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Biliary collateral veins and associated biliary abnormalities of portal hypertensive biliopathy in patients with cavernous transformation of portal vein☆

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ABSTRACT

Purpose: The purpose was to investigate magnetic resonance imaging (MRI) features of biliary collateral veins and associated biliary abnormalities of portal hypertensive biliopathy (PHB).
Materials and methods: Thirty-six patients including 18 patients with abnormal biliary changes and 18 patients as control group were involved in this study. MRI features of biliary collateral veins were analyzed.
Results: Stenosis with dilated proximal bile ducts occurred in 33.3% of patients, 27.8% of patients had irregular ductal walls, 22.2% of patients had thickened ductal walls, 16.7% of patients had angulated ductal walls, and 44.4% of patients had thickened gallbladder walls.
Conclusions: Biliary collateral veins and associated biliary abnormalities of PHB can be detected by MRI.

1. Introduction

Portal hypertensive biliopathy (PHB) refers to abnormalities of the entire biliary tract due to portal hypertension, including intrahepatic and extrahepatic bile ducts, cystic duct, and gallbladder in patients, and "portal biliopathy" is the same entity. It is most probably related to longstanding portal hypertension that results in the development of large collaterals in the biliary region with formation of cavernous transformation [1]. PHB occurs frequently in patients with extrahepatic portal vein obstruction but is far less common in the setting of cirrhosis [2]. The resultant ductal narrowing is ascribed to extrinsic compression caused by portal collateral vessels or to ischemia, leading to fixed stricture formation [2].

PHB is predominantly associated with extrahepatic portal venous obstruction [2–7]. The abnormalities of PHB occur with engorgement of the paracholedochal veins of Petren and the epicholedochal venous plexus of Saint, which lie adjacent to and within the biliary duct walls, respectively. Ductal displacement, kinking, and further narrowing can occur as the larger paracholedochal and pancreaticoduodenal veins enlarge and elongate, locating at the peripheral area of the bile duct [2].

Cavernous transformation of portal vein (CTPV) is defined as the development of portoportal collaterals that maintain hepatopetal flow around a chronically obstructed main portal vein. The cavernoma usually consists of vasa vasorum of portal vein wall or newly developed periportal veins (or both). The collaterals are seen as tortuous, wormlike vessels, and the collaterals can cause the biliary abnormalities [8].

It can be challenging to interpret the features of PHB and CTPV by using computed tomography (CT). CT is widely available, is relatively inexpensive, and allows rapid image acquisition. Yet the risk of radiation or contrast-induced nephropathy has limited its use in repeated examinations beyond the immediate postoperative period. Magnetic resonance imaging (MRI) has become an invaluable imaging modality in evaluating the features of PHB and CTPV. This study is designed to investigate the abnormalities of biliary system associated with the collaterals of PHB and to explain the causes of the secondary biliary abnormalities.

2. Materials and methods

2.1. Patients

Our institutional review board approved this retrospective study and waived informed patient consent. Between January 2009 and January 2015, 18 patients (10 men, 8 women; mean age, 52.5 years; range, 41 to 72 years) with abnormal biliary changes associated with CTPV and 18 patients who served as the control group (9 men, 9 women; mean age, 48.2 years; range, 38 to 67 years), without CTPV but with other suspicious upper abdominal lesions, were accepted into this

Abbreviations: PHB, portal hypertensive biliopathy; CTPV, cavernous transformation of portal vein; ICC, interclass correlation coefficient.
☆ Conflict of interest: The authors declare that they have no conflict of interest.
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study. The patients of portal hypertension with upper gastrointestinal bleeding, ascites, and normal thrombin time underwent shunt surgery. All the patients underwent MRI examinations, and the diagnosis of CTPV was confirmed by operation and pathology or follow-up of clinical, cross-sectional imaging including ultrasound (US), CT, and MRI.

2.2. Magnetic resonance imaging

All MRI studies were performed at 3.0-T scanners (Signa Excite; GE Medical Systems, Milwaukee, WI, USA) by using a surface phased-array coil. All patients underwent the same MRI protocol: three-plane scout view acquisition, axial T1-weighted imaging unenhanced sequence, and coronal and axial enhancement sequences. T1-weighted images were obtained with a repetition time (TR) of 400 ms and an echo time (TE) of 12 ms. T2-weighted images were obtained with TR of 2000 ms and TE of 85 ms. The matrix size was 256×256; the field of view (FOV) varied from patient to patient but was typically 40×40 cm. Magnetic resonance cholangiopancreatography (MRCP) was also performed. For MRCP, the bile duct was imaged with single-shot fast spin echo pulse sequence and positioned over the bile duct system with a single 40-mm-thick coronal "slab." Contrast-enhanced MRI was performed by using liver acquisition with volume acceleration sequence. A total of 0.1 mmol gadopentetate dimeglumine (Magnevist; Bayer Healthcare, Berlin, Germany) per kilogram of body weight was administered as the intravenous contrast material, injected at 2 ml/s. Three-phase imaging was obtained at approximately 30 s, 1 min, and 5 min after injection of the contrast agent. Before MRI examination, fasting for 4–6 h and/or the oral administration of 300 ml of water as negative contrast agent were used for removing the effect of high signal resulting from overlying near structures such as stomach and duodenum.

2.3. Image analysis

All images were viewed and analyzed by using the picture archiving and communication system. All patients were retrospectively reviewed by two experienced abdominal radiologists with 15 and 14 years of experience, who were unaware of the information with regards to other imaging findings and laboratory studies such as liver function studies. The collateral vein vessels on MRI findings were divided into two different venous systems: one was the paracholedochal veins of Petren, running parallel to the common duct, and the other one was the epicholedochal plexus of Saint, which was a reticular vein vascular web in direct contact with the outer surface of the common bile duct. Usually, MRI cannot demonstrate these vein vessels in the patients with normal portal hemodynamics. These vein vessels were dilated and tortuous due to an increase of the blood flow of the associated vein vessels. So the vein vessels were regarded as abnormal collateral veins of PHB if they were visualized as dilated and tortuous on MRI including MRCP and MR angiography (MRA).

The strictures of bile ducts were divided into mild stricture, moderate stricture, and severe stricture according to whether the stricture segment was less than one third, between one third and two thirds, and more than about two thirds of the diameter of the near normal bile duct. Proximal dilatations of the bile ducts were similarly defined as mild dilatation, moderate dilatation, and severe dilatation according to whether the dilated segment was less than 1.5 times, between 1.5 and 2 times or more than 2 times the diameter of the normal segment. Whether the changes persisted, regressed partially, or disappeared completely were evaluated after portosystemic shunt operation, according to the differences of the abnormal biliary branches of CTPV between preoperatively and postoperatively.

2.4. Statistical analysis

SPSS version 19.0 software (SPSS, Chicago, IL, USA) and MedCalc (MedCalc, Mariakerke, Belgium) software were used for the analysis. Interobserver and intraobserver agreements were evaluated by using the interrater agreement (weighted kappa) analysis. Levels of agreement were defined as follows: interclass correlation coefficient (ICC) 0.91–1.00, excellent; ICC 0.81–0.90, very good; and ICC 0.71–0.80, good. Reviewer 1 reviewed all the images a second time to evaluate intraobserver agreement at least 4 weeks after initial review. For interobserver agreement, the first set of data by reviewer 1 was used to compare with data of reviewer 2.

3. Results

3.1. The MRI features of the patients in control group

In the control group, MRI including MRCP and dynamic contrast-enhanced (DCE)-MRA did not display abnormal bile duct, gallbladder wall changes, or abnormal collateral veins.

3.2. The MRI features of biliary branches of PHB with CTPV

Both reviewers and the second identification of reviewer 1 detected the same results of MRI findings for the abnormalities of PHB with CTPV on the MRI images; the results of the first detection of reviewer 1 were used for further study (Table 1). Each reviewer categorized the same cases of the abnormal MRI findings. These analyses had perfect interobserver and intraobserver agreement ($k=1$).

The abnormal extrahepatic bile ducts accompanied by two venous systems were visualized on MRI and DCE-MRA: Of 18 patients with CTPV, the paracholedochal veins were noted in 94.4% (17 of 18) of patients before portosystemic shunt surgery (Fig. 1), and the paracholedochal veins were noted in 17.6% (3 of 17) of patients after portosystemic shunt surgery. The epicholedochal plexus of Saint appeared in 94.4% (17 of 18) of patients before portosystemic shunt surgery (Fig. 2) and appeared in 11.8% (2 of 17) of patients after portosystemic shunt surgery.

3.3. The biliary abnormalities of PHB with CTPV

All the cases with abnormal biliary branches of PHB were visualized on MRI, including smooth strictures, angulations, proximal dilatation, indentations, irregular bile ducts, and caliber irregularities.

Pre-portosystemic shunt surgery, 33.3% (6 of 18) of patients had moderate to severe smooth strictures, including 27.8% (5 of 18) of patients with common bile duct stricture and 5.6% (1 of 18) of patients with common hepatic duct stricture on MRI, strictures in 83.3% (5 of 6) of patients were completely recovered after portosystemic shunt surgery, and strictures in 16.7% (1 of 6) of patients became mild stricture after portosystemic shunt surgery.

A total of 33.3% (6 of 18) of patients had proximal dilatations of common hepatic ducts, right or left hepatic ducts. In 83.3% (5 of 6) of patients, the dilatation disappeared completely after portosystemic

Table 1
Demographic data of the 18 patients and MRI findings

Data or MRI findings	Value
Sex, no. of patients, male/female	10/8
Age (y), mean (range)	52.5 (41–72)
Paracholedochal vein (cases of preshunt/postshunt)	17/3
Epicholedochal plexus of Saint (cases of preshunt/postshunt)	17/2
Moderate to severe smooth stricture (cases of preshunt/postshunt)	6/1
Proximal dilatation of common hepatic duct (cases of preshunt/postshunt)	6/1
Indentation of the duct (cases of preshunt/postshunt)	2/0
Dilatation of the proximal bile duct due to stenosis (cases of preshunt/postshunt)	6/0
Irregular ductal wall (cases of preshunt/postshunt)	5/4
Thickened ductal wall (cases of preshunt/postshunt)	4/1
Thickened gallbladder wall and the dilatation of collateral vein (cases of preshunt/postshunt)	8/4