Usefulness of Magnetic Resonance Cholangiopancreatography in Pancreatobiliary Abnormalities in Pediatric Patients

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Background: Magnetic resonance cholangiopancreatography (MRCP) is an innovative and noninvasive technique for evaluating the biliary tree and pancreatic duct in children. The aim of this study was to assess the usefulness of MRCP as a noninvasive method to evaluate the biliary system in children.

Methods: We retrospectively reviewed the records of patients undergoing MRCP between October 2002 and May 2007 for suspected biliary system abnormalities. MRCP findings were compared with other imaging modalities, operative findings, and clinical endpoints.

Results: Complete data were available for 60 patients (35 girls, 25 boys; mean age 2 years, 33 children less than 1 year old). Ultrasound was performed in all 60 patients. Twenty-two patients had choledochal cyst, and 19 had a thin or invisible gall bladder. Endoscopic retrograde cholangiopancreatography was done in two patients. The sensitivities and specificities of MRCP for diagnosing choledochal cyst and biliary atresia were 100.0% and 100.0% and 86.7% and 100.0%, respectively. Surgery was performed in 37 patients, including 21 with a choledochal cyst, 14 with biliary atresia, and 1 with a pancreatic duct stone.
1. Introduction

Ultrasonography (US) and computed tomography are the initial imaging methods for evaluating the pediatric pancreaticobiliary ductal system. If they fail to provide an accurate diagnosis, endoscopic retrograde cholangiopancreatography (ERCP) is often performed. However, ERCP is difficult to perform in young children and infants because it requires special equipment and expertise that are not available in many institutions. In addition, ERCP is an invasive procedure with potential complications; it is both more difficult and more hazardous in the pediatric population than when performed in adults. Magnetic resonance cholangiopancreatography (MRCP) is an innovative technique for evaluating the biliary tree and pancreatic duct, initially used in adults in the early 1990s. It is considered to be a reliable diagnostic tool to evaluate primary sclerosing cholangitis, Caroli disease, choledochal cyst, and other forms of biliary pathology. The advantages of MRCP are that it is noninvasive, requires no contrast material, is without ionizing radiation, and can be performed on an outpatient basis. The safety is deemed comparable with that of US. MRCP is therefore increasingly replacing ERCP or percutaneous cholangiogram in assessing many pancreaticobiliary diseases.

Given its success in adults, MRCP has begun to be used in children during the past decade, with reports on its application for suspected biliary atresia, choledochal cyst, cholelithiasis, choledocholithiasis, bile plug syndrome, pancreatitis, and in liver transplantation. However, the pediatric literature to date consists mostly of case reports and a few serial studies focusing on particular clinical conditions. We therefore designed this retrospective review of our experience using MRCP in a larger series of pediatric patients.

2. Materials and Methods

Mackay Memorial Hospital, Taipei, Taiwan is a tertiary referral center for pediatric gastrointestinal and hepatobiliary disease. The records of all pediatric patients younger than 18 years undergoing MRCP for suspected pancreaticobiliary system abnormalities between October 2002 and May 2007 were retrieved in this hospital, yielding 62 cases. We excluded records of two patients who underwent MRCP only for follow-up after operation, leaving a total of 60 cases. Data extracted from the records included gender and age; medical history (including prenatal history, abdominal US findings on newborn screening, and any surgery before MRCP); and clinical manifestations, including jaundice, clay-colored stool, abdominal mass, and abdominal pain. All imaging study findings were recorded, including those from abdominal US, MRCP, ERCP, Tc-99m disopropyl iminodiacetic acid scan, and operative cholangiography. The results of surgery and pathology examination were also reviewed.

MRCP examinations were all performed with a 1.5-T scanner (Signa EXCITE; GE Medical Systems, Waukesha, Wisconsin, USA) by using head or phased-array surface coil, depending on the body size of patients. The T2-weighted fast spin-echo and fat-suppressed sequence images were acquired with the following parameters: single-shot fast spin-echo sequence, repetition time/echo time range, 2015–16,000/33.8–541; slice thickness, 6 mm; slice gap, 0; field of view, 35 cm; and matrix, 288 × 256. The images were acquired by use of breath-hold technique in the older children if possible. In children who could not hold their breath, the MRCP examination was performed with respiratory triggering. The acquisition time for each sequence varied according to the patient’s body volume and breathing rate. The whole MRCP examination time was about 45 minutes in general. Patients fasted at least 6 hours before the examination. Sedation with oral chloral hydrate at a dose of 40 mg/kg of body weight (maximum, 1 g) was used if the child was younger than 6 years or not able to cooperate during the examination. Vital signs were monitored during the sedation, and all the patients completed the examination smoothly, without any complications.

MRCP images were analyzed by an experienced pediatric radiologist. The MRCP diagnosis of choledochal cyst was based on the disproportional dilatation of extrahepatic bile ducts and excluding other cause of dilatation, such as stone, tumor, or inflammation. The MRCP diagnosis of biliary atresia was made on the basis of the nonvisualization of either the common bile duct or the common hepatic duct and demonstration of a small or atresic gall bladder. For patients suspected with choledochal cyst in whom the results of MRCP were also consistent, a pediatric surgeon was consulted for complete surgical excision of the cyst. In the patients suspected with biliary atresia and consistent with MRCP findings, Kasai portoenterostomy was performed after direct cholangiography confirmed the diagnosis. For those patients suspected to have biliary atresia after normal MRCP examination, we observed the clinical manifestations, reviewed all follow-up images (abdominal US), and arranged Tc-99m scanning. Direct cholangiography was performed if the diagnostic work-up was still inconclusive. The final diagnosis of choledochal cyst was based on the findings of cystic dilatation occurring at varying segments of the extrahepatic or intrahepatic bile duct by direct cholangiography, ERCP, and operative findings. The final diagnosis of biliary atresia was confirmed by direct cholangiography of obstruction or absence of the biliary tree, operative findings of small and fibrotic gallbladder along with diffuse fibrosis of the extrahepatic system, pathology
of expanded portal tracts with variable levels of edema, proliferation of bile ducts, and fibrosis. All the patients with choledochal cyst or biliary atresia were followed up for at least 2 years for postoperative care and prevention of complications. The data were entered and stored in a Microsoft Excel database. The sensitivity, specificity, and positive and negative predictive values of MRCP for the diagnosis of choledochal cyst and biliary atresia were calculated relative to the final diagnosis. The 95% confidence intervals were also estimated. This study was approved by the Institutional Review Board of Mackay Memorial Hospital.

3. Results

The 60 patients (25 boys and 35 girls) in the series ranged in age from 1 day to 15 years (mean age: 2 years). There were 33 (55%) children younger than 1 year, 20 children 1–5 years old, and 7 children older than 5 years. The clinical manifestations varied (Table 1), but jaundice was present in nearly two-thirds of the patients. Abnormalities were found incidentally in four children on screening US (2 on prenatal US and 2 on neonatal abdominal US). All 60 patients underwent abdominal US before MRCP. Eighteen patients underwent Tc-99m scanning, of whom 14 were suspected to have biliary atresia; of these, 11 in fact had a final confirmed diagnosis of biliary atresia. Six patients had intraoperative cholangiogram for the same reason, and five patients were finally diagnosed with biliary atresia. Only two patients underwent ERCP examination, performed for pancreaticobiliary stones that were suspected on the MRCP study. Choledochal cyst, biliary atresia, and hepatitis syndrome in infancy accounted for most (85%) of the final diagnoses (Table 2). The presentation of MRCP images with biliary atresia and choledochal cyst are shown in Figure 1.

Table 1 Clinical manifestations of 60 children undergoing magnetic resonance cholangiopancreatography.

<table>
<thead>
<tr>
<th>Symptoms and signs</th>
<th>n (%)</th>
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<tbody>
<tr>
<td>Jaundice</td>
<td>37 (61.7)</td>
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<tr>
<td>Clay-colored stools</td>
<td>21 (35.0)</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>18 (30.0)</td>
</tr>
<tr>
<td>Abdominal mass</td>
<td>1 (1.7)</td>
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</tbody>
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Table 2 Final diagnoses of 60 children undergoing magnetic resonance cholangiopancreatography.

<table>
<thead>
<tr>
<th>Final diagnosis</th>
<th>n (%)</th>
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<tbody>
<tr>
<td>Choledochal cyst</td>
<td>22 (36.7)</td>
</tr>
<tr>
<td>Biliary atresia</td>
<td>15 (25.0)</td>
</tr>
<tr>
<td>Hepatitis syndrome in infancy</td>
<td>14 (23.3)</td>
</tr>
<tr>
<td>Common bile duct dilatation</td>
<td>4 (6.7)</td>
</tr>
<tr>
<td>Common bile duct stone</td>
<td>1 (1.7)</td>
</tr>
<tr>
<td>Pancreatic duct stones with pancreatitis</td>
<td>1 (1.7)</td>
</tr>
<tr>
<td>Hepatic cyst</td>
<td>1 (1.7)</td>
</tr>
<tr>
<td>Intrahepatic duct dilatation</td>
<td>1 (1.7)</td>
</tr>
<tr>
<td>Hepatic tumor</td>
<td>1 (1.7)</td>
</tr>
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In the diagnosis of choledochal cyst, MRCP had excellent sensitivity and specificity; but for the diagnosis of biliary atresia, MRCP had a higher specificity and therefore a better positive predictive value (Table 3).

Figure 1 (A) Biliary atresia in a 1-month-old boy. No gallbladder, hepatic, or common bile duct could be identified on thick-slab magnetic resonance cholangiography (MRCP). (B) MRCP of a 11-year-old girl with choledochal cyst shows involvement of both the common bile duct (*) and hepatic duct (#).

4. Discussion

The results of this study illustrate the role that MRCP can play in assessing the pediatric pancreaticobiliary tract, especially for the diagnosis of biliary atresia and choledochal cyst. The patients in our study tended to be female and young, compatible with the previously reported female
predilection of the two most common entities, choledochal cyst and biliary atresia. The two diseases are more often diagnosed in infancy or neonatal period.\textsuperscript{24,25} Slightly more than one-half of the patients were younger than 1 year, where imaging of ERCP can be difficult to perform.\textsuperscript{2} Children who present with obstructive jaundice may have a congenital disorder such as choledochal cyst or biliary atresia, but another possibility is ductal obstruction secondary to stones. MRCP demonstrated stones in two patients, one in the common bile duct stone and one in the pancreatic duct. These were the only patients in the series who needed ERCP, during which the stones were successfully removed. Our experience thus confirms the recommendation that ERCP be avoided unless required for intervention. A National Institutes of Health statement on ERCP noted that MRCP, endoscopic ultrasound, and ERCP all had comparable sensitivity and specificity in the diagnosis of choledocholitiasis; they advised avoiding ERCP if the likelihood of a biliary stone or stricture is low.\textsuperscript{26} North American Society for Pediatric Gastroenterology and Nutrition also put out a statement emphasizing that MRCP can provide high-quality noninvasive imaging of biliary and pancreatic ducts in adults and may eliminate the need for diagnostic ERCP in some settings. But the initial reports of MRCP in children are limited, so further study is needed.\textsuperscript{27}

The accuracies of MRCP for diagnosing choledochal cyst and biliary atresia were 100.0% and 96.7% in our series, respectively. These values were very close to the results of other studies.\textsuperscript{1,28} The sensitivity and specificity of MRCP for the diagnosis of biliary atresia in our study were 86.7% and 100%, compared with a sensitivity of 100% and specificity of 96%, respectively as reported by Han et al.\textsuperscript{28} But varying values were also reported by Yang et al\textsuperscript{20} (sensitivity of 85.29% and specificity of 57.14%). However, it was not possible to compare the accuracy, sensitivity, and specificity between MRCP and abdominal US in our study because some of our patients who underwent MRCP were selected after the abnormal findings of abdominal US examination. But abdominal US was more sensitive if the "triangular cord" was found by abdominal US but less specific than MRCP for biliary atresia in other studies (sensitivity of 88.9% and specificity of 76.1–88.9%).\textsuperscript{20,29,30} Both the sensitivity (100.0%) and specificity (100.0%) of MRCP in diagnosing choledochal cyst in our study were somewhat better than those reported by Park et al.\textsuperscript{31} Abdominal US is a valuable method and preferred to screen for choledochal cyst.\textsuperscript{32} Therefore, we suggest MRCP if definitive diagnosis of either biliary atresia or choledochal cyst is required.

This was a retrospective study and therefore has limitations inherent in all such research. It may tend to overestimate true positives and negatives. Despite the fact that it is generally a relatively larger series than those previously reported, the actual numbers of each diagnostic entity are relatively small. Because the basis for the final diagnosis varied, that is, not all children underwent surgery or ERCP, our statistical results must be viewed with caution. However, we believe our findings do indicate that in some cases, such as choledochal cyst, MRCP eliminates the need for ERCP because of its excellent sensitivity and specificity, thus avoiding an invasive procedure with substantial radiation exposure.

5. Conclusion

In conclusion, our findings support the contention that MRCP is a useful method for evaluation of the pancreaticobiliary system in pediatric patients. Because of its high specificities for biliary atresia and choledochal cyst, it may yield a definitive diagnosis of these entities when abdominal US does not give a clear enough picture.

References


