Advanced MR Imaging Techniques for Pancreas Imaging

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KEYWORDS

• MR imaging pancreas • Diffusion-weighted imaging • Secretin enhanced MRCP • MR perfusion • MR elastography • Pancreatitis • Pancreatic neoplasms

KEY POINTS

- Advances in pancreatic MR imaging, specifically using diffusion-weighted imaging and secretin-enhanced MR cholangiography, have improved the diagnostic performance of MR in the evaluation of pancreatic diseases.
- Diffusion-weighted imaging has the potential to identify and characterize both focal and diffuse pancreatic processes.
- Diffusion-weighted imaging has better sensitivity than conventional computed tomography in detecting causal pancreatic tumors in acute pancreatitis, and is more accurate in identifying infected peripancreatic fluid collections.
- Diffusion-weighted imaging can help to distinguish chronic pancreatitis from normal pancreas, and may aid in identifying and monitoring treatment response in the setting of autoimmune pancreatitis.

INTRODUCTION

Advances in imaging techniques have led to an increased use of MR imaging in the evaluation of the pancreas[1] (**Table 1**). Optimization of diffusion-weighted imaging (DWI) has allowed for an increasing role in body applications, especially in the detection and characterization of pancreatic disorders.[2–4] Several studies have demonstrated promising results in using DWI for the detection and staging of acute pancreatitis (AP), grading chronic pancreatitis (CP), and detecting as well as monitoring treatment response for autoimmune pancreatitis (AIP).[5–8] Also, there is an increasing role of DWI in detecting and characterizing pancreatic lesions, identifying early hepatic and nodal metastases, and assessing for malignant degeneration in cystic pancreatic neoplasms.[9–11] MR cholangiography (MRCP) is an established, noninvasive alternative to endoscopic retrograde cholangiography (ERCP) for the evaluation of anatomic variation and diseases of the biliary and pancreatic ducts. More recently, secretin-enhanced MRCP (S-MRCP) has emerged as a useful adjunct in assessing pancreatic disorders with improved detection of morphologic abnormalities of the pancreatic duct and evaluating acute and CP.[12–15] Additionally, emerging MR techniques show promise in evaluating pancreatic diseases. MR perfusion techniques including

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Table 1
Advanced MR techniques for pancreatic imaging

Advanced MR Techniques	Description
Diffusion-weighted imaging	• Depicts the random microscopic motion of water molecules, which depend on tissue cellularity and cell membrane integrity. • Tissue types that exhibit restricted diffusion include tumor, inflammation, infections, and fibrosis. • Use of multiple b-values and generation of ADC maps allow for qualitative and quantitative assessment of pancreatic disease processes.
MRCP	• Exploits heavily T2-weighted imaging to evaluate the pancreatic duct and biliary tract. • Strong correlation between MRCP and ERCP in regards to pancreatic duct assessment.
S-MRCP	• Secretin distends the pancreatic duct allowing for better delineation of ductal anatomy on MRCP. • S-MRCP can identify subtle side branch dilatation in mild chronic pancreatitis, complex ductal anomalies and stenosis of the pancreatic duct. • S-MRCP can be used to evaluate the exocrine response of the pancreas.
MR perfusion	• MR perfusion assesses regional tissue perfusion based on the dynamics of uptake and washout of contrast agents. • MR perfusion may be useful in evaluating for pancreatic cancer and assessing treatment response to antiangiogenic therapies.
T1 mapping/relaxometry	• T1 relaxation time of pancreatic parenchyma increases with fibrosis, atrophy and edema. • Detection of subtle changes in T1 relaxation may be helpful in the early detection of pancreatic parenchymal diseases.
MRE	• MRE detects changes in tissue stiffness, which may result from fibrosis, inflammation or edema. • Detection of increased stiffness could indicate and potentially quantify pancreatic parenchymal diseases such as chronic pancreatitis.

Abbreviations: ADC, apparent diffusion coefficient; MRCP, MR cholangiography; MRE, MR elastography; S-MRCP, secretin-enhanced MRCP.

dynamic-contrast enhancement (DCE) are mostly in the early phases of investigation, but show potential in assessing tumor perfusion, especially in evaluating treatment response to antiangiogenic therapies.[16] T1 mapping/relaxometry of the pancreas has demonstrated promising results in distinguishing between mild CP and disease-free pancreas.[17] MR elastography (MRE) has been shown to be the most accurate noninvasive test to assess hepatic fibrosis in chronic liver disease, and the application to deeper organs such as the pancreas are being developed.[18] In this article, we discuss the advances in pancreatic imaging using the aforementioned techniques.

DIFFUSION-WEIGHTED IMAGING

Principles

Diffusion-weighted MR imaging exploits the random thermally induced mobility of water molecules, known as Brownian motion, in the biological environment. The restriction of water molecules results in high signal intensity on DW images and low signal on apparent diffusion coefficient (ADC) maps, whereas the unimpeded movement of water results in high signal intensity on DW images, which has decreased signal at higher b-values and high signal on ADC maps.[19]

Technical Considerations

Improvements in MR technology with the optimization of "ultrafast" echoplanar and parallel imaging, and refinements in high-density surface coils and respiratory navigation have allowed for an increased role of DWI in body applications.[20,21] The fast spin-echo T2-weighted sequence allows for the measurement of diffusion by using a pair of gradients that are applied before and after the 180° refocusing radiofrequency pulse. In restricted diffusion, the phase shift caused by the first gradient is canceled by the second gradient, resulting in no significant loss of signal.[2–4] Conversely, in free diffusion, the interval