MANAGING THE ANIMAL WITH AN ACUTE ABDOMEN

Theresa W. Fossum DVM, MS, PhD, Diplomate ACVS
Tom and Joan Read Chair in Veterinary Surgery, Professor of Surgery
Texas A&M University College of Veterinary Medicine, College Station, TX 77843-4474
tfossum@cvm.tamu.edu

PERITONITIS

Peritonitis is inflammation of the peritoneal cavity. It may be **primary** (e.g., hematogenous infection of the peritoneum as in feline infectious peritonitis) or **secondary** (i.e., resulting from chemical or septic contamination of the peritoneal cavity) and may be **generalized** (i.e., diffuse) or **localized** (i.e., only a small portion of the abdomen is involved). Chemical peritonitis is caused by the effect of irritating agents on the peritoneum (e.g., bile, urine, pancreatic secretions).

GENERAL CONSIDERATIONS AND CLINICALLY RELEVANT PATHOPHYSIOLOGY

Secondary generalized peritonitis is the predominant form of peritonitis in dogs and is usually caused by bacteria. Primary generalized peritonitis occurs in cats associated with feline infectious peritonitis. Generalized peritonitis may result from intestinal or gall-bladder perforation, rupture, or necrosis (e.g., gastric or intestinal foreign bodies, intussusception, mesenteric avulsion, gastric dilatation-volvulus, or necrotizing cholecystitis), pancreatic abscessation, prostatic abscesses, or foreign body penetration.

In early cases of peritonitis there may be little or no abdominal effusion. When effusion is present, abdominocentesis should be performed (see below) and fluid retrieved for analysis. Inflammatory fluids should have an elevated number of neutrophils, which may appear degenerative. Significant numbers of leukocytes accumulate in the peritoneal cavity within 2 to 3 hours of contamination with blood, bile, urine, feces, or gastric or pancreatic secretions. Leukocyte counts in abdominal fluid of normal dogs are usually less than 500 cells/μl. Following peritoneal lavage in dogs, white blood cell (WBC) counts of 1000 to 2000 cells/μl are indicative of mild to moderate irritation, while counts of greater than 2000 cells/μl indicate marked peritonitis. The presence of degenerate leukocytes and bacteria in the lavage fluid also suggests intraabdominal infection. However, the presence and number of WBCs should be correlated with other clinical findings when considering abdominal exploration. Elevated leukocyte counts are found in most dogs following abdominal surgery. In animals that have undergone recent surgery, 7000 to 9000 cells/μl indicates mild to moderate peritonitis and greater than 9000 cells/μl indicates marked peritonitis. An abdominal effusion glucose concentration of less than 50 mg/dl may be a specific indicator of bacterial peritonitis in dogs.

Diagnosis

Signalment. Any age, sex, or breed of dog or cat may develop peritonitis. It is particularly common in young animals that have perforating foreign bodies and in those that receive abdominal trauma (i.e., vehicular trauma and bite wounds).

History. The history is often nonspecific. The animal may not show signs of illness for several days after the traumatic episode. Mesenteric avulsions often do not cause clinical signs of peritonitis for 5 to 7 days after the injury. Animals with traumatic bile peritonitis may be asymptomatic for several weeks after the injury. Most animals are presented for lethargy, anorexia, vomiting, diarrhea, and/or abdominal pain.

Physical Examination Findings

Affected animals are usually painful on abdominal palpation. The pain may be localized but generalized pain is more common and the animal will often tense or "splint" the abdomen during palpation. Vomiting and diarrhea may be noted. Abdominal distension may be noted if sufficient fluid has accumulated.

Pale mucous membranes, prolonged capillary refill times, and tachycardia may indicate that the animal is in shock. Dehydration and arrhythmias may also occur.

Radiography/Ultrasonography

The classic radiographic finding in animals with peritonitis is loss of abdominal detail with a focal or generalized "ground-glass" appearance. The intestinal tract may be dilated with air and/or fluid. Free air in the abdomen may be noted with rupture of a hollow organ or sometimes occurs with gas-producing anaerobes, without gut rupture. A more localized peritonitis may occur secondary to pancreatitis and cause the duodenum to appear fixed and elevated. Ultrasonography is useful to localize fluid accumulation and help determine etiology.

Laboratory Findings

The most common laboratory finding in animals with peritonitis is a marked leukocytosis; however, the neutrophil count may be normal or low in some cases. The predominant cell type is the neutrophil, and a left shift is often but not always apparent. Other abnormalities may include anemia, thrombocytopenia, dehydration, hypoglycemia, hyperbilirubinemia, and/or electrolyte and acid-base abnormalities. The activity of circulating anticoagulant proteins (protein C and antithrombin) were found to be significantly lower in dogs with naturally occurring sepsis compare to controls in a recent study. Bile peritonitis usually causes elevations of alkaline phosphatase, alanine transaminase, and total bilirubin concentrations

Little or no abdominal effusion may be seen in early cases of peritonitis. When effusion is present, abdominocentesis should be performed and fluid retrieved for analysis. Toxic degenerative neutrophils with intracellular or extracellular bacteria are indicative of bacterial peritonitis. Leukocyte morphology and the presence of bacteria are more important than leukocyte numbers. If total nucleated cell counts (TNCC) are performed, they should be done on fluid that has been placed in an EDTA (lavender top) tube. Bacteria are sometimes not seen in patients with bacterial peritonitis, especially if they have been receiving antibiotics. Differentiating between these effusions and those due to pancreatitis may be difficult because large numbers of degenerative white blood cells can be seen with both. A concentration difference greater than 20 mg/dl between blood and peritoneal fluid glucose concentration has been reported to reliably differentiate between septic peritoneal effusions and nonseptic peritoneal effusions in dogs and cats. Lactate concentrations greater 2.5 mmol/L were indicative of septic peritoneal effusions in dogs in another study; however, lactate concentrations were not accurate tests for detecting septic peritoneal effusions in cats.

After abdominocentesis the amount of blood in the abdominal cavity can be estimated by observing the lavage sample. A red color reflects the presence of red blood cells (RBCs), and a deep red color usually indicates severe hemorrhage. If newsprint cannot be read through the plastic tubing, hemorrhage is significant; if print can be seen through the tubing, only moderate or minimal hemorrhage is present. Surgical intervention is indicated when the packed cell volume (PCV) of lavage samples taken within 5 to 20 minutes of each other increases substantially or if an animal in shock does not respond to aggressive fluid therapy.

MEDICAL MANAGEMENT

The goals of management of animals with peritonitis are to eliminate the cause of the contamination, resolve infection, and restore normal fluid and electrolyte balances. Food should be withheld if the animal is vomiting. Intravenous fluid replacement therapy should be initiated as soon as possible, particularly if the animal is dehydrated or appears to be in shock (in dogs, 60 to 90 ml/kg/hour; in cats, 40 to 60 ml/kg/hour). Synthetic colloids such as hetastarch and dextran 70 may be beneficial, particularly if vasculitis is present. Hypokalemia and hyponatremia may be present and require intravenous supplementation. Hypoglycemia is common in animals with septic shock (systemic inflammatory response syndrome), and glucose may need to be added to the fluids (i.e., 2.5% to 5% dextrose). Standard shock therapy should be initiated (i.e., fluid replacement and antibiotics, with or without soluble corticosteroids). If severe metabolic acidosis is present, bicarbonate therapy may be indicated.

Broad-spectrum antibiotic therapy should be initiated as soon as the diagnosis is made. *Escherichia coli, Clostridium* spp., and *Enterococcus* spp. are commonly isolated from animals with peritonitis, and ampicillin plus enrofloxacin typically is an effective antimicrobial combination. However, amikacin plus either clindamycin or metronidazole may be necessary. A second generation cephalosporin (e.g., cefoxitin), also has a reasonable gram-negative and anaerobic spectrum. If renal compromise is present in an animal with a resistant bacterial infection, imipenem may be considered. The initial antibiotic therapy should be altered according to

the aerobic and anaerobic culture results of lavage fluid or cultures obtained at surgery. Septic peritonitis typically causes DIC, and plasma administration to replace clotting factors is probably one of the most beneficial therapies in such patients.

Low-dose heparin (50-100 U/kg, SC, bid) increases survival and significantly reduces abscess formation in experimental peritonitis. The inflammatory process in peritonitis is associated with an outpouring of fibrous exudate that causes intraabdominal loculation of bacteria. The loculated bacteria are protected from host defense mechanisms, and antibiotics that may not be able to penetrate the fibrin clots. Although the exact mechanism of its beneficial effect is still unknown, heparin appears indicated in patients with severe peritonitis. Heparin may also be incubated with plasma and given to animals with disseminated intravascular coagulation (DIC). Low molecular weight heparin (enoxaprin, dalteparin) differs from unfractionated heparin in its mechanism of action and may be more effective; however, large clinical studies are lacking.

SURGICAL TREATMENT

Abdominocentesis (see below) is the percutaneous removal of fluid from the abdominal cavity, usually for diagnostic purposes, although it may occasionally be therapeutic. Indications include shock without apparent cause, undiagnosed disease with signs involving the abdominal cavity, suspicion of postoperative GI dehiscence, blunt or penetrating abdominal injuries (i.e., gunshot wounds, dog bites, automobile accidents), and undiagnosed abdominal pain. A multifenestrated catheter should be used to enhance fluid collection. Physical and radiographic examinations should precede abdominocentesis to rule out instances where it may not be safe and to guide needle placement. Four-quadrant paracentesis may be performed if simple abdominocentesis is not successful in retrieving fluid. It is similar to simple abdominocentesis except that multiple abdominal sites are assessed by dividing the abdomen into four quadrants through the umbilicus and tapping each of these four areas. Diagnostic peritoneal lavage should be performed in animals with suspected peritonitis if the above methods are unsuccessful in obtaining fluid for analysis

Exploratory surgery is indicated when the cause of peritonitis cannot be determined or when bowel rupture, intestinal obstruction (e.g., bowel incarceration, neoplasia), or mesenteric avulsion is suspected. Serosal patching and plication are techniques that decrease the incidence of intestinal leakage, dehiscence, or repeated intussusception. Animals requiring surgery and that have peritonitis secondary to intestinal trauma (disruption of mesenteric blood supply, bowel perforation, chronic intussusception, foreign body) are frequently hypoproteinemic. The role that protein levels play in healing intestinal incisions is not well understood. However, most surgeons are concerned that hypoproteinemic patients may not heal as quickly as patients with normal protein levels despite one study that showed similar complication rates among animals with normal protein levels and those that were hypoproteinemic and undergoing intestinal surgery. Most experimental evidence has shown that retardation of wound healing is not seen with moderate protein depletion but only with severe deficiencies (less than 1.5 to 2 g/dl).

Although the practice of lavaging the abdominal cavity of animals with peritonitis is controversial, lavage is generally indicated with diffuse peritonitis. Lavage should be done with care in animals with localized peritonitis to prevent causing diffuse dissemination of infection. When lavage is performed, as much of the fluid as possible should be removed because fluid inhibits the body's ability to fight off infection, probably by inhibiting neutrophil function. Historically, many different agents have been added to lavage fluids, especially antiseptics and antibiotics. Povidone-iodine is the most widely added antiseptic; however, its use may be contraindicated in established peritonitis. Furthermore, no beneficial effect of this agent has been shown in repeated experimental and clinical trials in animals. Although a great many antibiotics have been added to lavage fluids over the years, there is no substantial evidence that their addition is of any benefit to patients who are being treated with appropriate systemic antibiotics. Warmed sterile physiologic saline is the most appropriate lavage fluid.

Open abdominal drainage (OAD) is a useful technique for managing animals with peritonitis. Reported advantages include improvement in the patient's metabolic condition secondary to improved drainage, reduced abdominal adhesion and abscess formation, and access for repeated inspection and exploration of the abdomen. With this technique the abdomen is left open and sterile wraps are placed around the wound. The frequency of the wrap changes is dependent upon the amount of fluid being drained and the

amount of external soiling. Complications of open abdominal drainage include persistent fluid loss, hypoalbuminemia, weight loss, adhesions of abdominal viscera to the bandage, and contamination of the peritoneal cavity with cutaneous organisms.

Preoperative Management

Animals with peritonitis should be stabilized before surgery if they are in shock. Preoperative management of peritonitis is similar to that described in the previous discussion on medical management. Nutritional management of animals with peritonitis is extremely important. If they are debilitated, vomiting, or likely to not resume eating for several days after surgery, enteral or parenteral hyperalimentation should be considered.

Anesthesia

Animals with peritonitis are often endotoxic and/or hypotensive. Small amounts of endotoxins are normally absorbed from the intestine and transported via the portal system to the liver, where they are removed and destroyed by hepatocytes. Hypotension in dogs is associated with intense portal vasoconstriction. This vasoconstriction causes breakdown of the intestinal mucosal barrier, allowing increased endotoxin to be absorbed from the intestines. If hepatic function is impaired (common in septic animals), small doses of endotoxin that would normally be nonharmful may be lethal. Thus hypotension should be corrected before and prevented during and after surgery in animals with peritonitis. Animals with total protein less than 4.0 g/dl or albumin less than 1.5 g/dl may benefit from perioperative colloid administration. Colloids may be given preoperatively, intraoperatively, and/or postoperatively for a total dose of 20 ml/kg/day. If colloids are given during surgery (7 to 10 ml/kg), acute intraoperative hypotension should be treated with crystalloids.

Dobutamine or dopamine may be given during surgery for inotropic support. Dobutamine is less arrhythmogenic and chronotropic than dopamine and is preferred if the patient is hypotensive and anuric. If the patient is anuric and normotensive, low dose dopamine (0.5 to 1.5 µg/kg/min intravenously) plus furosemide (0.2 mg/kg intravenously) may be preferable. These patients should be monitored for arrhythmias or tachycardia.

Hepatic necrosis occurs during sepsis and causes reduced liver function. The pathogenesis of hepatic necrosis is uncertain but may be caused by hypotension and hypoxia. These animals may have reduced ability to metabolize drugs, and prolonged duration of action or altered function of drugs may result. Acepromazine should not be used in animals with peritonitis if severe hepatic dysfunction is suspected . Diazepam plus an opioid are useful premedicants in patients with hepatic dysfunction (. Diazepam used alone may disinhibit some behaviors. 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 as a result of 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 dysfunction. An anticholinergic may be given if the animal is bradycardic. Etomidate should be used with caution in animals with renal insufficiency as a single induction dose of this agent has caused hemolysis in dogs and cats. The benefit of cardiovascular stability should be weighed against this potential risk when etomidate is used. Etomidate should not be used in animals with adrenal insufficiency.

Differential Diagnosis

Advanced peritonitis with significant accumulation of abdominal fluid is not difficult to diagnose. The difficulty usually arises in determining the etiology of the effusion or infection. Early peritonitis, prior to the onset of overt clinical signs, is difficult to diagnose and may require diagnostic peritoneal lavage (see below).

Techniques

Abdominocentesis

Insert an 18 or 20-gauge, 1-1/2 inch plastic over-the-needle catheter (with added side holes) into the abdominal cavity at the most dependent part of the abdomen. Do not attach a syringe, instead allow the fluid to

drip from the needle and collect it in a sterile tube. If sufficient fluid is obtained, place the fluid in a clot tube, and EDTA tube, submit samples for aerobic and anaerobic culture, and make 4 to 6 smears for analysis. If fluid is not obtained, apply gentle suction using a 3cc syringe. It is difficult to puncture bowel by this method since mobile loops of bowel move away from the tip of the needle as it strikes them. Perforations created by a needle this size usually heal without complications. The major disadvantage of needle paracentesis is that it is insensitive to the presence of small volumes of intraperitoneal fluid and hence a negative result can be meaningless. At least 5 or 6 ml of fluid/kg body weight must be present in the abdominal cavity of dogs to obtain positive results in a majority of cases using this technique.

Diagnostic Peritoneal Lavage

Make a 2-cm skin incision just caudal to the umbilicus and ligate any bleeders to avoid false positive results. Spread loose subcutaneous tissues and make a small incision in the linea alba. Hold the edges of the incision with forceps while the peritoneal lavage catheter (without the trocar) is inserted into the abdominal cavity. Direct the catheter caudally into the pelvis. With the catheter in place, apply gentle suction. If blood or fluid cannot be aspirated, connect the catheter to a bottle of warm sterile saline and infuse 22 ml/kg of fluid into the abdominal cavity. When the calculated volume of fluid has been delivered, roll the patient gently from side to side, place the bottle on the floor, vent it, and collect the fluid by gravity drainage. Do not attempt to remove all the fluid.

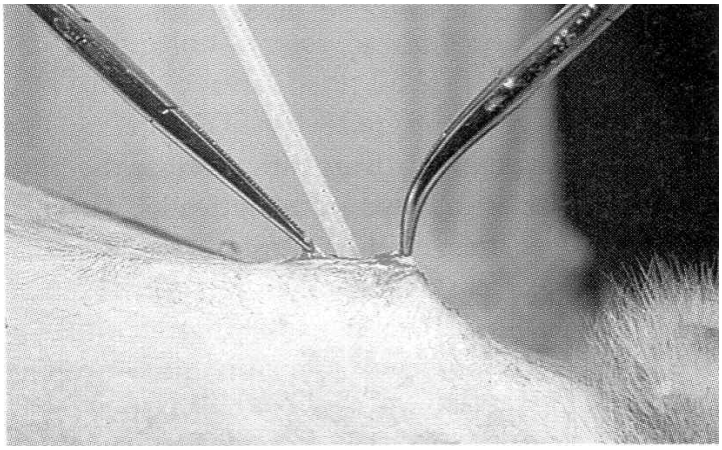

Fig. 1 Diagnostic peritoneal lavage

Exploratory Laparotomy

Perform a ventral midline incision from the xiphoid to the pubis. Obtain a sample of fluid for culture and analysis. Explore and inspect the entire abdomen. Find the source of infection and correct it. Break down adhesions that may hinder drainage. Lavage the abdomen with copious amounts of warm sterile saline if the infection is generalized. Remove as much necrotic debris and fluid as possible. Close the abdomen routinely or perform open abdominal drainage.

Open Abdominal Drainage

After completing the abdominal procedure, leave a portion of the abdominal incision (usually the most dependent portion) open to drain. Close the cranial and caudal aspects of the incision with monofilament suture using a continuous suture pattern. Place a sterile laparotomy pad over the opening, then place a sterile wrap

over the laparotomy pad. Change the wrap at least twice daily initially with the animal standing (sedation is seldom necessary). Break down adhesions to the incision that may interfere with drainage. Abdominal lavage may be attempted, but is seldom necessary. Place a diaper over the wrap to decrease contamination from urine. Assess the fluid daily for bacterial numbers and cell morphology. When bacterial numbers have decreased and normal neutrophil morphology is present (non-degenerative), close the incision (generally in 3 to 5 days). If the opening is small it may be left to heal by second intention.

SUTURE MATERIALS/SPECIAL INSTRUMENTS

Monofilament synthetic nonabsorbable (i.e., polypropylene or nylon) or slowly absorbable (i.e., polydioxanone or polyglyconate) suture should be used to close the abdomen in animals with peritonitis. Braided suture (i.e., dacron, silk, braided nylon) or suture that may be rapidly degraded (i.e., chromic gut) should not be used.

POSTOPERATIVE CARE AND ASSESSMENT

Fluid therapy should be continued postoperatively in most animals with peritonitis and is mandatory in those being managed with an open abdomen. Electrolytes, acid-base, and serum protein should be assessed in the postoperative period and corrected as necessary. Nasal oxygen may benefit septic animals. Ensuring that patients with peritonitis have an adequate caloric intake postoperatively often is difficult. An animal's energy requirement is much greater after injury or illness than at rest. Generally, the formula [30 × Weight (kg)] 1 + 70 is used to calculate a resting animal's energy requirement. Postoperatively, the metabolic rate of dogs and cats increases 25% to 35% over resting levels. With mild trauma the increase in the energy requirement is 35% to 50%; with sepsis 50% to 70% more calories can be required. The factor 1.5 has been used to estimate the energy requirement of ill or injured dogs and cats. Meeting these caloric requirements in dogs with intestinal disease is particularly difficult and may require enteral or parenteral nutritional support. If hypoproteinemia becomes severe, plasma transfusions should be considered. Postoperative analgesia is recommended,.

PROGNOSIS

The prognosis for animals with generalized peritonitis is guarded; however, with proper and aggressive therapy, many survive. Some authors have suggested that the mortality rate approaches 50%. The mortality rates reported in animals with generalized peritonitis treated with open abdominal drainage have varied from 20% to 48%.

UROABDOMEN

GENERAL CONSIDERATIONS AND CLINICALLY RELEVANT PATHOPHYSIOLOGY

Bladder rupture is the most common cause of uroabdomen in dogs and cats. It may occur spontaneously (associated with tumor, severe cystitis, or urethral obstruction), be due to blunt or penetrating abdominal trauma, or be iatrogenic following cystocentesis or bladder catheterization. Urinary tract leakage may also be a complication of surgery. Any animal presenting after vehicular trauma should be assessed for possible urinary tract trauma. The impact of the collision may cause the bladder, urethra, or ureter to rupture or necrose. The sharp ends of pelvic fractures may sever or lacerate the urethra. Diagnosis is usually delayed because clinical signs are rarely present at initial examination (see below).

Immediate surgery is contraindicated in animals with uroabdomen that are hyperkalemic or uremic. They should first be treated medically to normalize electrolytes and decrease circulating nitrogenous waste

products. Intravenous fluids should be given and abdominal drainage performed. Penrose drains can be placed in the ventral abdomen under local anesthesia (sedate if necessary) to allow drainage for 6 to 12 hours. This will stabilize most animals with previously normal renal function. If there is concurrent renal dysfunction, a peritoneal dialysis catheter may be placed instead of Penrose drains, and the abdominal cavity flushed with dialysis solution.

When urine leaks into the abdominal cavity, some nitrogenous waste products and electrolytes are reabsorbed across the peritoneal membrane and reenter the circulation. Whether molecules are reabsorbed depends on their size. Urea is a small molecule that rapidly equilibrates across the peritoneal surface; however, some larger molecules (e.g., creatinine) cannot pass back into the bloodstream and therefore remain concentrated in the abdominal fluid. To diagnose uroabdomen, creatinine levels in the abdominal fluid should be measured and compared to serum levels. If the fluid is urine, the creatinine concentration in the fluid will be substantially greater than that found in serum. Because urea rapidly equilibrates across the peritoneum, bun may be approximately the same in both abdominal fluid and serum, regardless of the cause of the abdominal effusion.

DIAGNOSIS

Clinical Presentation

Signalment. It has been suggested that urinary bladder rupture occurs more frequently in male dogs than female dogs because their long, narrow urethras cannot dilate rapidly; however, ruptured bladders are common in females that have sustained vehicular trauma. Urethral rupture in female dogs following trauma is uncommon. Male dogs and cats with obstruction due to calculi or sterile cystitis (FUS) have a high risk of bladder rupture if the obstruction is not alleviated promptly.

History. Clinical signs of urinary tract trauma are often vague and may be masked by other signs of trauma. In one study of dogs with pelvic trauma in addition to urinary tract trauma, the urinary trauma went clinically undetected in one third of dogs. The animal may present for azotemia (i.e., vomiting, anorexia, depression, lethargy), or hematuria, dysuria, abdominal pain, and/or abdominal swelling or herniation may be noted. Abdominal and perineal bruising are common with vehicular trauma, particularly if there are pelvic fractures. Bruising in this region, however, may also indicate subcutaneous urine leakage. Further evaluation of the urinary tract is therefore warranted in such patients. In female dogs, there may be a history of previous catheterization using a rigid catheter. Rupture of the urethra is most frequently associated with pelvic fractures in male dogs. Often urinary tract rupture is overlooked in the initial workup of traumatized patients and the diagnosis is not made until the animal shows signs of azotemia. It is important to remember that animals with ruptured bladders or unilateral ureteral trauma may urinate normal volumes, without evidence of hematuria. If the rupture is located dorsally or is small, leakage may only occur when the bladder becomes distended. Similarly the ability to retrieve fluid while performing bladder catheterization does not preclude the diagnosis of a ruptured bladder.

Physical Examination Findings

Abdominal palpation should be performed to determine the size and shape of the bladder. The animal should be closely examined for abdominal swelling or fluid accumulation. Urine quantity and character (i.e., hematuria, dysuria) and bruising on the ventral abdomen or perineum should be monitored.

Radiography/Ultrasonography

Survey radiographs may show reduced size or absence of the urinary bladder, lack of contrast and increased size of the retroperitoneal space, and/or lack of normal intraabdominal contrast. If a ruptured bladder is suspected a positive contrast cystourethrogram should be performed; however, leakage of contrast medium into the peritoneal space during cystography does not necessarily mean that the animal needs to have exploratory surgery performed. If there is no clinical evidence of uroabdomen, conservative management of the patient may be appropriate. To perform cystography a balloon-tipped catheter is placed in the distal urethra (just past the os penis in male dogs) and the balloon is inflated. While palpating the bladder for distention, approximately 2.2 ml/kg of diluted (1 part contrast medium to 2 parts sterile saline) aqueous organic iodide contrast medium is injected into the catheter. A radiograph is taken while the last few milliliters of contrast are being injected. Fluoroscopy, if available, can be used to determine when the bladder

is distended. Taking a radiograph while the contrast agent is being injected may show a "jet" lesion of contrast agent from the bladder. Free contrast agent in the abdominal cavity will coat and highlight abdominal organs. If a lesion is not identified in the bladder or urethra and the animal is well-hydrated, an excretory urogram can be performed. Contrast leakage into the retroperitoneal space (for proximal lesions) or abdomen (for distal lesions) occurs with ureteral rupture or laceration. If periureteral fibrosis has occurred, obstruction rather than leakage may be noted. Leakage of contrast from the renal capsule may be noted with renal parenchymal trauma. Parenchymal trauma of the right kidney should be suspected in dogs with uroabdomen and fractures of the thirteenth right rib.

Laboratory Findings

A CBC and serum biochemical profile with electrolytes should be performed. Hyperkalemia and azotemia may be noted. Analysis of abdominal fluid should be performed if urinary tract rupture is suspected. With uroabdomen, creatinine levels of the abdominal fluid will be greater than those in the blood (see above). Renal failure may be present if obstruction preceded the rupture. Bladder rupture secondary to urinary tract infection may result in septic peritonitis.

MEDICAL MANAGEMENT

If the animal is not hyperkalemic or azotemic (i.e., uroabdomen is diagnosed within 12 to 18 hours after rupture), it should be rehydrated with 0.9% saline and immediate surgical repair should be considered. Occasionally, concurrent trauma (e.g., traumatic myocarditis, pulmonary contusions) will delay surgery. In such patients, abdominal drainage and/or urinary diversion (i.e., urethral catheter and/or tube cystostomy may be necessary until the animal is stable. With delayed diagnosis, correction of electrolytes, hydration, and acid-base balance should be performed prior to surgery. Antibiotics may be administered based on culture results if infection is present, or prophylactically if abdominal drains are placed.

SURGICAL TREATMENT

Urethral trauma may be repaired by primary anastomosis (immediate or delayed) or the urethra may be allowed to heal over a urinary catheter if it is not completely transected. Ureteral rupture may be repaired by anastomosis or reimplantation into the bladder, depending on location of the damage. Bladder rupture generally occurs near the apex. Although small ruptures may heal if the bladder is kept decompressed, surgical exploration and repair are indicated in most patients. The entire abdomen should be explored to determine the reason for rupture and/or identify concurrent trauma. If bladder rupture is secondary to severe cystitis, tumor, or obstruction, the bladder may be extremely friable or large areas may be necrotic making excision and primary closure of the rent difficult. In such cases, prolonged urinary diversion may be beneficial. If cystitis or tumor is present, a biopsy of the bladder mucosa should be submitted for culture and histologic examination. In animals with rupture due to obstruction from calculi, the urethra should be carefully checked for calculi and its patency verified prior to repairing the bladder defect.

An ECG should be evaluated for arrhythmias. If possible, hydration, acid-base, and electrolyte abnormalities should be corrected prior to surgery . If antibiotic therapy has not been initiated prior to surgery, perioperative antibiotics (e.g., cefazolin) may be administered at induction.

POSTOPERATIVE CARE AND ASSESSMENT

Intravenous fluids should be given until the animal is able to drink adequate fluids to maintain hydration. The patient should be observed closely after surgery for signs of urinary obstruction or peritonitis. If bladder atony is present, the bladder should be kept decompressed by intermittent urinary catheterization or by manual expression. Urinary tract infection is common with indwelling or repeated catheterization. An α-blocker (e.g., phenoxybenzamine) and/or a somatic muscle relaxant (e.g., diazepam) can be used to decrease urethral sphincter tone. Bethanechol is a cholinergic that increases detrusor contractility and may aid voiding. Manual expression of the bladder should be done with care following surgery (particularly in patients with friable bladders secondary to infection or obstruction) to avoid disrupting the suture line.

PROGNOSIS

The prognosis is excellent for animals with traumatic bladder rupture. Occasionally rupture secondary to obstruction may have a guarded prognosis if the majority of the bladder is necrotic.

BILE PERITONITIS

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GENERAL CONSIDERATIONS AND CLINICALLY RELEVANT PATHOPHYSIOLOGY

Acute abdomen (i.e., shock or pain or both caused by severe abdominal disease) may be caused by leakage of bile into the abdominal cavity, particularly with concurrent septic peritonitis. Leakage of bile into the abdominal cavity may occur with traumatic rupture of any portion of the extrahepatic biliary tree or may occur secondary to necrotizing cholecystitis or chronic obstruction (rare).

Untreated bile peritonitis often is lethal, therefore early diagnosis is imperative. If rupture is associated with biliary tract infection, clinical signs of bile peritonitis usually develop quickly. Dogs with sterile bile peritonitis (i.e., rupture caused by trauma), may only have ascites and icterus for weeks. Bile in the abdominal cavity causes chemical peritonitis, which may not be associated with overt clinical signs initially; however, changes in intestinal mucosal permeability may lead to secondary bacterial infection of the effusion. If diagnosis of a ruptured biliary tract is delayed, repair of the biliary tract is complicated by necrotic tissues and adhesions. Diagnostic peritoneal lavage may assist in the early diagnosis of bile peritonitis (before the onset of clinical signs) in animals that have suffered abdominal trauma.

Rupture of the extrahepatic biliary ducts or gallbladder may be due to blunt abdominal trauma, necrotizing cholecystitis, or obstruction that occurs secondary to calculi, neoplasia, or parasites. Trauma usually causes rupture of the common bile duct rather than the gallbladder. Ductal rupture probably occurs when a force is applied adjacent to the gallbladder sufficient to cause rapid emptying, combined with a shearing force on the duct. In human beings, biliary duct rupture has been reported in individuals who had previously undergone cholecystectomy, suggesting that shearing of the duct alone sometimes is sufficient. The most common site of ductal rupture appears to be the common bile duct just distal to the entrance of the last hepatic duct; however, rupture may occur in the distal common bile duct, cystic duct (rare), or hepatic ducts. Gallbladder rupture is principally caused by necrotizing cholecystitis or cholelithiasis but has also been reported secondary to gunshot wounds. Many dogs with necrotizing cholecystitis have obstruction of the common bile duct; however, rupture can be caused by necrosis and perforation of only the gallbladder wall.

DIAGNOSIS

Clinical Presentation

Signalment. Traumatic rupture of the common bile duct or gallbladder may occur in animals of any age. Necrotizing cholecystitis is more common in middle-aged or older animals.

History. The animal may have sustained trauma several weeks before presentation. Clinical signs may be slowly progressive or acute if the bile becomes infected (see below).

Physical Examination findings

The clinical signs of bile peritonitis depend on the presence of bacteria and on whether the peritonitis is diffuse or localized. Animals with infected bile peritonitis generally are in shock and have acute abdominal pain, fever, vomiting, and anorexia. Animals that develop localized peritonitis secondary to inspissated bile tend not to be as sick as those with diffuse peritonitis. Pain sometimes can be localized to the anterior abdomen. Some animals are diagnosed before a diseased gallbladder ruptures, in which case signs are similar to those with localized peritonitis.

Diagnostic Imaging

Radiographs of animals with bile peritonitis may show a generalized loss of visceral detail if the peritonitis is diffuse, or a soft tissue ill-defined opacity in the cranial abdomen if the infection is localized. Survey radiographs may reveal radiopaque gallstones or air in the gallbladder wall or lumen. Ultrasonography may also delineate the location of mass lesions and evaluate the gallbladder and biliary ducts. Exploratory laparotomy is indicated in any patient with bile peritonitis and negates the need for extensive diagnostic workups.

Laboratory Findings
Comparing bilirubin concentrations in serum and abdominal fluid is 100% effective in diagnosing bile leakage. Bilious effusions have bilirubin concentrations greater (typically two times) than those found in serum. Neutrophilia often is noted if the peritonitis is generalized; however, the white blood cell count may be normal with localized infections. A normal or near normal peripheral white blood cell count plus low numbers of immature neutrophils may be associated with improved survival. Serum biochemical abnormalities commonly found in dogs with bile peritonitis include hyperbilirubinemia, increased alkaline phosphatase, increased alanine aminotransferase, hypoalbuminemia, and hyponatremia. Other findings are inconsistent and depend on the severity of the peritonitis. With septic biliary effusion, multiple types of gram-negative bacteria are typically found on bacterial culture and susceptibility.

MEDICAL MANAGEMENT
Animals with bile peritonitis may be anemic, hypoproteinemic, or dehydrated or may have electrolyte imbalances. The irritating effects of bile on the peritoneum cause inflammation and fluid transudation into the abdominal cavity, and the animal may be presented for treatment in hypovolemic or septic shock (or both). Aggressive fluid therapy may be needed, and electrolyte imbalances should be corrected. Broad-spectrum antibiotics should be administered before, during, and after surgery. Whole-blood transfusions may be indicated (i.e., hematocrit less than 20%). Administration of vitamin K_1 or fresh frozen plasma should also be considered if there are no coagulation abnormalities (vitamin K malabsorption and DIC are potential complications).

SURGICAL TREATMENT
Surgical treatment options for common bile duct rupture include ductal repair or biliary diversion. Repair is possible if the rupture is diagnosed early but becomes difficult once adhesions develop. Cholecystoduodenostomy or cholecystojejunostomy usually is easier and safer. Rupture of a hepatic duct can be treated by ligation of the leaking duct. Gallbladder rupture that occurs secondary to infective processes should be treated by cholecystectomy.

Treatment of necrotizing cholecystitis includes early surgical exploration once the animal's condition has been stabilized. Treatment consists of cholecystectomy, antibiotics, and appropriate therapy for peritonitis. Generally, attempts to salvage the gallbladder by closing the defect are inappropriate because the wall usually is necrotic. Be sure that the common bile duct is not ligated when the gallbladder is removed. Delayed diagnosis probably contributes to the high mortality associated with necrotizing cholecystitis.

Preoperative Management
Surgery should be performed as soon as the animal's condition has been stabilized. Electrolyte and fluid abnormalities should be corrected before surgery. See also medical management of patients with bile peritonitis, above.

SURGICAL TECHNIQUE
Cholecystectomy is discussed on p. xxx. Laceration or transection of the bile ducts may be treated by primary repair or biliary diversion. A damaged hepatic duct may be ligated, because alternative routes for biliary drainage from a single liver lobe will develop. The abdominal fluid and site of rupture or perforation should be cultured during surgery. Once the site of leakage has been identified and corrected, the abdomen should be flushed with copious amounts of warm, sterile fluids. Open abdominal drainage (OAD) may be considered if generalized peritonitis is present.

POSTOPERATIVE CARE AND ASSESSMENT
Fluid therapy should be continued until the animal is able to maintain hydration on its own. Electrolytes and acid-base status should be monitored. Many patients with bile peritonitis are extremely debilitated before

surgery. Animals with bile peritonitis are in extreme pain. Postoperative analgesia may be provided with hydromorphone or a fentanyl-lidocaine-ketamine CRI. Butorphanol is also effective, but the analgesia is of shorter duration than with hydromorphone. Nutritional supplementation via a needle-catheter jejunostomy or parenterally is beneficial in these patients. Antibiotic therapy based on culture of bile should be continued for at least 7 to 14 days after surgery.

PROGNOSIS

The prognosis for patients with diffuse, septic bile peritonitis is guarded. Without aggressive surgical management, most of these patients die. The prognosis is better if the condition is diagnosed and treated early and is better in animals with nonseptic biliary effusions. In one study of 24 dogs and 2 cats with bile peritonitis, only 27% of animals with septic biliary peritonitis survived, whereas 100% of those with nonseptic biliary peritonitis.