LIVER

Many patients with liver disease are anorectic and may require nutritional supplementation prior to surgery. Hypoglycemia occurs with severe hepatic insufficiency; monitoring blood glucose levels and supplementing fluids with glucose may be needed. Patients with massive ascites may have ventilatory disturbances due to diaphragmatic displacement and restriction of lung expansion. Removal of some abdominal fluid in such patients prior to anesthetic induction may help prevent hypoventilation. Patients with hepatic encephalopathy should be treated with dietary therapy, appropriate antibiotics, enemas, fluids, and other medications decrease or eliminate clinical signs prior to surgery.

ANESTHETIC CONSIDERATIONS

Animals with hepatic dysfunction may have impaired ability to metabolize and inactivate some drugs due to a decreased hepatic metabolic rate, decreased hepatic blood flow, decreased volume of distribution (i.e., of drugs that are highly protein bound), and a decreased extraction efficiency. Prolonged duration of action or altered function of drugs commonly used to anesthetize veterinary patients may result. Acetylpromazine lowers the seizure threshold and should not be used in patients with hepatic encephalopathy. It also lowers systemic vascular resistance and blood pressure and may alter the metabolism of some drugs (i.e., procaine, succinylcholine) and should be avoided in patients with severe hepatic dysfunction. Diazepam is useful as a premedicant in patients with hepatic dysfunction because it causes mild, dose-related CNS depression, does not depress the cardiopulmonary system, raises the seizure threshold, and can be antagonized with flumazenil. Diazepam is best used in conjunction with an opioid since it may disinhibit some behaviors when used alone. It should be used with caution in hypoalbuminemic patients. Most opioids have little or no adverse effect on the liver; however, intravenous morphine should be avoided in dogs with hepatic dysfunction because it may cause hepatic congestion due to histamine release and hepatic vein spasm. Although some opioid analgesics may have prolonged action when hepatic function is reduced, their effects can be antagonized. Barbiturates (e.g., thiopental) should be used cautiously or avoided in patients with significant hepatic disease because they may have a prolonged duration of action. Ketamine is metabolized in the liver of dogs (it is excreted largely unchanged in the urine of cats) and its central stimulant action may precipitate seizures in encephalopathic patients. Thus, ketamine should be administered at reduced dosages to dogs with mild hepatic dysfunction and avoided in patients with severe dysfunction.

Inhalation anesthetics are the preferred method of maintaining anesthesia in these
patients. Heart rate and rhythm, respiratory rate, and urine output should be monitored. Hyperventilation may cause a significant decrease in portal blood flow. Halothane and isoflurane both cause decreases in portal blood flow but hepatic arterial blood flow tends to increase during isoflurane anesthesia, preserving hepatic oxygenation. Isoflurane, unlike halothane, has not been associated with postoperative hepatic dysfunction. Isoflurane is the inhalation agent of choice for patients with severe hepatic disease. Monitoring blood gases, blood pressures, blood glucose concentrations, hematocrit, and total protein is advantageous in these patients.

ANTIBIOTICS

Anaerobic bacteria normally reside in the liver but may proliferate if there is hepatic ischemia or hypoxia. Thus, prophylactic antibiotics are warranted in most patients undergoing hepatic surgery. The pharmacokinetics of antibiotics may be altered in these patients by depressed hepatic metabolism, alterations in hepatic arterial or portal blood flow, hypoalbuminemia, and/or reductions in biliary excretion. Antibiotics are specifically indicated in the treatment of hepatic encephalopathy, bacterial hepatitis, and hepatic abscesses. Broad spectrum antibiotics effective against anaerobes (i.e., penicillin derivatives, metronidazole, or clindamycin) are appropriate and relatively safe in patients with hepatocellular compromise. Metronidazole, when administered at doses greater than 60 mg/kg of body weight has caused neurologic signs (e.g., ataxia, nystagmus, head tilts, and/or seizures) in some dogs. Potentially hepatotoxic antibiotics (e.g., chloramphenicol, chlortetracycline, or erythromycin) should be avoided, if possible.

TECHNIQUES

Surgery of the liver is complicated by the fact that hepatic tissue is friable. Because of the sparsity of fibrous protein in the liver, sharp dissection is difficult and results in retraction of blood vessels and bile ducts within the friable stroma. Ligation of structures (i.e., blood vessels and bile ducts) after they have been cut is extremely difficult. Packing the liver firmly enough to obtain hemostasis may cause compressed cells to become ischemic and necrotic. Maintaining hepatic blood supply is important because the liver normally harbors pathogenic anaerobes. Thus, surgery of the liver requires different techniques than are used in most other abdominal organs.

Hepatic biopsies are commonly indicated in patients with known or suspected hepatic disease. They may be obtained percutaneously, with laparoscopy, or at surgery. Partial hepatectomies are less commonly performed, but may be indicated for focal neoplasms or trauma. The standard approach for hepatic surgery is a cranial ventral midline abdominal incision. The caudal aspect of the sternum can be split if additional exposure is needed.
Percutaneous core biopsies or fine needle aspirates are most successful in patients with diffuse hepatic disease; however, ultrasound guidance will allow some focal lesions to be biopsied. **Animals with clinical bleeding, severe thrombocytopenia (i.e., < 20,000 platelets/µl), cavitary lesions, or highly vascular lesions (determined with ultrasound) should not have percutaneous core biopsies performed due to the risk of uncontrollable hemorrhage or abdominal infection. Caution is also recommended with fine-needle aspiration in these patients.** Tissue core biopsies may be obtained with a Tru-cut biopsy or an automated biopsy device. Fine needle aspirates may be obtained with a hand-held syringe or an aspiration gun with syringe attached to a 20 to 25 gauge, 1- to 3-inch needle. For histopathology, the needle should be removed from the syringe or gun and placed in formalin. Once the sample has been fixed it should be removed from the needle for processing. Fine-needle aspiration is most likely to be diagnostic in patients with diffuse hepatic neoplasia (i.e., lymphosarcoma), fungal disease, and idiopathic hepatic lipidosis. However, inability to diagnose these conditions on a fine-needle aspirate does not preclude disease. If core biopsies are performed, 2 or 3 (2-cm long) samples should be obtained. Percutaneous biopsies may be obtained under tranquilization or heavy sedation using a transthoracic or transabdominal approach. The latter is described here.

*With the animal in dorsal recumbency, clip the hair from the area surrounding the xiphoid process and prepare it for aseptic surgery. Make a small incision in the skin between the costal arch and xiphoid process on the left side. Insert the biopsy needle through the skin incision in a craniodorsal direction, angling it slightly towards the left of midline. Advance the needle until resistance is met or ultrasound guidance shows the needle to be positioned at the surface of the liver. Advance the biopsy needle into the hepatic tissue and obtain the biopsy.*

**Surgical liver biopsy**

Biopsies of the liver should be routinely obtained during exploratory laparotomy in animals with known or suspected liver disease. Surgical biopsy allows the entire liver to be thoroughly inspected and palpated, and focal lesions to be biopsied for histopathology, culture, and/or copper analysis. Furthermore, hemorrhage from the biopsy site can be readily identified and controlled with proper technique. If generalized hepatic disease is present, the biopsy can be taken from the most accessible site (marginal biopsy samples). With focal disease, the entire liver should be carefully palpated for the presence of intraparenchymal nodules or cavities and representative samples obtained. The information gained from histologic examination of the liver may prove beneficial in determining prognosis, diagnosis, and long-term management of patients with hepatic dysfunction.

* A biopsy of the hepatic margin may be obtained by the "guillotine" method. *Place a loop of suture around the protruding margin of a liver lobe. Pull the ligature tight and allow it to*
crush through the hepatic parenchyma before tying it. As the suture tears through the soft hepatic tissue, vessels and biliary ducts are ligated. Hold the liver gently between the fingers and using a sharp blade, cut the hepatic tissue approximately 5 mm distal to the ligature (allowing the stump of crushed tissue to remain with the ligature). Do not handle the biopsy sample with tissue forceps to avoid crushing it and causing artifacts. Place a portion of the sample in formalin for histologic examination; reserve the remainder for culture and cytologic examination. Check the biopsy site for hemorrhage. If hemorrhage continues, place a pledget of absorbable gelatin foam over the site. Alternately, if a focal (non-marginal) area of the liver is to be biopsied, use a punch biopsy or Tru-cut biopsy or place several overlapping guillotine sutures around the margin of the lesion and excise it. With a punch biopsy use caution to avoid penetrating more than half the thickness of the liver with each biopsy. Apply pressure to the site until bleeding stops. If hemorrhage continues, place a pledget of absorbable gelatin foam over the site.

Partial lobectomy

Partial lobectomy may be indicated in some conditions where disease involves only a portion of a liver lobe (e.g., peripheral hepatic arterio-venous fistulae, focal neoplasia, hepatic abscesses, trauma). Partial lobectomy may be challenging because of the difficulty in obtaining hemostasis and should be done with extreme caution in animals with bleeding disorders. Stapling instruments have been used for both partial and complete lobectomies, but discretion should be used in their application because hemorrhage may occur if the staples do not adequately compress hepatic tissue.

Determine the line of separation between normal hepatic parenchyma and that to be removed and sharply incise the liver capsule along the selected site. Bluntly fracture the liver with fingers or the blunt end of a Bard scalpel handle and expose parenchymal vessels. Ligate large vessels (hemoclips may be used) and electrocoagulate small bleeders that are encountered during the dissection. Alternately, place a stapling device (Autosuture 7 TA J 90, 55, or 30) across the base of the lobe and deploy the staples. Excise the hepatic parenchyma distal to the ligatures or staples. Ensure that the raw surface of the liver is dry and free of hemorrhage, prior to closing the abdomen. In small dogs and cats you may place several overlapping guillotine sutures (as described above) along the entire line of demarcation. Be sure the entire width of the hepatic parenchyma is included in the sutures. After tightening the sutures securely, use a sharp blade to cut the hepatic tissue distal to the ligature allowing a stump of crushed tissue to remain with the ligature.

Complete lobectomy

Complete lobectomy may be indicated in some focal lesions involving one or two hepatic lobes (e.g., traumatic lacerations of the liver or hepatic arterio-venous fistulas). The left lobes
(i.e., left lateral and left medial lobes) of the liver maintain their separation near the hilus more so than do the other lobes; therefore, these lobes can often be removed in small dogs and cats by placing a single encircling ligature around the base of the lobe. For the right lateral and caudate lobes, careful dissection around the hepatic caudal vena cava is usually necessary.

Left lobes in small dogs and cats: Crush the parenchyma near the hilus with fingers or forceps. Place an encircling ligature around the crushed area and tie.

Left lobes in larger dogs and right and caudate lobes. If necessary, carefully dissect the lobe from the caudal vena cava. Isolate the blood vessels and biliary ducts near the hilus and ligate them. Double ligate or oversew the ends of large vessels. Resect the parenchymal tissue leaving a stump of tissue distal to the ligatures to prevent retraction of the hepatic tissue from the ligatures and subsequent hemorrhage. Prior to performing the dissection, umbilical tape can be passed around the portal vein, celiac artery, cranial mesenteric arteries, and the caudal vena cava in front of and behind the liver. The umbilical tape is passed through rubber tubing which can be used to occlude the hepatic blood supply if uncontrollable hemorrhage occurs.

HEALING OF THE LIVER

The liver is uniquely different in its healing properties from other visceral organs. It has a relative absence of connective tissue stroma, it is highly susceptible to small changes in blood flow, and it has an enormous regenerative capacity. With regeneration, adequate liver function is possible in patients even after 80% of the organ has been removed or destroyed. Lacerations of the liver should be closed only when bleeding is profuse. If they are sutured, they should be closed in a manner that does not create an internal pocket of bile or blood or cause ischemia of the surrounding cells. Ligation of the proper hepatic artery can be performed as an emergency measure to control hemorrhage from extensive liver lacerations. Complex fractures or severe contusions should be treated by hepatic lobectomy if ligation of the hepatic artery does not result in hemostasis.

POSTOPERATIVE CARE AND ASSESSMENT

Recovery from anesthesia should be closely monitored in animals with severe hepatic dysfunction. Because of the increased half-life of some drugs in patients with hepatic dysfunction, prolonged recoveries may occur. Intravenous fluids should be provided until the patient is able to maintain hydration. Blood glucose levels should be monitored; transient hypoglycemia is common after removal of large portions of the liver. Albumin levels should be maintained (i.e., > 2.0 g/dl) by the administration of plasma or whole blood, and clotting factors should be assessed if hemorrhage or petechiation occur. Antibiotics given during surgery should be continued for two to three days if partial hepatectomy has been performed. Nutritional
supplementation may be necessary in some patients during the early postoperative period, particularly if the animal is anorexic or has severe vomiting or diarrhea. Analgesics (e.g., oxymorphone, butorphanol, buprenorphine) should be provided to patients who exhibit pain after surgery.

COMPLICATIONS

Non-diagnostic biopsies may occur if the tissue sample is crushed, fragmented, is of insufficient quantity, or if the specimen contains predominantly blood or necrotic portions of mass lesions. Bile peritonitis may occur if the gall bladder or bile ducts are inadvertently penetrated. A recent study found the complication rate in 246 animals undergoing ultrasound-guided biopsy of abdominal structures to be 1.2%.

The most common and serious complication of hepatic surgery is hemorrhage. This may result from ligatures slipping off of friable hepatic tissue. Care should be exercised to assure that a stump of tissue remains distal to the ligature when encircling sutures are used for biopsy or partial hepatectomy. Following hepatic trauma, anaerobic bacteria may proliferate in hypoxic portions of the liver and cause sepsis. Therefore, broad spectrum antibiotics should be used in patients with severe hepatic trauma and those undergoing hepatic surgery. Complications following major hepatic resections may include portal hypertension, ascites, fever, coagulopathies, and persistent bile drainage.

**BILIARY SYSTEM**

Diseases of the biliary system are relatively uncommon in dogs and cats, as compared to human beings, because of the low incidence of cholelithiasis in the former species. The most common cause of bile leakage in dogs and cats is blunt or penetrating trauma of the gall bladder or biliary ducts. Occasionally, biliary obstruction may be noted following trauma, calculi, or neoplasia. This lecture will discuss definitive treatment of extrahepatic biliary disease in small animals.

**ANATOMY OF THE BILIARY SYSTEM**

The extrahepatic biliary system is composed of the hepatic ducts from the liver, the cystic duct from the gallbladder, and the common bile duct. The bile canaliculi in the liver form intralobular ducts. These merge to become lobar ducts, which on exiting from the liver surface are called hepatic ducts. The hepatic ducts receive the cystic duct from the gallbladder to become known as the common bile duct. The bile duct empties into the duodenum between 3 and 6 cm from the pylorus.
Unlike the dog, the bile duct and major pancreatic duct in the cat often fuse prior to entering the duodenum. Reflux of pancreatic secretions into the bile duct may predispose to inflammation of the liver. The gallbladder lies in a depression on the visceral surface of the liver between the quadrate and right medial lobes. Blood supply to the gallbladder originates from the left branch of the proper hepatic artery.

DISEASES OF THE EXTRAHEPATIC BILIARY SYSTEM

Disease of the biliary system requiring surgical intervention are either caused by leakage of bile into the abdomen or obstruction of bile flow. Leakage of bile may occur when there is damage to the gallbladder or a tear or complete transection of the hepatic ducts or common bile duct. This is most often caused by blunt trauma following motor vehicle accidents, however, it may also occur with sharp abdominal trauma (such as gunshot wounds).

Obstructive biliary disease may be caused by biliary stones, infection, inflammation of the gallbladder (cholecystitis), pancreatitis, or neoplasia. Cholelithiasis and choledocholithiasis should be considered when obstructive icterus is suspected, however, gallstones are rare in dogs and cats. Most cases have been discovered at necropsy and have not been associated with clinical signs unless there is a secondary infection of the gallbladder.

Clinical signs

The clinical signs associated with leakage of the biliary system are often insidious in onset. Many times there is a delay of several weeks following trauma before the onset of clinical signs referable to the biliary system are noted. Early signs of biliary leakage are vomiting, anorexia, lethargy, and abdominal pain. Signs of abdominal discomfort and systemic disease often are not present until the bile becomes infected. Because bile salts are toxic to tissues and cause tissue necrosis, peritonitis usually occurs secondarily in chronic, untreated bile leakage. Animals with bile leakage generally die due to the effects of bacterial peritonitis.

Clinical signs associated with obstructive diseases depend on the cause of the obstruction. Icterus, abdominal pain, vomiting, depression, fever, weight loss, and anorexia may be noted.

Diagnosis

A history of trauma is frequently present in patients with biliary tract leakage. Abdominal radiographs may show evidence of fluid accumulation and loss of detail. Serum biochemical abnormalities include increased total bilirubin and serum alkaline phosphatase. Bilirubinuria may be present and occasionally the animals have clay-colored stools.
Abdominocentesis should be performed on all animals in which bile peritonitis is suspected. The total bilirubin should be higher in the fluid than in serum in animals with bile leakage.

Animals with obstructive disease are generally icteric. Total bilirubin is elevated and serum alkaline phosphatase is usually markedly increased. Survey abdominal radiographs may demonstrate radiopaque stones. Ultrasonography may also indicate dilated biliary ducts. Intravenous cholangiography or nuclear scintigraphic procedures outlining the biliary system may aid in the diagnosis of obstructive biliary disease.

PREOPERATIVE CONSIDERATIONS

Many patients with liver disease are anorectic and require nutritional supplementation prior to surgery. These animals may also have a tendency to bleed extensively following minor surgical manipulations due to concurrent clotting abnormalities. Last, but not least, these animals are often hypoalbuminemic. Albumin levels less than 2.0 gm/dl may interfere with normal wound healing.

When anesthetizing animals with liver disease it should be remembered that drugs that are metabolized by the liver, such as acepromazine and the barbiturates, may have a prolonged effect and should be used with caution. Normal bile is sterile, however in cases of cholangitis and cholecystitis the bile frequently contains bacteria. Antibiotic therapy should be based on culture and sensitivity. Administration of presurgical and postsurgical antibiotics is indicated. Empirically, ampicillin, cephalosporins, and chloramphenicol are often used because they are excreted into the bile.

SURGERY OF THE BILIARY TRACT

Exploratory laparotomy should be performed in animals in whom leakage of bile into the abdomen is suspected, in animals with obstruction of bile flow that is not clearly due to pancreatitis, and in animals with suspected neoplasia (biliary tract, intestinal, or pancreatic), parasitic disease, or stones. During exploration, patency of the common bile duct needs to be assured by manually expressing the gallbladder, or by retrograde (i.e., from the duodenum) or occasionally normograde (i.e., from the gallbladder) catheterization of the duct.

Treatment in animals with biliary obstruction secondary to benign pancreatic disease initially consists of medical management of the pancreatitis. If clinical or laboratory improvement is not seen within 7 to 10 days of initiating appropriate therapy; or, if clinical deterioration occurs despite appropriate medical therapy, cholecystoduodenostomy or cholecystojejunostomy may be considered. In extremely ill patients with biliary obstruction who cannot undergo surgical exploration, temporary decompression of the gallbladder using ultrasound-guided aspiration, or a Foley or self-retaining accordion catheter may be warranted.
Cholecystotomy

Cholecystotomy is rarely performed but may be indicated to remove some choleliths or when the gallbladder contents are inspissated and cannot be aspirated into a syringe. Pack the area surrounding the gallbladder with sterile, moistened laparotomy sponges. Place stay sutures in the gallbladder to facilitate manipulation and decrease spillage. Make an incision in the fundus of the gallbladder. Remove the gallbladder contents and submit for culture. Lavage the gallbladder with warmed, sterile saline. Catheterize the common bile duct via the cystic duct with a 3.5 or 5 French soft catheter and flush it to ensure patency. Close the incision with a one or two-layer inverting suture pattern using absorbable suture material (3-0 to 5-0).

Cholecystectomy

Diseases such as cholecystitis and cholelithiasis are best treated by cholecystectomy. Cholecystectomy may also be indicated for primary neoplasia or traumatic rupture of the gallbladder. Expose the gallbladder and incise the visceral peritoneum along the junction of the gallbladder and liver with Metzenbaum scissors. Apply gentle traction to the gallbladder and using blunt dissection free it from the liver. Free the cystic duct to its junction with the common bile duct. Be sure to identify the common bile duct and avoid damaging it during the procedure. If necessary, identify the common bile duct by placing a 3.5 or 5 French soft catheter into the duct via the duodenal papilla. Make a small enterotomy in the proximal duodenum, locate the duodenal papilla, and place a small red rubber tube into the common bile duct. Flush the duct to ensure its patency. Clamp and double ligate the cystic duct and cystic artery with non-absorbable suture material (2-0 to 4-0). Sever the duct distal to the ligatures and remove the gallbladder. Submit a portion of the wall plus bile for culture if infection is suspected. Submit the remainder of the gallbladder for histologic analysis if indicated (for cholecystitis or neoplasia). Close the duodenal incision with simple interrupted sutures of absorbable suture material.
Choledochotomy

Direct incision of the bile duct should only be performed in animals in which the duct is markedly dilated, such as may occur with chronic obstruction and where the obstruction can be removed (i.e., choledocholithiasis, biliary sludge). An attempt should first be made to remove the obstruction by flushing the common bile duct using a catheter placed via an enterotomy or cholecystotomy. Extrapluminal obstruction or stricture of the duct is best treated with biliary diversion techniques.

Pack the area surrounding the common bile duct with sterile, moistened laparotomy sponges. Place traction sutures into the distended duct. Make a small incision into the duct and remove the obstruction. Flush the duct with copious amounts of warmed, sterile saline and pass a 3.5 to 5 French soft catheter into the gallbladder and duodenum to ensure patency. Close the incision with a simple continuous or simple interrupted suture pattern of absorbable suture material (4-0 or 5-0). If leakage is a concern pass a catheter into the duct via an incision in the proximal duodenum (see above). Small leaks may be treated by stenting the incision with a 3.5 to 5 French soft catheter.
Bile flow diversion

Bile flow diversion is indicated when common bile duct obstruction is present or the duct is severely traumatized and the gallbladder is not directly involved in the disease process. Cholecystojejunostomy or cholecystoduodenostomy is preferred over choledochoduodenostomy in dogs and cats because the latter procedure is often difficult to perform successfully due to the small size of the common bile duct in these species. If cholecystojejunostomy is performed, the proximal jejunum should be used to decrease the incidence of postoperative maldigestion of lipids. Additionally, duodenal ulceration may occur more commonly as a sequelae to cholecystojejunostomy than cholecystoduodenostomy. In dogs, it has been recommended that the stoma between the bowel and the gallbladder be at least 2.5 cm long to minimize the potential for obstruction of bile flow or retention of bowel contents in the gallbladder. Making the stoma too small is more apt to result in ascending or chronic cholecystitis than making it too large.

Mobilize the gallbladder from the liver as described for cholecystectomy. Place stay sutures approximately 3 cm apart in the gallbladder. Bring the gallbladder into apposition with the antimesenteric surface of the descending duodenum so that there is little or no tension on the gallbladder or intestine. Pack the area surrounding the gallbladder and duodenum with sterile, moistened laparotomy sponges. Place a continuous suture of absorbable suture material between the serosa of the gallbladder and the serosa of the duodenum near the mesentery (referred to as original suture line. Make the suture line 3 to 4 cm in length. Leave the ends of the suture long and use them to manipulate the intestine and gallbladder. Drain the gallbladder and make a 2.5 to 3 cm incision into it, parallel with the preplaced suture line. Have an assistant occlude the duodenum proximal and distal to the proposed incision site and make a similar parallel incision in the antimesenteric surface of the duodenum. Place a continuous suture line of absorbable suture material (2-0 to 4-0) from the mucosa of the gallbladder to the mucosa of the duodenum beginning with the edges closest to the original suture line first. Then, use the same suture material to suture the mucosal edges of the stoma farthest from the original suture line. Complete the stoma by suturing the serosal edges of the gallbladder and intestine over the near side of the stoma (i.e., the side furthest from the original suture line).
Repair of common bile duct injuries

The surgical technique used to repair lacerations of the common bile duct depends on the location and severity of the lesion. Severely damaged ducts, particularly if there has been bile leakage and/or adhesion formation, are difficult to repair primarily. Incisional dehiscence, leakage, and stricture formation are common. If the injury is distal to the entrance of the hepatic ducts, the common bile duct should be ligated proximal and distal to the injury and biliary diversion performed (i.e., cholecystoduodenostomy or cholecystojejunostomy; see above). If the duct has been cleanly severed and the luminal diameter is greater than 4 to 5 mm, primary suturing and anastomosis is possible. Similarly, proximal lacerations or perforations may be treated with primary suturing. The mucosa of the bile duct should be accurately reapposed. Small sutures
should be used and tension on the suture line avoided. The use of stenting catheters in the common bile duct is controversial, but temporary bile diversion may allow bile duct injuries to heal that would otherwise dehisce, leak, and/or stricture. The tube acts to decompress the biliary tree and minimizes bile leakage from the site during healing. Disadvantages of tubes placed in the bile duct include an increased potential for stricture due to the presence of a foreign body at the injured site, obstruction of the tube, and ascending infection. If the bile duct is stented, a soft tube that is smaller than the diameter of the duct should be used to minimize irritation to the duct wall. The use of rubber tubes or catheters which enter the duodenum and T-tubes which exit the duct and are exteriorized through the abdominal wall have been described in the veterinary literature. The use of a straight catheter (i.e., Brunswick feeding tube) is described here.

Identify the common bile duct (see above under cholecystectomy). This may be facilitated by passing a catheter into the duct from the duodenum (see above). Be careful to not interfere with the blood supply to the duct during manipulation. Carefully debride the transected ends of the duct, but be sure to leave adequate duct length to avoid having tension on the suture line when the ends are reapposed. Reappraise the ends of the duct with absorbable suture material using simple interrupted sutures (4-0 to 6-0). Place a 3.5 to 5 French soft catheter in the duct from the duodenum to stent the suture line. Suture the distal end of the catheter to the duodenal lumen with a small chromic gut suture (3-0 or 4-0). As the suture dissolves, peristalsis will cause the catheter to enter the intestinal lumen where it will pass in the feces.

HEALING OF THE BILIARY TRACT

Studies have shown that if just a small strip of the common bile duct wall remains intact, the duct will regenerate. However, longitudinal tension on the suture line of a repaired biliary duct causes severe stenosis. In addition to promoting stricture of the duct, there is some suggestion that intraluminal tubes may interfere with normal biliary drainage, thus promoting cholangitis. Because of uncertainties regarding healing of the duct in the presence of infection, leakage, or tension, drainage procedures such as cholecystojejunostomies are commonly performed in lieu of direct repair of the common bile duct (see above).

SUTURE MATERIALS/SPECIAL INSTRUMENTS

Absorbable suture material should be used in the biliary tree because non-absorbable suture may act as a nidus for stone formation. Biliary duct surgery is aided by the use of small instruments such as those that are used for ophthalmic surgery. The gallbladder should be emptied prior to surgical manipulations and to decrease spillage of intestinal contents during biliary diversion surgery.

POSTOPERATIVE CARE AND ASSESSMENT
Fluid therapy should be continued until the animal is able to maintain hydration with oral fluids. Electrolytes and acid-base status should be assessed and corrected during the postoperative period. Many patients with bile peritonitis are debilitated prior to surgery and nutritional supplementation may be beneficial. Antibiotic therapy should be continued for 7 to 10 days if cholecystitis was present or bile leakage occurred prior to or during surgery. Open abdominal drainage may be considered in patients with generalized bile peritonitis.

**COMPLICATIONS**

Surgery of the extrahepatic biliary tree requires technical competence, manual dexterity, and sound surgical judgement to prevent serious complications. Potential complications after cholecystectomy (particularly if perforation was present) include generalized peritonitis, shock, sepsis, hypoglycemia, hypoproteinemia, and hypokalemia. Stricture, bile leakage, and dehiscence may occur after surgery of the common bile duct. Ascending cholangiohepatitis may occur in some animals after biliary diversion, particularly if the stoma of the enteric-biliary anastomosis is too small and intestinal contents remain in the gallbladder lumen for prolonged periods. Intermittent antibiotic therapy may be necessary in such animals.