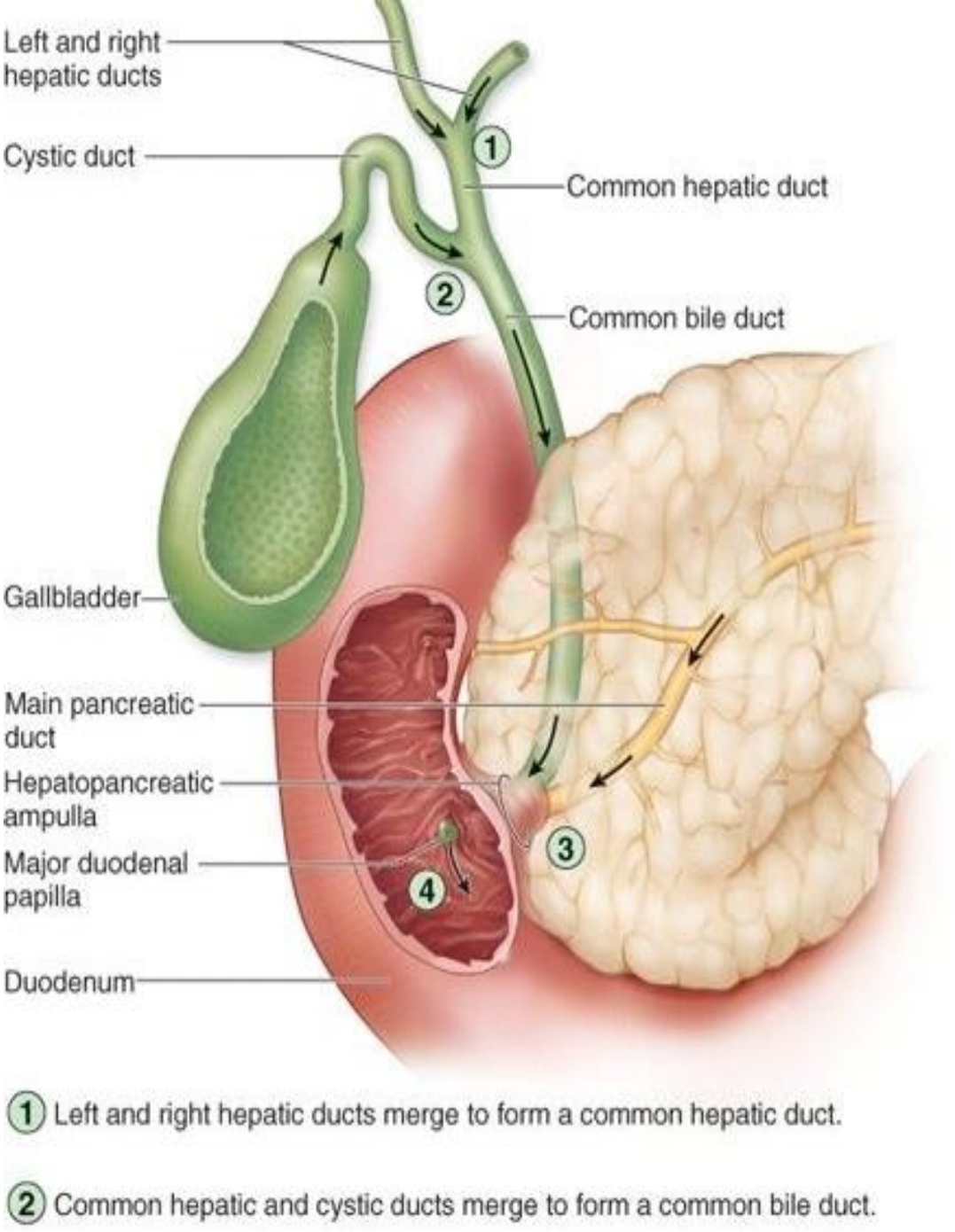
Species Differences

In dog, The accessory pancreatic duct enters at the minor duodenal papilla; this smaller, less obvious papilla is located approximately 2 cm aboral to the major duodenal papilla and, in dogs, is the principal conduit for pancreatic secretions.



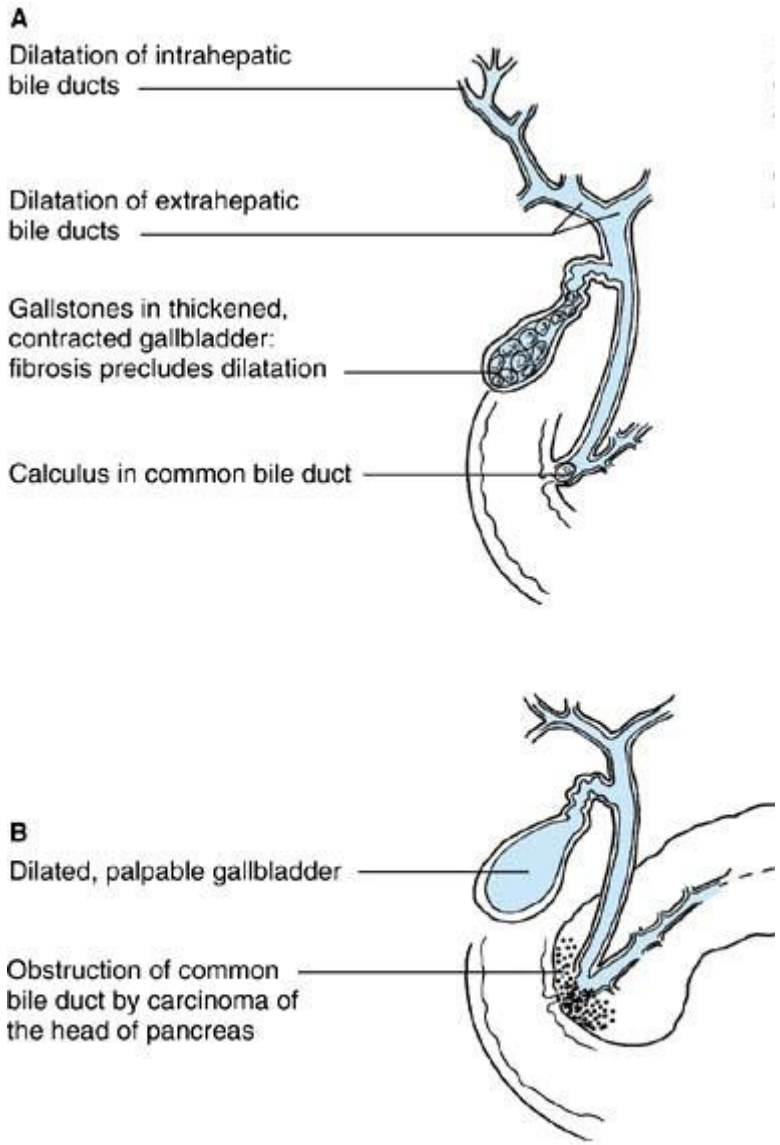
Species Differences

<u>In cats, the common bile duct and the pancreatic duct conjoin just before their entry into the duodenum at the major duodenal papilla. This may be a possible explanation for the frequent concurrence of pancreatic and hepatobiliary disease in cats.</u>



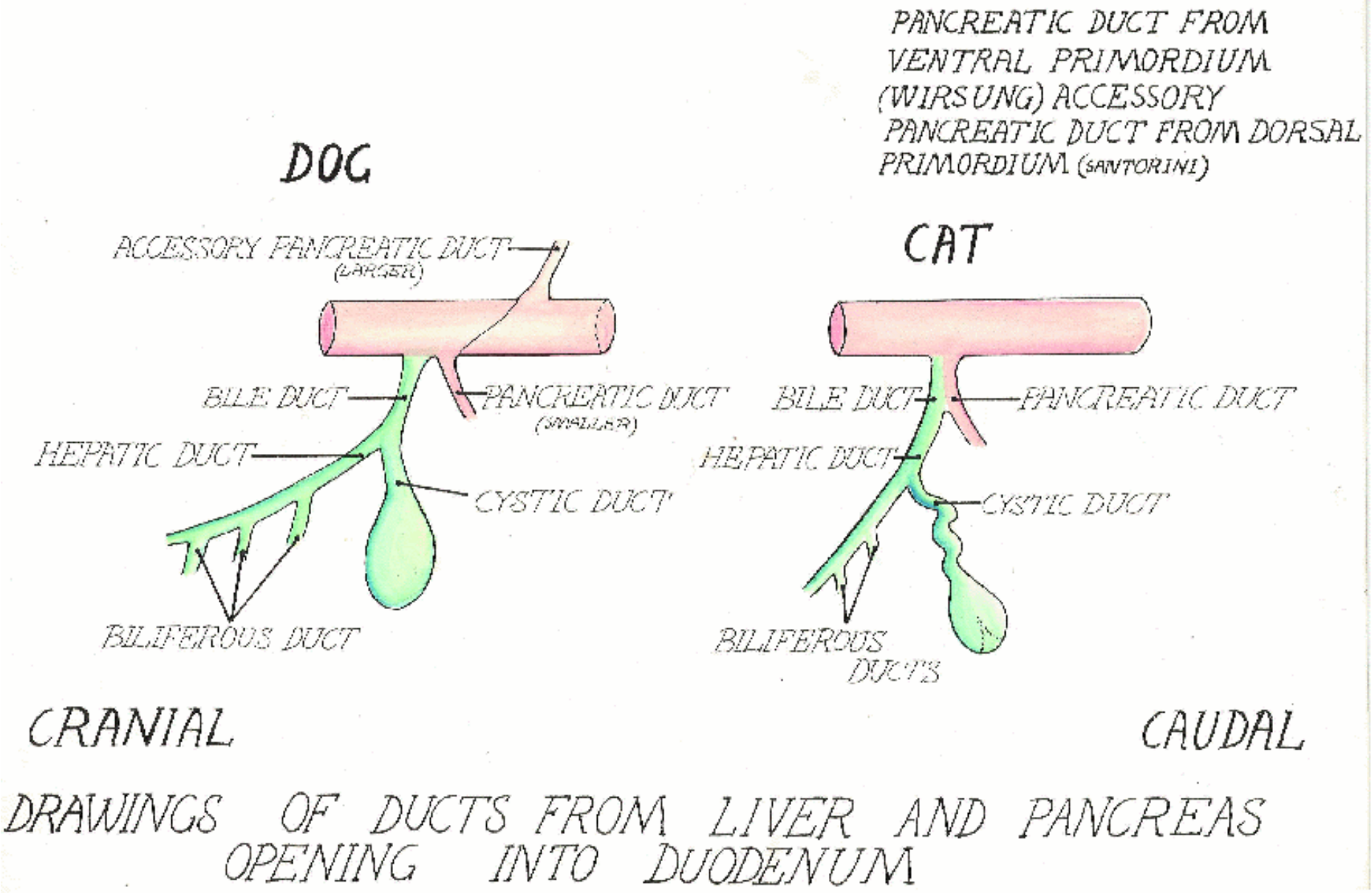
Species Differences

- *only about 20% of cats have an accessory pancreatic duct exiting at a minor duodenal papilla.*
- *Thus, any disease process or surgical procedure that affects the major duodenal papilla has the potential to affect the entire exocrine pancreatic secretion in cats.*
- Pancreatic exocrine insufficiency has been reported as a complication of duodenal lesions involving the major duodenal papilla in cats.



Source: Chandrasoma P, Taylor CR: *Concise Pathology*, 3rd Edition: http://www.accessmedicine.com

Species Differences

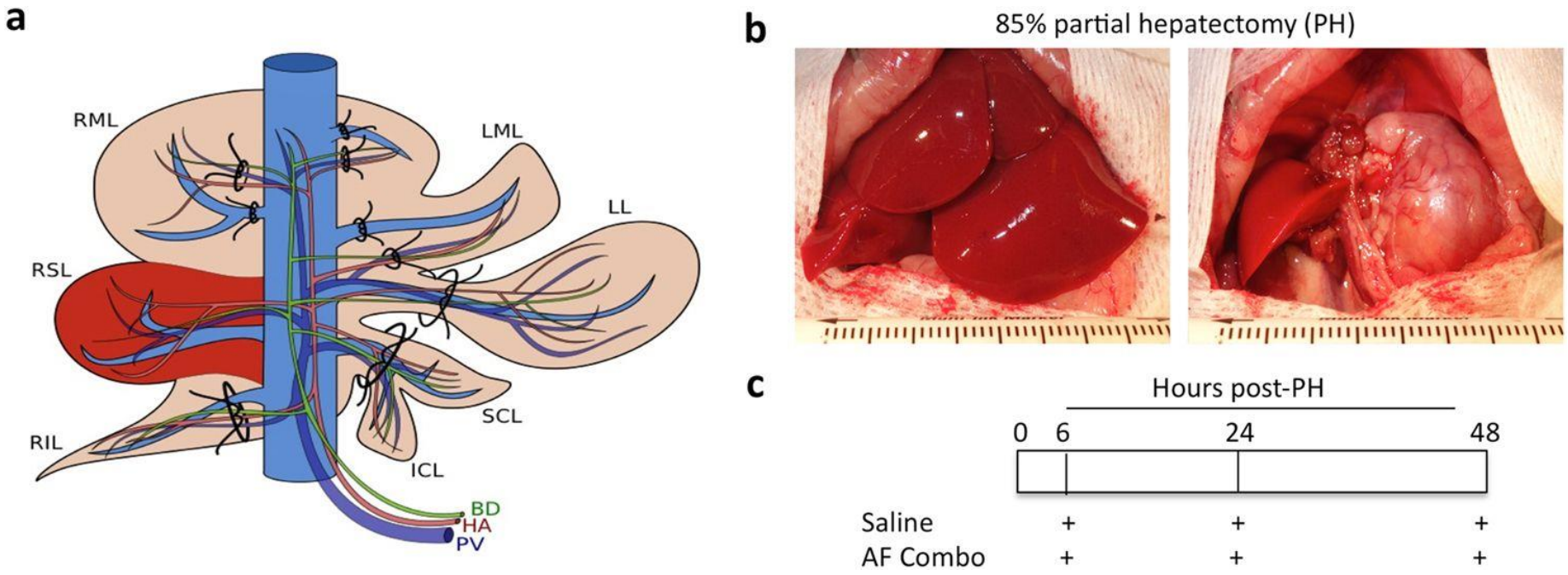


DRAWINGS OF DUCTS FROM LIVER AND PANCREAS OPENING INTO DUODENUM

Regenerative Capacity After Hepatic Resection or Injury

- *Fortunately, the normal liver has an incredible regenerative capacity.* In experimental studies, *normal dogs tolerated acute removal of 65% to 70% of total liver volume, but they did not tolerate 84% removal*.

- Mortality was not related to hepatic failure but rather the inability of the remnant liver to accommodate total portal vein blood flow without development of *excessive portal hypertension.*

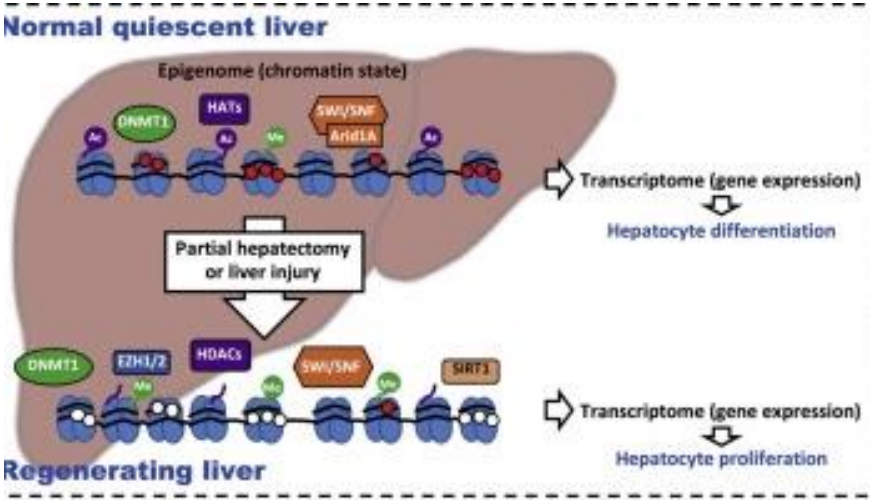


- Liver regeneration begins within hours and peaks within 3 days; near complete compensatory hypertrophy and hyperplasia on average is reached by 6 days after 70% hepatectomy but may take up to 6 to 10 weeks.

- Liver capacity returns because of compensatory hypertrophy and hyperplasia, and the change in liver volume is a result of the change in liver blood flow, particularly portal blood flow.

- Disruption in portal perfusion to the liver results in increased hepatic arterial perfusion because of an intrinsic regulatory mechanism in the liver called the hepatic arterial buffer response.

- The hepatic arterial buffer response is believed to occur secondary to a lack of washout of adenosine(a potent vasodilator) via the portal circulation, which triggers a compensatory increase in arterial perfusion



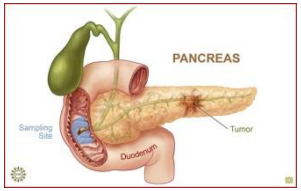
Several factors have been identified that reduce hepatic regeneration.

- Biliary obstruction reduces portal blood flow rapidly in dogs and impedes hepatic regeneration.

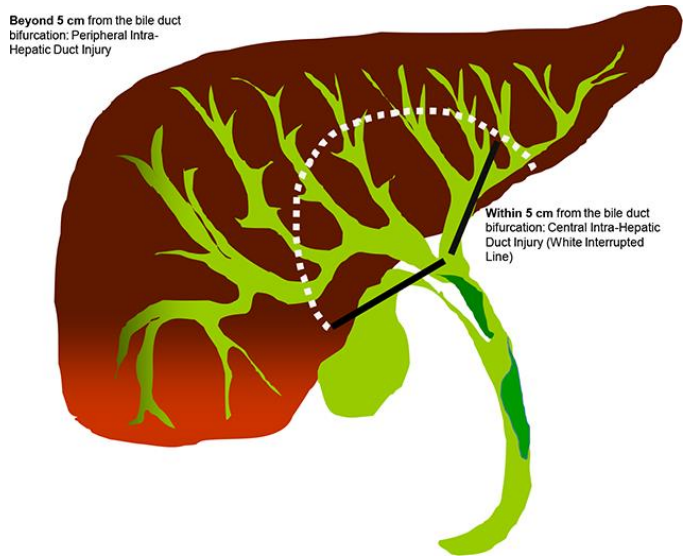
- Diabetes mellitus also impedes liver regeneration, most likely through decreased concentrations of insulin, one of the most potent hepatotrophic factors in portal blood.

- hepatectomy and simultaneous pancreatectomy had reduced liver regeneration compared with dogs undergoing hepatectomy alone Malnutrition, male gender,

- and older age also negatively impact hepatic regeneration



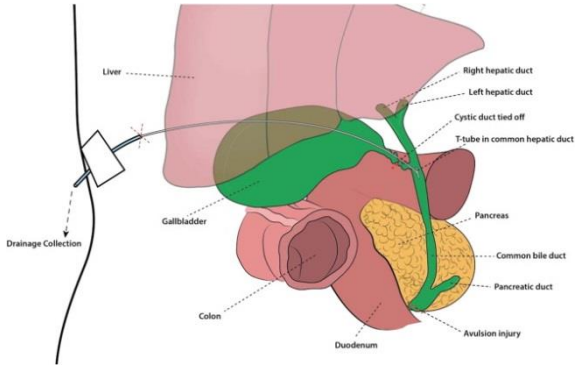
Traumatic Biliary Tract Rupture



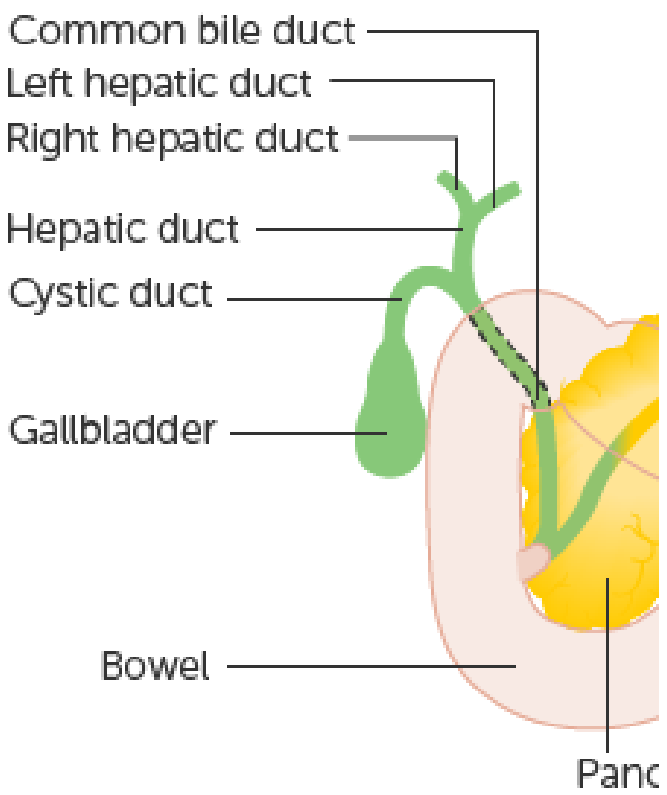
- The most frequent cause of injury to the extrahepatic biliary tract is blunt abdominal trauma after:

a motor vehicle accident; penetrating wounds from gunshot, stab, or bite injuries have also been reported.

- Iatrogenic injury sustained during abdominal surgery associated with either overzealous gallbladder expression, postoperative leakage from a cholecystotomy, cholecystectomy, or choledochotomy incision, or inadvertent laceration of the common bile duct can also result in leakage and subsequent bile peritonitis.



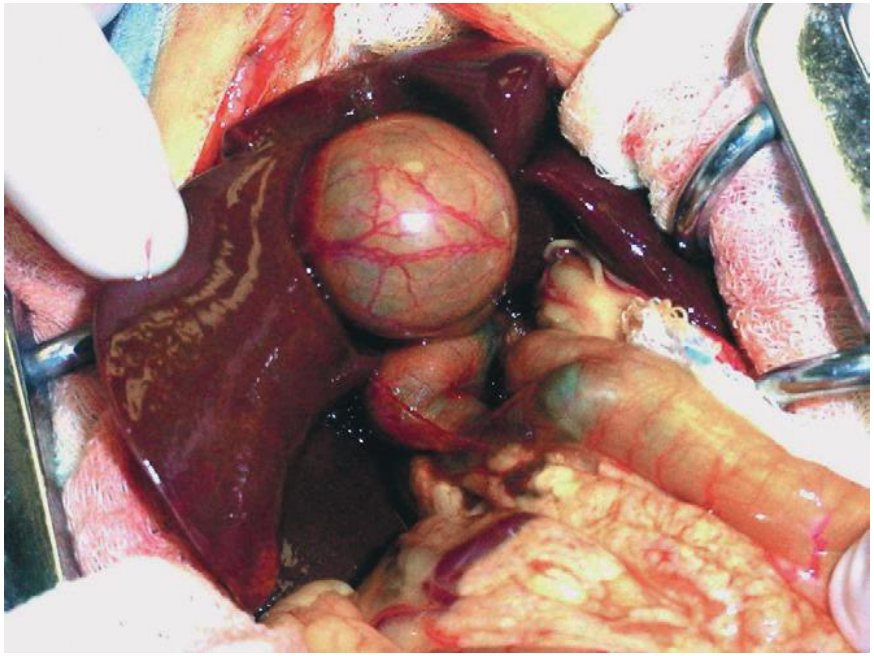
- Such injuries may be seen more frequently in dogs and cats in the future with the increasing use of laparoscopic surgery in veterinary medicine.
- When leakage occurs as a result of blunt trauma, location of the perforation is almost always within *the common bile duct* or hepatic ducts; rarely, leakage from the gallbladder has been reported.
- Tears or transections are usually located within the body of the *common bile duct* or, less commonly, the cystic duct.
- Avulsion injuries of *the common bile duct* from the duodenum or avulsions of hepatic ducts from the common bile duct are also common



Extrahepatic Biliary Obstruction

- The most common causes of extrahepatic biliary obstruction in dogs include pancreatitis, neoplasia, gallbladder mucoceles, cholangitis, and cholelithiasis.
- In cats, most commonly a complex of inflammatory diseases that includes pancreatitis, cholangiohepatitis, cholecystitis with or without cholelithiasis, and neoplasia is responsible

Severely icteric tissues can be seen in this cat with extrahepatic biliary tract obstruction. Severe distention of the entire extrahepatic biliary tract is present, and the dark outline of a cholelith can be seen lodged in the distal common bile duct



Pathophysiologic consequences of extrahepatic biliary obstruction :

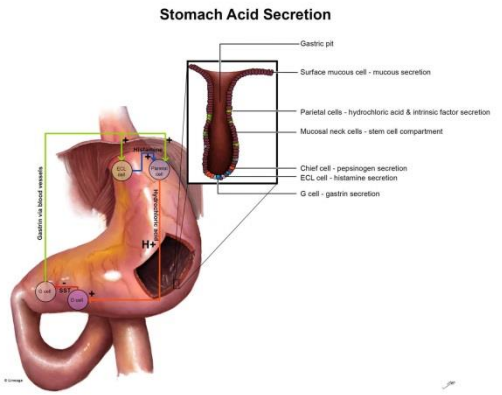
it is hypothesized that (a). the absence of bile salts in the intestinal tract leads to (b). bacterial overgrowth and (c). endotoxin absorption.

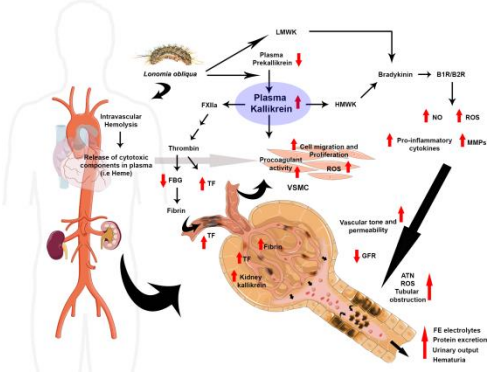
(d). Impaired clearance of endotoxin from reduced hepatic reticuloendothelial function results in (e). systemic endotoxemia.

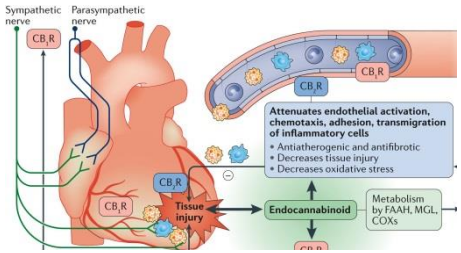
(f). Endotoxin is a potent renal vasoconstrictor capable of causing acute tubular necrosis. (f). Gastrointestinal bleeding may occur because of endotoxin-mediated 1. gastric ischemia and 2. increased acid secretion.

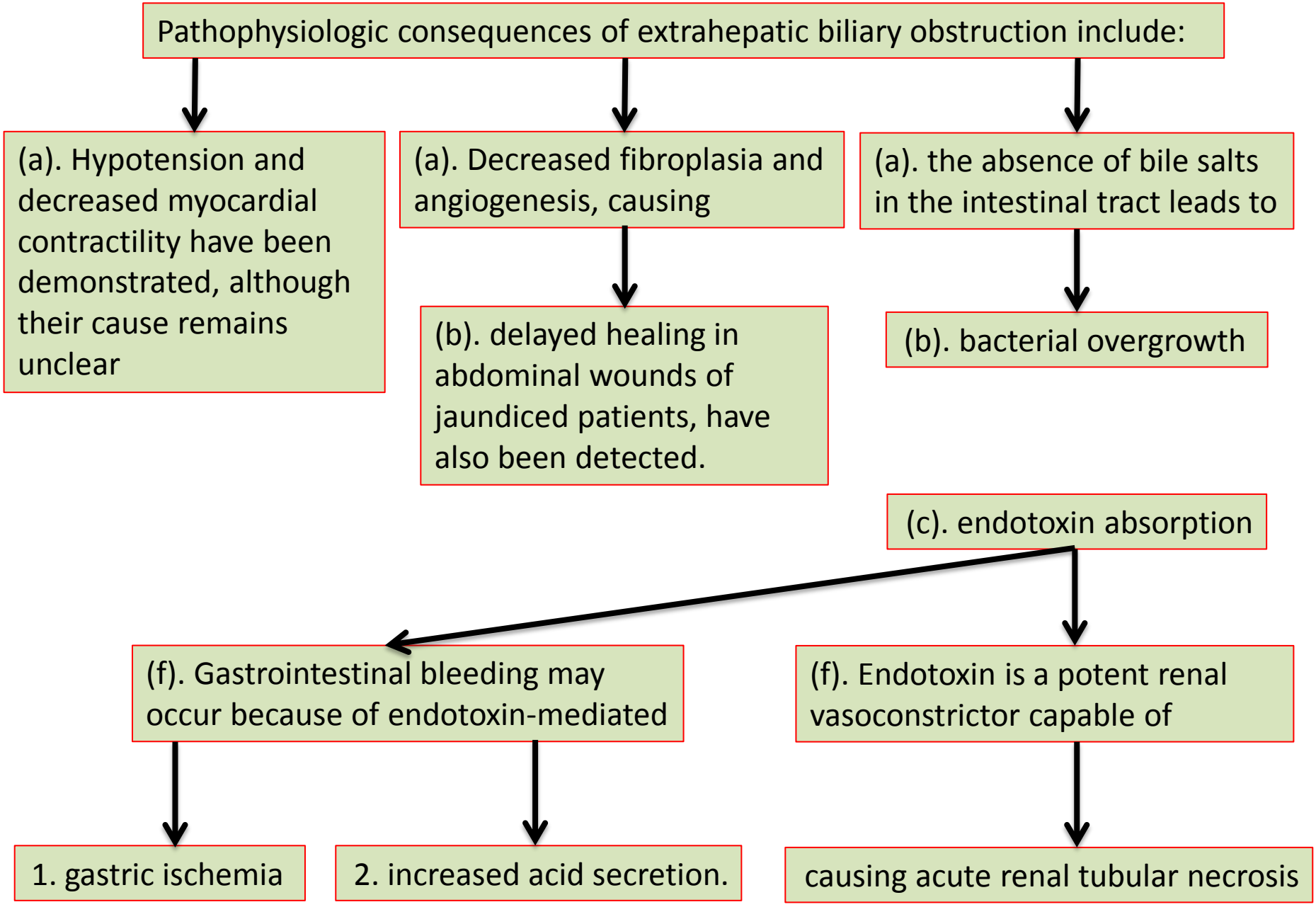
(a). Decreased fibroplasia and angiogenesis, causing delayed healing in abdominal wounds of jaundiced patients, have also been detected.

(a). Hypotension and decreased myocardial contractility have been demonstrated, although their cause remains unclear.



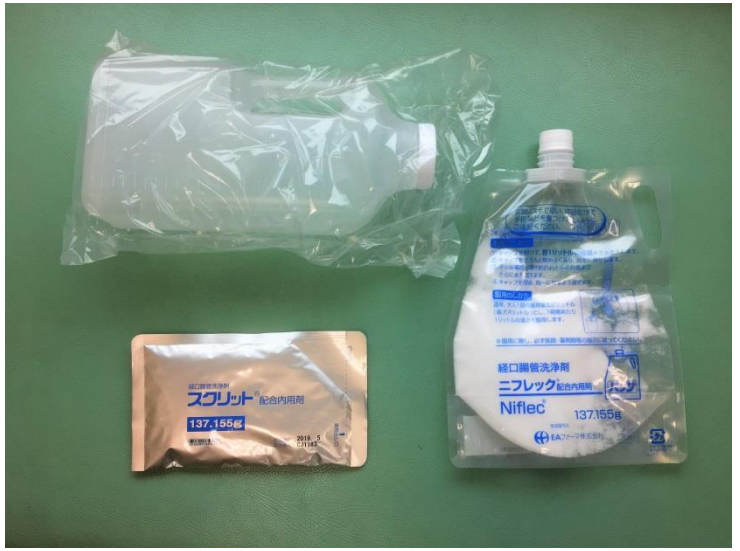





Pathophysiologic consequences of extrahepatic biliary obstruction include:
(a). Hypotension and decreased myocardial contractility have been demonstrated, although their cause remains unclear
(a). Decreased fibroplasia and angiogenesis, causing
(b). delayed healing in abdominal wounds of jaundiced patients, have also been detected.
(a). the absence of bile salts in the intestinal tract leads to
(b). bacterial overgrowth
(c). endotoxin absorption
(f). Gastrointestinal bleeding may occur because of endotoxin-mediated
1. gastric ischemia
2. increased acid secretion.
(f). Endotoxin is a potent renal vasoconstrictor capable of
causing acute renal tubular necrosis

Although endotoxemia has never been documented in clinical cases of extrahepatic biliary obstruction in small animals, morbidity and mortality in most reports remain high, and anesthetic-related issues, such as hypotension and a lack of response to vasopressor agents, have been reported.

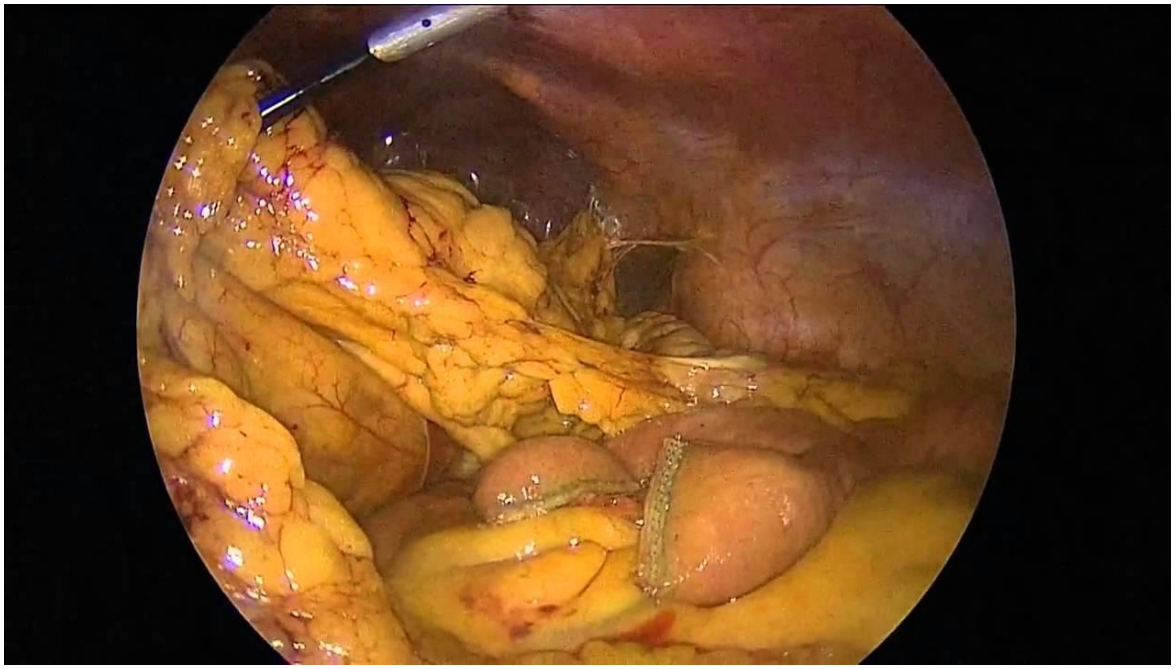
Bile salt supplementation; administration of polymyxin B, cimetidine, and lactulose; and bowel irrigation have all been shown to prevent endotoxemia in human studies. The efficacy of such treatment protocols in small animal patients has never been tested.



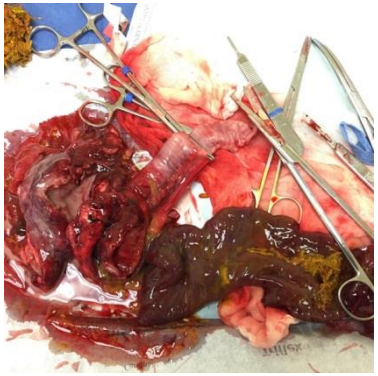
Bile Peritonitis

- The release of bile salts into the peritoneum is principally responsible for initial pathologic changes that occur with spillage of bile into the peritoneal cavity.

- *Bile salts cause inflammation, hemolysis, and tissue necrosis. Their hyperosmolality leads to significant fluid shifts from the vascular space into the peritoneal cavity, resulting in dehydration and eventually hypovolemic shock*

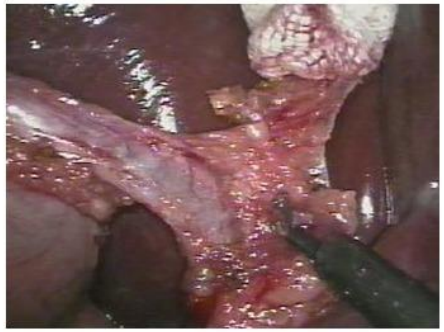


- Normal canine bile is sterile; blunt trauma–induced bile leakage is initially more likely to result in sterile peritonitis.
- Infection, however, can develop as a result of ascending gastrointestinal contamination, intestinal translocation, or colonization by resident hepatic anaerobes



In penetrating injuries, bacterial infection can be introduced via direct inoculation.

This is very significant because in the absence of bacterial infection, **bile normally causes mild chemical peritonitis**.

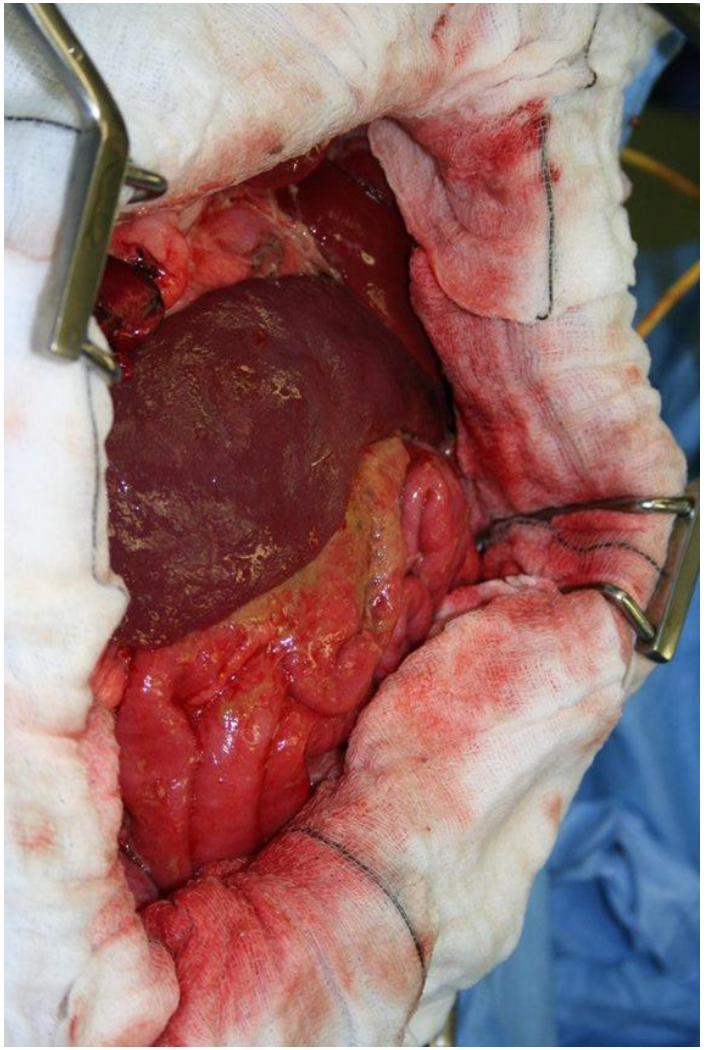


Bacterial infection profoundly worsens the pathology and subsequent prognosis: multiple studies have demonstrated a significantly higher mortality rate in dogs with septic bile peritonitis compared with those with sterile effusion

- Biliary tract trauma with bile peritonitis can also result in a partial or total absence of bile salt passage into the small intestine. As previously discussed, when bile salts are not present in the lower small intestine to bind endotoxins, systemic endotoxemia may develop, resulting in significant morbidity.

- The most common underlying causes of bile peritonitis in dogs are trauma, necrotizing cholecystitis, and ruptured gallbladder mucoceles.

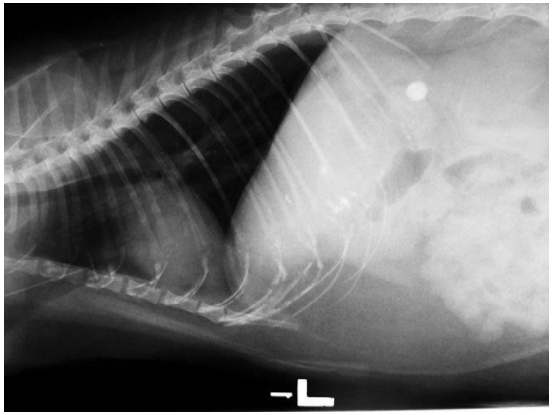
- In cats, bile peritonitis is very rare but is usually associated with trauma. Injuries or lesions of the upper gastrointestinal tract can also result in bile peritonitis because of leakage of bile out of an intestinal perforation close to the major duodenal papilla.



HEPATOBILIARY IMAGING

Radiography

- estimate of hepatic size
- Space-occupying lesions in the cranial abdomen may be suggestive of a liver mass or enlarged gallbladder



Approximately 50% of canine choleliths (most frequently composed of calcium bilirubinate) and 80% of feline choleliths (usually composed of calcium carbonate) are radiopaque and may be visible on abdominal radiography

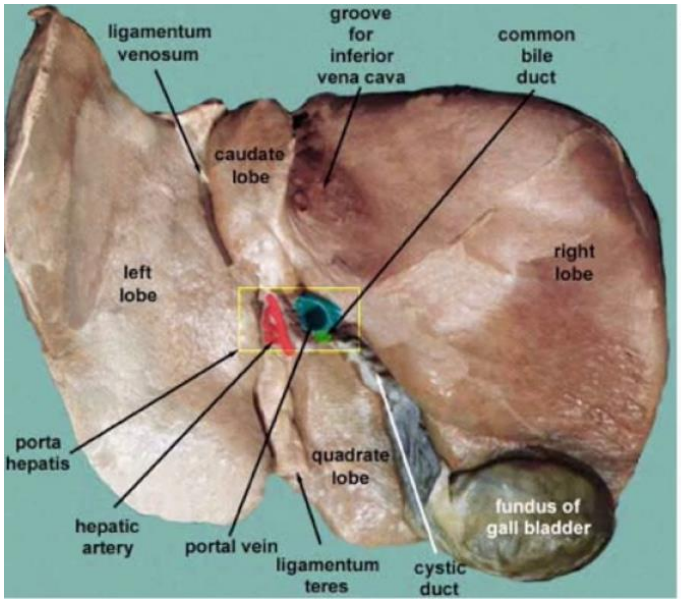
Choleliths may be detected in the region of the gallbladder or common bile duct

Abdominal Ultrasonography

- Ultrasonographic appearance and histopathologic diagnosis

- ultrasonography must be used in combination with fine needle aspiration or needle biopsy techniques.

- Colorflow Doppler can be used to evaluate hepatic vascular anomalies or focal reductions in hepatic blood flow, as seen with liver lobe torsion.
- Contrast-enhanced harmonic ultrasonography is a newer modality that detects the harmonic signal produced by intravenous injection of gas microbubbles to evaluate the perfusion patterns of different organs.
- Ultrasonography is the principal imaging modality for evaluation of the extrahepatic biliary tract. The normal diameter of the common bile duct is approximately 3 to 4 mm in dogs and cats



- Another option is to inject a synthetic cholecystokinin (sincalide) intravenously. Whereas normal dogs empty 40% of their gallbladder volume within 1 hour of administration, obstructed dogs empty less than 20% of their gallbladder volume within that time

<u>Dogs with gallbladder mucoceles frequently present with enlarged gallbladders that have a typical immobile stellate or finely striated ultrasonographic appearance ("kiwi fruit" gallbladder).</u>

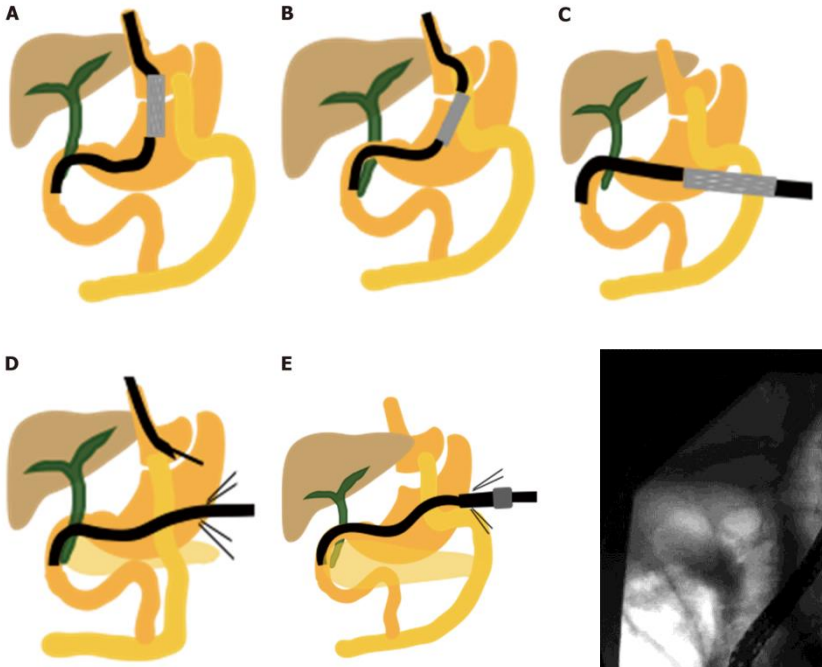
Choleliths can usually be identified by their focal echogenic appearance and acoustic shadowing

Hepatobiliary Scintigraphy

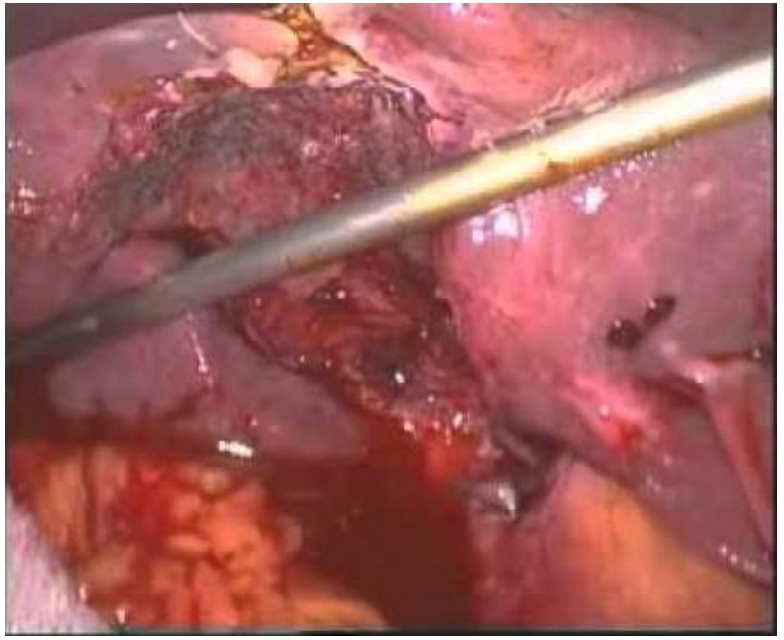
- diagnosis of cholestasis and extrahepatic biliary obstruction.
- Radiopharmaceutical agents used for hepatobiliary scintigraphy in dogs and cats are usually derivatives of mtechnetium iminodiacetic acid (mebrofenin or disofenin).
- After intravenous injection in normal animals, these compounds accumulate within the biliary tract and then pass into the intestines through the major duodenal papilla.
- If the intestines cannot be visualized within 3 hours of the injection of the agent, extrahepatic biliary obstruction is generally considered to be present.

Endoscopic Retrograde Cholangiopancreatography

- Biliary and pancreatic ductal systems are imaged by retrograde injection through the duodenal papillae of an iodinated contrast agent.
- Therapeutic interventions, such as cholelith removal or stent placement, may also be possible after a diagnosis has been established in the future



PREOPERATIVE CONSIDERATIONS FOR HEPATIC SURGERY



Hemorrhage

- The majority of procedures performed on the liver involve risk of hemorrhage that can be life threatening.

Hypoglycemia

- Hypoglycemia is uncommonly associated with end-stage liver disease in veterinary patients but may be a factor in small or otherwise debilitated patients perioperatively. Glucose supplementation should be considered in these patients and for those undergoing extensive hepatectomy. Hypoglycemia was not associated with liver resection of approximately 50% but can occur when 70% of the parenchyma is removed.

Anesthesia

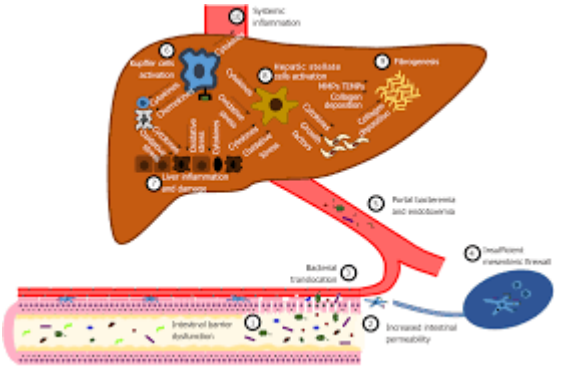
- Drugs undergoing hepatic metabolization should be avoided when possible.

- In addition, halothane has been demonstrated to have potential hepatotoxic effects in dogs and results in significantly increased serum liver enzyme activities for at least 2 weeks after anesthesia in healthy dogs compared with dogs undergoing isoflurane or sevoflurane anesthesia.

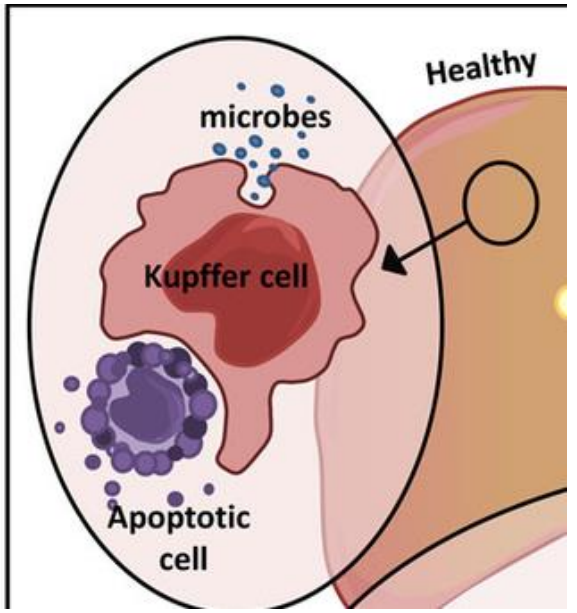
- Because complete hepatic exposure may require a caudal thoracotomy, the anesthetist should be prepared to ventilate the patient.

Bacteria

- Intestinal bacteria and endotoxins continually delivered through the portal system are normally removed via the liver's mononuclear phagocytic system, primarily the Kupffer cells.



- there remains some controversy regarding the presence of a normal bacterial flora in the canine liver. variety of organisms, including strict anaerobes, strict aerobes, and facultative anaerobes.



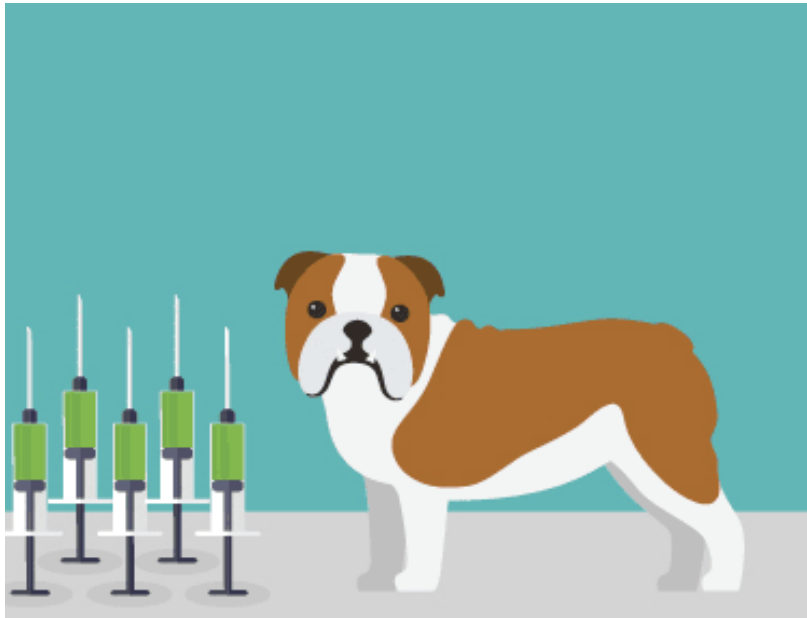
- The most common isolate was *Clostridium perfringens* followed by *Staphylococcus* spp.

- Postoperative broad-spectrum coverage should continue until antimicrobial changes can be made based on individual patient culture and sensitivity testing.

- In no patient was the hepatic culture result positive with a negative bile culture result.

- Based on isolates and sensitivity testing, suggested protocols included a combination of

1. fluoroquinolone, penicillin, and metronidazole;
2. fluoroquinolone and amoxicillin– clavulanate;
3. fluoroquinolone and clindamycin.



HEMORRHAGE CONTROL DURING HEPATIC SURGERY

Capsular Hemorrhage

- Capsular hemorrhage may be controlled with pressure, but when it is excessive, surgical clips or staples, various hemostatic agents, or vascular occlusion techniques can be used. Common topical hemostatic agents include gelatin sponge (Gelfoam, Pfizer, New York, NY), oxidized regenerated cellulose (Surgicel, Johnson & Johnson, New Brunswick, NJ), cyanoacrylate glue, and fibrin glues.

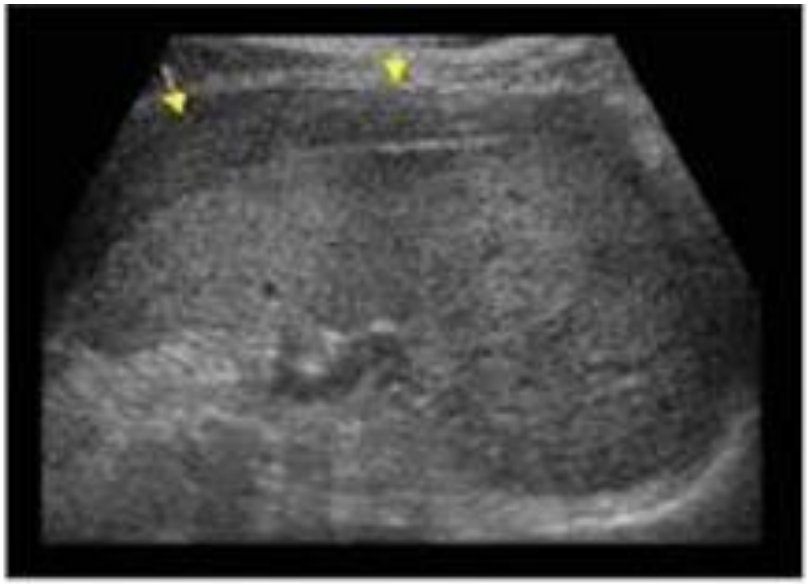


Fig.1: Ultrasound showing hyperechoic shadow of subcapsular hematoma.

Fig.2: Intraoperative finding of subcapsular hematoma.

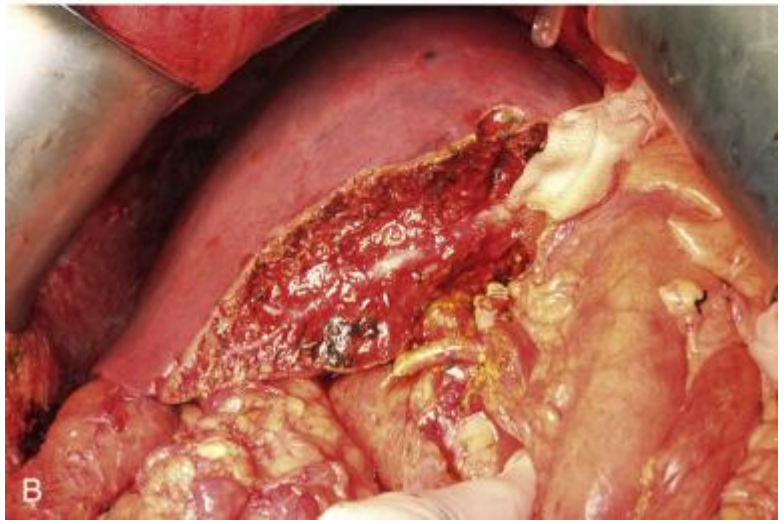
Extensive Hemorrhage

- More extensive hemorrhage may require increasingly invasive procedures.

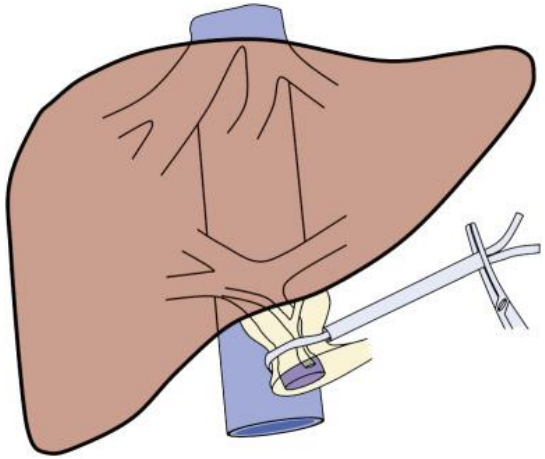
Vascular occlusion techniques can be characterized

1. as control of central venous pressure (CVP),
2. occlusion of liver inflow, and
3. occlusion of liver inflow and outflow.

Maintenance of CVP below 5 cm H2O is considered essential for minimizing blood loss during major hepatic surgery in humans and is emphasized by close communication between the surgeon and anesthetist



Inflow Occlusion



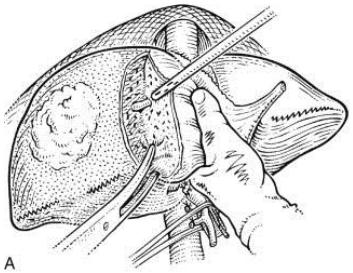
- Occlusion of liver inflow implies a temporary or intermittent Pringle maneuver, which provides occlusion of liver vascular inflow and was originally developed to arrest hemorrhage from traumatic liver injuries in humans.

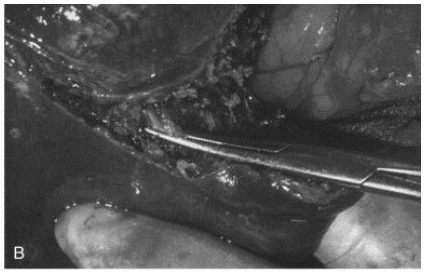
- hepatic artery and portal vein, was ligated resulted in acute death, suggesting this could not be tolerated. Demise of the animals is attributed to subsequent portal hypertension and intestinal congestion rather than hepatic ischemia.

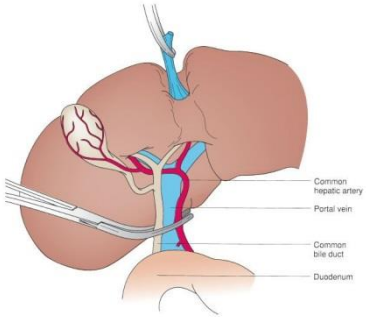
- This is one of the few circumstances in which dogs have a reduced collateral circulation compared with humans, and care must be taken to avoid applying to our animal patients the safe, tolerated ischemic times reported in humans.

- Ischemia-reperfusion injury to the liver is enhanced with prolonged inflow occlusion in patients concurrently undergoing hepatic resection or that have biliary obstruction.

simultaneous portal vein decompression that would likely not be performed in the clinical setting

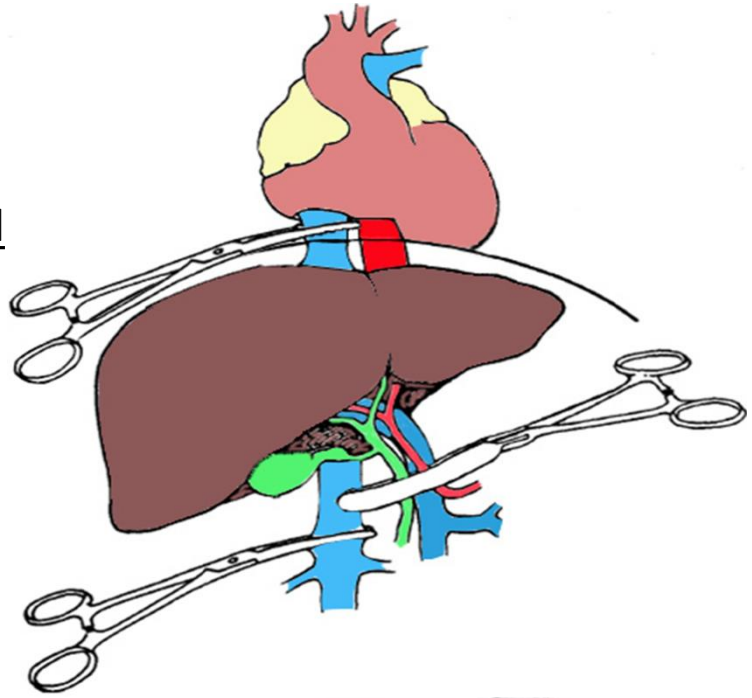






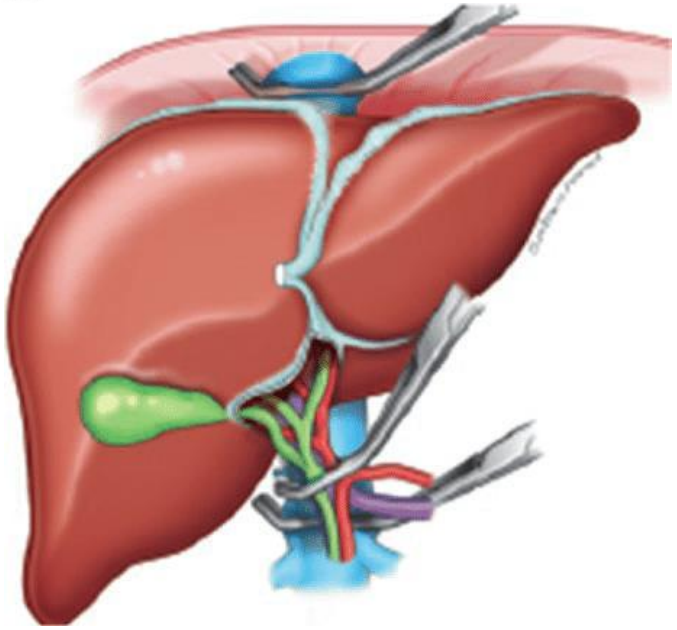
Total Hepatic Vascular Exclusion

- Hemorrhage may still continue with application of the Pringle maneuver because of continued flow through the gastroduodenal vein in dogs, retrograde arterial flow through the gastroduodenal artery (via the cranial mesenteric artery), and back bleeding through hepatic veins.



- Total hepatic vascular exclusion involves simultaneous occlusion of the suprahepatic and infrahepatic caudal vena cava with concurrent inflow occlusion. It should be performed with extreme care and monitoring because cardiac return is dramatically reduced during the procedure. As with inflow occlusion, total hepatic vascular exclusion should be as brief as possible.

- hepatic artery ligation resulted in death because of gangrenous necrosis;



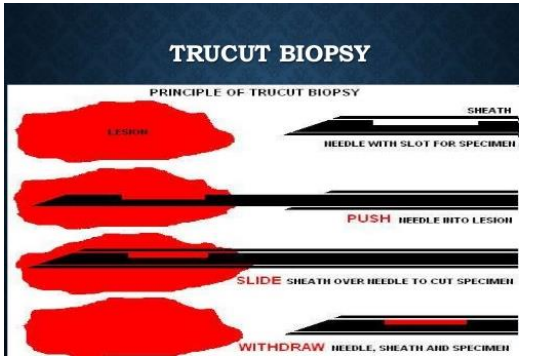
- If hepatic artery ligation is performed in an extreme situation, antibiotics should be administered, and ligation should be limited to the lobar arteries when possible; the patency of the portal branches should be confirmed, and prophylactic cholecystectomy should be considered if time and conditions permit.

HEPATIC SURGICAL PROCEDURES

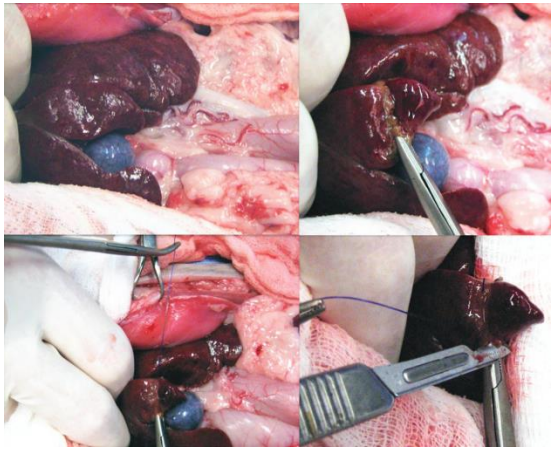
Liver Biopsy

- evaluation of cytologic or histologic samples of the liver.

1. Fine needle aspiration, the least invasive technique, can be performed safely in almost all circumstances; however, even under ultrasonographic guidance, diagnostic accuracy using cytologic evaluation of fine needle aspiration samples has been poor.



2. Cutting needle biopsy instruments (Tru-Cut) provide larger tissue samples that enable histopathologic diagnoses but canbe associated with increased risk



3. Open Surgical Technique

- If patients are undergoing surgery for other reasons or having surgical procedures performed on the hepatobiliary tract, open surgical liver biopsies are obtained. For diffuse liver disease, the easiest procedure to perform is the suture fracture (Figure 95-6) or guillotine technique on the periphery of the liver lobes.

- Alternatively, an ultrasonically activated scalpel (Harmonic Scalpel, Ethicon Endosurgery, Cincinnati, OH) or other device can be used to seal the edges of the liver as biopsy specimens are obtained.

- **ultrasonically activated scalpel** was similar to the ligature technique; both techniques resulted in significantly less hemorrhage than using a biopsy punch, biopsy needle, or laparoscopic biopsy forceps.

- For focal lesions, biopsy punch or wedge biopsies can be performed.

- Hemorrhage was greatest when using a biopsy punch in one study compared with other biopsy techniques.

- **Biopsy punch** depths should be limited to less than half the thickness of the lobe to avoid damage to larger hepatic vein branches.
- If bleeding occurs, a gelatin sponge (Gelfoam) can be packed into the hole.

- The authors often use the same punch to cut similarly sized gelatin sponge pieces to pack into the biopsy site immediately after obtaining the specimen

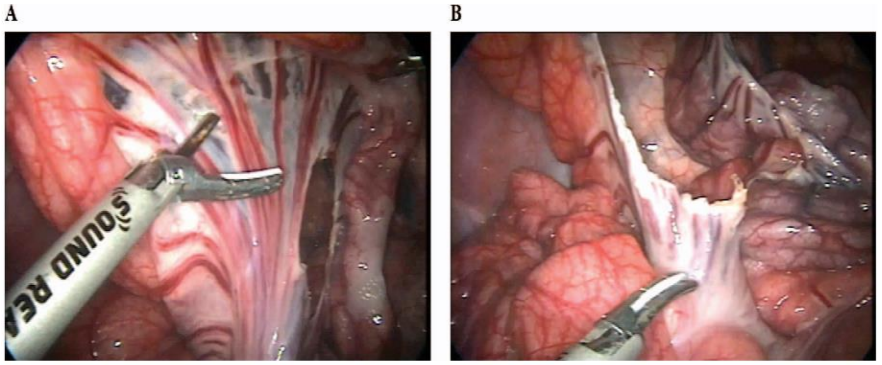
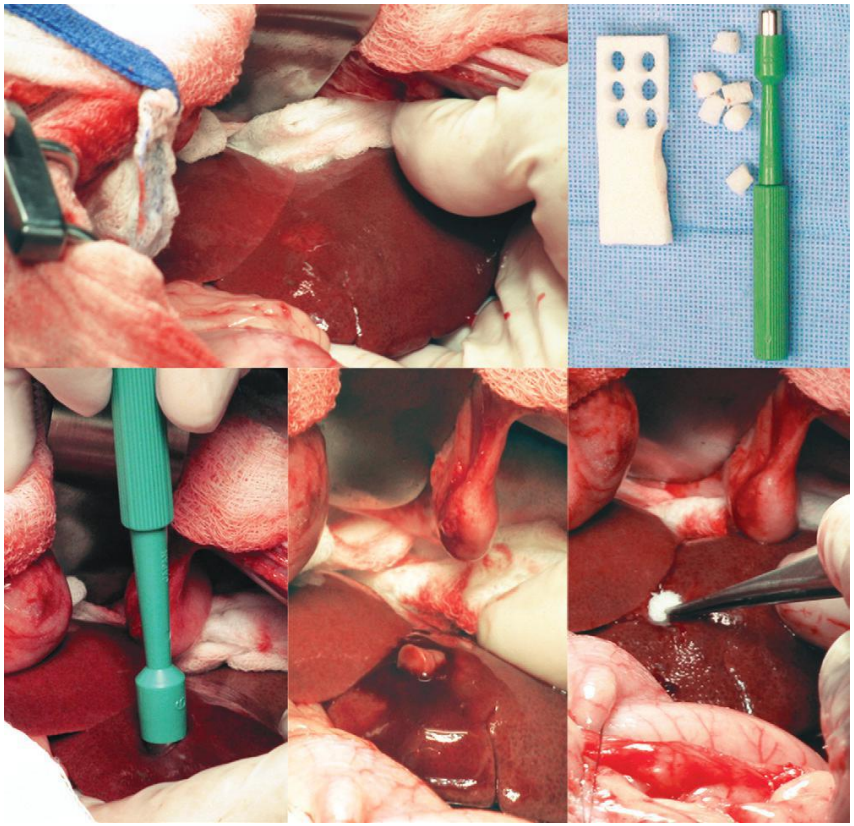
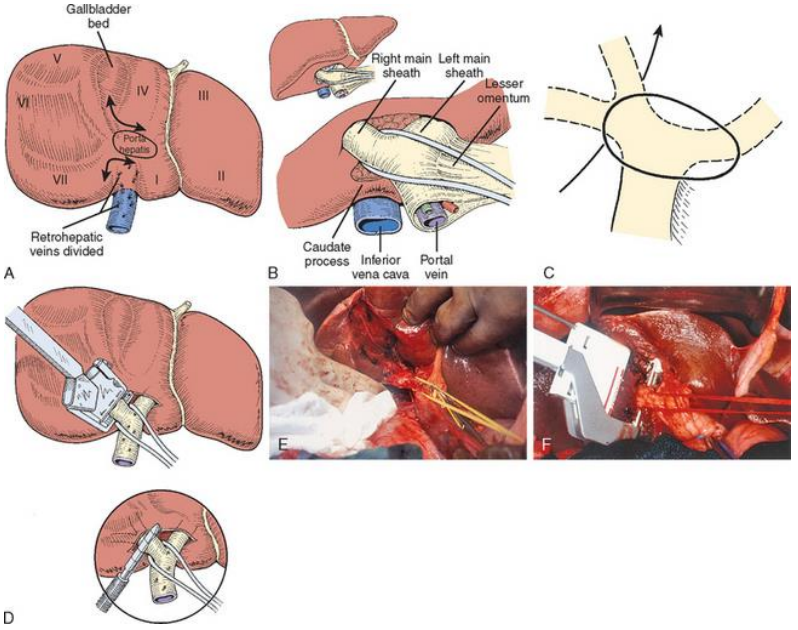


Figure 1. Mesenteric blood vessels. **A.** The 4- to 5-mm mesenteric vessels prior to cutting and sealing. **B.** Immediately after sealing, with



- **<u>Laparoscopic liver biopsy</u>** allows direct visualization of the organ and may enhance targeted diagnosis of grossly abnormal parenchymal lesions

- **<u>Partial and Complete Hepatic Lobectomy Techniques</u>** for partial and complete hepatectomy are similar. Larger resections may require additional surgical exposure, including combined paracostal approaches or diaphragmatic incisions with caudal sternotomy. In general, animals should be clipped and receive sterile preparation for these approaches, even if unanticipated.



PREOPERATIVE CONSIDERATIONS FOR EXTRAHEPATIC BILIARY TRACT SURGERY

Clinical Signs and Laboratory Testing

- Clinical signs of most extrahepatic biliary tract diseases are generally nonspecific, with most patients demonstrating lethargy, anorexia, and vomiting.* Evidence of abdominal pain may be present. Signs often wax and wane over days or several weeks.

- Clinical icterus will be present after the serum bilirubin concentration increases above 1.5 to 2.0 mg/dL.51 In animals with extrahepatic biliary obstruction or bile peritonitis, signs are likely to progress to include evidence of hypovolemia and shock.

Surgical Procedures of the Extrahepatic Biliary Tract

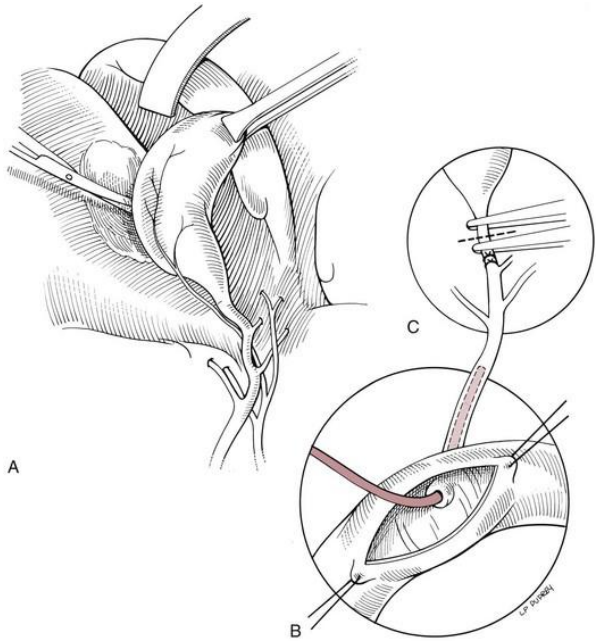
Choledochal Catheterization and Lavage

- Catheterization and flushing of the common bile duct are crucial to ensure patency of the duct in many cases of extrahepatic biliary tract disease, especially those with extrahepatic biliary obstruction, gallbladder mucocele, or cholelithiasis.

Technique

- Flushing can be performed in a normograde or retrograde manner, or both, using an appropriately sized red rubber catheter (usually an 8- to 12-Fr catheter for dogs and a 3.5 to 5-Fr catheter for cats). Flushing normograde through a cholecystotomy incision or through the open cystic duct stump after cholecystectomy tends to lead to contamination of the area from backflow of biliary tract contents

- When a cholecystectomy will be performed, the author prefers to first perform a small antimesenteric duodenotomy and catheterize the major duodenal papilla. A red rubber catheter is passed up the common bile duct as high as it will go to ensure patency of the duct. After patency of the duct has been established, cholecystectomy (if indicated) can be completed.

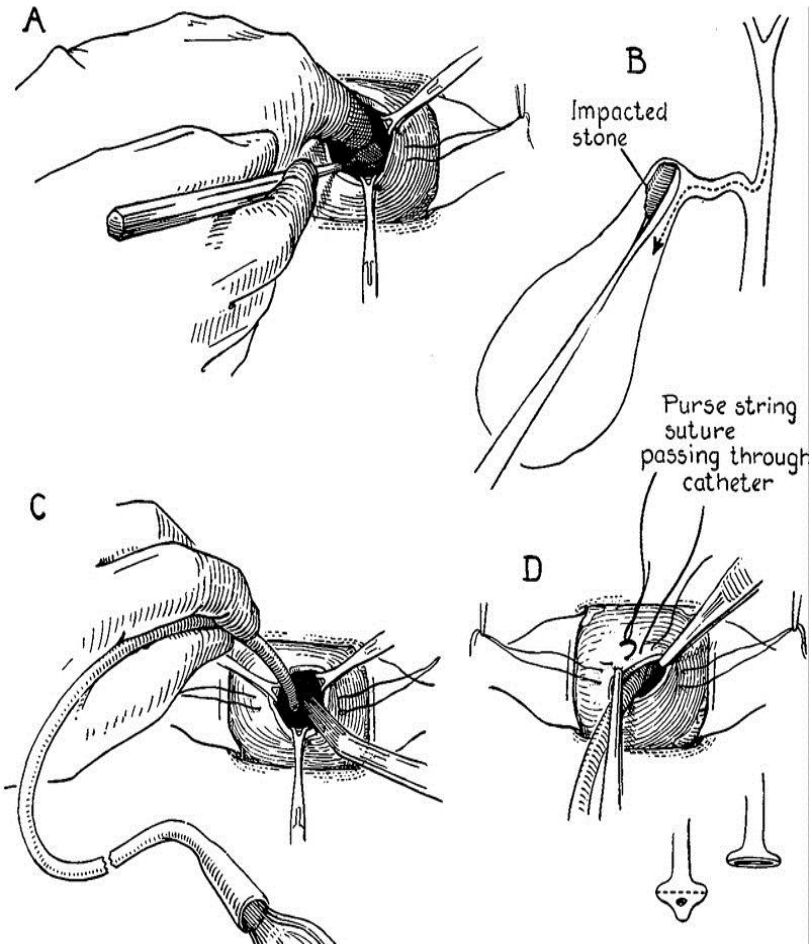


Cholecystotomy

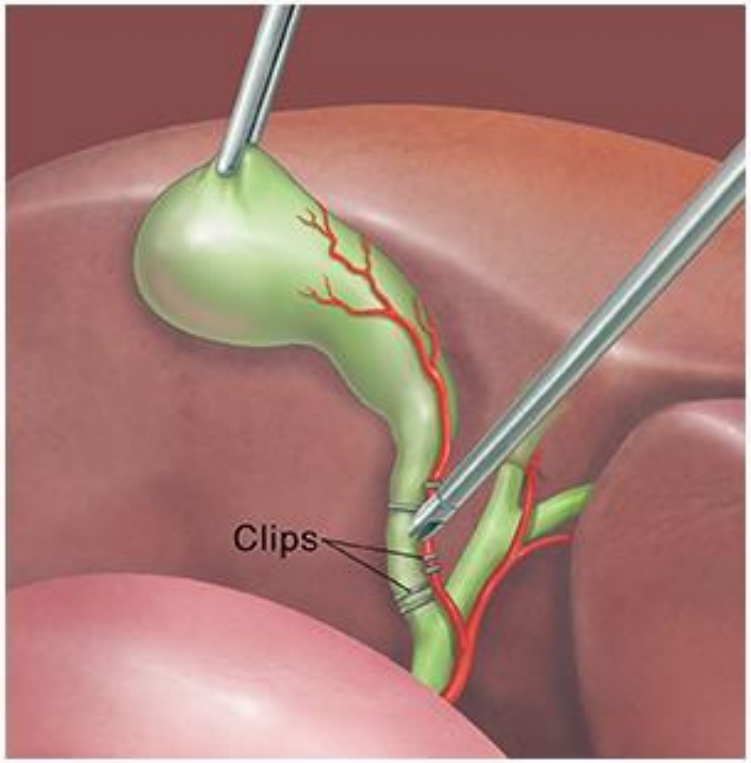
- Removal of choleliths can be performed by cholecystotomy;

- ***Technique***
- The gallbladder should be packed off with sterile sponges. A stay suture of fine-gauge material is placed through healthy gallbladder wall adjacent to the proposed incision site to elevate the gallbladder and reduce bile spillage. A 1- to 2-cm incision is made in the apex of the gallbladder. All bile should be suctioned out and the gallbladder lavaged. The major duodenal papilla should be catheterized so that retrograde flushing can be performed, ensuring no residual cholelith or inspissated bile is left in the cystic duct or common bile ducts.

- Closure of the incision is performed in a simple continuous inverting pattern with 2-0 to 4-0 monofilament absorbable suture material, depending on the thickness of the gallbladder wall.



- **Cholecystectomy**
- ***Traditional "Open" Cholecystectomy***
- Before cholecystectomy, the patency of the common bile duct must be confirmed. If performed as part of management of a gallbladder mucocele, flushing the common bile duct to ensure that all gelatinous bile is removed from the common



- **Technique.** The gallbladder is usually dissected out of the hepatic fossa before ligation of the cystic duct. In some patients, initial sharp transection of attachments between the gallbladder wall and liver capsule with scissors may be necessary to expose an appropriate plane for dissection.
- Using a combination of cotton-tipped applicators or the single-port inner cannula of a Poole suction tip (outer cannula removed), the gallbladder is bluntly dissected out of the hepatic fossa.

Cholecystectomy

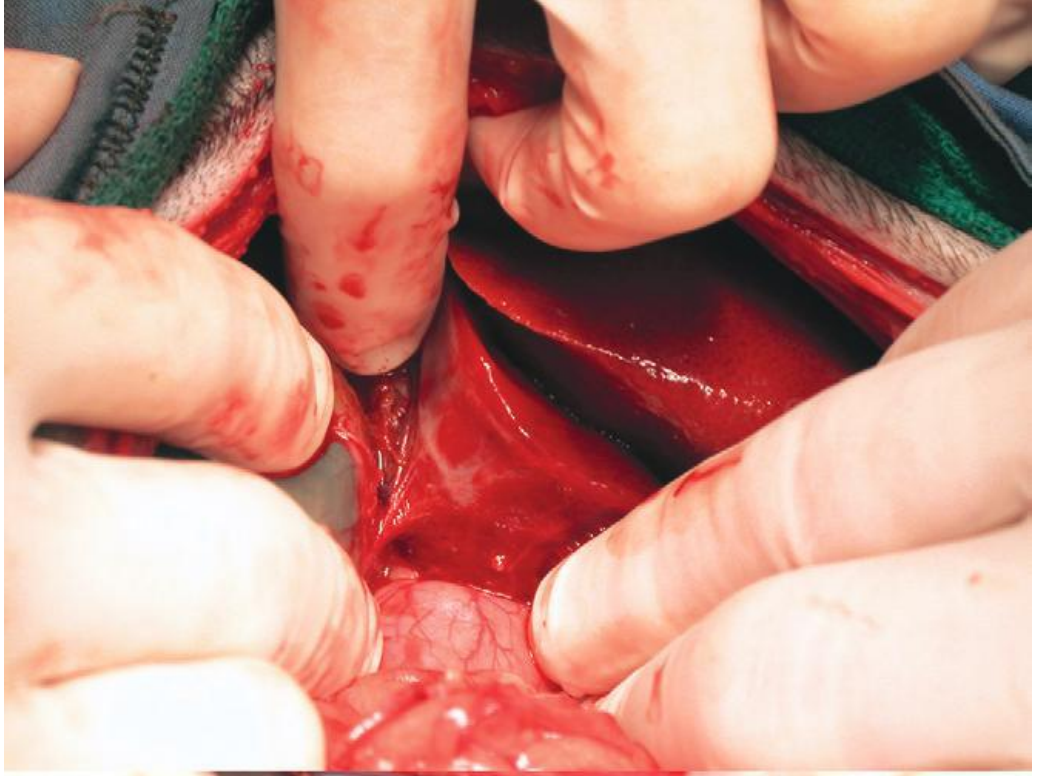
Encircling ligatures or monopolar or bipolar cautery can be used for occlusion of larger vessels or small bile ducts that might be encountered during gallbladder exposure.

Double ligation of the cystic duct and artery should be performed with 0 or 2-0, nonabsorbable suture material.

The duct is transected distal to the ligatures, and the gallbladder is removed.

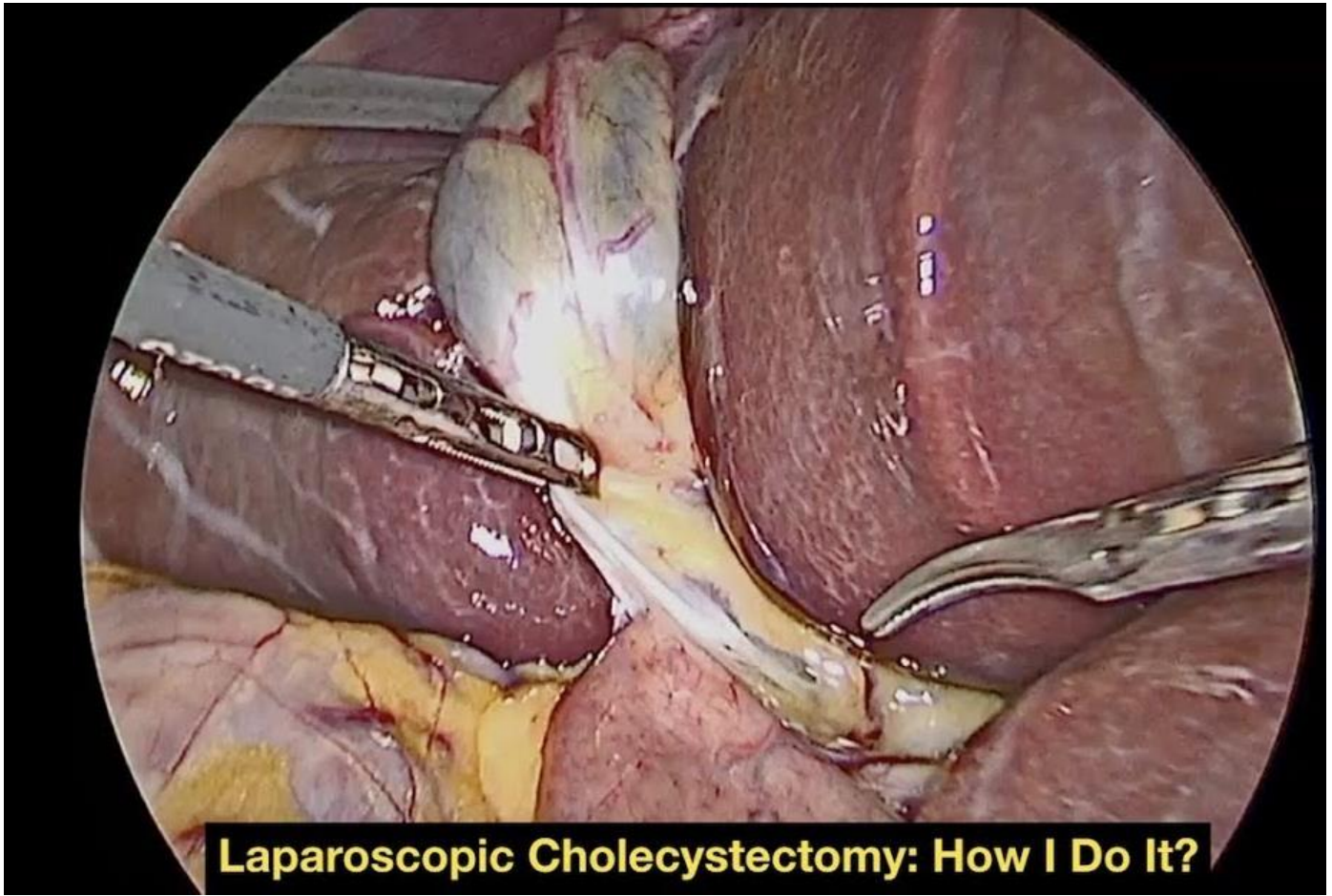
The stump is carefully inspected for any leakage of bile or residual hemorrhage, and the area is thoroughly lavaged before closure.

The gallbladder should be submitted for histopathologic examination, and the gallbladder wall or bile should be submitted for aerobic and anaerobic bacterial culture and sensitivity



Laparoscopic Cholecystectomy

- for management of uncomplicated gallbladder mucocele and symptomatic cholelithiasis or cholecystitis not associated with extrahepatic biliary obstruction, gallbladder rupture, or choledocholithiasis

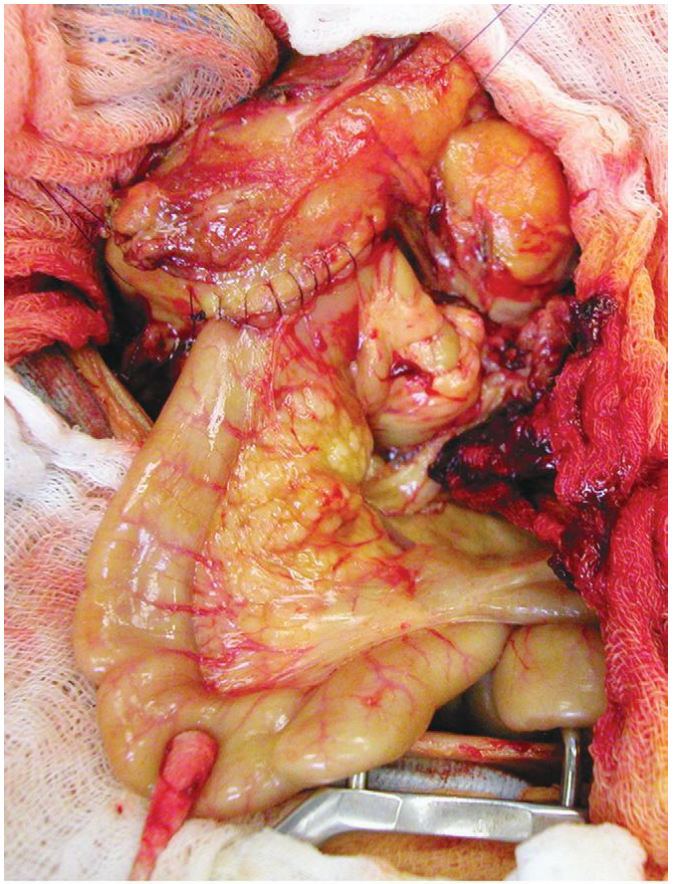


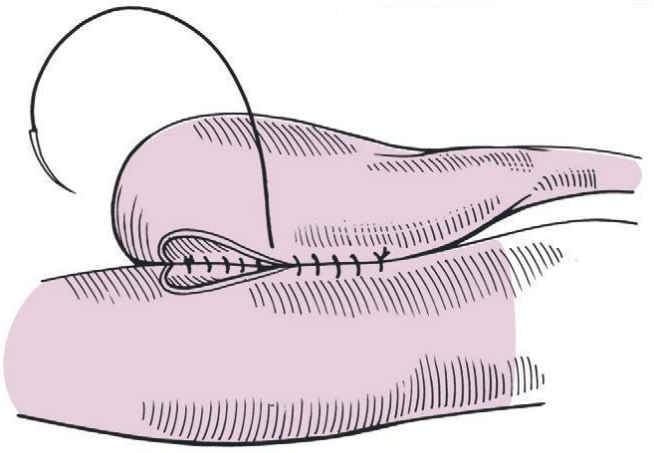
- Cholecystoenterostomy
- Cholecystoduodenostomy and cholecystojejunostomy are the most common techniques used to reroute the biliary system in dogs and cats because the common bile duct is usually too small and friable to permit choledochoduodenostomy.

- Physiologically, a cholecystoduodenostomy should be chosen if the gallbladder can be brought into a position adjacent to the proximal duodenum without excessive tension on or twisting of the cystic duct. If this is anatomically impossible, the anastomosis can be made to the proximal jejunum, which is generally more mobile.

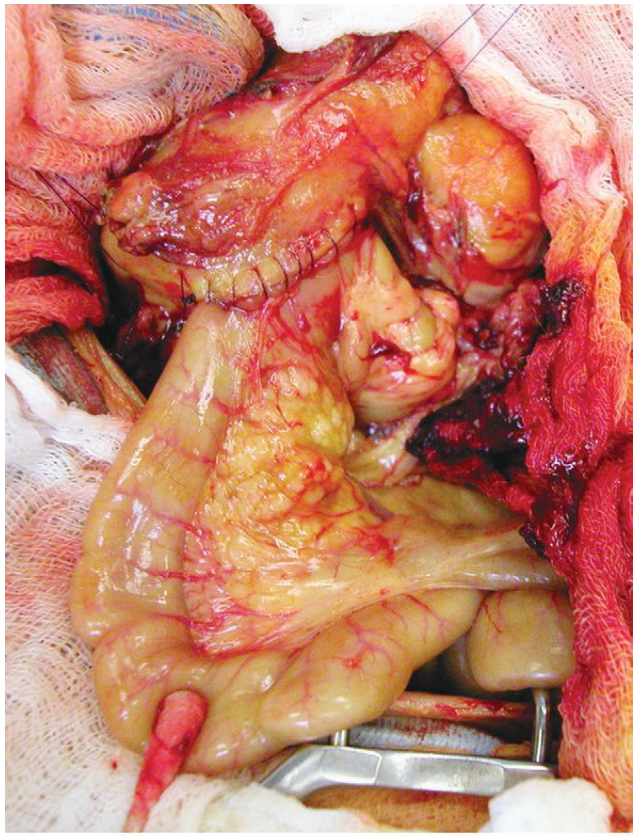
- The significance of allowing bile to continue to be secreted into the duodenum, as occurs in a cholecystoduodenostomy, relates to the physiologic control of gastric acid secretion. It is known that diversion of bile from the duodenum can lead to duodenal ulceration in dogs.

- Through a hormonal mechanism, gastric acid secretion is inhibited when bile is present in the duodenum. If this inhibitory feedback is lost, gastric acid oversecretion may occur, resulting in an elevated incidence of ulcer formation.



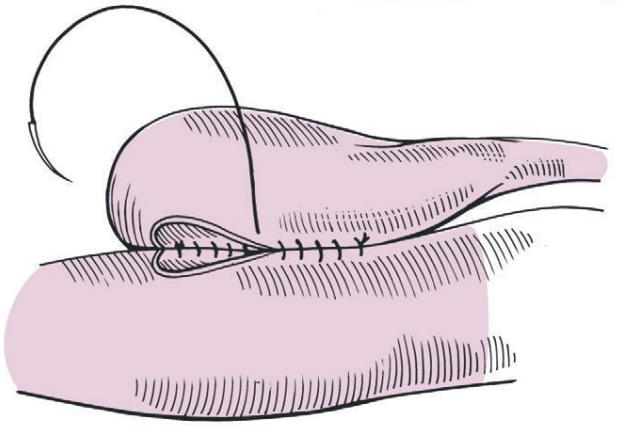


- **Technique.** The gallbladder must first be dissected from the hepatic fossa. This allows complete mobilization and reduces tension between the gallbladder and the section of intestine to where it will be anastomosed.



- For a cholecystoduodenostomy, the mobilized gallbladder is positioned adjacent to the antimesenteric border of the duodenum.
- An incision is created through the long axis of the gallbladder, and bile is removed with suction.
- A duodenotomy of similar dimension is created; if a duodenotomy has already been created over the site of the major duodenal papilla for common bile duct flushing, that same incision in the duodenum can usually be used for anastomosis.

- For cholecystojejunostomy, a loop of proximal jejunum is aligned alongside the gallbladder lumen, and incisions of similar lengths are created.
- The far and near walls of the two incisions are sutured with 3-0 or 4-0, monofilament, absorbable material in a separate simple continuous pattern on each side (Figure 95-9).
- An additional simple interrupted suture can be added to pexy the gallbladder to the duodenum at each end of the anastomosis.



- The stoma should be created as long as possible because a small stoma (<2.5 cm) may predispose to obstruction from stricture formation, resulting in the retention of intestinal chyme within the gallbladder and subsequent ascending cholangiohepatitis.82,123,206 The anastomosis can also be completed with surgical stapling devices.

- Possible complications associated with cholecystoduodenostomy include hemorrhage, incisional dehiscence, stricture of the stoma, ascending cholangitis, and gastric ulceration

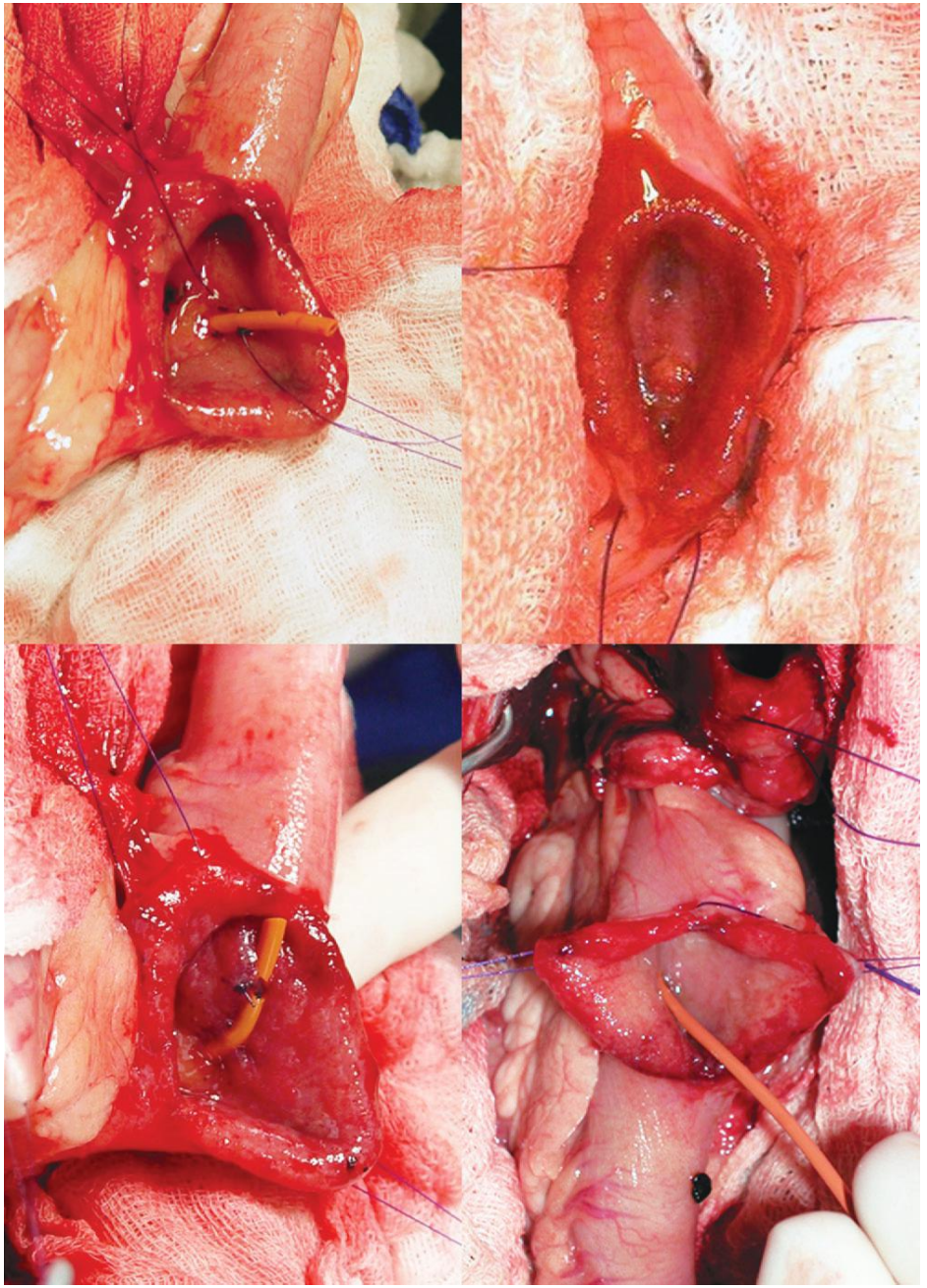
Choledochal Stenting

- The most common indication for choledochal stenting in dogs and cats is for treatment of temporary reversible extrahepatic biliary tract obstruction caused by pancreatitis or cholangiohepatitis and choledochal tube stent placed to relieve obstructions of the common bile duct and duodenal papilla due to extraluminal compression

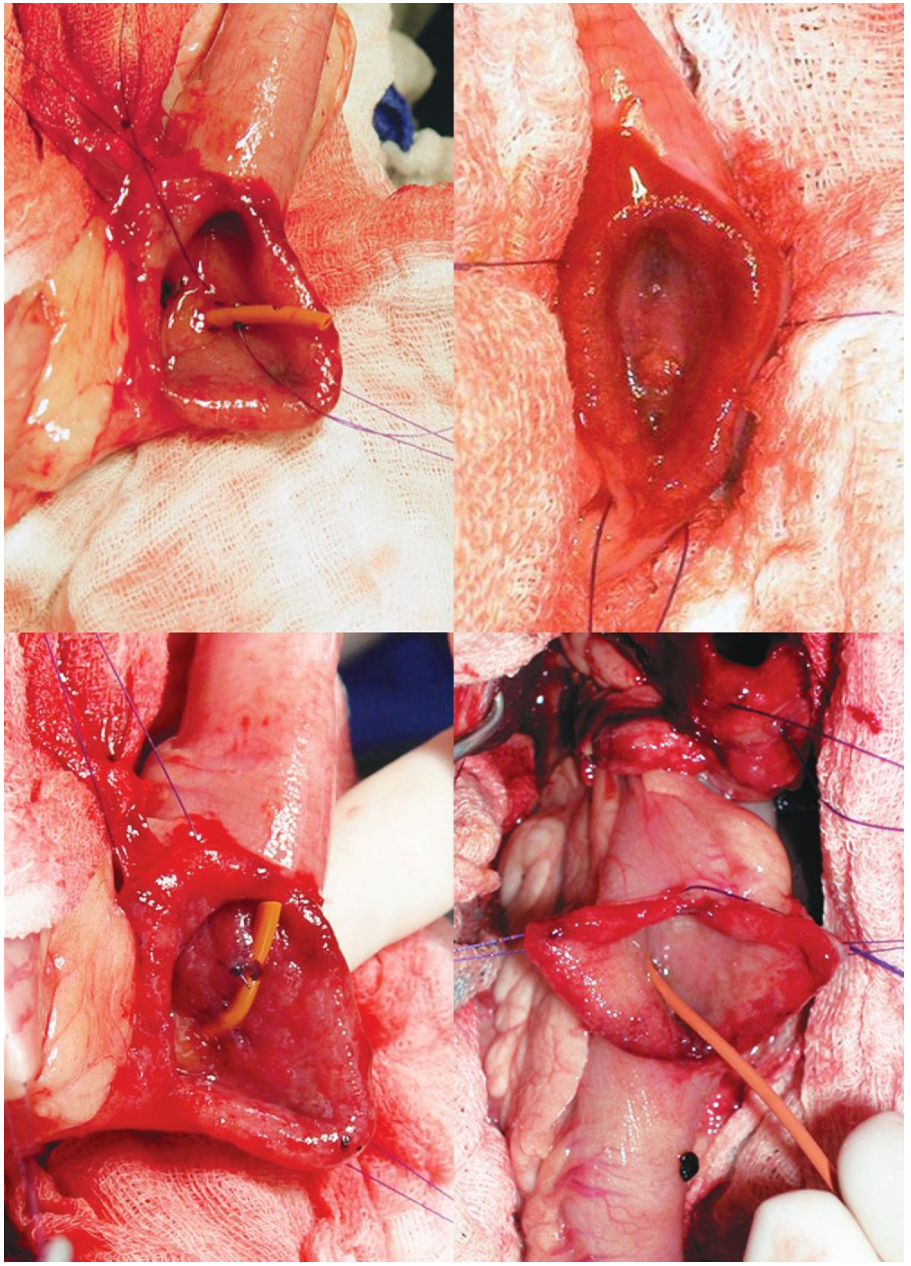
- A duodenotomy was created and the stent (i.e., red rubber catheter of appropriate size (usually 3.5- to 5-Fr for cats and 8- to 12-Fr for larger dogs)) placed up the duodenal papilla and into the common bile duct.

- (If passage of even a small catheter is impossible, choledochal stenting is not an option in that patient and cholecystoenterostomy should be considered).

- The largest stent size that does not completely fill the common bile duct lumen should be chosen. If using a red rubber catheter, a section is cut long enough to bridge the constriction while leaving 2 to 4 cm of stent residing in the duodenum.



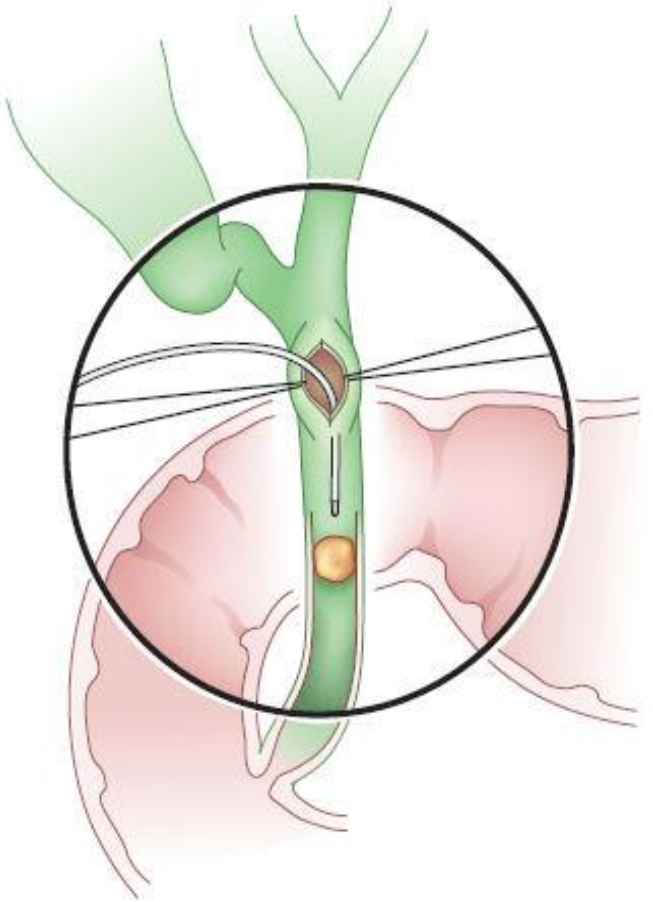
- Several morefenestrations can be cut into each end of the stent.
- The stent was then sutured in place to the submucosa of the duodenum with one or two stay sutures of poliglecaprone 25 (Monocryl) or polydioxanone when short-term drainage is anticipated, and nonabsorbable suture can be used if permanent palliation is required..
- A hemostatic clip was placed in the lumen of the duodenal side of the stent to allow radiographic assessment of the position of the stent
- Theoretically, after the suture breaks, the stent is passed in the feces.
- For the perminant, stent removal by endoscopy 2 to 4 months postoperatively is advised because of the possibility forobstruction and ascending cholangiohepatitis.

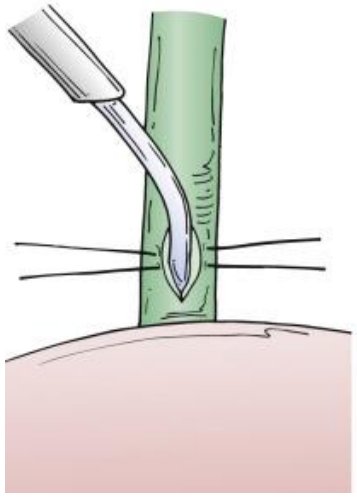


Choledochotomy

- Choledochotomy is ideally avoided if there is an alternative because dehiscence is possible because of the thin-walled and often friable nature of the common bile duct in dogs and cats

- If choledochotomy is necessary, a small longitudinal incision is made over the choleliths, which are removed. The duct incision is closed with 4-0 to 6-0 monofilament absorbable suture in a simple continuous pattern



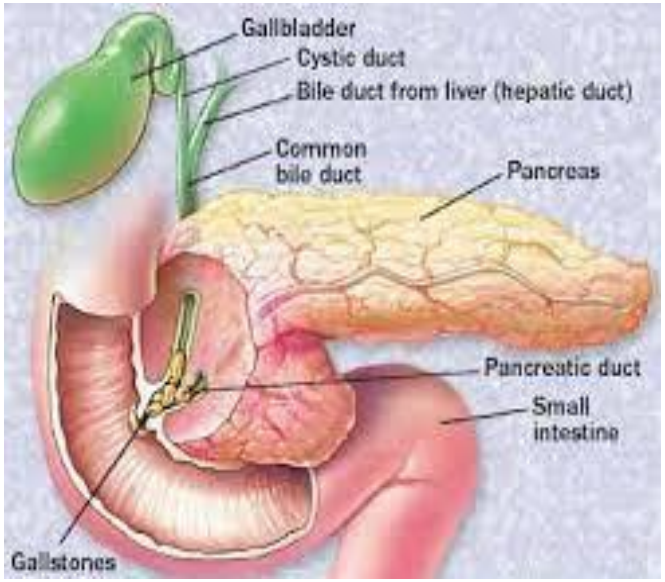


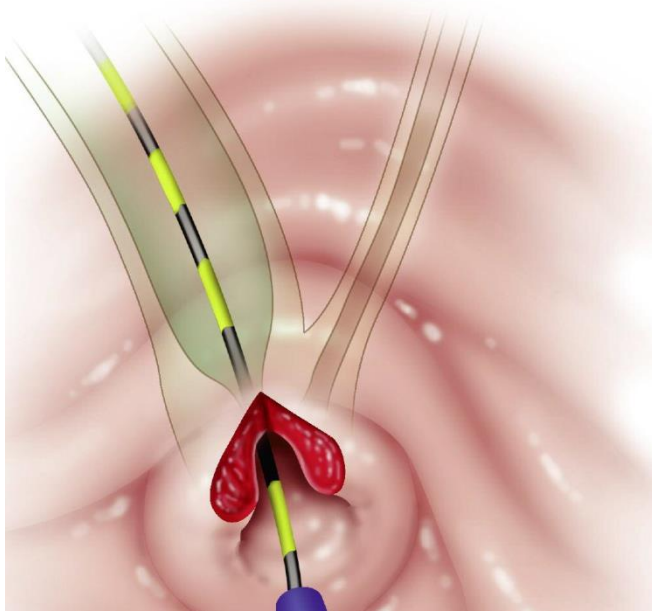
Sphincter-Altering Procedures

- Occasionally, a cholelith lodged in the terminal common bile duct adjacent to the major duodenal papilla can be removed by sphincterotomy.

- An incision is made over a small section of the intramural common bile duct oral to the papilla to allow the cholelith to be removed from within the lumen of the duodenum.

- It is helpful to place a red rubber catheter into the papilla to ensure that the incision only enters the bile duct and does not damage peripheral structures.
- procedure is infrequently necessary but represents another option for management of choleliths that are difficult to dislodge from the terminal common bile duct





SPECIFIC DISEASES

- **Hepatic Abscesses and Cysts**

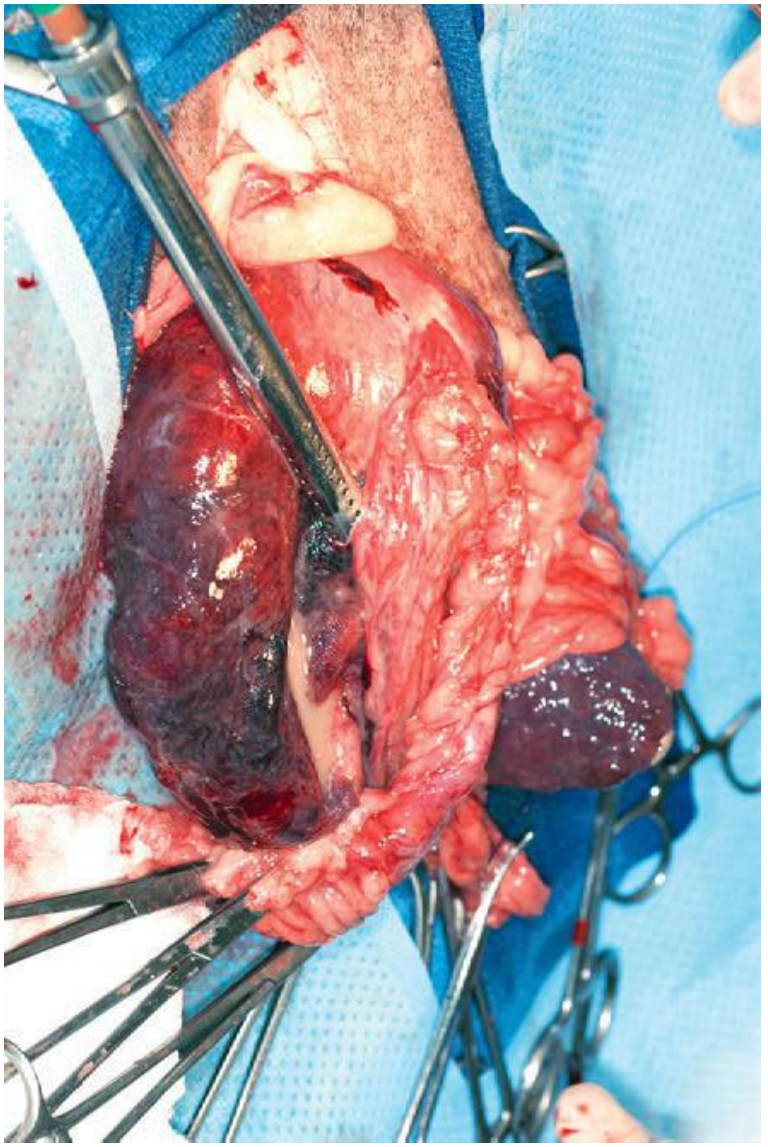
- Hepatic abscessation is a relatively uncommon disease in dogs

- **Diagnosis.** Abdominal ultrasonography appears to be a sensitive tool for diagnosis; results were abnormal in all animals examined

- Bacterial culture most often identified *E. coli*, but various other organisms, including *Staphylococcus* spp., *Enterococcus* spp., and *Klebsiella* spp., were also identified

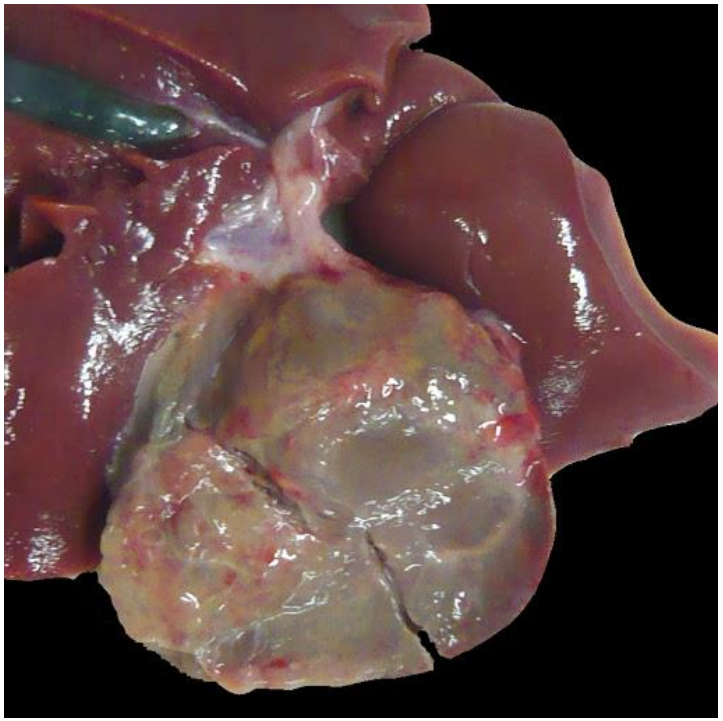
-

- broad-spectrum antibiotics should be instituted, with changes based on culture and sensitivity results.



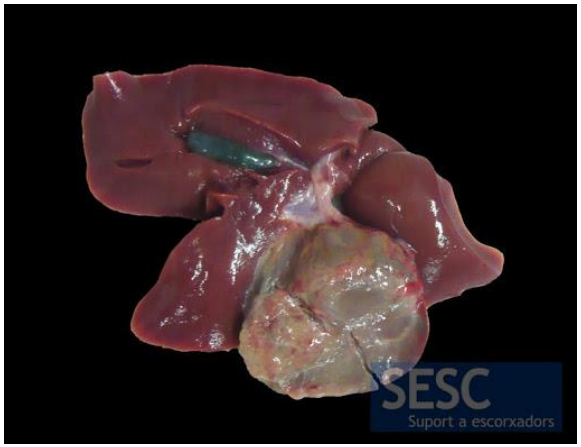
- **Treatment and Outcome.**
- a combination of medical and sometimes surgical treatments.
- systemic antibiotic treatment alone or ultrasound-guided drainage, or surgical resection

- **Liver Lobe Torsion**
- Liver lobe torsion is another relatively uncommon disease of dogs,. It is reported most commonly in middle-aged to older large-breed dogs*
- Clinical signs

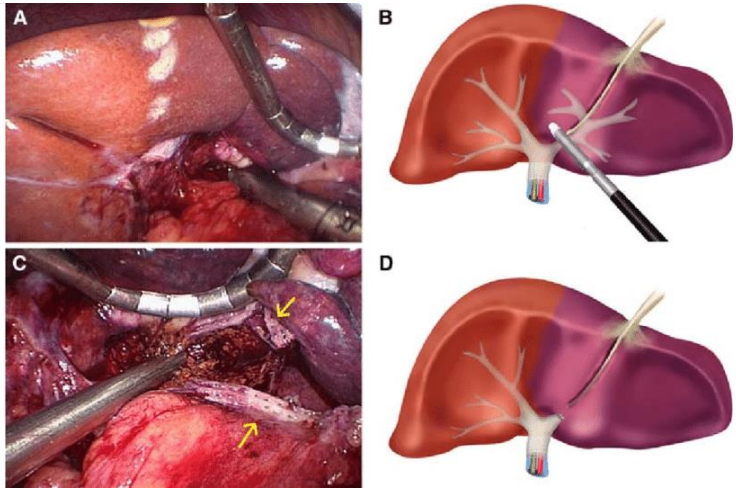


- vomiting, lethargy, and anorexia with concurrent increased serum hepatic enzyme activities and a mature neutrophilia.
- Imaging, particularly Doppler ultrasonography, is useful in identifying hepatic vessels with decreased blood flow.

- Torsion of the left lateral lobe is most commonly reported, presumably because of its large size, mobility, and separated anatomy compared with the rest of the liver and potential for laxity in related hepatogastric ligament.
-
- This condition is considered a surgical emergency to avoid further hepatic necrosis, hepatic abscessation, and related sequelae.



- Treatment is stapled or sutured liver lobectomy. Because of a potentially increased risk in large-breed dogs and possible ligamentous laxity,



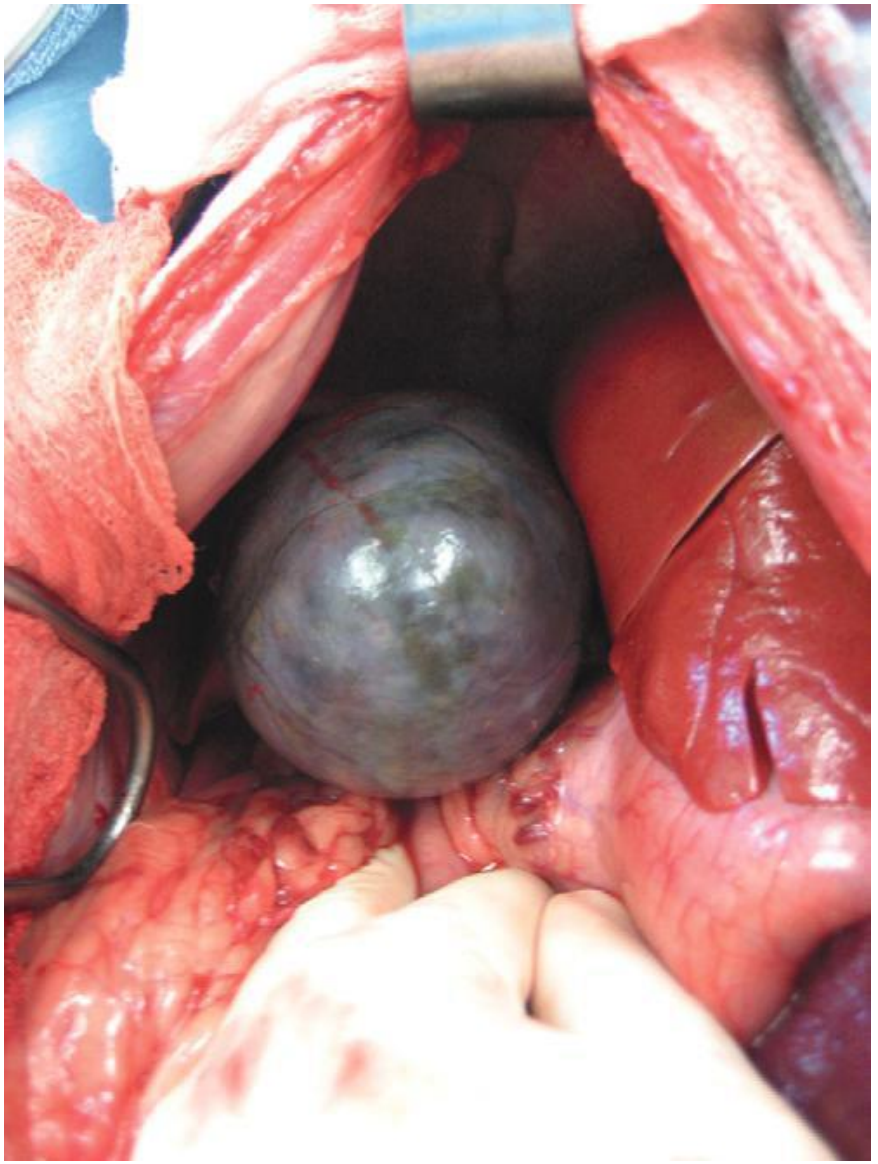
- some authors have recommended considering concurrent prophylactic gastropexy when partial hepatectomy for liver lobe torsion is performed, as is recommended with splenic torsion.

- Prognosis is considered excellent after prompt diagnosis, with 11 of 12 surgically treated dogs having a favorable outcome.

Gallbladder Mucocele

- Gallbladder mucocele may currently represent the most common indication for surgical management of extrahepatic biliary tract disease in dogs. It has not yet been convincingly described in cats.

- ***Etiology***
- The underlying lesion has been described as cystic mucosal hyperplasia. Hypersecretion of mucus leads to an accumulation of thick, gelatinous bile within the gallbladder.
- Increased viscosity over a period of weeks or months leads to filling of the entire gallbladder lumen with thick, gelatinous material that can in some cases also be present in the common bile duct and hepatic ducts.
- This may lead to extrahepatic biliary obstruction or development of bile peritonitis secondary to gallbladder rupture. The cause of the condition remains largely unknown.



Diagnosis

- Diagnosis of gallbladder mucocele relies on a combination of clinical signs, laboratory parameters, and imaging studies.

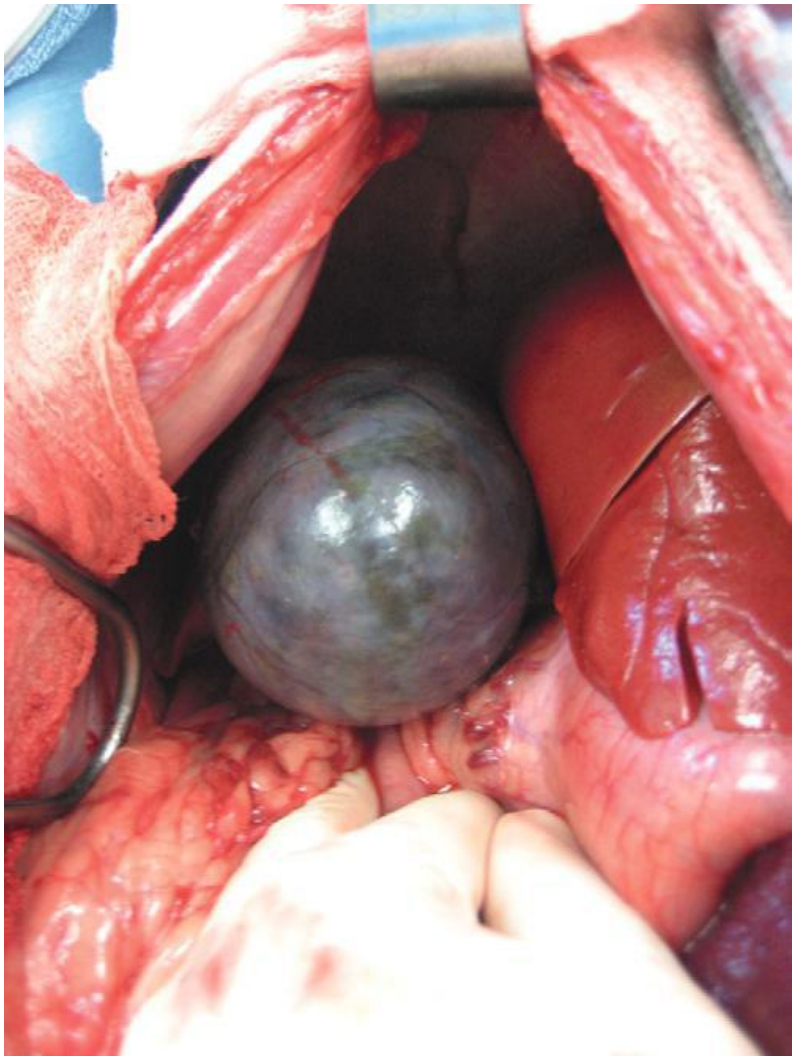
Treatment

- **Medical Management.** Appropriate management of gallbladder mucocele depends on the clinical presentation. Successful medical management of two dogs with gallbladder mucocele that were followed ultrasonographically has been reported.

- Medications administered included ursodiol, *S*-adenosyl-Lmethionine, and famotidine, although the relative role of these drugs in the resolution of the gallbladder mucocele can only be hypothesized.

- The belief that most gallbladder mucoceles should be treated surgically is probably justified by the high morbidity and mortality seen in dogs that develop extrahepatic biliary obstruction or bile peritonitis secondary to gallbladder rupture.

- However, medical management can be considered in early cases that have significant comorbidities and are poor anesthetic candidates.



Incidental Mucoceles.

- The treatment of incidentally discovered or asymptomatic mucoceles is controversial.
- Recently, the development of a laparoscopic cholecystectomy technique in dogs and its application to the treatment of gallbladder mucoceles may be a good option for dogs with incidentally diagnosed gallbladder mucoceles.

A cut section of the solidified mucocele

Surgery.

- The gallbladder wall is generally considered to be the source of excessive mucus production; cholecystectomy therefore would remove the underlying cause. The gallbladder should always be submitted for histopathologic analysis and a sample of the bile and a portion of the gallbladder wall submitted for bacterial culture and sensitivity testing.

- Evidence is somewhat conflicting as to whether infection is common with biliary mucoceles: positive cultures for aerobes and anaerobes have been reported in 9% to 75% and 0% to 25% of samples, respectively.

Figure 8. A gallbladder mucocele in a dog.

- *Enterococcus* spp. and *E. coli* isolates are most frequently cultured. Gallbladder rupture with subsequent bile peritonitis is encountered in 23% to 60% of cases; thus, surgeons should be prepared for this eventuality.21,133,233 Some form of ongoing drainage is helpful in many cases and can consist of closed suction drainage using Jackson Pratt drains or open abdominal drainage postoperatively.

- To reduce the risk of persistent postoperative obstruction, bile duct patency should be ensured intraoperatively by catheterization and flushing, as outlined above, particularly in patients that have laboratory or imaging evidence of extrahepatic biliary obstruction

- Postoperative complications consist of further leakage of bile from the surgery site, pancreatitis, and re-obstruction of the common bile duct with gelatinous bile.

Cholelithiasis

- Choleliths are fewer than 1% of dogs with biliary tract disease

Pathophysiology

- different to that in humans, in whom supersaturation of bile with cholesterol and decreased bile salt secretion are known to be important factors for lithogenesis.

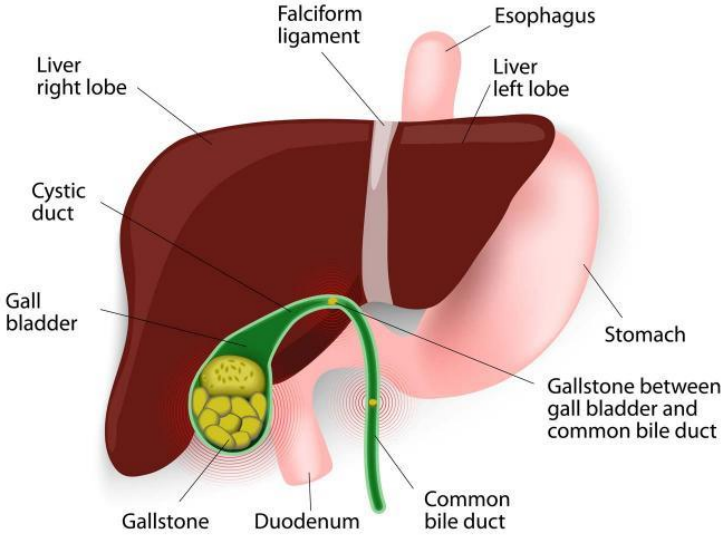
- In contrast to humans, canine bile is far less saturated with cholesterol. Cholesterol-containing choleliths are much less common in small animals, although feline choleliths composed primarily of cholesterol have been reported.

- In small animals, so called "**pigment stones**" are more common.

- **In dogs**, they are usually composed primarily of calcium bilirubinate, with bilirubin and cholesterol present in varying quantities.

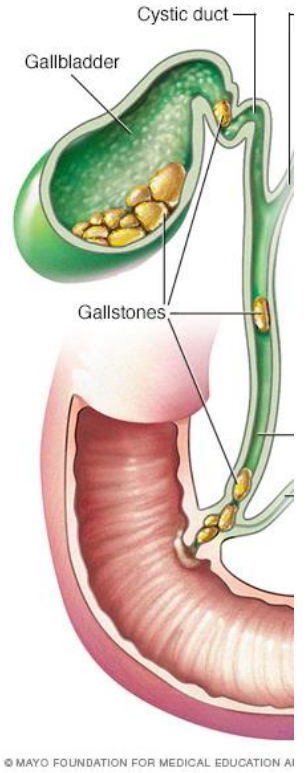
- **In cats**, most choleliths are calcium carbonate, with calcium bilirubinate and cholesterol reported less frequently.

- Any obstruction of bile flow into the duodenum will potentially lead to formation of bile sludge, which is a known precursor to cholelith formation in humans
- Cholestasis has also been implicated in formation of gallbladder mucoceles, a condition in which micro- and macrolithiasis can often be observed. In addition, mucin overproduction from the glands within the gallbladder wall, as seen in mucoceles, acts as a pronucleating agent that binds cholelith components and is a precursor to cholelith formation in animal model.
- A role for infection in cholelith formation is also hypothesized and is made plausible by the observation that 70% of canine choleliths had positive aerobic culture results and 55% had positive anaerobic culture results in one study. The most common bacteria cultured were *E. coli*, *Streptococcus* spp., *Enterococcus* spp., and *Klebsiella* spp.
- Some bacteria produce β-glucuronidase that deconjugates soluble bilirubin glucuronide to insoluble unconjugated bilirubin, which can then precipitate out as calcium bilirubinate



- ***Clinical Signs and Diagnosis***

- Most choleliths are formed within the gallbladder,
- Cholelithiasis may be a cause of extrahepatic biliary tract obstruction when migration of one or more choleliths into the common bile duct occurs. Choleliths can also be associated with clinical signs of cholecystitis in dogs and with the inflammatory complex of cholecystitis, pancreatitis, and inflammatory bowel disease (sometimes known as “triaditis”) in cats
- A variable percentage of choleliths are visible on plain abdominal radiography, depending on their relative calcium salt composition
- Abdominal ultrasonography is an effective diagnostic imaging tool for diagnosis of cholelithiasis, with most choleliths appearing as focal hyperechoic structures of varying size and shape with acoustic shadowing
- ***Treatment and Prognosis***
- Medical dissolution is generally not considered successful.



- When cholelithiasis is associated with extrahepatic biliary obstruction, emergency surgery is warranted after patient stabilization. Cholecystectomy is the treatment of choice for removal of choleliths and prevention of their recurrence.

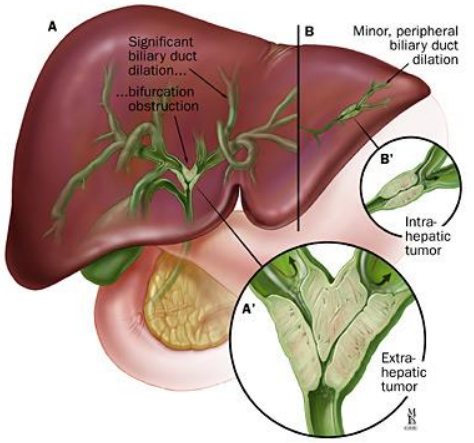
- it is essential that choledochal choleliths are first flushed back into the gallbladder and that the patency of the common bile duct is confirmed before cholecystectomy is performed. If patency cannot be established, choledochotomy or cholecystoenterostomy may be required.

- In cases in which choleliths are lodged close to the major duodenal papilla, sphincterotomy has rarely been reported for cholelith removal.

- Bile and cholelith samples should be collected during surgery for aerobic and anaerobic bacterial culture and sensitivity testing.

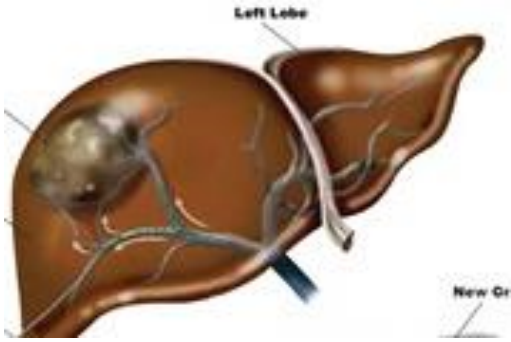
Hepatobiliary tumors are of four general types:

1. hepatocellular (adenomas, hepatocellular carcinomas)
2. cholangiocellular (adenomas, Cholangiocellular carcinoma)
3. neuroendocrine (*carcinoids* or *amine precursor uptake and decarboxylation* (APUD) cell tumors)
4. mesenchymal (Hemangioma, Primary hepatic hemangiosarcoma,)



- Primary or Metastatic tumors are more common than primary ones, and approximately 30% of dogs with nonhepatic primary tumors present with hepatic metastases

- The most common secondary tumors are hematopoietic and lymphoid tumors followed by epithelial and mesenchymal tumors. Mast cell tumors are also rarely found as primary or secondary tumors in the live



Clinicopathologic Features

- Most animals with hepatobiliary neoplasia are aged 9 to 12 years old at presentation. Clinical signs, when present, are likely to be nonspecific, with lethargy, anorexia, weight loss, and vomiting being most prevalent.* Physical examination may reveal a palpable abdominal mass, especially in the case of the massive form of hepatocellular or cholangiocellular carcinoma.

- Other signs may be secondary to hepatic failure and include icterus, poor body condition, or ascites

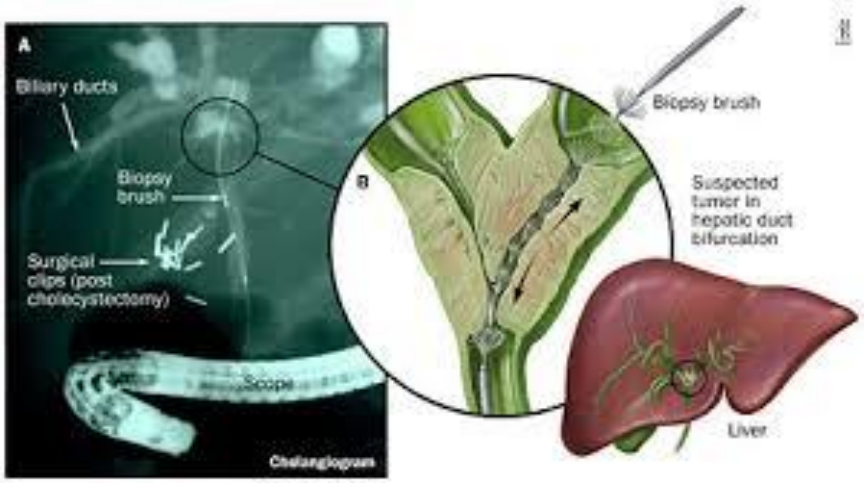
- Laboratory abnormalities are also very variable and may include hypoalbuminemia and nonspecific increases in liver enzymes and pre- and postprandial bile acids. Hypoglycemia, A complete blood count may reveal anemia and leukocytosis

Diagnosis	Symptomatic Dogs		Asymptomatic Dogs	
	Nº	%	Nº	%
Anemia	19[a]	55.88	2[b]	11.76
Leukocytosis	7[a]	20.59	3[a]	17.65
Leukopenia	1[a]	2.94	0[a]	0
Thrombocytopenia	10[a]	29.41	10[a]	58.82
Azotemia	2[a]	5.88	0[a]	0

Same letters in the same line does not show significant difference by Fisher's exact test at 5% probability.

Diagnosis

- Plain radiography



- Abdominal ultrasonography

- aspiration or biopsy of masses is required for histologic diagnosis. Diagnosis of specific tissue types requires fine needle aspiration of cells, needle core biopsy, laparoscopic liver biopsy, or “open” surgical biopsy.
- <u>The simplest method for obtaining a diagnosis of hepatic neoplasia is ultrasound-guided fine needle aspiration.</u>

- Contrast enhanced harmonic ultrasonography increases the ability to differentiate between benign and malignant hepatic nodules

Good Luck

Don't Stress.

Do Your Best.

Forget the Rest.