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Imaging the Pancreas: Into the Deep

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I'm tired of all this nonsense about beauty being skin deep. That's deep enough. What do you want, an adorable pancreas?

—*Jean Kerr* (American Writer, 1923–2003)

The pancreas, lying deep to the stomach and duodenum, is among the most inaccessible organs in the body to direct palpation, visualization, and biopsy. Hence, confirmation of pancreatic disease has remained a great challenge in medicine. Two diseases in particular present special challenges to gastroenterologists, namely detection of early pancreatic cancer and diagnosis of chronic pancreatitis (CP). In this review, I discuss major recent advances in imaging the pancreas with a focus on CP.

Diagnosis of CP remains challenging and controversial. Patients presents with vague and nonspecific symptoms that overlap considerably with functional dyspepsia. Therapy is often challenging and complicated by the social stigma of chronic narcotic use and enzyme replacement of variable efficacy. One of the first attempts to reach consensus on the diagnosis of CP was the Cambridge classification, based on a 1983 meeting of experts in Cambridge, England.[1] This was one of the first standardized, image-based classification systems that relied on endoscopic retrograde pancreatography (ERP) and extracorporeal ultrasound. This landmark study set the stage; however, the methodologies for pancreatic imaging have now become nearly obsolete because of the risk of the diagnostic procedure (ERP) and the poor accuracy of ultrasound, especially in the head of the pancreas.

Pancreatic function testing, to diagnose CP, complements the "form" of imaging with the "function" of measuring bicarbonate production after stimulation of the pancreas with secretin. These tests have proven highly valuable in a research setting, but have had limited application owing to difficulty with test standardization outside of a few academic laboratories, and patient discomfort due to the requirement of prolonged nasoduodenal intubation.

Over the past 5–10 years, imaging has reemerged as a valuable and safe method for detection of CP, although controversy remains. Endoscopic ultrasound (EUS) was modified from a joint effort of the American and Japanese Cancer Institutes to improve detection of pancreatic cancer.[2] The close proximity of the pancreas to the gastric and duodenal lumen permits EUS to obtain high-frequency, high-resolution imaging without interference by overlying bowel gas.

The EUS diagnosis of CP relies on quantitative and qualitative parenchymal and ductal criteria of which several have been published[3] (Figure 1). It is generally accepted that in the absence of any criteria, CP is unlikely, whereas in the presence of ≥5 criteria, CP is highly likely even though endoscopic retrograde cholangiography (ERCP) and tests of pancreatic function may still be normal. The clinical significance of fewer (1–4) features found on EUS is unclear, particularly when other diagnostic tests such as ERCP and function testing are normal.

EUS has allowed for the recognition of several features of CP that had not been appreciated with other imaging modalities. These include hyperechoic margins of the pancreatic duct, subtle lobularity of the parenchyma, small cystic changes in the parenchyma, and side branch duct ectasia. The ability to detect these subtle changes has raised questions as to how CP should be defined and whether EUS may be overly sensitive. However, accumulating evidence suggests that these early changes detected by EUS correlate with histologic changes of early or mild CP and may predict progression to more overt disease.[4] Recently, EUS has been combined with endoscopic aspiration of pancreatic juice after secretin stimulation, thus allowing simultaneous evaluation of pancreatic form and function.[5]

EUS also has significant limitations. The procedure has only recently become widely available in most tertiary care centers and clinical practices. Training in EUS is still limited; pancreatic EUS is one of the most difficult techniques to learn. Even among expert endoscopists, there is limited agreement on which individual features of CP are present at EUS, although agreement on whether the pancreas is normal or abnormal is good.[6] Overall, EUS appears to have very

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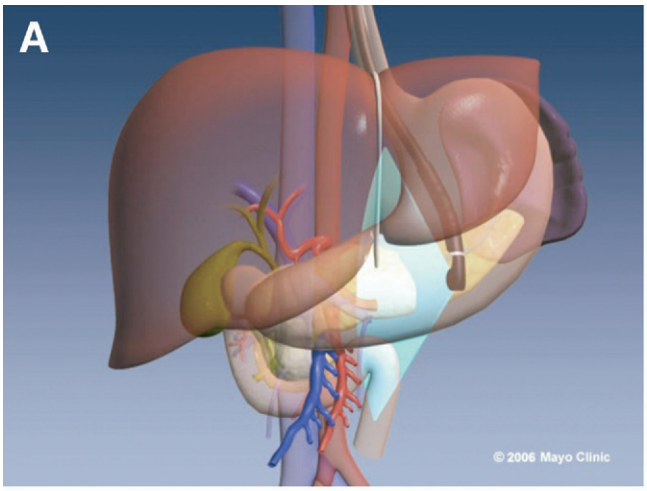

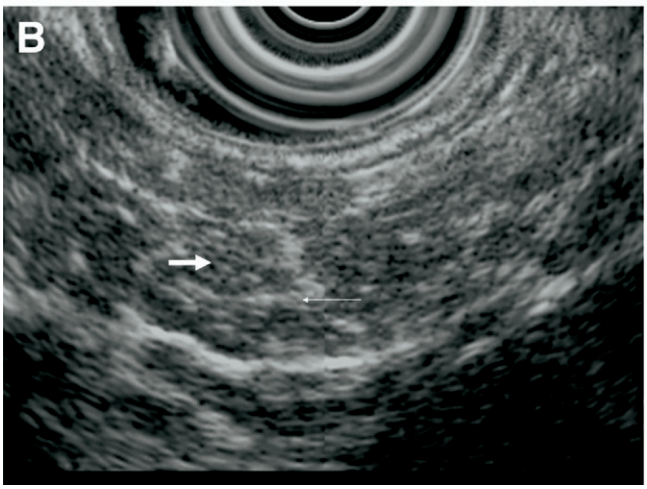

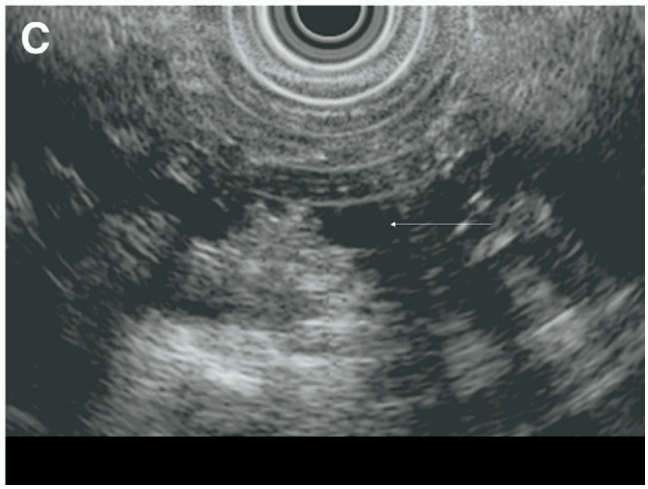

Figure 1. (*A*) Schematic of endoscopic ultrasound instrument in the stomach, image the pancreatic body and tail. (*B*) Top: Endoscopic ultrasound view of pancreatic parenchyma showing lobulation (*thick arrow*) and hyperechoic (*bright*) strands surround lobule (*thin arrow*). (*C*) Bottom: Endoscopic ultrasound view of the pancreatic duct (*arrow*) showing dilation and irregular contour.

high sensitivity for disease and is thus valuable to "rule out" CP in patients with nonspecific abdominal pain; however, specificity is only moderate and likely requires other tests to confirm. Until recently, the only other available tests, such as ERP or pancreatic function testing, also have major limitations. In this setting, magnetic resonance imaging (MRI) of the pancreas is a welcome addition.

Like EUS, MRI can image both pancreatic parenchyma and ducts, as well as some aspects of pancreatic function. This is particularly true when used in combination with secretin stimulation. MRI characteristics of early CP include decreased signal on T_1-weighted fat-suppressed images, delayed enhancement after intravenous gadolinium administration, and dilated or irregular pancreatic ducts and side branches on MRCP (Figure 2). Late changes are less challenging to recognize but include pancreatic atrophy (Figure 3), pseudocyst development, and calcifications (although these are more recognizable on computed tomography).[7]

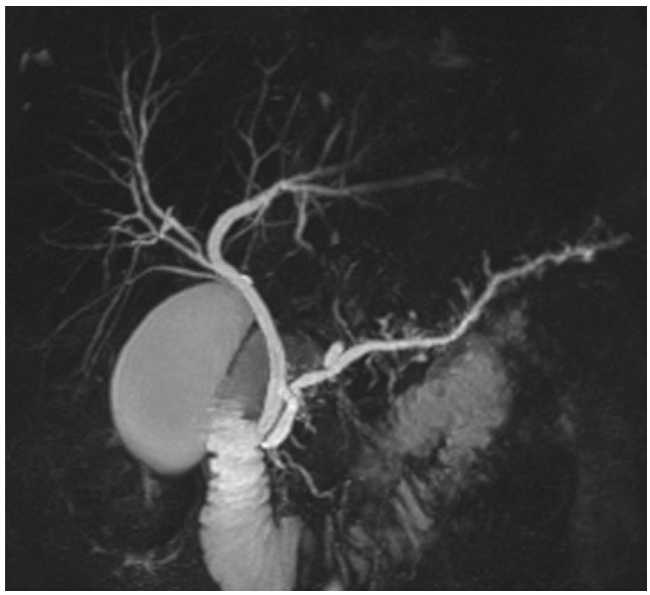

Figure 2. Coronal volumetric MRCP (heavily T_2-weighted MRI) showing simple CP, pancreatic duct dilatation and side branch clubbing. (Courtesy of Mellena Bridges, MD, Mayo Clinic Jacksonville, Department of Radiology.)