Magnetic Resonance Cholangiopancreatography of Benign Disorders of the Biliary System

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KEYWORDS

• MRCP • Benign liver disorders • Biliary • Imaging

NORMAL ANATOMY AND CONGENITAL VARIATIONS

Knowledge of biliary anatomy is often needed to plan surgical intervention.

Bile duct anatomy and variants can be well evaluated using a standard two-dimensional (2D) magnetic resonance cholangiopancreatography (MRCP) technique. Obscuration of duct anatomy caused by overlap from adjacent fluid-filled ducts and bowel was once a limitation inherent to the standard 2D technique. However, with the routine use of three-dimensional (3D) MRCP sequences and processed maximum intensity projection (MIP) images, this problem is less often encountered.[1,2]

The classically described normal anatomic configuration of the bile duct, consisting of 2 right segmental hepatic ducts (anterior and posterior) joining to form the main right hepatic duct and 2 major segmental branches of the left hepatic duct (medial and lateral) joining to form the main left hepatic duct, is present in only 50% to 60% of the population.[3] The main right and left hepatic ducts typically fuse to form the common hepatic duct 1 cm beyond the liver margin. The common hepatic duct extends from the confluence of the right and left main ducts and becomes the common bile duct (CBD) at the point where the cystic duct inserts.[4] The sphincter of Oddi consists of smooth muscle surrounding the common channel of the distal CBD and pancreatic duct as they insert into the duodenal papilla. The average CBD diameter is reported as 5 mm in individuals less than 50 year old; it can increase by 1 mm per decade after age 50 years.[5] However, after cholecystectomy, the CBD is often capacious and can measure up to 13 mm, but it shows lack of intrahepatic biliary ductal dilation—a finding useful in discrimination of CBD obstruction from normal expected dilation in these patients.

Because variant biliary duct anatomy is common, it is important to identify such variants for surgical planning before major hepatectomy, liver transplantation, and laparoscopic cholecystectomy to facilitate planned liver resection and ductal anastamosis as well as to minimize inadvertent biliary injuries during surgery.

A crossover anomaly is characterized by drainage of the right posterior segmental hepatic duct into the left main hepatic duct (**Fig. 1**). The crossover anomaly is found in 13% to 19% of the population, and is similar in prevalence to trifurcation of the biliary confluence that drains into the common hepatic duct. An accessory or aberrant right hepatic biliary duct draining into

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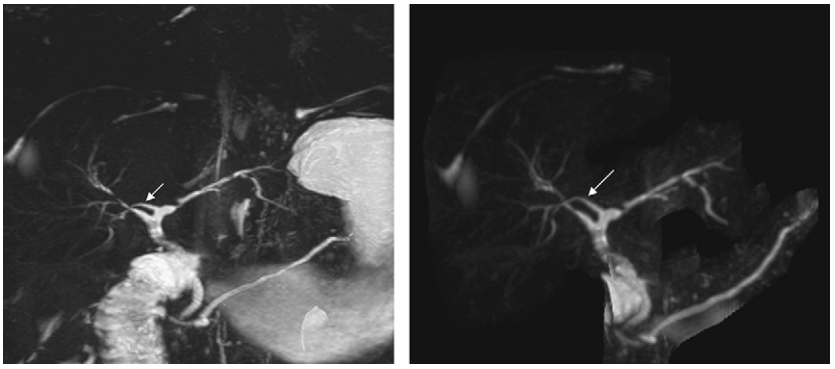

Fig. 1. Right posterior hepatic duct draining into left hepatic duct (crossover anomaly). Coronal MIP images demonstrate the right posterior segmental hepatic branch draining in the left hepatic duct (*arrows*).

the common hepatic or cystic duct can be seen in 7.4% of the population.[4,6,7]

The biliary ductal variants of surgical interest (**Tables 1** and **2**) involve those that affect the outflow, length, and course of the intra- and extrahepatic biliary ducts. A crossover anomaly and trifurcation of the biliary confluence are of surgical importance when planning a left hepatectomy, because the inadvertent surgical ligation of these variant ducts leads to atrophy and cirrhosis of liver segments VI to VII or V to VIII.[6] In addition, inadvertent resection or ligation of these anomalous ducts can lead to biliary leaks and strictures, especially in laparoscopic cholecystectomy or living donor right-lobe liver transplantation.[8]

Cystic duct anomalies are correctly identified with preoperative imaging in about 18% to 23% of cases, but such identification is important to reduce risk of major injury to the biliary tree during laparoscopic cholecystectomy. For example, in patients with a low cystic duct insertion (**Fig. 2**), the cystic duct has a long parallel course before inserting into the distal one-third of the CBD. Failure to recognize a low cystic duct insertion may lead to injury to the common duct during laparoscopic cholecystectomy. An aberrant right hepatic duct joining the common hepatic duct or cystic duct can also be inadvertently injured or ligated during laparoscopic cholecystectomy, leading to atrophy of segments VI and VII of the right hepatic lobe.[7,9] Similarly, failure to recognize a proximal cystic duct insertion may lead to inadvertent ligation of the cystic duct and subsequent development of a stricture in the common hepatic duct. Long-term complications associated with low insertion of the cystic duct include postcholecystectomy syndrome, which is caused by development of calculi and inflammatory changes of a long cystic duct remnant, and instrumentation injury during endoscopic retrograde cholangiopancreatography (ERCP).[9]

Congenital Abnormalities of the Biliary Duct

Bile duct cysts (or choledochal cysts) are rare cystic dilations of the biliary tree. There are 5 types of biliary cysts according to the Todani classification system:

1. Type I choledochal cysts are the most common, comprising 80% to 90% of bile duct cysts, and are defined as fusiform dilatation of the extrahepatic CBD.
2. A type II cyst is a true saccular diverticulum from the extrahepatic bile duct or an intrahepatic bile duct.
3. A type III cyst, or choledochocele, represents a focal protrusion of a dilated segment of the distal CBD into the duodenum. An individual with a type III cyst may present with abdominal pain, jaundice, and vomiting, but many are incidentally detected.

Table 1
Biliary ductal variants of surgical significance

Variant	Prevalence (%)
Trifurcation of the biliary duct	19
Right posterior segmental hepatic duct draining into the left hepatic duct (crossover anomaly)	13–19
Right hepatic duct emptying into the common hepatic or cystic duct	7.4