Chronic pancreatitis

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INTRODUCTION

EUS was developed to improve the imaging of the pancreas. High-quality images of the pancreas can be obtained because the pancreas lies close to the gastric and duodenal lumen. EUS is considered safer than endoscopic retrograde pancreatography (ERP) and can detect abnormalities suggestive of chronic pancreatitis (CP) in the pancreatic parenchyma and duct that is not visible on any other imaging modality. The diagnosis of CP via EUS relies on quantitative and qualitative parenchymal and ductal criteria found during examination of the pancreas. It is generally accepted that, in the absence of any criteria, CP is unlikely, whereas in the presence of ≥ 5 criteria (of 9 total) CP is likely, although ERP and standard tests of pancreatic function may still be normal. The diagnostic significance of patients with fewer[1-4] features found on EUS is currently unclear, particularly when other diagnostic tests, such as ERP and function testing, are normal. Through early feasibility studies in the use of EUS for the imaging of the pancreas and the diagnosis of CP, several important observations were made.[1-4] EUS had significant technical advantages over transabdominal US (TUS), because of the lack of overlying bowel gas and higher-resolution images obtained with high-frequency transducers. In addition, these high-quality images led to the detection of several new features of CP not previously seen on TUS or CT. These features include hyperechoic margins of the pancreatic duct, lobularity of the parenchyma, small cystic changes in the parenchyma, and side-branch duct ectasia. With the discovery of new subtle features, there is a question of whether EUS is too sensitive.

EUS FEATURES OF A NORMAL PANCREAS

To diagnose CP via EUS, it is necessary to understand the ''normal'' features of the pancreas. Ikeda et al[5] reported the TUS features (when using a 3.5-MHz or 5-MHz transabdominal probe) of the pancreas in 130,951 ''screening'' examinations performed in Japan. Although these data cannot be completely translated to EUS findings, several important conclusions can be made from this large population survey. The pancreatic-duct diameter, which is measured similarly by TUS and EUS, was dilated (>3 mm) in only 0.49% of individuals and was more common in men and older individuals. In fact, there was a strong trend toward an increasing duct diameter with age. Cystic lesions and calcifications were detected in 0.21% and 0.05% of individuals. However, TUS may underestimate the prevalence of these abnormalities compared with EUS.

Several studies evaluated the pancreas in ''control'' populations, such as those patients undergoing EUS for nonpancreatic indications, such as nonpancreatic tumor staging, submucosal tumors, or portal hypertension.[6,7] Although important contributions, there may be important pancreatic changes in these populations because of similar risk factors (ethanol) or severe cachexia (nonpancreatic malignancies). Nattermann et al[7] reported EUS findings in 20 patients without suspected pancreatic disease. They described the pancreatic parenchyma as a ''homogeneous fine granular pancreas with smooth margins.'' The pancreatic-duct diameter in the body was, on average, 1.9 mm (range 1.5-2.4 mm).[7] Catalano et al[6] reported 25 patients without suspected pancreatic disease. They described the parenchyma as ''homogeneous and finely reticulated, without evidence of side-branch ectasia'' (Fig. 1). A ventral anlage (echogenic difference between the ventral and dorsal pancreas) was seen in 68% of controls (Fig. 2). No cysts or stones were described. The main pancreatic duct was uniformly tubular in shape, with anechoic walls and a mean diameter (in the pancreatic body at the portal vein confluence) of 1.7 mm (range 1-3 mm). Side branches were visible in 32% (8 of 25 patients).

Wiersema et al[8] evaluated the EUS criteria of a small group of healthy volunteers with no history of abdominal pain or alcohol abuse. The pancreatic parenchyma was ''uniform'' and more echogenic than the liver. A ventral anlage was detected in 45%. No cysts were seen. The main pancreatic-duct diameter was 2.4 mm (range 0.8-3.6 mm) in the head, 1.8 mm (range 0.9-3.0 mm) in the body, and 1.2 mm (range 0.5-2.0 mm) in the tail. Side branches were visible but narrow in normal individuals (mean diameter: 0.8 mm, head; 0.5 mm, body; 0.3 mm, tail). These data from control populations and healthy volunteers provide important standards for the normal EUS appearance of the pancreas but are limited by their small numbers and potential biases in control populations.

EUS FEATURES OF CP

Parenchymal features

The parenchymal features are shown in Table 1. The 5 pancreatic parenchymal features of CP include the following:

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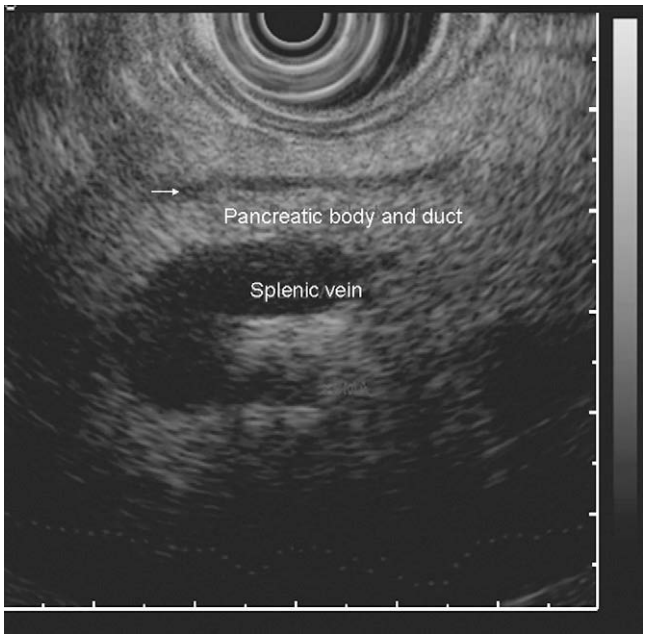

Figure 1. Normal pancreas. The echotexture of the pancreatic body is homogeneous, with a fine reticular pattern; the main pancreatic duct (*arrow*) is uniform is size, with anechoic margins and without visible side duct branches; the splenic vein is seen traversing below the main pancreatic duct.

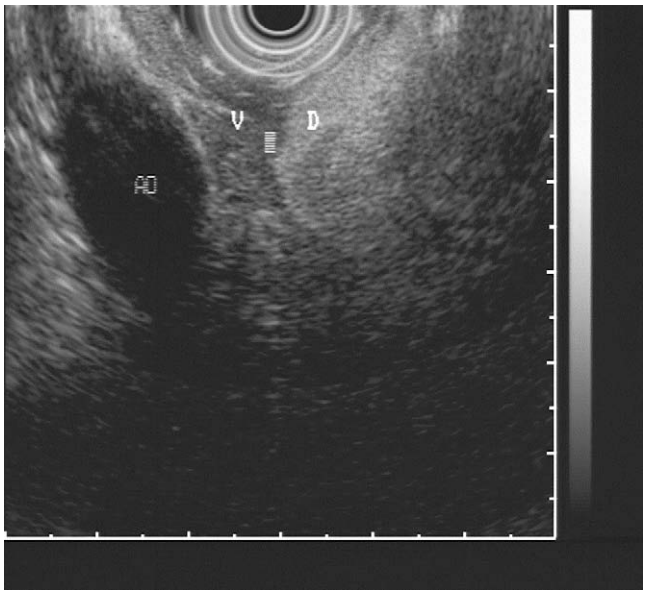

Figure 2. Ventral anlage. There is distinct difference in the echotexture of the brighter dorsal pancreas (*D*) and the darker ventral pancreas (*V*); the aorta (*A0*) is traversing along the ventral pancreas.

hyperechogenic foci, hyperechogenic strands, lobulation, cysts, and calcification. Hyperechogenic foci are small distinct bright echoes and hyperechogenic strands are bright string-like structures, which correlate, on histologic examination, with focal and bridging fibrosis. The process of these hyperechogenic strands forming a rounded homogeneous area is called lobulation. (Fig. 3) A cyst (Fig. 4) is an anechoic round or oval structure that represents a fluid-filled structure, and calcification (Fig. 5) is a hyperechoic lesion with acoustic shadowing.

TABLE 1. EUS criteria for CP

EUS criteria for CP	Appearance	Histologic correlate
Hyperechoic foci	Small distinct foci of bright echoes	Focal fibrosis
Hyperechoic strands	Small string-like bright echo	Bridging fibrosis
Lobularity	Rounded areas separated by hyperechoic strands	Fibrosis, glandular atrophy
Cyst	Abnormal anechoic round or oval structure	Cysts, pseudocysts
Calcification	Hyperechoic lesion with acoustic shadowing within the pancreas	Parenchymal calcification
Ductal dilatation	>3 mm in the head, >2 mm in the body, >1 mm in the tail	Duct dilatation
Side branch dilatation	Small anechoic structure outside the main pancreatic duct	Side-branch dilation
Duct irregularity	Coarse uneven outline of the duct	Focal dilatation, narrowing
Hyperechoic duct margins	Hyperechoic margins of the main pancreatic duct	Periductal fibrosis

Ductal features

The ductal features are presented in Table 1. The 4 ductal features of CP include the following: the dilated duct, irregular duct, hyperechogenic-ductal margins, and visible side-branch ducts. The main pancreatic duct is considered to be dilated if the size is larger than 3 mm in the head, 2 mm in the body, and 1 mm in the tail. An irregular duct is a tortuous main pancreatic duct, which correlates to focal dilatation and narrowing. When the duct lining is hyperechoic, this is considered to be a hyperechoic-duct margin. Visible side-branch ducts are tubular anechoic structures seen outside the main pancreatic duct (Fig. 6).

The threshold for diagnosing CP based on EUS can be varied (eg, ≥ 3, ≥ 4, or ≥ 5 criteria). The ''sensitivity'' and ''specificity'' of EUS compared with ERP or histology depends on which threshold is chosen. A low threshold (>1-2 criteria) will produce a high sensitivity and a negative predictive value but a low specificity and positive predictive value. However, a higher threshold (>5-6 criteria) will produce a high specificity and positive predictive value but