The Role of MR Imaging in Pancreatic Cancer

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KEYWORDS

• Pancreas • Adenocarcinoma • Pancreatic neoplasm • MR imaging • Staging • Diagnosis

KEY POINTS

- The superior soft tissue contrast of MR imaging facilitates the detection of small, non–contour-deforming pancreas tumors that are suspected but remain occult on CT.
- MR imaging can serve as a problem-solving tool for characterizing indeterminate findings in the pancreas at CT.
- MR imaging can improve the detection and characterization of liver lesions in patients with pancreatic ductal adenocarcinoma, thereby improving the selection of appropriate surgical candidates.

INTRODUCTION

Pancreatic ductal adenocarcinoma (PDAC) is the third leading cause of cancer-related deaths in the United States and is anticipated to become second by 2030.[1] Accurate diagnosis and staging are pivotal for guiding treatment planning and potentially for improving outcome for patients with this malignancy. PDAC is particularly challenging to image, and meticulous technique is imperative to diagnose and stage this often subtle and infiltrative tumor. Although computed tomography (CT) is the established and most widely used modality for imaging PDAC, MR imaging can play an important role. This article reviews the MR imaging appearance of PDAC and its mimics, and the role of MR imaging in the diagnosis and staging of this disease.

MR IMAGING TECHNIQUES FOR IMAGING PANCREATIC DUCTAL ADENOCARCINOMA

A complete MR imaging evaluation of the pancreatic parenchyma and the pancreaticobiliary ductal system should include the following sequences: (1) T1-weighted dual-echo; (2) T2-weighted fast spin-echo or single-shot fast spin-echo; (3) 3-D magnetic resonance cholangiopancreatography (MRCP); and (4) T1-weighted fat suppressed 3D gradient-echo acquisition before and dynamically after intravenous administration of gadolinium-based contrast material. Additionally, diffusion-weighted imaging (DWI) is an increasingly used optional sequence that may improve the detection and characterization of pancreatic lesions. A suggested protocol for pancreas MR imaging is included in **Table 1**.

The characteristic MR imaging appearance of PDAC includes a hypoenhancing infiltrative pancreatic mass, abrupt ductal cutoff at the site of the mass, pancreatic ductal obstruction, and pancreatic atrophy (**Fig. 1**). The classic double duct sign may be seen in up to 77% cases of pancreatic head masses, which causes obstruction of both the pancreatic and bile ducts.[2] Masses in the uncinate process may present with no or minimal ductal dilation, and the uncinate process

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Table 1
Suggested pancreatic MR imaging protocol

Sequences	Plane	Slice Thickness/Gap	Comments
2-D T2-weighted single-shot fast spin-echo	Axial and/or coronal	4–5 mm/no gap	Alternative: 2-D axial T2-weighted fast spin-echo
2-D T1-weighted gradient-echo in/opposed phase	Axial	5–6 mm/0.5–1 mm	Alternative: 3-D Dixon technique for in/opposed phase
3-D MRCP	Coronal	1.5 mm/no gap	
3-D T1-weighted SPGR with fat saturation, precontrast	Axial and coronal	3–4 mm/no gap	
3D T1-weighted SPGR with fat saturation, dynamic postcontrast	Axial and coronal	3–4 mm/no gap	Dynamic timing[a]: Axial: 20 s, 45 s, 90 s, 120 s Coronal: 300 s
DWI	Axial	5–6 mm/no gap	Suggested b-values: 0–50 s/mm^2, 400–500 s/mm^2, 800–1000 s/mm^2

Abbreviation: SPGR, spoiled gradient.
[a] If hepatobiliary contrast material such as gadoxetate disodium is used, further delayed imaging at hepatobiliary phase (15–20 min) would be added.

should always be carefully evaluated at imaging for presence of any subtle abnormalities.

One of the biggest strengths of MR imaging is the superior soft tissue contrast compared with other modalities, such as CT. This can be particularly useful when a patient is unable to get iodine-based CT contrast. MR imaging without gadolinium contrast can still provide important information on the abdominal organs including pancreas and liver. Normal pancreas has high signal on T1-weighted fat-suppressed images prior to contrast administration. The hyperintense signal has been attributed to aqueous proteinaceous contents of the gland; high content of paramagnetic ions, such as manganese; and high amounts of endoplasmic reticulum within the glandular tissue.[3,4] In contrast, PDAC is usually hypointense against the background of hyperintense parenchyma on T1-weighted sequences, thereby facilitating its visualization. Pancreatic duct obstruction by tumors can lead to pancreatitis in the obstructed gland, which may become hypointense relative to the unobstructed glandular tissue on T1-weighted images. On T2-weighted images,

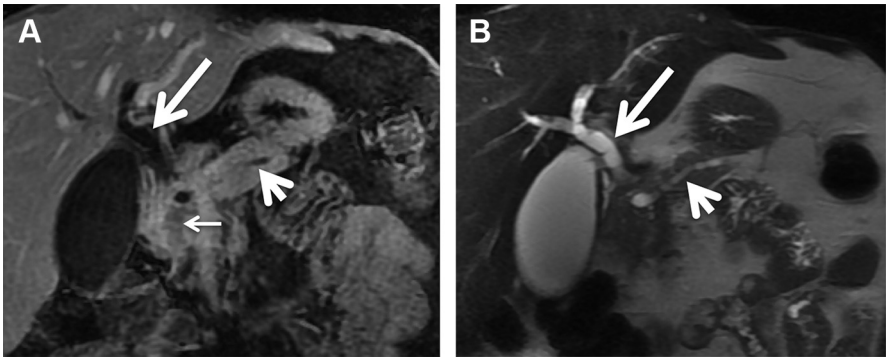

Fig. 1. Classic imaging appearance of PDAC in a 45-year-old man. (*A*) Coronal gadolinium-enhanced T1-weighted image shows a hypoenhancing mass (*thin arrow*) in the head of the pancreas with pancreatic duct dilatation (*short thick arrow*) and bile duct dilatation (*long thick arrow*). (*B*) Coronal T2-weighted single-shot fast spin-echo image shows the pancreatic duct dilatation (*short thick arrow*) and bile duct dilatation (*long thick arrow*), caused by the obstructing mass, to better advantage.

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