

TABLE 370-2 CAUSES OF HYPERAMYLASEMIA AND HYPERAMYLASURIA

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 carcinoma
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.	Diabetic ketoacidosis
VII.	Pregnancy
VIII.	Renal transplantation
IX.	Cerebral trauma
X.	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

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, calcium deposits (see Chap. 371, Figs. 371-1, 371-2, and 371-4), and pancreatic neoplasms. Acute pancreatitis is characterized by (1) enlargement of the pancreatic outline, (2) distortion of the pancreatic contour, and/or (3) a pancreatic fluid that has a different attenuation coefficient than normal pancreas. Oral, water-soluble contrast agents are used to opacify the stomach and duodenum during CT scans; this strategy permits more precise delineation of various organs as well as mass lesions. Dynamic CT (using rapid IV administration of contrast) is useful in estimating the extent of pancreatic necrosis and in predicting morbidity and mortality. CT provides clear images much more rapidly and essentially negates artifact caused by patient movement. If acute pancreatitis is confirmed with serology and physical examination findings, CT scan in the first 3 days is not recommended to avoid overuse and minimize costs.

Endoscopic ultrasonography (EUS) produces high-resolution images of the pancreatic parenchyma and pancreatic duct with a transducer fixed to an endoscope that can be directed onto the surface of the pancreas through the stomach or duodenum. EUS and MRCP have largely replaced ERCP for diagnostic purposes in many centers. EUS allows one to obtain information about the pancreatic duct as well as the parenchyma and has few procedure-related complications associated with it, in contrast to the 5–10% of post-ERCP pancreatitis observed. EUS is also helpful in detecting common bile duct stones in acute

TABLE 370-3 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	Cyst
Visible side branches	

pancreatitis. Pancreatic masses can also be biopsied via EUS in cases with suspected pancreas cancer, and one can deliver nerve-blocking agents through EUS fine-needle injection in patients suffering from pancreatic pain from chronic pancreatitis or cancer. EUS has been studied as a diagnostic modality 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 370-3 is highly predictive of chronic pancreatitis. Recent studies comparing EUS and ERCP to the secretin test in patients with unexplained abdominal pain suspected of having chronic pancreatitis show similar diagnostic accuracy in detecting early changes of chronic pancreatitis. The exact role of EUS versus CT, ERCP, or function testing in the early diagnosis of chronic pancreatitis has yet to be clearly defined.

Magnetic resonance imaging (MRI) and *magnetic resonance cholangiopancreatography* (MRCP) are now being used to view the bile ducts, pancreatic duct, and the pancreas parenchyma in both acute pancreatitis and chronic pancreatitis. For diagnostic imaging in chronic pancreatitis, non-breath-holding and three-dimensional turbo spin-echo techniques are being used to produce superb MRCP images. The main pancreatic duct and common bile duct can be seen well, but there is still a question as to whether changes can be detected consistently in the secondary ducts. The secondary ducts are not visualized in a normal pancreas. Secretin-enhanced MRCP is currently under investigation but is emerging as a method to better evaluate ductal changes. In anteroposterior imaging, T2 imaging of fluid collections can differentiate necrotic debris from fluid in suspected walled-off necrosis, and T1 imaging can diagnose hemorrhage in suspected pseudoaneurysm rupture.

Both EUS and MRCP have largely replaced ERCP in the diagnostic evaluation of pancreatic disease. As these techniques become more refined, especially with the administration of secretin, they may well be the diagnostic tests of choice to evaluate the pancreatic duct. ERCP is still needed for treatment of bile duct and pancreatic duct lesions. ERCP is primarily of therapeutic value after CT, EUS, or MRCP has detected abnormalities requiring invasive endoscopic treatment. ERCP can also be helpful at clarification of equivocal findings discovered with other imaging techniques (see Chap. 371, Fig. 371-1). Pancreatic carcinoma is characterized by stenosis or obstruction of either the pancreatic duct or the common bile duct; both ductal systems are often abnormal (double-duct sign). In chronic pancreatitis, ERCP abnormalities in the main pancreatic duct and side branches have been outlined by the Cambridge classification. The presence of ductal stenosis and irregularity can make it difficult to distinguish chronic pancreatitis from carcinoma. It is important to be aware that ERCP changes interpreted as indicating chronic pancreatitis actually may be due to the effects of aging on the pancreatic duct or sequelae of a recent attack of acute pancreatitis. Although aging may cause impressive ductal alterations, it does not affect the results of pancreatic function tests (i.e., the secretin test). Elevated serum amylase levels after ERCP have been reported in the majority of patients, and clinical pancreatitis in 5–10% of patients. Recent data suggest that pancreatic duct stenting and rectal indomethacin can decrease the incidence of ERCP-induced pancreatitis. ERCP should rarely be done for diagnostic purposes and should especially be avoided in high-risk patients.

PANCREATIC BIOPSY WITH RADIOLOGIC GUIDANCE Percutaneous aspiration biopsy or a trucut biopsy of a pancreatic mass often distinguishes a pancreatic inflammatory mass from a pancreatic neoplasm.