The Clinical Value of Secretin-enhanced MRCP in the Functional and Morphological Assessment of Pancreatic Diseases

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Learning objectives

- To understand the role of secretin-enhanced MRCP (S-MRCP) in the diagnostic algorithm of patients with pancreatic disorders.
- To become familiar with the technique of S-MRCP.
- To assess pancreatic exocrine function and morphological changes in the biliary tract and pancreatic duct (PD).
- To explain the advantages and limitations of S-MRCP.
Background

Secretin is a gastrointestinal hormone secreted by the duodenal mucosa in response to increased intraluminal acidity. It’s main physiologic effects include stimulation of PD epithelial cells to secrete a bicarbonate-rich fluid and a transient increase in the tone of the sphincter of Oddi. Whereas the former increases the volume of fluid in the PD, the latter delays PD fluid from draining into the duodenum, both of which improve visualization of the PD. To achieve this goal, in an S-MRCP exam, a synthetic secretin-like peptide is administered to the patient intravenously (IV). Thus, S-MRCP is a noninvasive way of evaluating the morphology of the PD. Moreover, due to serial acquisition of PD images, it allows us to infer the ability of the pancreas to respond to secretin. Analyzing the change in PD caliber on serial images allows us to detect the subtle changes occurring in the early stages of disease; early and accurate diagnosis leads to early treatment.

Dynamic S-MRCP examination can estimate:

- Exact anatomy of the main PD by distending it entirely; delineation of side-branches.
- Monitoring of pancreatic duct flow dynamics.
- Qualitative and quantitative evaluation of duodenal filling, which reflects exocrine reserve of the pancreas.

To eliminate signal from overlying bowel and stomach, patients should be prepared as follows:

- Fasting 4 hours prior to the examination.
- Approximately 600 ml of superparamagnetic iron oxide-containing oral contrast agent should be drunken before the imaging.
- When cystic lesions overlie the PD, MRCP sequences should be performed in coronal, sagittal and axial projections.

To decrease the peristalsis either glucagon (0.25-0.5 mg) or buscopan (20-40 mg) are given IV.

Imaging: obtain a single-shot 30-50 mm thick slab MRCP image before secretin injection. The FOV of this image should include the PD biliary tree and duodenum. A scan of this identical area is then repeated every 30 s, for 10 min, after IV administration of secretin.

Secretin should be injected slowly to reduce the likelihood of adverse-effects, for eg. nausea, flushing, abdominal pain.
The recommended dose of secretin is 0.2 µg/kg (at an average 16 µg for adults) or 1 mL/10 kg of body weight.

The peak effect following IV secretin administration is usually observed at 3-5 minutes.

A comprehensive pancreas MR examination consists of a standard pancreas MR protocol and the S-MRCP sequence to evaluate both pancreatic morphology and function in the same sitting.
Findings and procedure details

**Normal Pancreatic Duct**

In healthy patients, the main PD is smooth and has a diameter <3 mm. The normal main PD distends about 1-2 mm in response to secretin and returns to baseline within 10 minutes. The maximum diameter of the PD is observed at 2-8 minutes after injection.

**Acute pancreatitis**

The most frequent causes of acute pancreatitis are alcohol abuse and choledocholithiasis. For both conditions, S-MRCP is not needed. After excluding these disorders, S-MRCP can be helpful in evaluation of anatomic variants and anomalies (pancreas divisum, Santorinicele etc.).

In patients with severe acute necrotizing pancreatitis, S-MRCP can be useful to look for main PD fistulae, rupture or discontinuity, i.e. complications (Fig.1)

**Chronic Pancreatitis**

In the past, chronic pancreatitis was diagnosed and graded by ERCP, according to the Cambridge classification. However, S-MRCP has replaced its invasive counterpart, ERCP, in routine clinical practice. The diagnosis of chronic pancreatitis is made on S-MRCP if any of the following signs are noted:

- Side-branch PD dilation especially in the body and tail of the pancreas (according to Cambridge criteria more than three dilated side-branch ducts establishes the diagnosis of chronic pancreatitis).
- Main PD strictures and/or sacculations.
- Loss of PD tapering within the tail of the pancreas.
- Rigidness of main PD, i.e. failure to dilate in response to secretin.
- Reduced and/or delayed duodenal filling.

Matos et al. suggested a grading system in which duodenal filling is defined as:

Grade 0 when no fluid is observed.

Grade 1 when fluid is limited to the duodenal bulb.

Grade 2 when it partially fills the duodenum up to the genu.

Grade 3 when it fills beyond the genu.
Recurrent Pancreatitis

S-MRCP helps in the evaluation of patients with recurrent episodes of pancreatitis (Fig.2).

Main causes of recurrent pancreatitis:

- **Strictures.** One of the major advantages of S-MRCP over ERCP is an ability to delineate the duct proximal to very severe stricture.
- **Pancreas divisum** can be associated with recurrent pancreatitis because of inadequate pancreatic drainage via the accessory duct. Distention of the ductal system allows visualization of the accessory ducts.
- **Santorinicele** may cause recurrent pancreatitis. S-MRCP may show the focal cystic dilation of the accessory duct and its stenotic site.
- **Pancreatic necrosis or trauma** may result in discontinuity of the PD due to recurrent episodes of inflammation and/or fistula formation.
- S-MRCP helps to assess an intrapancreatic fluid collection along the expected course of main PD or ductal obstruction at the level of this fluid collection.
- **Post-surgical strictures.** Cannulation of the PD, by ERCP, is often difficult in such patients because of the altered anatomy.

Pancreas Divisum

Found in 15-20% of patients with unexplained pancreatitis.

Types of pancreas divisum:

- **Complete.**
- **Incomplete="dominant dorsal duct"** (with a diminished communication between the dorsal and ventral ducts).

Both conditions may have similar manifestations. The accuracy of diagnosing pancreas divisum with S-MRCP is very high (Fig.3).

Santorinicele and Wirsungocele

S-MRCP allows clear delineation of Santorinicele and Wirsungocele; one sees focal saccular distention of the terminal parts of the dorsal (Santorini) and ventral (Wirsung) ducts where they enter into the duodenal wall.

Some authors think that a Santorinicele may be formed as a result of impaired flow across the minor papilla.

Patients with the combined pathology (Pancreas divisum/Santorinicele/Wirsungocele) have an increased risk of recurrent acute pancreatitis.
Anomalous Pancreaticobiliary Junction

S-MRCP has high diagnostic accuracy in the detection this congenital anomaly, which represents a malunion of the pancreatic and biliary ducts before they enter the duodenal wall. On the post-secretin images, distention of gallbladder is sometimes an indirect sign of reflux.

The main perils of this condition:

- Bidirectional flow at the level of confluence because of absence true sphincter muscle.
- Subsequent complications: cholangitis, pancreatitis, calculi formation.
- Increased risk of biliary tract or gallbladder cancer.

Annular Pancreas

It is a congenital anomaly that occurs due to failed or incomplete rotation of a portion of the ventral pancreas during embryologic development. S-MRCP depicts an annular duct encircling the descending duodenum at the level between the major papilla and the minor papilla.

Cystic Lesions

S-MRCP plays a major role in the assessment of cystic pancreatic lesions. The detection of a communication between the cystic lesion and main PD implies that the lesion is an Intraductal Papillary Mucinous Neoplasms (IPMNs). If there is no connection between the cystic lesion and the PD, the lesion is almost certainly a mucinous cystic neoplasms. However, the following caveat is worth mentioning. If, on serial images, the signal intensity of a cyst continues to increase post-secretin stimulation, even if no direct communication with the PD is seen, the lesion very likely does arise from the PD, i.e. is an IPMN (Fig.3,4). Because the treatment of IPMNs and mucinous cystic neoplasms differs greatly, determining PD communication is of critical importance in the work-up of the cystic lesion.

S-MRCP can diagnose all subtypes of IPMN:

- Main duct IPMN (diffuse or segmental).
- Side-branch IPMN.
- Mixed type IPMN.

Pancreatic carcinoma

S-MRCP helps to differentiate an inflammatory pancreatic mass from pancreatic carcinoma; patency of the PD implies the presence of a soft (i.e. inflammation) rather than rigid mass, the so-called penetrating duct sign (Fig.5).
**Fig. 1:** A 33 y.o. male with clinical symptoms suggestive of acute pancreatitis. There is segmental dilatation of the main PD tail. The size of the dilated segment does not change after secretin stimulation. Between the dilated and normal PD, a small pseudocyst, due to pancreatitis, is visualized. A moderate transient increase in the caliber and signal intensity of the main PD, within the body and head of the pancreas, is seen. Note that the duodenum fills completely, indicating that pancreatic exocrine function is normal. PD=pancreatic duct

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Fig. 2: A 55 y.o. male patient with an acute episode of known recurrent chronic pancreatitis. Significant segmental dilation of the main PD is seen along the entire length of the pancreas. Several side-branches are also dilated. The large pseudocyst is due to a former episode of acute pancreatitis. At the transition zone between the head and body of the pancreas, the main PD is obstructed due to a significant stricture. No fluid is seen in the duodenum indicative of reduced or absent exocrine function of the pancreatic gland.

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Fig. 3: A 63 y.o. male with two side-branch type IPMNs and pancreas divisum. S-MRCP dynamic images show the CBD crossing the main PD, which is draining through the minor papilla, consistent with the anatomic variant of pancreas divisum. Coronal images also show two cystic lesions within the head and body of the pancreas which, post-secretin, clearly are seen to communicate with the main PD, consistent with the diagnosis of side-branch IPMN. The main PD is depicted throughout its entire course and is slightly dilated. CBD=common bile duct, PD=pancreatic duct

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**Fig. 4:** A 76 y.o. male patient with segmental IPMN, main-duct type. An irregular and extremely dilated (>10 mm) main PD within the neck and proximal body of the pancreas is visualized. On CT (not shown here), no calcifications were seen. The pancreatic parenchyma is moderately atrophic. These findings are highly suggestive of IPMN from main-duct type with high malignant potential. The diagnosis was confirmed, by histopathology, after operation. PD=pancreatic duct

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Fig. 5: A 49 y.o. male patient with elevated tumor markers and suspicion of pancreatic cancer. No tumor mass was visible on CT (not shown here). On S-MRCP, there is complete obstruction of the upstream segment of main PD causing dilatation of the distal PD. There are signs of focal pancreatitis, as well, within the tail of the pancreas, which resolved after the treatment. However, the obstruction persisted suggestive of a cancer. Following surgical resection, histopathology confirmed the presence of a small T1 adenocarcinoma. PD=pancreatic duct

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Conclusion

S-MRCP is a safe, noninvasive and comprehensive exam for evaluating PD anatomy and exocrine function impairment. It is highly sensitive for early disease, due to its dynamic feature.

Therefore, S-MRCP can be used during the routine MR examination in patients with an equivocal diagnosis, to rule out subtle pancreatic duct involvement, and thus, avoid the development of chronic disease.
References