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Usefulness of Magnetic Resonance Cholangiopancreatography and Intraoperative Cholangiography in Detection of Biliary Variants in Children with Choledochal Cysts

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Abstract ***Background:*** Paediatric choledochal cyst (CC) is mainly diagnosed and evaluated by magnetic resonance cholangiopancreatography (MRCP). Although visualisation of CC, biliary stenosis, and pancreaticobiliary maljunction (PBM) is valuable for preoperative diagnosis, it is not enough for making a meticulous surgical plan in consideration of biliary variants. Therefore we aim to evaluate biliary variants as well as CC, biliary stenosis, and PBM by MRCP in children with CC, and to share our experience in managing children with CC using MRCP and intraoperative cholangiography (IOC). ***Methods:*** Totally 39 patients with CC who consecutively underwent MRCP, IOC, and radical operation between February 2008 and December 2010 were enrolled in this study. The visualisation rates of CC, biliary stenosis, biliary variants and PBM were compared between by means of MRCP and IOC. The duration of IOC examination was evaluated. ***Results:*** The duration of IOC was 23±3 min for all the 39 patients. The visualisation rates of CC, biliary stenosis, biliary variants and PBM were 100%, 79.5%, 46.2%, and 61.5% respectively by MRCP and 100%, 48.5% (p=0.012), 15.3% (p=0.003), and 74.4% (p=0.832) respectively by IOC. ***Conclusions:*** Nearly half of the CC patients were accompanied with biliary variants, which should be paid more attention to make a meticulous surgical plan. MRCP was superior to IOC in detecting biliary stenosis and biliary variants, but they are comparable in detecting CC and PBM.

Key words Biliary variants; Choledochal cyst; Intraoperative cholangiography; Magnetic resonance cholangiopancreatography; Pancreaticobiliary maljunction

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Introduction

Choledochal cyst (CC) is a congenital anomaly of the intrahepatic and/or extrahepatic biliary tract, and closely associated with pancreaticobiliary maljunction (PBM).[1] Despite an uncertain cause, it has been accepted that PBM is a factor in both the pathogenesis and the malignant degeneration of CC. Moreover, it is considered to be important in the surgical management and prognosis of choledochal cysts.[2] The standard treatment for CC is total excision of dilatations of the intrahepatic or extrahepatic biliary tree with Roux-en-Y hepaticojejunostomy. Any unresected remnant of the cyst portends a considerable risk

of recurrent cholangitis, pancreatitis, sepsis, liver abscesses, and malignancy.[3,4] Therefore it is necessary to delineate the biliary and pancreatic morphology so as to make a meticulous surgical plan. The preoperative diagnosis and visualisation of the pancreaticobiliary system depend on such examinations as USG, CT scan, PTC, magnetic resonance cholangiopancreatography (MRCP) and endoscopic retrograde cholangiopancreatography (ERCP).[5,6] Most reports in the literature focused on the visualisation rates of CC, biliary stenosis, and PBM by MRCP in children with CC, but biliary variants are often associated with CC which must be of concern. Herein we aim to evaluate the usefulness of MRCP and intraoperative cholangiography (IOC) for the surveillance of biliary pancreatic structures in children with CC and planning meticulous operative procedures.

Methods

Patients

The institutional review board of our hospital approved this retrospective study. We identified 172 patients with CC from a database in our department; of the 172 patients, 58 patients consecutively underwent MRCP, IOC, and radical operation between February 2008 and December 2010. The inclusion criteria were as follows: patients who were scanned by MRCP and consequently underwent total excision of dilatations of the intrahepatic and/or extrahepatic biliary tree with Roux-en-Y hepaticojejunostomy, and during the operation IOC was performed; the presence of a dilatation of the biliary tract (>8 mm for common bile duct; >3 mm for intrahepatic duct); the presence of biliary variants (we detected two kinds of variants: aberrant bile duct; left hepatic duct and right hepatic duct communicating with CC separately); and the presence of PBM (>15 mm for common channel). The exclusion criteria were as follows: a contraindication for contrast; the interval between MRI and IOC examination more than 14 days; and nondiagnostic image quality. Of the 58 patients initially collected, 19 were excluded for one of the following reasons: the interval between MRI and IOC examinations was more than 14 days (n=15); the image quality was nondiagnostic (n=4). A total of 39 patients (10 male, 29 female; aged from 4 to 79 months, mean age: 41±23 months) were finally included in this study.

MRCP Techniques

For MRCP examination, standard clinical sequences for T1, T2, and MRCP images were preformed at 1.5 T (Magnetom Avanto, Siemens Medical Solutions, Erlangen, Germany) with the patients supine and free breathing 2D turbo spin echo. In all patients under 60 months, midazolam (0.1 mg/kg, maximum 2.5 mg) was administered intravenously.

IOC Techniques

After opening the abdomen, firstly we identified CC, then IOC was performed with 76% Compound Diatrzoatc Meglumlne (diluted to half strength with normal saline) following the iodine allergy test and intracysticly was administered with a power injector (1 ml/s). The duodenum was compressed if intrabiliary tree was not visualised. The findings were documented on X-ray films (from the front to the posterior axis).

Evaluation of IOC and MRCP Images

One experienced radiologist, who was blinded to patients' clinical records and laboratory data, evaluated biliary and pancreatic morphology on IOC and MRCP images. He focused on the presence of CC, biliary stenosis, biliary variants, and PBM. Additionally the surgical team also evaluated the images before operation. The difference was solved by consensus after discussing with the radiologist. Figure 1 demonstrates IOC (a) and MRCP (b) in a 36-month girl, on which CC, biliary stenosis, PBM, and pancreatic duct were all visualised by IOC while CC, PBM, and pancreatic duct were visualised by MRCP. Figure 2 demonstrates IOC (a) and MRCP (b) in a 20-month boy, on which only CC and pancreatic duct were visualised by IOC while CC, biliary stenosis, PBM, and pancreatic duct were all visualised by MRCP. Figure 3 demonstrates MRCP in a 42-month girl, on which aberrant bile duct was visualised. Figure 4 demonstrates MRCP in a 25-month girl, on which left hepatic duct and right hepatic duct communicating with CC separately were visualised.

The data on the duration of IOC was also collected.

Statistical Analysis

All data were expressed as mean±standard deviation (SD) for quantitative variables and percentages for categorical variables. Statistical analyses was performed using SPSS version 17.0. The McNemar test was used to compare the visualisation rates of biliary stenosis, biliary variants, and PBM by MRCP versus IOC. For all statistical analyses, P values <0.05 were considered statistically significant.

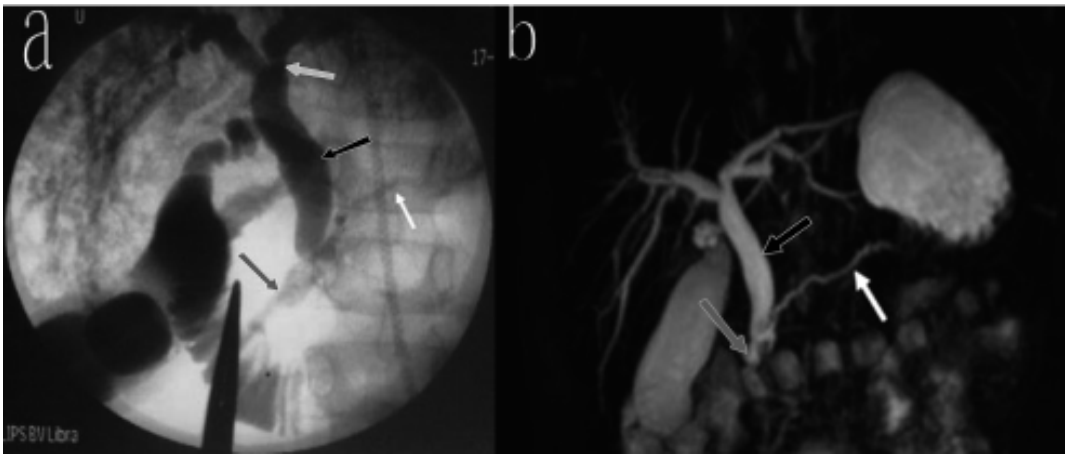

Figure 1 (a) Intraoperative cholangiography and (b) magnetic resonance cholangiopancreatography in a 36-month girl with choledochal cyst: choledochal cyst (black arrow), pancreaticobiliary maljunction (dark grey arrow), pancreatic duct (white arrow), biliary stenosis (light grey arrow).

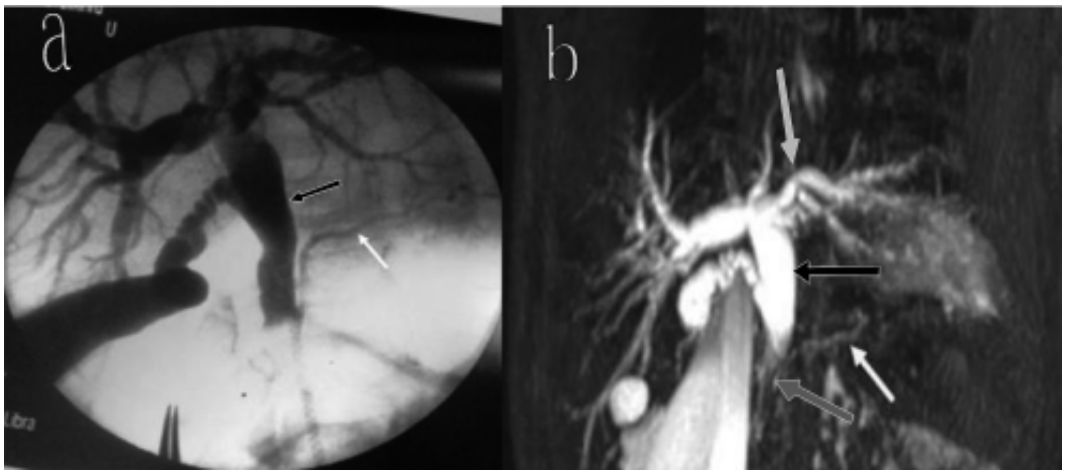

Figure 2 (a) Intraoperative cholangiography and (b) magnetic resonance cholangiopancreatography in a 20-month boy with choledochal cyst: choledochal cyst (black arrow), pancreaticobiliary maljunction (dark grey arrow), pancreatic duct (white arrow), biliary stenosis (light grey arrow).

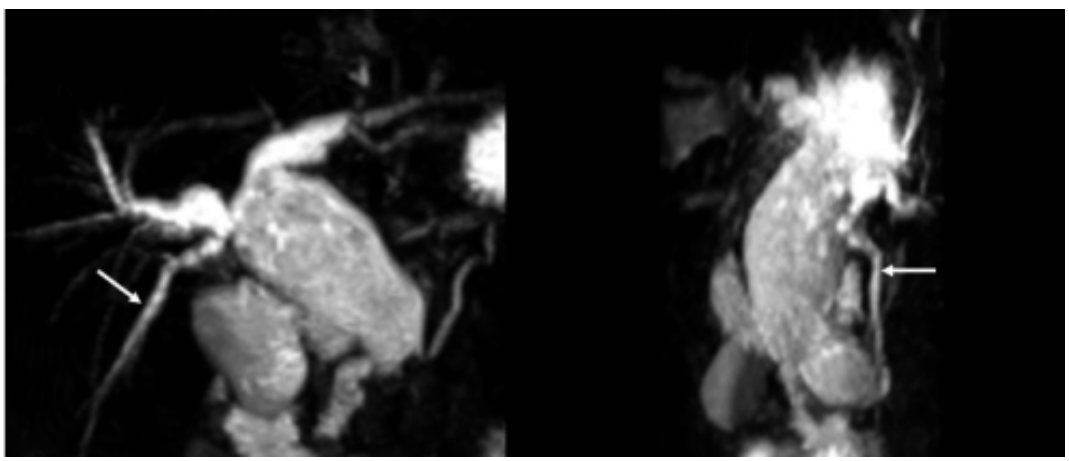

Figure 3 Magnetic resonance cholangiopancreatography in a 42-month girl with choledochal cyst. Aberrant bile duct (white arrow) communicating with left hepatic duct was visualised.

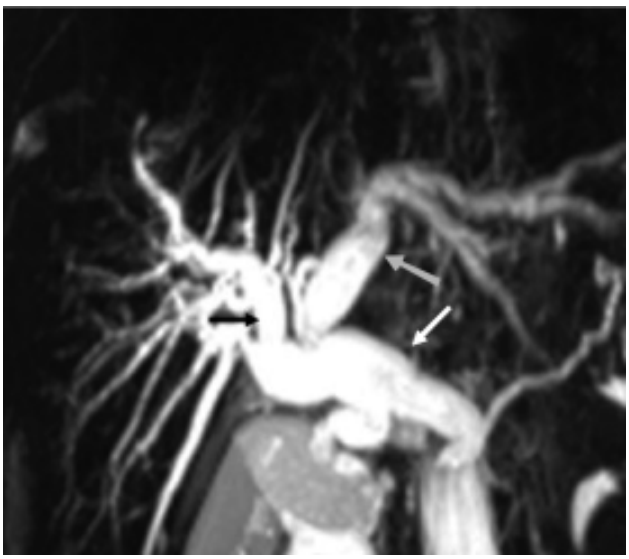

Figure 4 Magnetic resonance cholangiopancreatography in a 25-month girl with choledochal cyst. Left hepatic duct (light grey arrow) and right hepatic duct (black arrow) communicating with choledochal cyst (white arrow) separately were visualised.

Table 1 The visualisation rates of CC, biliary stenosis, biliary variants, and PBM by IOC and MRCP

	IOC	MRCP	P* value
CC	100% (39/39)	100% (39/39)	---
PBM	74.4% (29/39)	61.5% (24/39)	0.832
Biliary stenosis	48.7% (19/39)	79.5% (31/39)	0.012
Biliary variants	15.3% (6/39)	46.2% (18/39)	0.003

CC: choledochal cyst; IOC: intraoperative cholangiography; MRCP: magnetic resonance cholangiopancreatography; PBM: pancreaticobiliary maljunction.

*compared between IOC and MRCP.

Results

The Duration of IOC

The duration of IOC examination was 23±3 min for all the 39 patients.

The Visualisation Rates of CC, Biliary Stenosis, Biliary Variants, and PBM by MRCP and IOC

The visualisation rates of CC, biliary stenosis, biliary variants and PBM were 100%, 79.5%, 46.2%, and 61.5% respectively by MRCP and 100%, 48.5% (p=0.012), 15.3% (p=0.003), and 74.4% (p=0.832) respectively by IOC (Tables 1 and 2).

Discussion

Technique development offers a variety of algorithms for surveillance of biliary pancreatic structures, including IOC and MRCP. Moreover, ERCP, 3D-MRCP, 3-dimensional US cholangiography, and three-dimensional negative-contrast CT cholangiopancreatography are the up-to-date alternatives, and become more popular. But in the past decade there were rare reports about aberrant bile duct confirmed by MRCP or 3-D MRCP.[7,8] In this study we reevaluated the detection rates of biliary variants by MRCP in children with CC compared with IOC.

ERCP is the most valuable diagnostic method and can accurately show cystic segments of the biliary tree.[9] But its invasiveness and ERCP-related complications[10] hold back not only doctors but also parents. In addition, ERCP is available only in a very few big medical centers mostly located in metropolises in China, thus the applications of ERCP can not match the number of children with CC.

Table 2 The visualisation of biliary stenosis, biliary variants and PBM by IOC and MRCP

		IOC					
		Biliary stenosis		PBM		Biliary variants	
		+	−	+	−	+	−
MRCP	+	13	18	15	9	6	12
	−	6	2	14	1	0	21

+can be visualised; −can not be visualised

IOC: intraoperative cholangiography; MRCP: magnetic resonance cholangiopancreatography; PBM: pancreaticobiliary maljunction

Therefore this technique is difficult to be widely adopted in consideration of the invasiveness, potential complications and the need of general anaesthesia.

The great advantage of computed tomography cholangiography (CTC) consists in its ability to produce high-quality images without respiratory artifacts in young infants and that it allows accurate assessment of the presence of PBM equivalent to MRCP.[11] But to perform CT, radiation exposure is unavoidable. Importantly, potential side effects of the CT should be considered and mentioned. So CT is not always the first choice. The use of CT especially among children with benign diseases is becoming more difficult in order to avoid potential radiation exposure.

IOC is the most frequently applied technique for intraoperative assessment of the pancreaticobiliary system. It presents high visualisation rate of PBM but low detection rate of biliary variants in children with CC. Nevertheless there are still some drawbacks: Firstly, it takes time to perform IOC as well as the subsequent scrutiny, review, and discussion, which undoubtedly prolongs the operation time. It is the time consumed with the abdominal wall open in the operation room that we are really concerned, which would increase the loss of heat and fluid. Secondly, IOC puts variable pressure on the lumen of the ducts leading to the abnormally distended biliary shape, which can make us overlook some biliary strictures. Thirdly, patients with contraindication for contrast cannot undergo IOC.

MRCP is a noninvasive and repeatable modality for delineation of the pancreaticobiliary system with no known risk to children. It is more sensitive to detect biliary variants and biliary stenosis than IOC. MRCP reduces operative time, is less invasive, and may also alleviate damage to the CBD that can occur during IOC.[12] We detected 8 patients with aberrant bile duct by MRCP including one who was also visualised by IOC: the aberrant bile duct communicating with CC (n=5), the aberrant bile duct not communicating with CC (n=3). We also found left hepatic duct and right hepatic duct communicated with CC separately by MRCP in 10 patients including 5 patients visualised by IOC. The visualisation rate of PBM by MRCP (61.5%) was lower than that by IOC (74.4%), but there was no significant difference (p=0.832). Up to 46.2% of patients with CC were accompanied with biliary variants. Fortunately with the imaging given by MRCP preoperatively, surgeons have enough time for scrutiny, review, and discussion to work out an optimal surgical plan.

In conclusion, nearly half of the patients with CC were accompanied with biliary variants, which should be paid more attention to make a meticulous surgical plan. MRCP was superior to IOC in detecting biliary stenosis and biliary variants, but they are comparable in detecting CC and PBM.

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