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Section 4 Disorders of the Pancreas Somashekar G. Krishna,

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Approach to the Patient

with Pancreatic Disease ■ ■GENERAL CONSIDERATIONS Globally, pancreatic disorders, including acute and chronic pancreati tis, pancreatic cysts, and pancreatic cancer, are challenging to manage and associated with a high burden on health care resources. While the relationships between these diseases are multifaceted, there is ongoing scientific progress and a growing understanding in this field. Acute pancreatitis is one of the most common reasons for hospitalizations in gastroenterology, and there is increasing evidence of sequelae includ ing diabetes, exocrine pancreas insufficiency, and chronic pancreatitis. In elderly patients, acute pancreatitis may serve as an early symptom of pancreatic cancer. Chronic pancreatitis, an irreversible disease of the pancreas, associated with poor quality of life due to abdominal pain and associated exocrine insufficiency, is also an established risk factor for pancreatic cancer. Pancreatic cysts, mostly incidental, are increas ingly detected on cross-sectional abdominal imaging studies. Although only a small proportion of pancreatic cysts can progress to pancreatic cancer, the diagnostic uncertainty can introduce unwanted anxiety to patients and treating physicians. Meanwhile, with persistently high mortality rates, the incidence of pancreatic adenocarcinoma is increas ing and is the seventh leading cause of cancer-related death in the industrialized world and the third most common in the United States. PART 10 Disorders of the Gastrointestinal System As emphasized in Chap. 359, the etiologies and clinical manifesta tions of pancreatitis are quite varied. Although it is well-appreciated that acute pancreatitis is frequently secondary to biliary tract disease or alcohol abuse, it can also be caused by medications, genetic mutations, and trauma. In ~30% of patients with acute pancreatitis and 25–40% of patients with chronic pancreatitis, the etiology is initially unexplained. The global pooled incidence of acute pancreatitis

is ~33.7 cases (95% confidence interval [CI], 23.3–48.8) with 1.16 deaths (95% CI, 0.85–1.6) per 100,000 person-years. The global pooled incidence of chronic pancreatitis is ~9.6 cases (95% CI, 7.9–11.8) with 0.09 attrib utable deaths (95% CI, 0.02–0.5) per 100,000 person-years. In the A B FIGURE 358-1 A. Side-branch intraductal papillary mucinous neoplasm (magnetic resonance imaging [MRI] with magnetic resonance cholangiopancreatography [MRCP]). T2-weighted MRCP image demonstrates a dominant, lobulated, hyperintense cystic structure (arrow) within the posterior body of the pancreas. The pancreatic duct upstream from the cyst is dilated and irregular. Endoscopic ultrasound and fine-needle aspiration of cyst fluid were consistent with a mucinous cyst. Surgical histopathology revealed an infiltrating moderately differentiated adenocarcinoma, 0.3 cm, arising in a background of an intraductal papillary mucinous neoplasm (IPMN). B. Mucinous cystic neoplasm (computed tomography [CT] scan). In the tail of the pancreas, there is a well-circumscribed hypodense cyst (arrow) without any nodular enhancing components. Endoscopic ultrasound and fine-needle aspiration of cyst fluid were suggestive of a mucinous cyst. Surgical histopathology revealed a mucinous cystic neoplasm (3.4 cm) with low-grade dysplasia. The stroma of the cyst demonstrated diffuse positivity for progesterone receptor and focal positivity for CD10 (ovarian stroma), confirming the diagnosis. C. Serous cystadenoma (MRI). A lobulated microcystic cyst (arrow) is observed in the tail of the pancreas. Neither a communication with the main pancreatic duct nor intracystic soft tissue enhancing nodular components were observed. However, the cyst continued to increase in size, and a distal pancreatectomy was performed. Histopathology revealed a serous microcystic adenoma. (Courtesy of Dr. Z.K. Shah, The Ohio State University Wexner Medical Center; with permission.)

United States, the number of patients admitted to the hospital with acute pancreatitis is increasing, with estimated rates of almost 300,000 annually, whereas the number of patients hospitalized for chronic pan creatitis is decreasing, with recent estimates of ~13,000 admissions per year. Chronic pancreatitis has an annual prevalence of 42–73 cases per 100,000 adults in the United States, although higher prevalence rates (0.04–5%) have been noted among adults at autopsy. Together, acute and chronic pancreatic disease costs an estimated $3 billion annually in health care expenditures. During the COVID-19 pandemic, it was noted that the infection was associated with elevated pancreas enzyme serum levels and presumed acute pancreatitis, though causal relation ships have not been definitively established. The diagnosis of acute pancreatitis is generally defined based on a combination of laboratory, imaging, and clinical symptoms. The diag nosis of chronic pancreatitis, especially in mild disease, is hampered by the relative inaccessibility of the pancreas to direct examination and the nonspecificity of the associated abdominal pain. Many patients with chronic pancreatitis do not have elevated blood amylase or lipase levels. Some patients with chronic pancreatitis develop signs and symptoms of exocrine pancreatic insufficiency (EPI), and thus, objective evidence for pancreatic disease can be demonstrated. However, there is a large reservoir of pancreatic exocrine function. Maldigestion of fat and protein becomes evident only when more than 90% of the pancreas is functionally damaged or obstructed. Noninvasive, indirect tests of pancreatic exocrine function (e.g., fecal elastase) are much more likely to give abnormal results in patients with obvious advanced pancreatic disease (i.e., pancreatic calcification, steatorrhea, or diabetes mellitus) than in patients with occult disease. Invasive, direct tests of pancreatic secretory function (e.g., secretin stimulation test) are the most sensitive and specific tests to detect early chronic pancreatic disease when imag ing is equivocal or normal. The increasing utilization of cross-sectional imaging modalities with their improved resolution has contributed to a high prevalence (2–5% with computed tomography [CT] scans, 20–30% with

magnetic resonance imaging [MRI]) of incidentally detected pancreatic cysts. The most common cyst type encountered is an intraductal papillary mucinous neoplasm (IPMN), which is classified as a precancerous mucinous cyst. In the absence of high-risk features, radiographic surveillance is typically recommended (Fig. 358-1). Mucinous cystic neoplasms (MCNs) are relatively less common and occur almost exclu sively in women. Among the neoplastic cysts, serous cystadenomas have a negligible risk of progression to malignancy. Other infrequent neoplastic cysts include neuroendocrine tumors and solid pseudo papillary neoplasms. The most commonly encountered benign cyst is a pseudocyst, which can occur in patients with a history of acute C

or chronic pancreatitis. The challenges with accurately predicting the risk of malignant transformation of precancerous pancreatic cysts has contributed to the growing number of patients on imaging surveillance protocols placing a burden on health care systems in industrialized nations. TABLE 358-1 Tests Useful in the Diagnosis of Acute and Chronic Pancreatitis and Pancreatic Neoplasms TEST PRINCIPLE COMMENT Pancreatic Enzymes in Body Fluids Serum lipase Pancreatic inflammation leads to increased serum enzyme levels Amylase

1. Serum Pancreatic inflammation leads to increased serum enzyme levels
2. Urine Renal clearance of amylase is increased in acute pancreatitis
3. Ascitic fluid Disruption of gland or main pancreatic duct leads to increased amylase concentration
4. Pleural fluid Exudative pleural effusion with pancreatitis False positives occur with carcinoma of the lung and esophageal perforation Studies Pertaining to Pancreatic Structure Radiologic and radionuclide tests
5. Plain film of the abdomen or Can demonstrate large calcifications in chronic pancreatitis upper gastrointestinal x-rays
6. Ultrasonography (US) Can provide limited information on edema, inflammation, calcification, pseudocysts, and mass lesions
7. Computed tomography (CT) Permits detailed visualization of pancreas and surrounding structures, pancreatic fluid collection, pseudocyst; assessment of necrosis or interstitial disease scan
8. Magnetic resonance Permits noninvasive detailed evaluation of the pancreatic parenchyma, biliary and pancreatic ducts, adjacent soft tissues, and vascular structures. imaging (MRI) and cholangiopancreatography (MRCP)
9. Endoscopic ultrasonography High-frequency transducer used with EUS produces very-high-resolution images permitting focused evaluation of pancreatic parenchyma and biliary and pancreatic ducts, and FNA/B provides targeted tissue acquisition (EUS) and fine-needle aspiration/biopsy (FNA/B)
10. Endoscopic retrograde Cannulation of pancreatic and/or common bile duct permits visualization of pancreaticobiliary ductal system cholangiopancreatography (ERCP) Tests of Exocrine Pancreatic Function Direct stimulation of the pancreas with analysis of duodenal contents
11. Secretin test Secretin leads to increased output of pancreatic juice and HCO_3^-; pancreatic secretory response is related to the functional mass of pancreatic tissue; involves duodenal intubation and fluoroscopic placement of gastroduodenal tube
12. Endoscopic pancreatic Secretin-stimulated collection of pancreatic juice performed during upper endoscopy; replaces need for tube placement in the duodenum function test (ePFT)

13. EUS-ePFT Combines endosonographic evaluation of the pancreas and endoscopic collection of pancreatic juice
14. Secretin-stimulated MRCP Combines imaging evaluation of the pancreas and a semiquantitative estimation of pancreatic juice output in the duodenum Measurement of intraluminal digestion products
15. Stool fat determination Lack of lipolytic enzymes brings about impaired fat digestion; quantitative 72-h stool collection and estimation are more reliable than qualitative analysis of a random stool sample Measurement of pancreatic enzymes in feces
16. Fecal elastase Pancreatic secretion of proteolytic enzymes; not degraded in intestine

■ ■TESTS USEFUL IN THE DIAGNOSIS OF PANCREATIC DISEASE Several tests are of value in the evaluation of pancreatic disease. Examples of specific tests and their usefulness in the diagnosis of acute and chronic pancreatitis are summarized in Table 358-1 and Fig. 358-2. At some

Enzyme measurement of choice for the diagnosis of acute pancreatitis; increased specificity if the level is more than three times the upper limit of normal (3× ULN) Simple; increased specificity if the level is >3× ULN; may be falsely normal in patients with hypertriglyceridemic pancreatitis Infrequently used Can help establish source of ascites; false positives occur with intestinal obstruction and perforated ulcer; can also measure lipase Infrequently used Simple, noninvasive; sequential studies quite feasible; useful in diagnosis of gallstones; pancreas visualization limited by interference from overlying bowel gas CHAPTER 358 Useful in the diagnosis of pancreatic calcification, dilated pancreatic ducts, and pancreatic tumors; may not be able to distinguish between inflammatory and neoplastic mass lesions; multiphasic CT scans are the preferred imaging modality for staging pancreatic cancer; IV contrast is needed for characterization of most features Approach to the Patient with Pancreatic Disease Has mostly replaced ERCP for diagnostic assessment of the pancreatic duct; more sensitive than CT scan for detection of mild pancreatitis, necrosis, choledocholithiasis, pancreatic ductal abnormalities, and cystic neoplasms; no exposure to ionizing radiation Can be used to assess gallstones, choledocholithiasis, chronic pancreatitis, pancreatic masses, and cystic neoplasms; FNA/B facilitates diagnostic and therapeutic management of pancreatic diseases Primarily a therapeutic procedure; invasive with risks for iatrogenic complications Sensitive to detect occult disease; poorly defined normal enzyme response; large secretory reserve capacity of the pancreas; rarely performed Sensitive to detect occult disease; high negative predictive value for chronic pancreatitis; requires sedation Single endoscopic evaluation of pancreatic structure and function Improved visualization of pancreatic ductal anatomy; functional evaluation is less accurate than ePFT; noninvasive Reliable reference standard for defining severity of fat malabsorption; does not distinguish between pancreatic and nonpancreatic cause of malabsorption Diagnostic accuracy is highest when the pretest probability is high and the value is <100 µg/g; false positives will occur in patients with nonformed stools

• Clinical signs and symptoms suggestive of chronic pancreatic disease: abdominal pain, nausea, weight loss, steatorrhea, malabsorption, history of alcohol abuse, recurrent pancreatitis, fatty-food intolerance • Perform history, physical examination, review of laboratory studies; consider fecal elastase measurement Step 1 • Contrast-enhanced CT scan • CP diagnostic criteria: calcifications in combination with atrophy and/or dilated duct • Diagnostic criteria met; no further imaging needed • Inconclusive or nondiagnostic results; continue to step 2 Step 2 • MRI and MRCP, with or without secretin enhancement (sMRCP) • CP diagnostic criteria: Cambridge class III,a dilated duct,

atrophy of gland, filling defects in duct suggestive of stones • Diagnostic criteria met; no further imaging needed • Inconclusive or nondiagnostic results; continue to step 3 Step 3 • EUS with quantification of parenchymal and ductal criteria • CP diagnostic criteria: ≥5 EUS CP criteria • Diagnostic criteria met; no further imaging needed • Inconclusive or nondiagnostic results; continue to step 4 Step 4 • Pancreas function test (with secretin)—endoscopic (ePFT) collection method preferred; consider combining ePFT with EUS • CP diagnostic criteria: peak [bicarbonate] <80 mEq/L • Diagnostic criteria met; no further imaging needed • Inconclusive or nondiagnostic results require monitoring of signs and symptoms and repeat testing in 6 months–1 year FIGURE 358-2 A stepwise diagnostic approach to the patient with suspected chronic pancreatitis (CP). Endoscopic ultrasonography (EUS) and magnetic resonance imaging (MRI) with secretin-stimulated magnetic resonance cholangiopancreatography (sMRCP/MRCP) are appropriate diagnostic alternatives to endoscopic retrograde cholangiopancreatography (ERCP). CT, computed tomography; ePFT, endoscopic pancreas function test. aCambridge classification of pancreatic duct findings: class 0: normal— visualization of complete normal ductal anatomy; class I: equivocal—normal main duct, 1–3 abnormal side branches; class II: mild—normal main duct, >3 abnormal side branches; class III—dilated and irregular main duct, >3 abnormal side branches, small (<10 mm) cysts; class IV—irregular main duct, intraductal calculi, strictures, obstruction with dilation, or large (>10 mm) cysts. PART 10 Disorders of the Gastrointestinal System institutions, pancreatic function tests are available and performed if the diagnosis of chronic pancreatitis remains a possibility after noninvasive tests (i.e., ultrasound, CT scan, MRI with magnetic resonance cholangio pancreatography [MRCP]) or invasive tests (i.e., endoscopic retrograde cholangiopancreatography [ERCP], endoscopic ultrasound [EUS]) have given normal or inconclusive results. In this regard, tests using direct stimulation of the pancreas with secretin are the most sensitive. Pancreatic Enzymes in Body Fluids The serum amylase and lipase levels are widely used as screening tests for acute pancreatitis in the patient with acute abdominal pain or back pain. Lipase is more specific for the pancreas, and values greater than three times the upper limit of normal (3× ULN) in combination with epigastric pain strongly suggest the diagnosis of acute pancreatitis. In acute pancreatitis, the serum amylase and lipase are usually elevated within 24 h of onset and remain so for 3–7 days. Levels usually return to normal within 7 days unless there is pancreatic ductal disruption, ductal obstruction, or pseudocyst formation. Approximately 85% of patients with acute pan creatitis have threefold or greater elevated serum lipase and amylase levels. The values may be normal if (1) there is a delay (2–5 days) before blood samples are obtained, (2) the underlying disorder is chronic pancreatitis rather than acute pancreatitis, or (3) hypertriglyceridemia is present. Patients with hypertriglyceridemia and acute pancreatitis have been found to have spuriously low levels of amylase and perhaps lipase activity. In the absence of objective evidence of pancreatitis by abdominal ultrasound, contrast-enhanced CT scan, MRI with MRCP, or EUS, mild to moderate elevations of amylase and/or lipase are not helpful in making a diagnosis of chronic pancreatitis. It should be noted that the serum amylase can be elevated in other conditions (Table 358-2), in part because the enzyme is found in many organs. In addition to the pancreas and salivary glands, small quantities of amylase are found in the tissues of the fallopian tubes, lung, thyroid, and tonsils and can be produced by various tumors (carcinomas of the lung, esophagus, breast, and ovary). Isoamylase determinations do not accurately distinguish elevated blood amylase levels from pancreatic or nonpancreatic sources. In patients with unexplained hyperamylas emia, the measurement of macroamylase can avoid numerous tests in patients with this rare disorder.

Elevation of ascitic fluid amylase occurs in acute pancreatitis as well as in (1) ascites due to disruption of the main pancreatic duct or a leak ing pseudocyst and (2) other abdominal disorders that simulate pan creatitis (e.g., intestinal obstruction, intestinal infarction, or perforated peptic ulcer). Elevation of pleural fluid amylase can occur in acute pancreatitis, chronic pancreatitis, carcinoma of the lung, and esopha geal perforation. Serum lipase is the single best enzyme to measure for the diagnosis of acute pancreatitis. It is important to acknowledge that levels are often mildly elevated in the setting of renal disease, so determining whether a patient with renal failure and abdominal pain has pancreatitis remains a challenging clinical problem. One study found that serum amylase levels were elevated in patients with renal dysfunction only when creatinine clearance was <0.8 mL/s (<50 mL/min). In such patients, the serum amylase level was invariably <500 IU/L in the absence of objective evidence of acute pancreatitis. In that study, serum lipase and trypsin levels paralleled serum amylase values. With these limitations in mind, the recommended screening test for acute pancreatitis in renal disease is serum lipase, but a high index of clinical suspicion is needed based on symptoms. Elevations in serum lipase

> 3× ULN due to nonpancreatic etiology can be observed in hepato biliary or gastrointestinal malignancies, septicemia, liver cirrhosis, systemic lupus erythematosus, severe head injury, chronic alcoholism, diabetes mellitus, and post-ERCP without any associated evidence of pancreatitis. COVID-19 infection has been associated with asymptomatic eleva tions of both amylase and lipase. In a systematic review of 21 studies involving 36,496 patients during the COVID-19 pandemic, the pooled prevalence of hyperlipasemia (>3 × ULN) and hyperamylas emia (>3 × ULN) was 5.6% (95% CI, 2.8–9.3%) and 4.0% (95% CI, 0.9–8.7%), respectively. Importantly, the overall prevalence of acute pancreatitis in this cohort was 1.7%. Abnormal levels of amylase and lipase were more closely associated with the severity of COVID-19 than a diagnosis of acute pancreatitis. Studies Pertaining to Pancreatic Structure • RADIOLOGIC TESTS Plain films of the abdomen rarely provide useful informa tion related to pancreatic disease and have been superseded by more detailed imaging studies (ultrasound, EUS, CT, and MRI with MRCP).

TABLE 358-2 Causes of Hyperamylasemia Pancreatic Disease I. Pancreatitis A. Acute B. Chronic: ductal obstruction C. Complications of pancreatitis

1. Pancreatic pseudocyst
2. Ascites caused by pancreatic duct disruption
3. Pancreatic necrosis II. Pancreatic trauma III. Pancreatic adenocarcinoma Nonpancreatic Disorders I. Renal insufficiency II. Salivary gland lesions A. Mumps B. Calculus C. Irradiation sialadenitis D. Maxillofacial surgery III. “Tumor” hyperamylasemia A. Carcinoma of the lung, esophagus, breast, or ovary IV. Macroamylasemia V. Burns VI. Diabetes mellitus, particularly when ketoacidosis is present VII. Pregnancy VIII. Renal transplantation IX. COVID-19 infection X. Cerebral trauma XI. Drugs: opiates Other Abdominal Disorders I. Biliary tract disease: cholecystitis, choledocholithiasis II. Intraabdominal disease A. Perforated or penetrating peptic ulcer B. Intestinal obstruction

or inflammation C. Ruptured ectopic pregnancy D. Peritonitis E. Aortic aneurysm F. Postoperative hyperamylasemia Ultrasonography (US) can provide important information in the initial emergency ward evaluation of patients with acute pancreatitis, chronic pancreatitis, pseudocysts, and pancreatic adenocarcinoma. Sonographic changes can indicate the presence of edema, inflamma tion, and calcification (not obvious on plain films of the abdomen), as well as gallstones, biliary dilation, pseudocysts, and mass lesions. In acute pancreatitis, the pancreas is characteristically enlarged. In pan creatic pseudocyst, the usual appearance is primarily that of a smooth, round fluid collection. Pancreatic adenocarcinoma distorts the usual landmarks, and mass lesions >3.0 cm are usually detected as localized, solid lesions. US is often the initial investigation for patients with sus pected pancreatic disease. However, obesity and excess intestinal bowel gas can interfere with pancreatic imaging, limiting its sensitivity. CT with intravenous contrast is the best imaging study for the assessment of complications of acute and chronic pancreatitis. It is especially useful in the detection of pancreatic and peripancreatic acute fluid collections, fluid-containing lesions such as pseudocysts, walled-off necrosis (see Chap. 359, Figs. 359-1, 359-2, and 359-4), and pancreatic neoplasms. Acute pancreatitis is characterized by (1) enlargement of the pancreas, (2) distortion of the pancreatic contour with peripancreatic stranding of adjacent fat tissue, and/or (3) the presence of pancreatic fluid that has a different attenuation coeffi cient than normal pancreas. When possible, CT scans should ideally be performed with oral and intravenous contrast to detect areas of pancreatic necrosis. The major benefit of CT scan in acute pancreatitis

is the diagnosis of pancreatic necrosis in patients not responding to conservative management within 72 h. It may take 48–72 h to develop perfusion defects indicative of pancreatic necrosis. Therefore, if acute pancreatitis is confirmed with serology and physical examination find ings, CT scan in the first 3 days is not recommended to minimize risk of contrast-induced nephropathy and unnecessary health care costs. Improved imaging technology and increased resolution are facilitated by multiphasic CT scans using multidetector technology (MDCT) in which a pancreas protocol consisting of dual-phase scanning with intravenous contrast is utilized for the detection and staging of pan creatic cancers. While the sensitivity of MDCT for detecting smaller (≤2 cm) lesions is lower, the reported overall sensitivity for pancreatic cancers is 76–97%. The contraindications to using intravenous contrast include renal failure (serum creatinine >2 mg/dL) and a history of severe allergic reaction to iodinated contrast agents. In situations where EUS is not available, CT-guided percutaneous aspiration or biopsy of a pancreatic mass can be performed. Prior to the major advance of EUSguided fine-needle aspiration (FNA), CT-guided biopsy was utilized in the preceding decades and is regarded as a safe procedure.

MRI and MRCP provide excellent imaging of the bile duct, pan creatic duct, and pancreas parenchyma in both acute pancreatitis and chronic pancreatitis. MRI is more sensitive than transabdominal US and CT scans and comparable to EUS for the detection of choledo cholithiasis. Similar to CT, MRI can evaluate for the severity of acute pancreatitis. Moreover, T2-weighted MRI of fluid collections can dif ferentiate necrotic debris from fluid in suspected walled-off necrosis, and T1 imaging can diagnose hemorrhage in suspected pseudoaneu rysm rupture. In chronic pancreatitis, secretin-enhanced MRCP is a method to enhance the evaluation of major and minor ductal changes. While imaging is comparable to CT for evaluating pancreatic mass lesions, MRI with MRCP is the preferred imaging modality for evalu ating pancreatic cystic lesions. Nephrogenic systemic fibrosis has been described in patients with chronic renal failure following exposure to the

gadolinium contrast, but incidence rates are extraordinarily low with contemporary contrast agents. CHAPTER 358 Approach to the Patient with Pancreatic Disease EUS produces high-resolution images of the bile duct, pancreatic parenchyma, and pancreatic duct with a transducer fixed to an endo scope that can be directed onto the surface of the pancreas through the stomach or duodenum. EUS is not beneficial for the evaluation of pan creas during acute pancreatitis. It is preferable to perform EUS after the resolution of acute pancreatitis (~4 weeks) to detect any predisposing factors, including malignancy, choledocholithiasis, pancreatic divisum, or ampullary lesions. EUS can be combined with ERCP in a single ses sion and is increasingly preferred for the diagnosis and management of choledocholithiasis in acute pancreatitis and pancreatic neoplasm with biliary obstruction. EUS has been studied as a diagnostic modal ity for chronic pancreatitis. Criteria for abnormalities on EUS in severe chronic pancreatic disease have been developed. There is general agreement that the presence of five or more of the nine criteria listed in Table 358-3 is highly predictive of chronic pancreatitis in the correct clinical context. The sensitivity of EUS (81%; 95% CI, 70–89%) to diag nose chronic pancreatitis is comparable to that of MRI/MRCP (78%; 95% CI, 69–85%) and better than CT (75%; 95% CI, 66–83%); however, nonspecific changes are commonly seen in the pancreas that may be attributable to cigarette smoking, diabetes, or normal aging. EUS also facilitates the delivery of nerve-blocking agents via fine-needle injec tion in patients suffering from pancreatic pain from chronic pancre atitis (celiac plexus block) or cancer (celiac plexus neurolysis). When TABLE 358-3 Endoscopic Ultrasonographic Criteria for Chronic Pancreatitis (Total Criteria = 9) DUCTAL PARENCHYMAL Stones Echogenic strands Hyperechoic main duct margins Echogenic foci Main duct irregularity Lobular contour Main duct dilatation Cysts Visible side branches

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