

Pictorial review

Magnetic resonance cholangiopancreatography in the evaluation of pancreatic duct pathology

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Abstract. MR cholangiopancreatography (MRCP) may replace direct pancreatography in the evaluation of the pancreatic duct. The aim of this pictorial review is to demonstrate the usefulness of MRCP in the evaluation of pancreatic duct pathology. The examination technique included coronal, sagittal and axial breath-hold HASTE 2D imaging using a body phase array coil. We present the diagnostic features on MRCP of a variety of benign and malignant disorders of the pancreatic duct, and conclude that MRCP is a suitable method for imaging the pancreatic duct system.

Magnetic resonance cholangiopancreatography (MRCP) is a non-invasive imaging technique that accurately depicts the morphological features of the biliary and pancreatic ducts, and is a promising alternative to diagnostic endoscopic retrograde cholangiopancreatography (ERCP).

Technical considerations

The principle of MRCP is based on the acquisition of heavily T_2 weighted sequences in which stationary fluids have a resultant high signal intensity. The advent of fast sequences, especially RARE [1] and its variants, has dramatically shortened the imaging time and has made breath-hold techniques viable. Initially, MRCP was performed using a gradient recall echo sequence (GRE) with parameters that resulted in the generation of a steady state of free precession (SSFP). Using this technique neither the non-dilated biliary tree nor the bile duct distally to the site of obstruction were consistently visualized.

Nowadays two different techniques are used:

- (1) 2D or 3D heavily T_2 weighted FSE, usually with quiet breathing or respiratory gating, but may be used with breath-hold technique.
- (2) HASTE 2D with breath-hold technique.

Pancreatic duct imaging is susceptible to respiratory motion, requiring breath-holding or other respiratory compensating techniques.

Fat-suppression techniques, body arrays and post-processing techniques (MIP and MPR) improve the visualization of the pancreatic duct.

We use a 1 T system (Siemens Magnetom Impact Expert, Erlangen Germany) with phase-array body

coils. We perform two different sequences: firstly an oblique coronal breath-hold heavily T_2 weighted FSE (TR:2800; TE:1100; thickness: 80–40 mm; TA:7 seg.) as a localizer. Afterwards, we perform fat suppressed breath-hold HASTE 2D (TR:10.92; TE:87; TD:100; α :150; TA:15 seg.) in axial, sagittal and coronal planes with multiplanar reformation (MPR) and projection reconstruction (MIP). Other planes may be used to avoid overlying bowel loops.

The use of a negative oral contrast medium is controversial. Although it may eliminate overlapping fluid-containing organs, it obscures the duodenum, and may mask papillary pathology causing pancreatic duct dilatation.

Imaging after injection of secretin may add functional information to MR pancreatography that may reflect one aspect of the pancreatic exocrine physiology [2].

Normal anatomy

The main pancreatic duct is visualized in most cases. It courses cephalad, takes a 45–90° turn in the neck, and continues horizontally in the body and in the tail of the gland (Figure 1). Its normal diameter is between 2 and 3 mm. In normal conditions, neither the accessory duct of Santorini nor the side branches are visualized.

Congenital abnormalities

Pancreas divisum

Pancreas divisum is the commonest anatomical variant in the pancreas. It results from the failure of the ventral and dorsal pancreatic anlagen to fuse during the 6th to 8th week. In most cases, the absence of fusion is complete and no communication exists between the dorsal and the ventral pancreatic duct. Its prevalence is around 10%.

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Until now, the diagnosis of pancreas divisum was made by ERCP. However, owing to its small size, the failure rate of cannulation of the minor papilla is high (30–60%). This is the relative advantage of MRCP in the diagnosis of pancreas divisum. On the other hand, due to limited spatial resolution, the differentiation between complete and incomplete pancreas divisum may be difficult.

Two different and independent ducts are appreciated with MRCP [3]. The dominant pancreatic duct can be continuously tracked from the tail to the head, crossing anteriorly to the common bile duct, and drains into the duodenum (Figure 2). The duct of Wirsung might be normal, atrophic or absent. Transverse sections might be more advantageous than coronal planes (Figure 3) and MPR more useful than MIP to identify this abnormality.

Inflammatory changes

Acute pancreatitis

Recent reports show that MR is a very sensitive technique for demonstrating inflammation. However, the pancreatic duct can be normal in mild cases of pancreatitis (Figure 4).

Occasionally, the enlarged and oedematous pancreas can cause compression of the pancreatic duct. In these cases the pancreatic duct is either not visualized or presents a smooth and symmetric narrowing.

In more severe cases of pancreatitis, MRCP may provide information about the status of the pancreatic duct: the presence of ductal distension, disruption or leakage or the presence of an intraductal lesion that might predispose to pseudocyst formation (Figure 5). However, extrapancreatic fluid may restrict the visualization of the pancreatic duct in these cases. MRCP may easily detect pancreatic pseudocysts, their shape, number and size, providing valuable information for the surgeon.

Chronic pancreatitis

In its mild form, the diagnosis of chronic pancreatitis based on imaging criteria is often relatively subjective. MRCP has a limited application in the diagnosis of early stages of chronic pancreatitis due to its inability to depict non-dilated side branches and calcification, and because of limited spatial resolution.

With disease progression, the main pancreatic duct is involved with the appearance on MRCP of ductal dilatation, mural irregularities, loss of normal tapering, and stenoses. Stenoses are usually shorter, smoother, and more symmetrical than those associated with neoplasm (Figure 6). In advanced chronic pancreatitis, the dilatation is more marked and intraductal calculi may be seen. These calculi are seen as low signal filling defects surrounded by high

signal intensity pancreatic fluid (meniscus sign) (Figure 7). In severe pancreatitis, side branches have a “chain of lakes” appearance [4]. (Figure 8).

Desmoplastic ductal cancer and chronic fibrosing focal pancreatitis are often difficult to differentiate. MRCP can depict both the narrowed main pancreatic duct and the isolated dilated side branches within the mass which may suggest the benign nature of the mass [5]. Although this finding is characteristic of chronic pancreatitis, it is not specific.

Neoplasm

Pancreatic carcinoma

Obstruction of the main pancreatic duct is the most common pancreatographic finding in carcinoma. The ducts proximal to the obstruction may show some pre-stenotic dilatation, but they are otherwise normal, whereas changes consistent with pancreatitis are usual in obstruction due to pancreatitis (Figure 9). The obstruction itself is usually irregular, nodular, rat-tailed or eccentric in carcinoma, and smooth or blunt in pancreatitis. MRCP clearly shows the level, length and extent of the obstruction with adequate visualization of the distal tract.

The next most common appearance is localized encasement of the main pancreatic duct. The encasement is generally 1–2 cm long and irregular. Contiguous obstruction or encasement of the common bile duct, the “double duct sign”, is highly suggestive of malignancy (Figure 10).

Intraductal mucin-producing tumours are seen as cystic side branches dilatation or grape-like lesions with a communicating channel with the main pancreatic duct. MRCP may be superior to ERCP as mucin often impedes contrast filling of the ducts.

Periampullary carcinoma

In cases of ampullary carcinoma, apart from the common bile duct obstruction, high grade obstruction with abrupt termination and mild dilatation of the pancreatic duct is usually present [6] (Figure 11).

Miscellaneous

MRCP may be useful for the localization of the fluid collections, as well as determining the condition of the main pancreatic duct in blunt pancreatic trauma. However, the point of leakage has not been depicted in our experience.

Advantages and limitations

A clear advantage of this technique is the lack of invasiveness. In addition, MRCP is not limited

in patients with altered anatomy (pyloric or duodenal stenosis, hepatojejunostomy) and it is not operator dependent.

The current shortcoming of MRCP is its relatively low spatial resolution which limits the visualization of non-dilated pancreatic duct side branches and the characterization of strictures.



Figure 1. Axial slice, 5 mm. Normal pancreatic duct is seen.

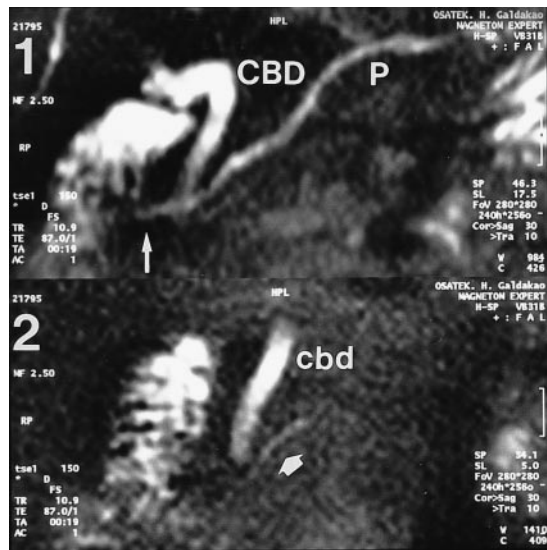


Figure 3. Pancreas divisum. Coronal MIP (1) and 5 mm individual slice (2). Independent drainage of dorsal pancreatic duct (long arrow) and ventral duct (thick arrow) is seen.

Conclusion

MRCP is a promising alternative to ERCP in the evaluation of the pancreatic duct; especially in ill patients, patients with prior gastroduodenal surgery, patients with complete occlusion of the pancreatic duct with or without suspicion of masses and in overweight debilitated or uncooperative subjects.

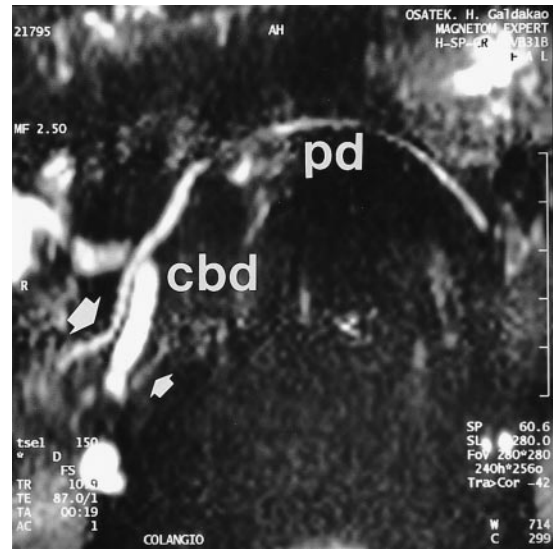


Figure 2. Pancreas divisum. Axial MIP. The ventral pancreatic duct (small arrow) drains with the CBD into the ampulla. The dominant dorsal duct courses anteriorly to the CBD and empties into the duodenum at the minor papilla (thick arrow).

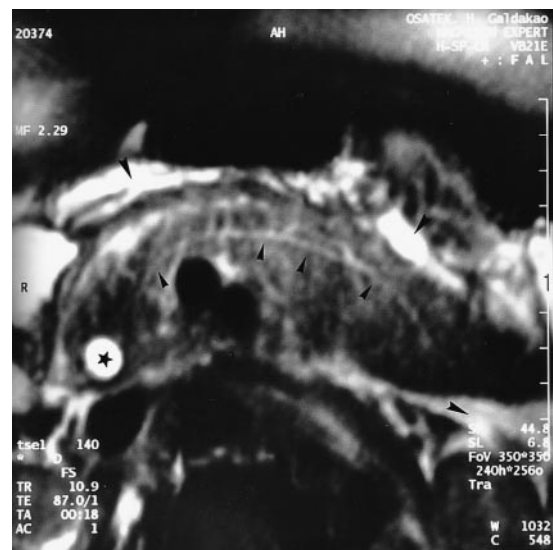


Figure 4. Axial MIP. Mild case of acute pancreatitis with oedematous changes in the retroperitoneal fat. The pancreatic duct is normal (arrows). Mild dilatation of CBD (★) is present.

Figure 5. Axial individual slice, 5 mm. Severe case of acute pancreatitis with necrosis of head and neck. Disruption of the pancreatic duct (long arrow) with pancreatic fluid leakage and a pseudocyst (*) are seen. Oedematous changes of the retroperitoneal fat (short arrows) are present.

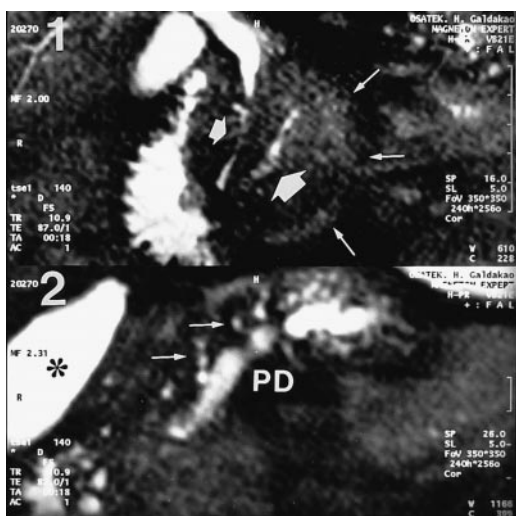


Figure 6. Coronal contiguous slices, 5 mm. (1) A "mass-forming" focal pancreatitis (small arrows) in the head of the pancreas with a smooth narrowing of the pancreatic duct (arrow) as well as the common bile duct (thick arrow). (2) Duct proximal to stenosis show changes of chronic pancreatitis with main duct and side branches dilatation (small arrows).

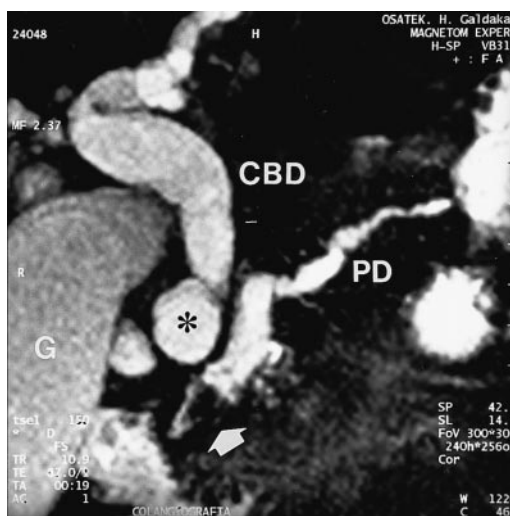


Figure 7. Coronal MIP. Dilated CBD due to pancreatic pseudocyst (*). Intraductal pancreatic lithiasis (arrow) with retrograde pancreatic duct dilatation.

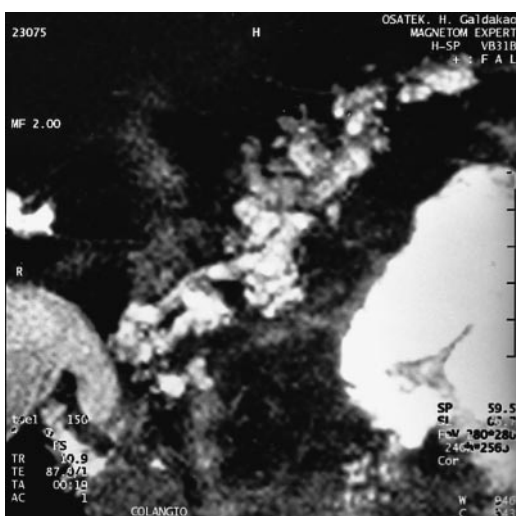


Figure 8. Coronal MIP. Chronic pancreatitis: Dilated and beaded pancreatic duct with side branches dilatation ("chain of lakes" appearance).



Figure 9. Coronal MIP. Marked dilatation of CBD (*) and pancreatic duct (★) due to pancreatic head carcinoma. No changes of chronic pancreatitis are seen in the pancreatic duct.

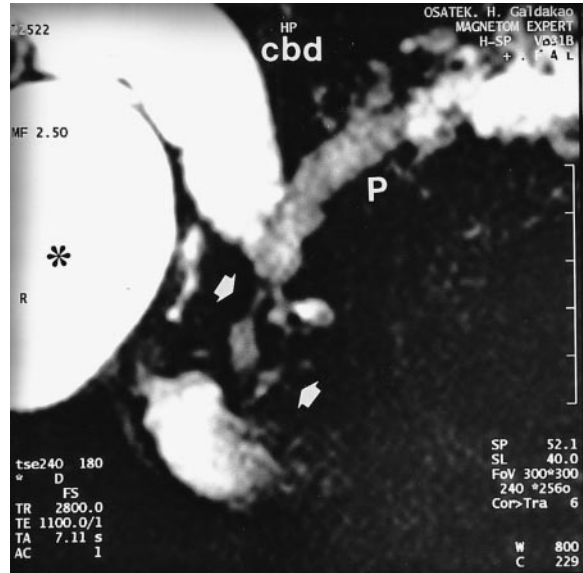


Figure 10. Coronal thick slice, 40 mm. Double duct sign: encasement of both the pancreatic and common bile duct, 2 cm long, with a severe and irregular stenosis highly suggestive of pancreatic neoplasm (arrows). Retrograde dilatation of biliary tree, pancreatic duct and gallbladder is seen.



Figure 11. Coronal MIP. Marked dilatation of the biliary tree and of the pancreatic duct up to the lever of the ampulla where a low signal intensity protruding mass is seen (arrow). Ampullary carcinoma.

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