

Title: Tailored Techniques for Biliary and Pancreatic Imaging
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Target Audience: Physicians and MR physicists/engineers interested in clinical imaging of the pancreas.

Outcome/objectives: To understand key issues in developing clinical protocols for MR imaging of the pancreas, including:

1. Clinical utility of different pulse sequence types
2. Magnetic resonance cholangiopancreatography (MRCP) techniques
3. Timing of imaging with respect to intravenous contrast administration
4. Motion-robust imaging

Magnetic resonance imaging is an excellent technique for evaluating pancreatic pathology. It is the best cross-sectional method for detecting pancreatic cancer, and provides superior depiction of the biliary and pancreatic ductal systems. Careful pulse sequence selection and optimization is important for developing clinical imaging protocols.

Indications for pancreatic MRI include: upper abdominal pain; complications of acute pancreatitis; jaundice/biliary obstruction; detection of pancreatic cancer; follow up of pancreatic cysts; and searching for causes of chronic pancreatitis.

For most applications, high-quality depiction of the biliary and pancreatic ducts is critical and aids in the detection of tumors, strictures, intraductal stones/debris, and other treatable causes of obstruction. Heavily T₂-weighted fast spin echo sequences with strong fat suppression are used to acquire these MRCP sequences. In general, MRCP can be performed with: thick slab, motion-insensitive techniques, which suffer from low SNR and volume averaging effects; thin slice acquisitions with maximum intensity projection reconstruction, which provide higher SNR but require robust motion compensation; or other pulse sequences which attempt to balance these benefits and penalties. MRCP sequences are also useful as large field-of-view “overview” sequences, particularly to depict the size and number of cystic lesions and their relationship to the ductal system.

Dynamic contrast-enhanced sequences are most important for the detection and characterization of focal pancreatic lesions. The primary decision point in the differential diagnosis of solid pancreatic lesions relates to their enhancement characteristic in the arterial phase, separating hyperenhancing lesions (typically neuroendocrine tumors, renal cell carcinoma metastases, or rarely pseudoaneurysms) from hypoenhancing lesions (pancreatic adenocarcinoma, pseudotumors, and rarely lymphoma). Contrast administration is also important for detecting pancreatic necrosis, an important predictor of pancreatic duct injury and poor clinical outcomes after acute pancreatitis. Additionally, the typically high spatial resolution of these sequences is key for depicting vascular abutment, invasion, and occlusion, criteria which are the primary determinants of the local tumor resectability. For that application, non-enhanced, non fat-suppressed images can be advantageous for demonstrating intact fat planes around critical blood vessels.

Accurate timing of early phase post-contrast is important for depiction of hyperenhancing pancreatic lesions as well as the regional arterial anatomy. Bolus triggering techniques are commonly used for this purpose. In addition, multi-phase acquisition methods are gaining popularity for realizing accurate timing, and have the additional benefits of motion robustness and separate depiction of the arteriographic and parenchymal phases.

In addition to MRCP, moderately T₂-weighted images with fat suppression can be helpful for identifying subtle peripancreatic edema. They also provide a degree of redundancy for ductal evaluation when MRCP images are suboptimal due to poor fat suppression or other factors.

Diffusion-weighted imaging (DWI) may have some utility as an ancillary sequence in pancreatic imaging. First, DWI provides superior image contrast for detecting solid lesions and visualizing lymph nodes, and can be useful for identifying small neuroendocrine tumors. Second, DWI acquired with a free breathing/multiple averages technique may provide images which are less affected by motion, compared with respiratory triggered techniques in patients with irregular breathing patterns.

Motion compensation or correction is important in pancreatic imaging, as the normal structures and lesions in this area may be small, and minor motion can cause substantial image degradation. Respiratory triggering is commonly used for MRCP and fast spin echo T₂-weighted image acquisition. Additionally, single shot techniques are very robust to motion, though they suffer from lower signal-to-noise and relatively poor T₂-weighting. Currently, conventional T₁-weighted sequences are the motion mostion-sensitive portions of a standard imaging protocol, motion-robust T₁-weighted sequences combining high temporal and spatial resolution are being developed, and have the potential to address this remaining clinical need.