Use of Magnetic Resonance in Pancreaticobiliary Emergencies

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KEYWORDS

• Emergency MR imaging • Pancreatitis • Cholecystitis • Biliary obstruction • Cholangitis • Bile leak • MRCP • Magnetic resonance cholangiopancreatography

KEY POINTS

- Magnetic resonance (MR) plays a role in the evaluation of several acute pancreaticobiliary conditions, including cholecystitis, pancreatitis, biliary obstruction, pancreatic trauma, and bile leak.
- Several MR imaging features may be used to assist in diagnosis and classification of pancreatic and biliary emergencies, including specific complications.
- Several imaging artifacts and pitfalls exist in the MR imaging of pancreaticobiliary emergencies that can mimic pathology.

INTRODUCTION

Acute abdominal symptoms are a common cause of emergency department visits in the United States. According to the results of a 2010 survey, the Department of Health and Human Services reported 7 million emergency department visits for noninjury abdominal pain in 2007 to 2008.[1] Disorders of the biliary system and pancreas constitute a large portion of these conditions, with approximately 250,000 admissions for acute pancreatitis[2] and more than 700,000 emergent cholecystectomies performed annually in the United States.[3] Cross-sectional imaging has become an invaluable tool in the clinicians' armamentarium to aid in the diagnosis and triage of patients presenting with acute abdominal conditions.

Technological advances in multidetector CT (MDCT) over the past several years, particularly involving the increased speed of acquisition and reduced radiation dose, have made it the workhorse of emergency abdominal imaging. The widespread utility of MDCT in abdominal emergencies is well established.

Despite its secondary role to MDCT, certain clinical scenarios may require evaluation with MR imaging. MR cholangiopancreatography (MRCP), first described in 1991 by Wallner and colleagues,[4] has become an essential tool for imaging the pancreas and biliary system. Heavily T2-weighted images enable rapid and noninvasive evaluation of the biliary tree and localization of pathology. In addition, MR may provide relevant information in patients evaluated for pancreatic or biliary trauma, bile leaks, acute cholecystitis, biliary obstruction, or pancreatitis. When compared with MDCT, MR also offers the distinct advantage of avoiding ionizing radiation.

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NORMAL ANATOMY AND IMAGING TECHNIQUE

The pancreas is a retroperitoneal organ that arises from the endodermal lining of the duodenum. It is formed by fusion of the dorsal and ventral pancreatic buds.[5] The main pancreatic duct (MPD) (duct of Wirsung) drains the body of the pancreas, whereas in some patients the accessory pancreatic duct of Santorini drains into the minor papilla.[5] Certain congenital anomalies can occur that may be relevant in acute abdominal conditions later in life (discussed later).

The 3 components of the portal triad are the hepatic artery, portal vein, and bile duct. The left and right hepatic ducts join shortly after the porta hepatis to form the common hepatic duct. The common hepatic duct joins the cystic duct to form the common bile duct, which runs in parallel to the pancreatic duct until they merge to form the hepatopancreatic ampulla of Vater.[6] Variant ductal anatomy may have implications in diagnosis and clinical management (discussed later).

Imaging Protocols

At the authors' institution, abdominal MR with MRCP sequences using phased-array surface body or torso coils is standardized (**Table 1**), but certain modifications may be implemented to address a specific clinical question. The contrast agent of choice at the authors' institution is gadobenate dimeglumine. In select cases where detection of a ductal leak is required, gadoxetate disodium may be used, with additional delayed hepatocellular phase images acquired 10 to 20 minutes after the injection of contrast. Currently the use of hepatobiliary contrast agents to detect bile leak is off-label. If a hepatocyte specific agent, such as gadoxetate disodium, is administered, MRCP and other T2-weighted sequences must be acquired prior to contrast administration to prevent T2 shortening in the biliary tree (discussed later).

In addition, MRCP sequences are typically performed when evaluating for pancreaticobiliary pathology. When feasible, patients are administered a negative oral contrast agent immediately prior to imaging to reduce or eliminate the background signal of the proximal gastrointestinal tract. Prior to its discontinuation, an oral suspension of ferumoxsil was routinely administered in the authors' department. Subsequently, the authors have switched to oral administration of pineapple juice. MRCP is typically acquired with both 2-D and 3-D techniques in the authors' department. 2-D MRCP technique is performed using a heavily T2-weighted fat-suppressed single-shot turbo spin-echo (TSE) with 40-mm slice thickness. Six breath-hold or respiratory-triggered images are acquired in the coronal oblique plane at various angles centered about the head of the pancreas. 2-D MRCP images have the advantage of rapid acquisition. 3-D MRCP images are acquired in the coronal plane using a 3-D TSE technique. Although acquisition time is significantly longer than using a 2-D technique, 3-D MRCP imaging allows high-resolution imaging of the biliary tree and the ability to perform multiplanar reconstructions. Maximum intensity projection reformats are acquired in the coronal oblique plane, and additional multiplanar reconstructions may be performed for additional information, including the distinction between choledocholithiasis and air in the duct (discussed later).

IMAGING FINDINGS AND PATHOLOGY

Pancreatic Trauma

Although MR acquisition times have decreased with advances in technology, MDCT remains the imaging modality of choice in the setting of blunt and penetrating abdominal trauma due to its speed, availability, and high spatial resolution. Select patients with blunt pancreaticobiliary injury on MDCT may benefit, however, from additional MR imaging.[7]

Pancreatic injury in the setting of blunt abdominal trauma is uncommon, with reported incidences ranging from approximately 2% to 12%.[8] The associated mortality is considerable, however, and may be as high as 30% to 50%, largely secondary to concomitant injuries.[7] Factors associated with poor outcomes include a delay in the time to diagnosis, high-grade injury, and disruption of the MPD.[7] Elevated serum amylase may be present, but the clinical presentation of pancreatic injury is variable and nonspecific.[9] Blunt pancreatic injuries occur more commonly in the body of the gland, accounting for two-thirds of cases, and are typically caused by a crushing impact against the vertebral column. Because the main cause for morbidity and mortality is disruption of the MPD, assessment for ductal injuries is critical. Deep lacerations (involving greater than 50% of the thickness of the pancreas) are predictive of ductal disruption and may be detected using T1-weighted postcontrast and T2-weighted sequences. Direct injury to the duct may be visible using T2-weighted sequences, including MRCP images (**Fig. 1**).

Pancreatic lacerations, defined as irregular linear, low-attenuation regions in the pancreatic parenchyma on MDCT,[10] may be either superficial (when involving <50% of the parenchymal