Clinical Significance of Magnetic Resonance Cholangiopancreatography for the Diagnosis of Cystic Tumor of the Pancreas Compared with Endoscopic Retrograde Cholangiopancreatography and Computed Tomography

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Background: Cystic tumor of the pancreas has been investigated by a variety of imaging techniques. Magnetic resonance cholangiopancreatography (MRCP) is being widely used as a non-invasive diagnostic modality for investigation of the biliary tree and pancreatic duct system. The purpose of this study was to compare MRCP images with those of endoscopic retrograde cholangiopancreatography (ERCP) and computed tomography (CT) in order to clarify the diagnostic efficacy of MRCP for cystic tumor of the pancreas.

Methods: We retrospectively studied 15 patients with cystic tumor of the pancreas that had been surgically resected and histopathologically confirmed. There were five cases of intraductal papillary adenocarcinoma, five of intraductal papillary adenoma, two of serous cyst adenoma, two of retention cyst associated with invasive ductal adenocarcinoma and one of solid cystic tumor.

Results: In all cases MRCP correctly identified the main pancreatic duct (MPD) and showed the entire cystic tumor and the communication between the tumor and the MPD. On the other hand, the detection rate by ERCP of the cystic tumor and the communication between the tumor and the MPD was only 60%. Although the detection rates by CT for the septum and solid components inside the cystic tumor were 100 and 90.0%, respectively, those of MRCP for each were 58.3 and 20.0%.

Conclusion: MRCP is capable of providing diagnostic information superior to ERCP for the diagnosis of cystic tumor of the pancreas. Although MRCP may provide complementary information about the whole lesion of interest, the characteristic internal features of cystic tumor of the pancreas should be carefully diagnosed in combination with CT.

Key words: endoscopic retrograde cholangiopancreatography – cystic tumor of the pancreas – magnetic resonance cholangiopancreatography

INTRODUCTION

Non-invasive diagnostic imaging of the biliary tree and pancreatic duct system has been traditionally performed by ultrasonography (US) and computed tomography (CT). However, these modalities are limited for the demonstration of fine ductal anatomy and intraductal abnormalities. Endoscopic retrograde cholangiopancreatography (ERCP) is the definitive method for evaluating the biliary tree and pancreatic duct system and has been considered the "gold standard" for accurate diagnosis (1,2). In addition, ERCP provides opportunities for endoscopic therapy such as endoscopic sphincterotomy, extraction of ductal stones and biliary drainage for stenosis of the bile duct. However, ERCP is an invasive method and is sometimes unsuccessful or incomplete because of technical difficulties or the presence of Billroth II or Roux-en-Y-anastomosis, peripapillary diverticula and ductal stricture.

Magnetic resonance cholangiopancreatography (MRCP) is a relatively new imaging technique that does not require contrast agents or biliary and pancreatic intervention. Since this technique was introduced by Wallner et al. (3), many clinicians have evaluated the different techniques for MRCP, its accuracy compared with ERCP and the imaging findings in various abnormalities affecting both the biliary tree and pancreatic duct system (4–9).
PATIENTS AND METHODS

We retrospectively studied 15 patients (seven male and eight female) with cystic tumor of the pancreas, which had been surgically resected and histologically confirmed between February 1995 and January 1998 at the National Cancer Center Hospital East, who had been examined by MRCP, ERCP and CT preoperatively. The mean age of all patients was 62 years (range, 50–75). There were five cases of intraductal papillary adenocarcinoma, five of intraductal papillary adenoma, two of serous cyst adenoma, two of retention cyst associated with invasive ductal carcinoma and one of solid cystic tumor. Twelve of 15 cystic tumors were located in the head of the pancreas and three in the body of the pancreas. The mean size of cystic tumor was 4.52 cm (range, 1.5–11.0).

MR imaging used commercially available software in a clinical MR scanner. From February to June 1995 patients underwent MR imaging with a 1.5 T MR system (Magnetom H15; Siemens Medical Systems, Erlangen, Germany) using a body coil, from July 1995 to July 1997 using a surface coil and from August 1997 to January 1998 with a 1.5T SIGMA HORIZON (GE Medical Systems, Milwaukee, WI, USA) using a phased array coil. MRCP was performed with heavily T2-weighted turbo spin echo (TSE) sequences (TR, 8000 ms; TE, 91 ms; slice thickness, 3 mm; FOV, 280 mm; matrix, 120 × 256) during a breath-holding period of 35 s and added fat suppression. The source images were processed with a maximum intensity projection (MIP) algorithm to create three-dimensional (3-D) images of the biliary tree and pancreatic duct system.

ERCP was performed in the usual fashion with selective cannulation and injection of the pancreatic duct and biliary tree with contrast material. In several cases it was performed using a balloon technique. Enhanced helical CT images of both early and late phases were obtained.

MRCP, ERCP and CT images were interpreted by two gastroenterologists and findings were determined by consensus with regard to the ability of each modality to identify the main pancreatic duct (MPD) and to show the entire cystic tumor, the communication between the cystic tumor and the MPD, the cystic pattern, such as solitary or multiple and the septum-like structures and solid components inside the cystic tumor. Histological investigations were also carried out according to the ‘General Rules for the Study of Pancreatic Cancer’ (10).

RESULTS

Table 1 shows the detection rate of MRCP, ERCP and CT for cystic tumor of the pancreas. In all cases MRCP could identify the MPD and the entire image of the cystic tumor and also show the presence and site of the MPD dilatation or stricture, although visualization of branches of the pancreatic duct was insufficient. The cystic lesions were depicted clearly with high and monotonous signal intensity. MRCP could demonstrate accurately the communication between the MPD and cystic tumor, using the 3-D technique.

<table>
<thead>
<tr>
<th></th>
<th>MRCP</th>
<th>ERCP</th>
<th>CT</th>
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<tbody>
<tr>
<td>Main pancreatic duct (MPD)</td>
<td>15/15 (100)</td>
<td>14/15 (93.3)</td>
<td>14/15 (93.3)</td>
</tr>
<tr>
<td>Cystic lesion</td>
<td>15/15 (100)</td>
<td>9/15 (60.0)</td>
<td>15/15 (100)</td>
</tr>
<tr>
<td>Communication between cystic lesion and MPD</td>
<td>15/15 (100)</td>
<td>9/15 (60.0)</td>
<td>14/15 (93.3)</td>
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<tr>
<td>Cystic pattern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(solitary or multiple)</td>
<td>13/15 (86.7)</td>
<td>4/15 (26.7)</td>
<td>15/15 (100)</td>
</tr>
<tr>
<td>Septum-like structure</td>
<td>7/12 (58.3)</td>
<td>3/12 (25.0)</td>
<td>12/12 (100)</td>
</tr>
<tr>
<td>Solid component</td>
<td>2/10 (20.0)</td>
<td>0/10 (0)</td>
<td>9/10 (90.0)</td>
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The detection rate by ERCP of the MPD and cystic tumor was 93.3% (14/15) and 60.0% (9/15), respectively. However, ERCP could not demonstrate the MPD completely where there was ductal stenosis or obstruction and the cystic tumors in nine of the 15 cases were insufficiently contrasted owing to a lot of mucus inside them. ERCP could demonstrate the communication between the MPD and the cystic tumor in nine of 15 cases (60.0%) using imaging with different body positions when the cystic tumors were contrasted.

CT demonstrated the cystic tumors in all cases and the detection rates for the MPD and the communication between the MPD and cystic tumor were both 93.3% (14/15).

Histopathologically, the cystic pattern of the tumor was multiple in 12 cases and solitary in three cases. In addition, septa were recognized in 12 cases and solid components inside the tumor in 10 cases. The cystic tumors with septa in five of the 12 cases were intraductal papillary adenoma, five cases were intraductal papillary adenocarcinoma and five cases were serous cystadenoma. The cystic tumors with solid component in five of the 10 cases were intraductal papillary adenocarcinoma, two cases were intraductal papillary adenoma, two cases were retention cyst associated with invasive ductal carcinoma and one case was solid cystic tumor. From the shape of the image on MRCP the cystic pattern was accurately identified in 86.7% (13/15), septum-like structures were demonstrated in 58.3% (7/12) and solid components in 20.0% (2/10). In MRCP images septa were visualized as linear structures with low intensity separating cystic lesions and solid components were visualized as irregularly margined defects of papillary excrescences whereas mucin was not visualized with low intensity. However, ERCP could identify the cystic pattern and septum-like structures in only 26.7% (4/15) and 25.0% (3/12), respectively and it could not identify solid components at all. On the other hand, the detection rates by CT for septum-like structures and solid components inside the tumor were 100% (12/12) and 90.0% (9/10), respectively. In CT images septum-like structures were visualized as thin or thick linear structures with low or iso density inside the cysts. Solid components were visualized as low or iso density of tubular structures connecting the cysts and which were sometimes enhanced by contrast material.
Two representative cases are presented.

CASE 1

The patient was a 50-year-old man. Cystic tumor of the pancreas was detected by US in the outpatient clinic and he was admitted for further investigation. MRCP showed a lobulated and irregularly margined cystic tumor with monotonous high signal intensity at the pancreatic head with the MPD (Fig. 1a). ERCP revealed the cystic tumor at the pancreatic head almost completely. The appearance of the cystic structure seen with MRCP resembled that obtained with ERCP (Fig. 1b). CT showed the cystic tumor and septa inside the tumor (Fig. 1c). He underwent duodenum-preserving pancreas head resection and histopathologically the tumor was an intraductal papillary adenoma with focal severe atypia, measuring 5.0 × 4.8 × 2.5 cm.

CASE 2

The patient was a 72-year-old man. He was referred to National Cancer Center Hospital East because of a suspected cystic tumor of the pancreatic head. MRCP showed multilobulated cysts with high signal intensity clearly at the pancreatic head with the MPD. The lesion consisted of a conglomeration of communicating cysts measuring 5–10 mm (Fig. 2a). ERCP images show only part of the cystic lesion (Fig. 2b). CT showed a microcystic tumor at the pancreatic head (Fig. 2c). He underwent pylorus-preserving pancreatoduodenectomy and histopathologically the tumor was serous cystadenoma, measuring 3.0 × 1.8 × 2.8 cm.

DISCUSSION

The high sensitivity of MRCP for abnormalities of the biliary tree and pancreatic duct system has been reported (11–16). MRCP provides both high-quality cross-sectional images of extraductal structures and projectional images of the biliary tree and pancreatic duct system without any oral or intravenous contrast materials. It is also known that cystic tumor of the pancreas is demonstrated with high signal intensity by MRCP, because of the high sensitivity of the MRCP sequence to fluid-filled structures (17). Therefore, several studies on the diagnosis of cystic tumor of the pancreas using MRCP have been conducted in recent years (18).

In the present study, in order to clarify the diagnostic efficacy of MRCP for cystic tumor of the pancreas, we compared the MRCP image with those of ERCP and CT and with the histopathological findings, in relation to the identification of the MPD, the communication between the MPD and cystic tumor and the internal features of the cystic lesion. Our study showed a high detection rate by MRCP for the identification of the MPD, similar to previous authors who have described the sensitivity for demonstrating stricture or dilatation of the MPD as ranging from 70 to 100% (11,13,15). Although the detection rate by ERCP for the MPD was 93.3% in our study, the image of the whole MPD could not be demonstrated completely in cases such as those with an obstructed MPD due to the tumor. In particular, information about the duct distal from the site of an obstruction could not be
MRCP and CT could demonstrate the cystic tumor in all cases, whereas the detection rate with ERCP was only 60%. ERCP could not demonstrate the cystic lesion in cases with an obstructed MPD or cystic tumors without communication to the MPD. In addition, it was difficult to demonstrate the entire image with ERCP in cases with cystic lesions filled with a lot of mucus. MRCP, with its ability to display static fluid, is able to demonstrate the entire cystic lesion without being affected by an obstruction of the pancreatic duct or by mucus.

For diagnosis and then the selection of therapy for cystic tumor of the pancreas, it is very important to investigate the presence of communication between the cystic lesions and the MPD. In all the present cases MRCP could detect this and show it with images obtained from different angles. It is one of the advantages of MRCP that 3-D projections allow a global display of the lesions, which can be viewed from different angles (15). Although CT also showed a high detection rate for the communication between the cystic tumors and the MPD, it could not demonstrate fine ductal anatomy or the accurate relationship of the cystic lesions and the MPD because of its limitations as a cross-sectional modality.

Solitary or multiple cystic pattern could be diagnosed accurately from their shapes on MRCP images. The tumor with a solitary cystic pattern was recognized as a smooth and round-shaped mass with a high signal intensity. The multiple cystic pattern was recognized as an irregular and lobulated mass. Our data showed that MRCP was obviously superior to ERCP in the depiction of the shape of cystic tumors.

One of the important diagnostic studies for cystic tumor of the pancreas is to characterize the internal structure, usually as septum and solid components, because the management of this disease is dependent on its histology. Our study showed relatively low detection rates by MRCP for these structures. The characterization of the structures inside the cystic tumors could be demonstrated more accurately by CT than by MRCP or ERCP. CT could detect septa and solid components in 100 and 90.0% of cases, respectively. From these results we suggest that, compared with MRCP and ERCP, CT may be more useful for diagnosing the internal features of cystic tumors. One of the limiting factors for the MRCP image is the MIP reconstruction algorithm itself and it can be reduced with careful review of the source images (4).

Endoscopic ultrasonography (EUS) has also been evaluated as one of the best modalities for demonstrating the fine structures inside the pancreatic tumor. However, EUS is an invasive method and requires operator skill, as does ERCP. A few comparative studies are available for evaluating MRCP and EUS in the diagnosis of abnormalities of the biliary tree and pancreatic duct system. Adamek et al. reported that precise etiological diagnosis by EUS is often impossible (6).
EUS with MRCP for the diagnosis of choledocholithiasis in 23 patients and the sensitivity and specificity of EUS were both 100%, respectively, whereas MRCP was 100% sensitive and 76% specific (22).

In conclusion, MRCP appears to be a very useful modality and is superior to ERCP for the diagnosis of cystic tumor of the pancreas, because it can accurately and non-invasively provide complementary information about the whole lesion.

When cystic tumor of the pancreas is suspected initially by methods such as ultrasonography, further tests should be performed for tumor characterization prior to treatment. CT, EUS and conventional MR imaging are indicated and MRCP may replace ERCP as a diagnostic modality. Because of its limitations in detecting the internal features of cystic tumors, these characteristics should be carefully diagnosed in combination with other diagnostic modalities such as CT or EUS at present. For improving the quality of the MRCP image, further development of software is desirable.

**Acknowledgment**

This study was supported in part by a Grant-in-Aid for Cancer Research from the Ministry of Health and Welfare of Japan.

**References**