

# Updated Review of Radiologic Imaging and Intervention for Acute Pancreatitis and Its Complications

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## Abstract

This is a current update on radiologic imaging and intervention of acute pancreatitis and its complications. In this review, we define the various complications of acute pancreatitis, discuss the imaging findings, as well as the timing of when these complications occur. The various classification and scoring systems of acute pancreatitis are summarized. Advantages and disadvantages of the 3 primary radiologic imaging modalities are compared. We then discuss radiologic interventions for acute pancreatitis. These include diagnostic aspiration as well as percutaneous catheter drainage of fluid collections, abscesses, pseudocysts, and necrosis. Recommendations for when these interventions should be considered, as well as situations in which they are contraindicated are discussed. Fortunately, acute pancreatitis usually is mild; however, serious complications occur in 20%, and admission of patients to the intensive care unit (ICU) occurs in over 10%. In this paper, we will focus on the imaging and interventional radiologic aspects for the serious complications and patients admitted to the ICU.

## Keywords

pancreatitis, pseudocyst, complications, percutaneous catheter drainage

## Clinical & Radiologic Classification of Manifestations and Complications of Pancreatitis

### Acute Manifestations

**Interstitial Edematous Pancreatitis.** Interstitial edematous pancreatitis is the acute inflammation of the pancreatic parenchyma and peripancreatic tissues in the absence of necrosis. It is the milder of the 2 manifestations of acute pancreatitis, in contrast to the more severe acute necrotizing pancreatitis. Acute edematous pancreatitis presents as diffuse enlargement of the pancreas. In general, clinical symptoms of interstitial edematous pancreatitis resolve within a week of presentation with supportive noninterventional, nonsurgical management.<sup>1</sup>

**Acute Fluid Collections.** Fluid collections develop in the early stages of acute pancreatitis and typically are adjacent to the pancreas. These are usually sterile collections of pancreatic fluid, rich in enzymes that resolve spontaneously in the majority of cases. However, fluid collections that are present for greater than 4 weeks have a high likelihood to develop into pancreatic pseudocysts. In most patients, acute fluid collections are asymptomatic and resolve without intervention.

**Pancreatic Necrosis.** Pancreatic necrosis is an early complication of acute pancreatitis that occurs within the first 4 weeks of onset. Necrosis can be noninfected (sterile necrosis) or infected, with the latter being the worst complication of acute pancreatitis.

Pancreatic necrosis is destroyed pancreatic tissue with varying amounts of fluid and necrotic tissue. The location of these collections can involve the pancreatic parenchyma or surrounding peripancreatic tissues. Necrosis can be distinguished from peripancreatic fluid collections by the presence of solid material within the characteristic brownish fluid (Figure 1).

Infected necrosis is defined as the infection of pancreatic and/or peripancreatic necrotic tissue. The clinical spectrum can range from minimal and localized to systemic and severe in some patients. It is important to differentiate necrosis from pancreatic abscess, as the treatment course of these complications differs. The mortality rate in patients with pancreatic necrosis increases significantly when necrotic tissue becomes infected. Studies suggest the mortality increases from 15% in sterile necrosis to 30%-39% when infection occurs.<sup>2-4</sup> Admission to the ICU (predominantly patients with necrosis) occurs in over 10% of patients.<sup>5,6</sup>

**Pancreatic Phlegmon.** Another less commonly used, and controversial, term is pancreatic phlegmon. This was previously used to describe areas of tissue in the peripancreatic space that were a combination of fat necrosis, extravasated pancreatic fluid,

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**Figure 1.** Classic appearance of pancreatic necrosis: Dark, brownish fluid extracted via percutaneous catheter placed for drainage of pancreatic necrosis.

nonspecific inflammation, and hemorrhage.<sup>7</sup> Use of the term was abandoned in the original Atlanta classification due to it being used ambiguously.

**Hemorrhage.** Hemorrhagic complications can occur early or late in the course of acute pancreatitis. Bleeding may occur due to severe inflammation, abscesses, regional necrosis, and pseudocysts causing erosion and rupture of surrounding vessels.<sup>8</sup> Hemorrhage ultimately can be linked to destruction by pancreatic enzymes. In some cases, pseudoaneurysms may form, and if ruptured, lead to significant hemorrhage into the peritoneal cavity, gastrointestinal tract, or retroperitoneum. Sources of bleeding typically include the splenic artery, portal vein, along with smaller peripancreatic vessels.

### Delayed Complications

**Pseudocysts.** Fluid collections persisting beyond 4 weeks can develop into pancreatic pseudocysts. Pseudocysts are encapsulated fluid collections that arise from inflammatory walls forming along the periphery of the fluid collections. Pseudocysts typically have well-defined walls and contain none to minimal debris within the walls. Pseudocysts can be noninfected or infected. Although pseudocysts most commonly are located adjacent to the pancreas, they also can occur in the lesser sac, mesentery, retroperitoneum, inguinal region, scrotum, liver, spleen, mediastinum, pleura, and lung.<sup>9</sup> Additionally, pseudocysts may vary widely in size. Intervention is not indicated unless they become larger than 4-5 cm or are symptomatic.<sup>10</sup>

**Pancreatic Abscess.** Pancreatic abscesses occur greater than 4 weeks after the onset of acute pancreatitis. They are due to limited necrosis leading to subsequent liquefaction and infection. In the case of a collection found to be pus-filled, the original Atlanta classification termed it pancreatic abscess, sometimes referred to as infected pseudocysts. Although this term was used previously to describe localized collections of pus occurring without the presence of significant necrotic material, this nomenclature is no longer used in the revised Atlanta Classification. Nonetheless, abscess should be distinguished from infected necrosis, as the mortality rate is significantly higher in the latter. In addition, pancreatic abscess can be drained percutaneously; infected necrosis typically cannot be cured percutaneously alone.<sup>11</sup>

## Classification & Scoring Systems

### Classification Systems

**Revised Atlanta Classification.** The revised Atlanta classification is the mainstay classification system used for acute pancreatitis. The revised Atlanta classification divides acute pancreatitis into 2 broad categories: interstitial edematous and necrotizing acute pancreatitis.<sup>12</sup> Interstitial edematous acute pancreatitis, as defined earlier, is the acute inflammation of the pancreatic parenchyma and peripancreatic tissues without tissue necrosis. Conversely, acute necrotizing pancreatitis has associated pancreatic parenchymal and peripancreatic necrosis.

Additionally, the revised Atlanta classification subdivides severity of acute pancreatitis into mild, moderate, or severe

disease.<sup>12</sup> Mild acute pancreatitis, the most common form, is characterized by the absence of both organ failure and local or systemic complications. In moderately severe acute pancreatitis, the presentation consists of either organ failure that resolves within 48 h, local or systemic complications, or the presence of both. Mortality still is significantly less (3%) compared to severe acute pancreatitis (~30%).<sup>1,13</sup> Severe acute pancreatitis is characterized by persistent organ failure (>48 h) that involves either single or multiple organs. As previously mentioned, progression to infected necrosis in these patients is associated with an extremely high mortality.

**Determinant-based Classification.** The Determinant-based classification system, albeit less widely adopted, shares many similarities with the revised Atlanta classification. The revised Atlanta classification provides a more accurate description of acute pancreatitis classification in the clinical setting and was a better choice to guide the selection of patient populations for clinical research purposes.<sup>14</sup> Unlike the revised Atlanta classification, the Determinant-based classification system divides acute pancreatitis severity into 4 categories: mild, moderate, severe, and critical.<sup>15</sup> The Determinant-based classification system also bases severity more heavily on necrosis, infected or noninfected, and the duration of organ failure. The revised Atlanta classification, however, classifies severity predominantly on the presence of local and/or systemic complications and organ failure duration.

### Scoring Systems

**Ranson's Criteria.** Ranson's criteria is the earliest scoring system that became utilized clinically to determine acute pancreatitis severity.<sup>16</sup> This scoring system uses 11 parameters, with 5 measured on admission, and the other 6 measured 48 h later. Each parameter is worth 1 point, with a maximum total score of 11; increasing scores correlate with a less favorable prognosis. Although it has been criticized for having low predictive power and a 48-h requirement to fully assess the score, the Ranson score consistently exhibits comparable predictive value to newer scoring systems.<sup>17</sup>

**APACHE II Score.** The Acute Physiology and Chronic Health Examination (APACHE) II score is based on 12 physiologic measures in addition to extra points depending on age and the presence of chronic disease. This scoring system is mainly used in the ICU setting and typically is measured daily. Within the first 48 h, increasing values are suggestive of a severe attack, while decreasing numbers are more prognostic of a mild disease. Main criticisms include the complexity of the scoring along with having a poor predictive value in the first 24 h.<sup>18</sup> Other modifications have been made to the APACHE II, such as APACHE III, although the latter has not been generally adopted.<sup>19</sup>

**CT Severity Index.** The CT severity index was developed to predict prognosis based on the degree of inflammation,

presence of fluid collections, and necrosis.<sup>20</sup> Later on, the modified CT severity index was created to account for limitations in the original system.<sup>21</sup> These are considered the most widely adopted radiologic scoring systems of acute pancreatitis for clinical and research purposes. The modified CT severity index, compared to the original CT severity index, simplifies the evaluation of pancreatic necrosis and inflammation, while also incorporating extrapancreatic complications into the assessment. In one of the early studies of modified CT severity index, it correlated better with patient outcome with respect to hospital stay, and more importantly, with organ failure compared to the original CT severity index.<sup>21</sup> Although no significant differences were noted between the original CT severity index and modified CT severity index in a further study, both severity indexes more accurately diagnosed clinically severe disease and correlated better with the need for intervention compared to the APACHE II score.<sup>22</sup>

**Bedside Index for Severity in Acute Pancreatitis.** The Bedside Index for Severity in Acute Pancreatitis (BISAP) is a recent method used for risk stratification in patients with acute pancreatitis. BISAP is relatively simple to use and an accurate prognostic tool that can be calculated based on data retrieved in the first 24 h.<sup>23</sup> The tool measures 5 variables, assigned 1 point for the presence of each: blood urea nitrogen >25, impaired mental status, systemic inflammatory response syndrome, age >60 years, and presence of pleural effusion. BISAP scores <2 points are associated with decreased mortality (<1%), with a score of 2 correlating with increased mortality (2%).<sup>24</sup> Patient mortality sharply increases with each successive BISAP score >3 (5%-20%).<sup>24</sup> Studies have shown BISAP to have similar prognostic accuracy in predicting disease severity and patient mortality compared to other models including APACHE II, CT severity index, and Ranson's criteria.<sup>25,26</sup>

## Radiologic Imaging Modalities

### Abdominal Ultrasound

In patients presenting with suspected acute pancreatitis, abdominal ultrasound is a quick and relatively inexpensive modality for initial evaluation. The American College of Radiology appropriateness criteria recommends ultrasound in almost all patients who present with suspected acute pancreatitis within 48-72 h of symptom onset.<sup>27</sup> Abdominal ultrasound allows for the assessment not only of the pancreatic parenchyma, but also of the gallbladder, biliary tree, peripancreatic tissues, and regional vascular structures.<sup>28</sup> The ability to visualize these extrapancreatic structures gives ultrasound its most important value, as it usually has limited utility in the diagnosis of acute pancreatitis or its complications.<sup>29</sup>

The pancreas may appear diffusely enlarged and hypoechoic on ultrasound in patients with acute pancreatitis. However, some patients may present with normal sonographic evaluation in mild to moderate pancreatitis. Ultrasound still is beneficial, as it can be used to evaluate etiologic factors such as gallstones or

evidence of biliary obstruction.<sup>28</sup> With careful evaluation, complications such as peripancreatic fluid collection and pseudoaneurysms may be identified. Although less commonly utilized in the United States compared to outside America, contrast-enhanced ultrasound may be used to overcome the difficulties of differentiating edematous and necrotizing acute pancreatitis that occur with conventional ultrasound.<sup>30</sup>

Beyond and within the early phase of acute pancreatitis, ultrasound has many limitations. Complete pancreatic visualization rarely is achieved in critically ill patients due to associated bowel ileus.<sup>28</sup> Bowel gas also presents another challenge in detecting choledocholithiasis, as gas often obscures visualization of the distal common bile duct and pancreatic head. For these reasons, contrast-enhanced CT is the imaging modality of choice for the diagnosis and evaluation of acute pancreatitis.

## CT

The high resolution achieved with CT enables radiologists to diagnose acute pancreatitis accurately, determine extent of disease severity, and rule out other diagnoses that may be suspected. In the majority of cases, contrast-enhanced CT of the abdomen and pelvis is the preferred imaging modality for patients who present with acute pancreatitis. CT mitigates many of the limitations of ultrasound and magnetic resonance imaging (MRI), due to its capability to effectively visualize complications that occur in both the early (<4 weeks) and late (>4 weeks) stages of the disease. Additionally, radiologists use CT findings to estimate disease severity accurately using the CT severity index.<sup>20,21</sup>

Ideally, contrast-enhanced CT should be performed at least 72 h after the initial presentation in patients that classify as having severe acute pancreatitis.<sup>31</sup> Performing contrast-enhanced CT before this period has been correlated with a higher likelihood of underestimating the extent of pancreatic damage and thus provides little benefit unless otherwise indicated.<sup>18</sup> CT studies performed prior to 72 h after presentation may be considered if other diagnoses are under consideration. Otherwise, it is unlikely for treatment to be altered based on CT findings before the 72 h mark. Pancreatic necrosis also takes time to develop and is not likely to be visualized on CT in the initial 48 h following symptom onset.<sup>32</sup> There is controversy regarding early versus delayed CT, and in clinical practice, early CT often is performed. When imaging is done before 72 h, repeat imaging typically is performed to assess ongoing severity and extent of disease.

Although contrast-enhanced CT is widely used and is highly reliable in the assessment of acute pancreatitis, a few limitations should be considered. The main limiting factors are ionizing radiation and use of an iodinated contrast material.<sup>32</sup> These limitations may be of special consideration for patients with renal failure or a history of contrast allergy. For this reason, nonenhanced MRI may be preferred over contrast-enhanced CT in specific situations.

## Magnetic Resonance Imaging

As MRI technology has advanced, it is increasingly regarded as a viable alternative to CT to diagnose acute pancreatitis.<sup>33</sup>

Similar to CT, MRI is capable of identifying many of the early and late complications of acute pancreatitis with high accuracy.<sup>34</sup> However, numerous factors must be considered when determining whether to obtain a CT versus an MRI.

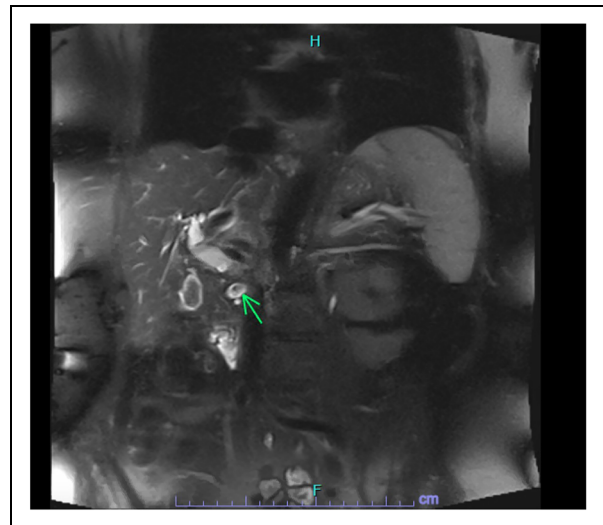
MRI has been shown to be more sensitive, specific, and accurate to diagnose acute pancreatitis compared to contrast-enhanced CT.<sup>35</sup> Additionally, MRI is better at characterizing the pancreatic and bile ducts and the complications of acute pancreatitis than contrast-enhanced CT.<sup>34</sup> As part of the MRI study, magnetic resonance cholangiopancreatography (MRCP) also can be extremely valuable to diagnose stones in the bile duct as a cause of acute pancreatitis (Figure 2). MRCP studies also can be performed without a conventional diagnostic MRI to decrease overall scan times. Other notable benefits of MRI include its nonionizing nature, higher safety profile of intravascular contrast media, and the ability to diagnose acute pancreatitis with high accuracy without the use of contrast enhancement.<sup>36</sup>

The advantages of MRI technology over CT to diagnose acute pancreatitis have led to conclusions of it being the more favorable modality in some studies.<sup>35,36</sup> However, important limitations of the MRI include longer scanning times, local diagnostic expertise, and availability. The clinical condition of patients often precludes MRI, thus, it is not usually utilized in acute situations. Contrast-enhanced CT remains the more frequently utilized and preferred modality for the diagnosis of acute pancreatitis and its complications.

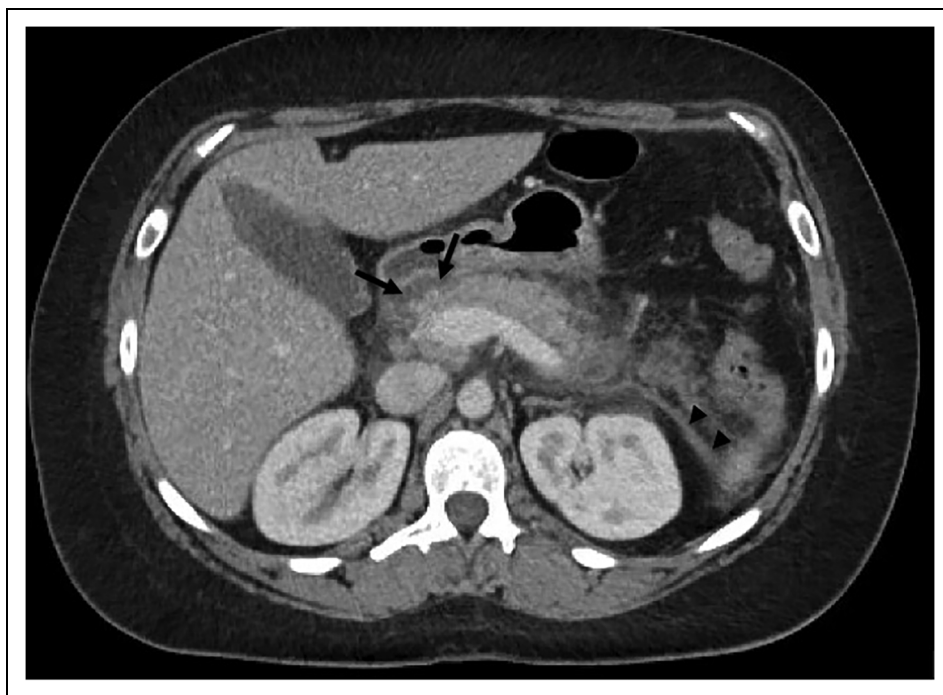
## CT Characteristics of Complications

### Interstitial Edematous Pancreatitis

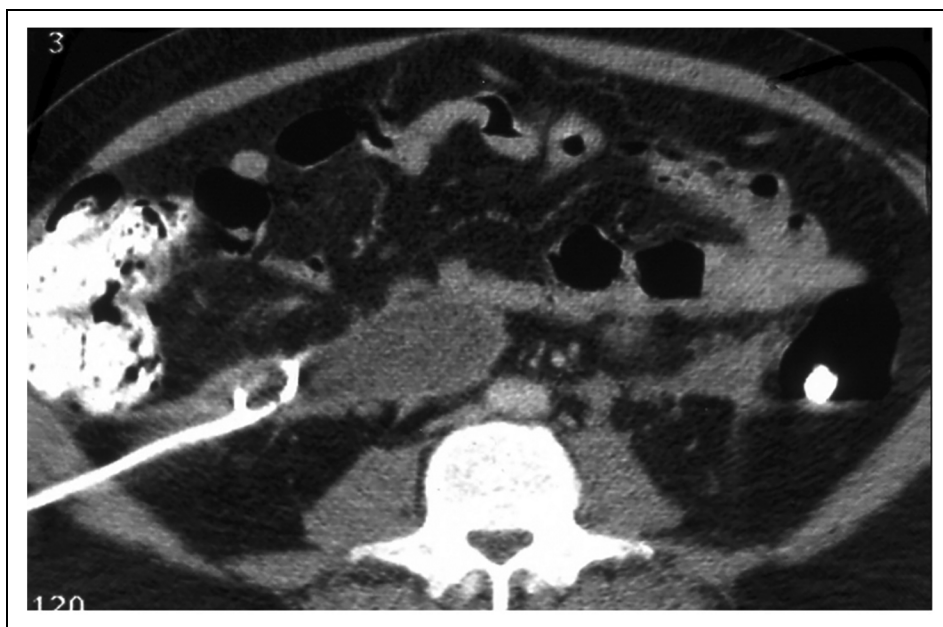
In interstitial edematous pancreatitis, enlargement and inhomogeneity of the pancreas will be seen on CT (Figure 3). The normal contrast enhancement of the pancreas on CT may be less apparent due to edema. In addition, peripancreatic inflammatory changes may cause the pancreatic margins to become indistinct.



**Figure 2.** MRCP diagnosing gallstone pancreatitis: MRCP demonstrates dilated extrahepatic bile duct with a filling defect in the distal common bile duct, diagnostic of a stone (arrow) that caused acute pancreatitis.



**Figure 3.** CT with IV contrast of acute pancreatitis: Edematous and disrupted body and tail of the pancreas with small amount of fluid in the lesser sac (arrows) and thickening of Gerota's fascia (arrowheads).



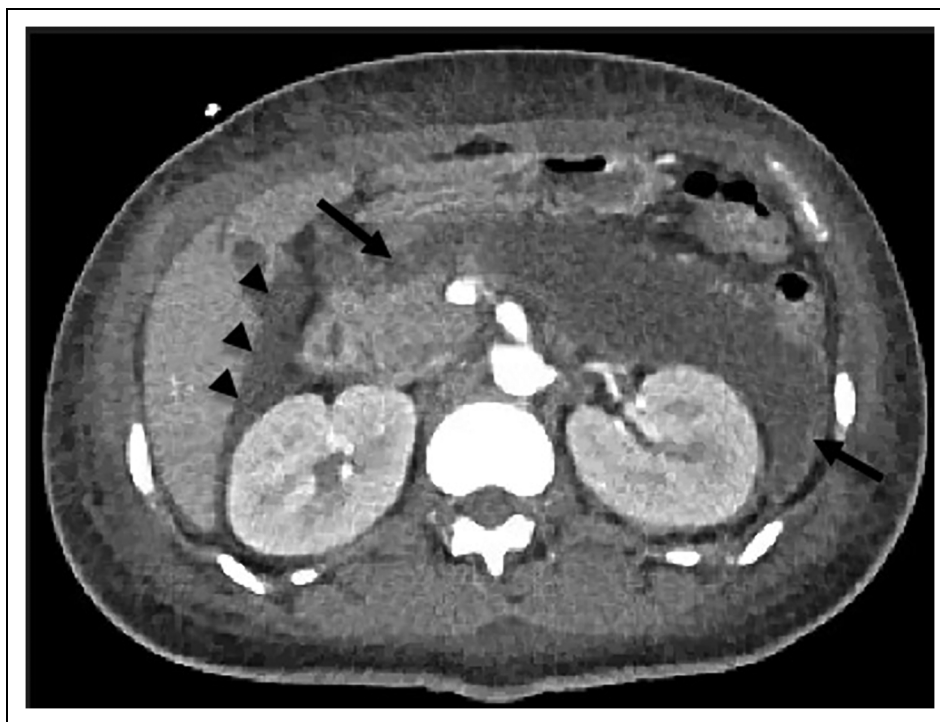
**Figure 4.** CT without IV contrast of secondary infection of acute pancreatitis fluid collection: 12 Fr percutaneous catheter drainage of right-sided, retroperitoneal infected fluid collection. *E. coli* was cultured. Catheter drainage was successful.

### Acute Fluid Collections

Acute fluid collections on CT lack a perceptible wall and appear as low density fluid-appearing areas. They commonly appear in the lesser sac and retroperitoneum, and often conform to the retroperitoneal spaces. If they do not spontaneously resolve, they can become infected (Figure 4).

### Pancreatic Necrosis

Necrotizing pancreatitis reveals nonenhancing pancreatic tissue on contrast-enhanced CT. The presence of fluid collections will differ from acute fluid collections due to their heterogeneity. In most cases, the heterogeneous appearance will be from solid debris from either the dead parenchyma or fat.<sup>37</sup> In later



**Figure 5.** CT with IV contrast of severe pancreatic necrosis: 90% necrosis of the pancreas due to systemic lupus erythematosus (arrows), with mild edema in the head and uncinus process. There is also pancreatic ascites in the subhepatic space (arrowheads).

phases, patients may develop walled off necrosis. This can be visualized as a thick, contrast-enhanced wall surrounding the heterogeneous fluid collection (Figure 5).

### Vascular

Vascular complications of acute pancreatitis are characterized by high attenuation contrast material leaking into pseudocysts or free hemorrhage into the abdominal cavity or GI tract. More commonly, filling defects can be appreciated due to thrombosis in the surrounding vasculature of the pancreas. This is most often seen in the splenic vein because of the mass effect from surrounding inflamed pancreas or the direct intimal damage of the venous wall by the liberated enzymes.<sup>38</sup>

### Pseudocysts

Pancreatic pseudocysts manifest as a mass with an enhancing capsule containing largely homogenous fluid; there can be dependent debris.

### Pancreatic Abscess

The formation of a pancreatic abscess can be visualized on CT as a focal area of low attenuation surrounded by a thick wall in the vicinity of the pancreas.<sup>39</sup> The associated wall may or may not be enhanced. There should be high suspicion for abscess if there are gas bubbles within the collection. Gas bubbles also can indicate a communication with the GI tract.

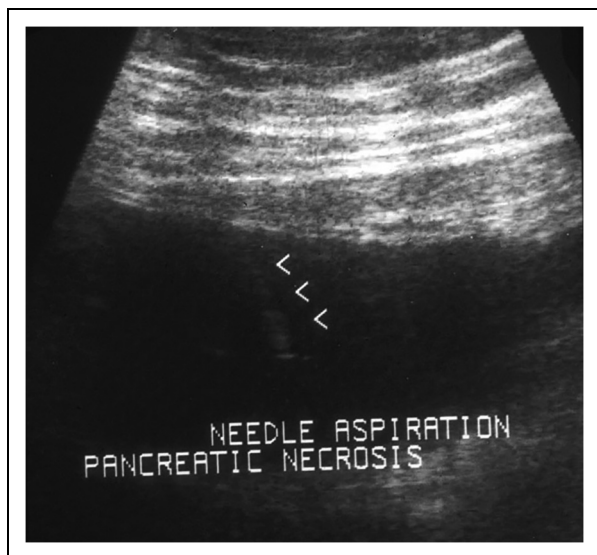
## Radiologic Interventions for Acute Pancreatitis and Its Complications

### Diagnostic Aspiration

Radiologic intervention may be indicated for diagnosis in patients with acute pancreatitis suspected of secondary infection. In these cases, CT-guided fine needle aspiration can be used to diagnose infection by gram stain and culture (Figure 6).<sup>40,41</sup> In addition, sensitivity studies dictate appropriate antibiotics. The decision to pursue intervention generally is determined by the patient's clinical status, along with imaging findings, and the results of culture and sensitivity. Radiologic intervention typically is indicated by consensus among gastroenterologists, surgeons, and diagnostic and interventional radiologists.

The benefit of CT-guided fine needle (18-22 g) aspiration has long been debated, with varying guidelines and recommendations.<sup>42,43</sup> The controversy revolves around the potential benefit of diagnosing infection versus the risk of introducing microbes into a sterile collection.<sup>44</sup> An analysis of 208 patients from a prospective, multicenter study concluded that diagnostic fine needle aspiration was most useful in patients with unclear clinical signs and no imaging signs of infected pancreatic necrosis.<sup>45</sup>

In daily practice, clinical parameters such as fever, white blood cell count, and increased serum inflammatory markers typically are used to decide on diagnostic aspiration for suspected infected necrosis. Aggressive treatment becomes warranted if there is a positive gram stain and culture from the diagnostic aspiration.<sup>46,47</sup>



**Figure 6.** Ultrasound-guided diagnostic aspiration: 20-gauge needle (arrowheads) inserted with ultrasound guidance into pancreatic necrotic collection. *Pseudomonas* was cultured, indicating infected pancreatic necrosis.



**Figure 7.** Catheter sinogram from percutaneous pseudocyst drainage: Catheter injection demonstrates contrast filling the pseudocyst with communication to the pancreatic duct (arrows). The catheter should not be removed when communication exists, or recurrence will occur. The communication spontaneously sealed in 2 weeks, at which time the catheter was removed, and drainage was successful.

### Percutaneous Catheter Therapy

**Pancreatic Pseudocyst.** Up to 10% of patients with a pancreatic pseudocyst will require intervention.<sup>48</sup> Percutaneous drainage is an effective front-line treatment for most pancreatic pseudocysts, and cure is likely if fluid collections are drained adequately, and there has been sufficient time for closure of fistulas (Figure 7).<sup>10</sup> Infected pseudocysts are treated as

abscesses and are drained urgently (Figure 8). For noninfected pseudocysts, sequential imaging is conducted with either ultrasound or CT every 1-2 weeks to monitor changes. If the pseudocyst is symptomatic, greater than 4-5 cm, growing on sequential imaging, or there is GI or biliary obstruction, intervention is warranted.<sup>10</sup> Conversely, asymptomatic patients with pseudocysts that are decreasing in size on sequential imaging can be monitored without intervention until the pseudocyst resolves spontaneously.<sup>49</sup>

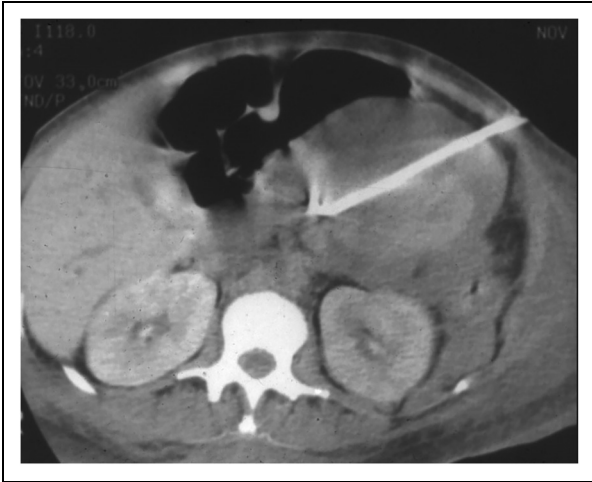
**Pancreatic Abscess.** Pancreatic abscesses are a serious complication of acute pancreatitis that should involve a coordinated, multidisciplinary team including hospitalists, intensivists, radiologists, gastroenterologists, and general surgeons.<sup>50</sup> The correct diagnosis is essential to guide proper management. As mentioned previously, pancreatic abscesses are localized collections of pus that occur without the presence of a significant necrotic material. CT imaging plays a vital role in the initial characterization of pancreatic abscesses, along with providing guidance for percutaneous catheter drainage.<sup>29</sup> Like other complications of pancreatitis, premature surgical intervention should be avoided if possible, in accord with recommendations from the multidisciplinary team.<sup>11,51-54</sup> In many patients, percutaneous drainage alone is effective to manage pancreatic abscesses.<sup>55</sup> High success rates (86%) are closely linked to patient selection; appropriate catheter size (12-14 Fr), and location, along with close clinical ward follow-up with appropriate catheter manipulations if necessary.<sup>7,11,56</sup> More than 1 catheter not uncommonly is necessary for cure.

Percutaneous drainage is contraindicated in patients with collections that involve solid components or active inflammatory tissue (phlegmon) seen on CT.<sup>7,57</sup> In more severe cases with multiple collections, several large-bore catheters can be used, with repeat CT scans and catheter manipulations when necessary.<sup>7,11</sup> Surgical drainage typically is reserved for patients that have had no improvement with percutaneous drainage.<sup>53,58</sup>

**Pancreatic Necrosis.** The approach to intervention in patients with pancreatic necrosis is based on several factors: the patient's clinical status, prior surgery or interventions, degree of liquefaction, sterile versus infected necrotic collections, along with other comorbidities such as multisystem organ failure.<sup>57</sup> Percutaneous drainage alone in sterile necrosis, or with concurrent use of antibiotics in infected necrosis, can be curative.<sup>57,59</sup> Catheter drainage may be used, initially as a temporizing measure prior to solid tissue surgical necrosectomy.<sup>60,61</sup>

Percutaneous catheters can be placed postsurgical necrosectomy to drain any residual collections. The "step-up approach" of placing catheter drains first has become a more standard practice, as it can defer and potentially obviate the need for surgery.<sup>62,63</sup>

Contraindications to percutaneous drainage include solid necrosis, active bleeding, uncorrectable coagulopathy, phlegmonous tissue, pseudoaneurysm, and an uncooperative patient.<sup>57</sup> Although catheter drainage is not a viable option alone for the treatment of solid necrosis, percutaneous catheters may serve as



**Figure 8.** CT with IV contrast demonstrates percutaneous drainage of infected pancreatic pseudocyst: 12 Fr catheter placed percutaneously into an infected pancreatic pseudocyst. The catheter remained in place for 10 days. The patient was treated successfully by the catheter drainage.

a point of access and guide for subsequent video-assisted retroperitoneal debridement (VARD) procedure to remove solid necrotic material.<sup>59</sup> Aside from VARD, direct endoscopic techniques using baskets, snares, and rat-tooth forceps are other minimally invasive options for the removal of solid necrotic debris.<sup>46</sup>

## Conclusion

Managing acute pancreatitis with evidence-based imaging and interventional strategies is crucial for optimizing patient outcomes. Conducting the proper imaging studies, at the appropriate time, is important, as it allows for accurate staging and treatment of pancreatic disease. When intervention is required, coordination should occur with a multidisciplinary team involving hospitalists, intensivists, radiologists, gastroenterologists, and general surgeons. Interventional radiology techniques are valuable to treat many of the complications of acute pancreatitis.

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