Pancreatic Masses Following Pancreatitis: Pancreatic Pseudocysts, Necrosis, and Abscesses

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ABSTRACT:
Pancreatic pseudocysts have been reported in dogs and cats, whereas necrotic mass lesions of the pancreas and pancreatic abscesses have been reported only in dogs. These conditions appear to be sequelae of pancreatitis. The clinical signs associated with pancreatic pseudocysts, necrosis, and abscesses are nonspecific and similar to those of pancreatitis. Diagnosis is made by abdominal ultrasonography combined with fine-needle aspiration or surgical exploration. Pseudocysts can be managed surgically or by ultrason-guided percutaneous aspiration. Guidelines for managing pancreatic abscesses and necrotic mass lesions have not been determined but can include both surgical intervention and medical therapy. Mortality rates are higher with necrotic mass lesions of the pancreas and pancreatic abscesses than with pancreatic pseudocysts.

DEFINITIONS AND PATHOPHYSIOLOGY
Pancreatic masses as a result of pancreatitis have been reported in dogs and cats. These masses include pancreatic pseudocysts in both species and pancreatic abscesses and necrotic mass lesions in dogs. \(^1\) \(^2\) \(^3\) \(^4\) \(^5\) \(^6\) \(^7\) \(^8\) \(^9\) \(^10\) \(^11\) \(^12\) \(^13\) \(^14\) The pathogenesis of pancreatitis has not been fully determined. It is generally accepted that activation of trypsinogen to trypsin within the acinar cells of the pancreas is the initial step in the pathogenesis of acute pancreatitis. Trypsin then prematurely activates pancreatic proteases and phospholipase \(A_2\), which leak into the interstitium, causing edema and possibly inflammation. \(^12\) \(^13\) Recent experimental studies suggest that inflammatory mediators released by leukocytes recruited to the areas of inflammation increase the inflammatory response. \(^12\) \(^13\) Destructive mediators include elastase, phospholipase \(A_2\), platelet-activating factor, reactive oxygen species, and cytokines. There is also increasing evidence that these mediators impair pancreatic microcirculation, leading to further tissue damage. \(^12\) Precise definitions and the pathophysiology of inflammatory pancreatic masses have not been determined in veterinary medicine. A clinically based classification system for acute pan-
creatitis has been developed in humans and is used as a guide in this article. The exact pathogenesis of pseudocyst formation is unknown. It has been proposed that a pseudocyst can form if a pancreatic duct ruptures during a bout of pancreatitis. As a result of inflammation, a cyst wall of fibrous and granulation tissue forms, surrounding the collection of pancreatic secretion. A pseudocyst is usually rich in pancreatic enzymes and sterile. The incidence of pancreatic pseudocysts in cases of canine and feline pancreatitis is unknown.

**Pancreatic necrosis** is defined as a diffuse or focal area of nonviable pancreatic parenchyma, which is typically associated with peripancreatic fat necrosis. The absence of purulent material with pancreatic necrosis differentiates it from a pancreatic abscess. A retrospective study of pancreatic masses in dogs revealed five (7%) cases of pancreatic necrosis in a total of 72 cases of pancreatitis. No bacteria were isolated from the necrotic mass lesions on aerobic or anaerobic culture; however, antibiotics had been administered during the preoperative period in all cases. Histopathology is required for definitive diagnosis. Acute necrotizing pancreatitis occurs commonly in cats but has not been associated with mass lesions of the pancreas.

**Pancreatic abscess** in humans has been defined as a circumscribed collection of purulent material containing little or no pancreatic necrosis and arising as a consequence of acute pancreatitis. The absence of necrosis, the presence of purulent material, and a positive culture result in pancreatic abscesses differentiate them from pancreatic necrosis. This definition does not apply to reported canine cases for a number of reasons. In 17 reported cases, 12 abscesses tested negative. The comparative lack of microbial agents isolated from reported pancreatic abscesses in dogs is an important difference between dogs and humans. It is unknown whether the canine pancreatic abscesses that tested negative via culture were sterile or culture results had been affected by presurgical antibiotic therapy, which had been administered in most cases. Significant pancreatic necrosis has also been present in some reported cases of canine pancreatic abscess in which histopathology had been conducted. At present, the precise definition of a pancreatic abscess in dogs is not clear, except that purulent material must be present during histopathology. In two retrospective reports of pancreatitis, pancreatic abscesses occurred in one (1.4%) of 72 cases and nine (6.5%) of 139 cases.

**Pancreatic phlegmon** has been used in both medical and veterinary literature to describe various pancreatic lesions ranging from edematous to necrotizing pancreatitis, either infected or sterile depending on individual interpretation. Use of this term has recently been discouraged because of its ambiguous nature.

**CLINICAL FINDINGS**

Clinical signs of pancreatic pseudocysts in dogs and cats are nonspecific and include vomiting, weight loss, and anorexia. An abdominal mass may be palpable in patients with pancreatic pseudocysts, necrotic mass lesions, and abscesses. Additional clinical signs associated with pancreatic necrosis or abscesses include anorexia, depression, lethargy, vomiting, abdominal pain, icterus, and fever. The duration of clinical signs before detection of a pancreatic mass lesion varies from a few hours to 3 months. The duration of clinical signs before diagnosis in cases of necrotic mass lesions is shorter (i.e., a few hours to 3 days). Clinical signs associated with pancreatic pseudocysts, abscesses, and necrotic masses are therefore not significantly different from those of pancreatitis, and these diagnostic differentials should be suspected in any patient with signs of pancreatitis.
DIAGNOSIS

There are no definitive laboratory tests for diagnosing pancreatic pseudocysts, abscesses, or necrotic mass lesions. Hematologic and biochemical findings are similar to those of pancreatitis. Hematologic abnormalities can include leukocytosis, neutrophilia with a left shift, toxic neutrophils, lymphopenia, and monocytosis. Serum biochemical abnormalities can include elevated serum amylase and lipase activities, increased serum alkaline phosphatase, alanine aminotransferase and \( \gamma \)-glutamyltransferase, hyperbilirubinemia, and electrolyte abnormalities.\(^{1-11}\)

The activity of pancreatic-specific lipase has not been evaluated in diagnosing pancreatic mass lesions in dogs and cats. However, because it is an indicator of pancreatitis, it is not likely to help differentiate pancreatic mass lesions.\(^{20}\)

Abdominal radiography of pancreatic masses reveals a soft tissue opacity in the cranial abdomen in most reported cases. This may cause displacement of the stomach and transverse colon. Focal or diffuse loss of serosal detail may also occur. If barium studies are conducted, restriction of gastric outflow by the soft tissue density may be seen. Abdominal radiography is a relatively insensitive and nonspecific tool for determining the cause of the soft tissue density.\(^{1-10}\)

Abdominal ultrasonography of pseudocysts shows anechoic to slightly echoic cyst-like structures in the region of the pancreas (Figure 1). A single structure or multiple structures may exist. Hyperechoic areas within the pseudocyst may represent debris. In most reported cases, the pseudocyst has been associated with the left lobe of the pancreas.\(^{3-10}\) If concurrent pancreatitis is present, other ultrasonographic changes may be seen, such as hypoechoic pancreatic parenchyma adjacent to the pseudocyst and hyperechoic peritoneal fat surrounding the pancreas. An enlarged gallbladder may be seen if the pseudocyst is causing bile duct obstruction.\(^{1-10}\) Reported accuracy of ultrasonography in humans with pancreatic pseudocysts is as high as 92%.\(^{21}\) The skill of the ultrasonographer in evaluating pancreatic lesions is thought to be a factor.\(^{22}\) Similar studies have not been conducted in veterinary medicine. Ultrasonography of pancreatic abscesses and necrotic masses can be variable in size, shape, and echogenicity. A mass effect can be visualized, and hypoechoic areas consistent with fluid accumulation may be seen.\(^{2,9,10,23}\) A recent report described the ultrasonographic appearance of pancreatic necrosis in two dogs.\(^{23}\) The diagnosis of sterile pancreatic necrosis was subsequently confirmed by fine-needle aspiration. Color Doppler ultrasonography was used to subjectively demonstrate lack of blood flow to the necrotic region of the pancreas. However, details of ultrasonographic assessment of pancreatic blood flow have not been published, and further investigation of the changes associated with pancreatic lesions is needed. It is not always possible to differentiate between pancreatic pseudocysts, pancreatic abscesses, and necrotic masses based on ultrasonography.

In humans, computed tomography (CT) is the diagnostic tool of choice and is routinely used in diagnosing pancreatic lesions. However, differentiating pancreatic necrosis, abscesses, and pseudocysts can still be difficult with this imaging modality.\(^{24}\) The same article that described the ultrasonographic appearance of pancreatic necrosis in two dogs also described the CT appearance, which revealed mass lesions in the cranial abdomen.\(^{23}\) Contrast medium was used to demonstrate the loss of blood supply to the pancreatic tissue.\(^{23}\) In humans, spe-

\[ \text{Ultrasonography and fine-needle aspiration are the best diagnostic tools for diagnosing pancreatic pseudocysts.} \]
cific contrast CT criteria have been developed to aid in diagnosing pancreatic necrosis. Similar criteria have not been developed for dogs. Given the lack of access, cost, and few studies evaluating the CT appearance of pancreatic lesions, this imaging modality is unlikely to become the diagnostic tool of choice in veterinary medicine.

Ultrasound-guided fine-needle aspiration is useful in diagnosing pseudocysts. In a recent study involving four dogs and two cats with pancreatic pseudocysts, this procedure was performed without complication. The fluid obtained from cysts in five of six animals was classified as a modified transudate with low cellularity and an increased protein level. Lipase activity of the fluid was elevated in all six animals and was higher than serum lipase activity in three cases. Amylase activity of the fluid was elevated in four patients but was not different from serum activity. In humans, analysis of cyst fluid can help distinguish pseudocysts from other cystic lesions of the pancreas. High enzyme activities are consistent with but do not provide a definitive diagnosis of pancreatic pseudocyst. Enzyme activity of pseudocyst fluid has not been fully evaluated in dogs and cats, and specific recommendations cannot be made. However, we recommend cytologic and enzyme activity analysis of any fluid mass associated with the pancreas.

Fine-needle aspiration has become the technique of choice to diagnose bacterial infection of pancreatic abscesses and necrosis in humans. Although this has not been evaluated in cats and dogs, our experience suggests that ultrasound-guided fine-needle aspiration of suspected pancreatic abscess or necrosis is valuable. Material should be collected before antibiotic therapy and submitted for cytologic analysis as well as aerobic and anaerobic culture.

Histopathologic examination of pancreatic pseudocysts from dogs and cats has shown varying degrees of pancreatic inflammation. A thick fibrous tissue wall without an epithelial lining surrounding the cyst and with inflammatory cell infiltration has been present in both surviving dogs, the pseudocyst was drained into the stomach via gastrotomy. In another reported case, the pseudocyst was drained into the duodenum with a successful outcome. One cat had a pseudocyst excised, and the animal completely recovered. A recently published report describes successful management of a pancreatic pseudocyst in a dog using omentalization of the pseudocyst cavity. Ultrasound-guided percutaneous drainage has been used to successfully treat four dogs and one cat with pancreatic pseudocysts. The volume of fluid aspirated ranged from 6 to 50 ml. In all cases, drainage of the pseudocyst was incomplete, and repeat aspiration was necessary in two dogs. More studies of ultrasound-guided percutaneous drainage are necessary to make specific recommendations. These studies may develop because ultrasonography is used more routinely.

**MANAGING PANCREATIC PSEUDOCYSTS**

Both surgical drainage and ultrasound-guided aspiration of pancreatic pseudocysts have been reported in dogs and cats (Figures 2 and 3). In five reported cases in dogs, the pseudocyst was surgically drained via gastrotomy into the stomach lumen (four dogs) and externally through the body wall (one dog). Only two of these five dogs survived, although the cause of death was not directly related to the surgical procedure. In both surviving dogs, the pseudocyst was drained into the stomach via gastrotomy. In another reported case, the pseudocyst was drained into the duodenum with a successful outcome. One cat had a pseudocyst excised, and the animal completely recovered. A recently published report describes successful management of a pancreatic pseudocyst in a dog using omentalization of the pseudocyst cavity. Ultrasound-guided percutaneous drainage has been used to successfully treat four dogs and one cat with pancreatic pseudocysts. The volume of fluid aspirated ranged from 6 to 50 ml. In all cases, drainage of the pseudocyst was incomplete, and repeat aspiration was necessary in two dogs. More studies of ultrasound-guided percutaneous drainage are necessary to make specific recommendations. These studies may develop because ultrasonography is used more routinely.

**The presence of a pancreatic pseudocyst, necrotic mass lesion, or abscess should be suspected in cases of pancreatitis, especially those that do not resolve.**
in diagnosing and monitoring cases of pancreatitis. At present, ultrasound-guided percutaneous drainage should be considered the initial procedure of choice for treating uncomplicated pseudocysts in dogs and cats. Indications for surgery in veterinary patients have not been fully determined but include failure of clinical signs to resolve as well as recurrence.

In humans, a number of management techniques have been described, including percutaneous drainage, endoscopic drainage, and surgical drainage or excision. Percutaneous drainage can be performed with guidance from CT, ultrasonography, or fluoroscopy. Placing an indwelling catheter that provides continuous drainage yields the best results. In humans, endoscopic drainage of pseudocysts has also proven safe and effective. Different endoscopic techniques have been described in which a pseudocyst is drained into the stomach or duodenum or via the pancreatic duct. A surgical approach is generally chosen for patients with recurrent pseudocysts, with pseudocysts associated with an abnormality of the duodenum or pancreatic duct, or when a cystic neoplasm of the pancreas cannot be ruled out. Surgical procedures that have been used include external and internal drainage as well as surgical excision. Internal drainage is currently the most popular surgical method.

Surgery was performed on five dogs with pancreatic masses diagnosed as pancreatic necrosis. Debridement and drainage were performed in each case. However, all dogs died or were euthanized during the postoperative period. No bacteria were aerobically or anaerobically cultured or seen during histopathologic examination. Parenteral antibiotics had been given preoperatively in all cases. In three reports involving 16 dogs with pancreatic abscesses, all were treated with surgical debridement and drainage. The combined mortality rate was 50%, although two of the dogs were euthanized at diagnosis. Surgical techniques included open peritoneal drainage in nine dogs, closure without drains in three dogs, and

**MANAGING PANCREATIC ABSCESSES AND NECROTIC MASS LESIONS**

Specific guidelines for successfully managing pancreatic abscesses and necrotic masses in dogs have not been established. In humans, the distinction between sterile and infected pancreatic necrosis is important because infected necrosis without surgical intervention is fatal, whereas sterile pancreatic necrosis can be treated medically. Also in humans, once a pancreatic abscess has been diagnosed, drainage is considered mandatory. There is general consensus that pancreatic abscesses do not resolve spontaneously. Whether this is true in veterinary medicine is unknown.

**Pancreatic masses have been reported as sequelae of pancreatitis in dogs and cats.**
Closure with drains exiting the body wall in two dogs. In one study, the method of closure did not seem to influence mortality.

Preoperative and postoperative treatment with fluids and broad-spectrum antibiotics was administered in most cases. In all reported cases, adhesions between the pancreas and adjacent structures (i.e., liver, duodenum, omentum) were present and required blunt dissection. Care must be taken not to damage these adjacent structures. In one case series, bandages were changed two to three times per day in dogs with open abdominal drainage, and surgery was repeated if serosanguineous abdominal drainage became purulent or there were other indications of deterioration. The original incision was closed when there was minimal serosanguineous drainage from the abdomen and the dog’s general condition improved. The outcome of these cases is not clear.

Postoperative complications have included cardiac/respiratory arrest, hypoproteinemia, hypoalbuminemia, peritonitis, and sepsis. In one study of nine dogs with pancreatic abscesses, six dogs received postoperative nutritional support—five via total parenteral nutrition and one via a jejunostomy tube. Three of these dogs survived.

Further studies are required to identify objective criteria for surgical intervention in dogs. However, we believe that surgery is indicated in documented cases of pancreatic abscess (Figure 4) or infected necrotic pancreatic mass. Early detection, aggressive debridement, and drainage combined with good preoperative and postoperative support may result in better survival in these cases. Supportive care is similar to that for pancreatitis and should include fluid and electrolyte replacement, analgesia, and nothing by mouth. Other therapeutic measures include administering fresh-frozen plasma, parenteral nutritional support, and antibiotics. The low number of positive aerobic or anaerobic cultures from pancreatic abscesses and necrotic masses makes routine use of antibiotics questionable. Antibiotic therapy should be reserved for patients with documented infection or that fail to respond to other supportive treatment. Clindamycin, metronidazole, chloramphenicol, and ciprofloxacin have been shown to achieve therapeutic tissue levels in canine models of acute pancreatitis. There have been no reports of successful medical management of pancreatic abscesses or infected necrotic masses in dogs.

CONCLUSION

Pancreatic pseudocysts, necrotic masses, and abscesses are reportedly uncommon complications of pancreatitis in dogs and cats. With increasing use of ultrasonography, detection of these lesions may increase. The presence of a pancreatic pseudocyst, necrotic mass, or abscess should be a diagnostic differential in any case of pancreatitis, especially when clinical signs of pancreatitis do not resolve or an abdominal mass can be palpated. When available, ultrasonography and CT are the best imaging tools in diagnosing pancreatic lesions. Ultrasound-guided aspiration of pancreatic masses appears safe and effective in diagnosing pseudocysts and is likely to provide useful information in cases of pancreatic necrosis and abscesses. Pancreatic pseudocysts can be effectively treated with percutaneous or surgical drainage. Specific guidelines for managing pancreatic abscesses and necrotic mass lesions have not been determined, and reported mortality rates with surgery are high. However, we believe that surgical debridement and drainage combined with good pre- and postoperative care are needed in documented cases of pancreatic abscesses and infected pancreatic necrosis.

REFERENCES


1. Which statement regarding pancreatic abscesses and/or pseudocysts is correct?
   a. Pancreatic abscesses and pseudocysts have been reported in dogs and cats.
   b. Pancreatic pseudocysts have been reported only in dogs.
   c. Pancreatic abscesses have not been reported in cats.
   d. Pancreatic pseudocysts have not been reported in dogs.
   e. Pancreatic pseudocysts have been reported only in cats.

2. The initiating event in the pathogenesis of pancreatitis is
   a. impairment of pancreatic microcirculation.
   b. bacterial infection of the pancreas.
   c. activation of phospholipase A2 within the acinar cells of the pancreas.
   d. activation of trypsinogen to trypsin within the acinar cells of the pancreas.
   e. activation of trypsinogen to trypsin outside the acinar cells of the pancreas.

3. Which statement regarding pancreatic pseudocysts is correct?
   a. The pathogenesis of pancreatic pseudocysts has been determined.
   b. Infected pseudocysts have been reported in dogs and cats.
   c. The incidence of pancreatic pseudocysts in cases of canine and feline pancreatitis is unknown.
   d. The incidence of pancreatic pseudocysts in cases of canine and feline pancreatitis is 7%.
   e. A pseudocyst has low levels of amylase and lipase activity.

4. Which statement regarding pancreatic abscesses is incorrect?
   a. Pancreatic abscesses arise as a consequence of pancreatitis.
b. Pancreatic abscesses are defined as a circumscribed collection of purulent material containing little or no pancreatic necrosis.
c. Bacterial infection has been reported in most cases of pancreatic abscess in dogs.
d. The comparative lack of microbial agents isolated from pancreatic abscesses is an important difference between dogs and humans.
e. Presurgical antibiotics have been given in most cases of reported pancreatic abscess in dogs.

5. Which statement regarding pancreatic necrosis is incorrect?
a. Pancreatic necrosis is defined as a diffuse or focal area of nonviable pancreatic parenchyma.
b. Pancreatic necrosis is typically associated with peri-pancreatic fat necrosis.
c. Histopathology is required to definitively diagnose pancreatic necrosis.
d. Bacteria have been isolated from necrotic mass lesions of the pancreas in dogs.
e. The absence of purulent material in pancreatic necrosis differentiates it from a pancreatic abscess.

6. Which statement regarding diagnosis of pseudocysts, pancreatic abscesses, and necrotic mass lesions is correct?
a. Clinical signs of pancreatic pseudocysts in dogs and cats are nonspecific and include vomiting, weight loss, and diarrhea.
b. The laboratory findings for pancreatic pseudocyst, pancreatic abscess, and necrotic mass lesions of the pancreas are different.
c. Abdominal radiography is the best imaging technique for evaluating the pancreas.
d. Most pseudocysts in cats and dogs have been associated with the right lobe of the pancreas.
e. In humans, CT is always able to differentiate between pancreatic pseudocysts, pancreatic abscesses, and necrotic mass lesions of the pancreas.

7. Which statement regarding ultrasound-guided needle aspiration of pancreatic pseudocysts in dogs and cats is correct?
a. This procedure is not advised because of an unacceptable complication rate.
b. Lipase activity of the pseudocyst fluid is always within the reference range of serum lipase.
c. In a 1999 study, the fluid in five of six animals was classified as exudate.
d. This procedure has a 50% complication rate.
e. This procedure is useful in diagnosing and treating pancreatic pseudocysts.

8. Techniques used in managing pancreatic pseudocysts in dogs and cats have included surgical
a. and endoscopic drainage.
b. drainage and percutaneous aspiration.
c. drainage, percutaneous aspiration, and surgical excision.
d. drainage, percutaneous aspiration, and endoscopic drainage.
e. none of the above

9. Which statement regarding supportive treatment of pancreatic abscesses and necrotic mass lesions is incorrect?
a. Using antibiotics is justified in documented cases of infected pancreatic abscesses and necrotic mass lesions.
b. Using antibiotics is justified in all cases of pancreatic abscesses in dogs.
c. Clindamycin, metronidazole, chloramphenicol, and ciprofloxacin have been shown to achieve therapeutic tissue levels in canine models of acute pancreatitis.
d. Fluid and electrolyte replacement, analgesia, and nothing by mouth are indicated.
e. Additional therapeutic measures can include administration of fresh-frozen plasma and parenteral nutritional support.

10. Which statement regarding treatment of pancreatic abscesses in dogs is incorrect?
a. All reported cases of pancreatic abscesses in dogs have been treated with surgical debridement and drainage.
b. The combined mortality rate of 16 dogs with pancreatic abscess was 50%.
c. Open peritoneal drainage has been shown to be the most effective technique for abdominal closure after abscess debridement.
d. Abdominal closure techniques have included open peritoneal drainage, closure without drains, and closure with drains exiting the body wall.
e. One study has shown that the method of closure did not seem to influence mortality.