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ความชุกของลักษณะกายวิภาคของทางเดินท่อน้ำดีตับแบบผิดปกติในผู้ป่วยที่มารับการตรวจคลื่นแม่เหล็กไฟฟ้าทางเดินน้ำดีในโรงพยาบาลศรีนครินทร์

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Prevalence of Anatomical Variations of Biliary Tree on MRCP among Patients in Srinagarind Hospital

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หลักการและวัตถุประสงค์: ปัจจุบันจำนวนการผ่าตัดรวมทั้งการส่องกล้องตรวจและรักษาของระบบตับและทางเดินท่อน้ำดีมีจำนวนมาก โดยเฉพาะในภาคตะวันออกเฉียงเหนือซึ่งเป็นเขตระบาดของโรคทางเดินน้ำดีอย่างเช่น โรคมะเร็งท่อน้ำดี นิ่วในท่อน้ำดี เป็นต้น จึงมีความจำเป็นอย่างมากที่จะต้องมีความเข้าใจต่อลักษณะทางกายวิภาคของระบบท่อน้ำดีของผู้ป่วย เพื่อป้องกันภาวะแทรกซ้อนต่างๆ ที่อาจจะเกิดขึ้นได้ระหว่างการผ่าตัด ดังนั้นการศึกษานี้จึงมีวัตถุประสงค์ เพื่อศึกษาหาความชุกของลักษณะกายวิภาคของทางเดินท่อน้ำดีตับแบบผิดปกติในผู้ป่วยที่มารับการตรวจด้วยคลื่นแม่เหล็กไฟฟ้าทางเดินน้ำดี ในโรงพยาบาลศรีนครินทร์

วิธีการศึกษา: ผู้ป่วยจำนวนสามร้อยแปดสิบเจ็ดคนได้รับการตรวจ ด้วยคลื่นแม่เหล็กไฟฟ้าทางเดินน้ำดี ในโรงพยาบาลศรีนครินทร์ จังหวัดขอนแก่น ตั้งแต่วันที่ 2 พ.ย.2555- 5 พ.ย. 2556 โดยผู้เชี่ยวชาญทางด้านรังสีวิทยา (วินิจฉัย) ในระบบทางเดินอาหารและตับ สองคนได้วิเคราะห์และแจกแจงท่อน้ำดีเป็นชนิดต่างๆตามการแบ่งของ Couinaud หาความสอดคล้องกันของการแปลผลคลื่นแม่เหล็กไฟฟ้าทางเดินน้ำดีแบบ interpersonal reliability และ แสดงผลความสอดคล้องกันของผู้อ่านสองคนด้วย Kappa score

ผลการศึกษา: ความชุกของลักษณะทางกายวิภาคของท่อน้ำดีปกติ (type A) 74.4 % (n=288), และ ความชุกของลักษณะทางกายวิภาคของท่อน้ำดีผิดปกติ 25.6 % (n=99) โดยที่ความชุกของ Type B พบใน คนไข้ 34 คน (8.8 %) และ ความชุก

Background and Objective: The growing recognition and awareness of hepatobiliary disease as led to increase the number of surgical procedures being conducted. Appropriate knowledge of biliary tract anatomic variants is crucial in order to reduce bile duct injuries during surgery. This study aimed to the variations in biliary anatomy in the general population of northeast Thailand using magnetic resonance cholangiopancreatography (MRCP).

Method: Three hundred and eighty-seven patients were examined by MRCP at Srinagarind Hospital between Nov 2nd, 2012 and Nov 5th, 2013. All MRCP images were reviewed and the biliary anatomy was classified by two radiologists according to the Couinaud classification system. The interobserver agreement was analyzed using a Kappa agreement score.

Result: The prevalence of typical duct anatomy (type A) was 74.4% (n=288), and that of variation from the conventional pattern was 25.6% (n=99). Type B (or trifurcation) was found in 34 patients (8.8 %). The frequencies of other types were as follows: type C1, 0.3 % (n= 1); type C2, 3.1% (n=12); type D1, 6.2% (n= 24); type D2,1.3% (n=5); type E1, 0% (n=0); type E2, 0.5 % (n=2); and type F, 0% (n=0). The remaining

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ของลักษณะทางกายวิภาคของท่อน้ำดีชนิดที่เหลือได้แก่ type C1, 0.3 % (n= 1); type C2,3.1% (n=12); type D1,6.2% (n= 24); type D2,1.3%(n=5),type E1, 0% (n=0) , type E2,0.5 % (n=2), และ type F, 0% (n=0), คนไข้ที่เหลือ21 คน (5.4 %) , มีส่วนส่วนเพิ่มกายวิภาคของท่อทางเดินน้ำดีที่จัดอยู่ในลักษณะทางกายวิภาคของท่อน้ำดีชนิดอื่นๆ หาและความสอดคล้องกันของการแปลผลคลื่นแม่เหล็กไฟฟ้าทางเดินน้ำดีแบบ interpersonal reliabilityแสดงผลความน่าเชื่อถือด้วย Kappa score ได้ 0.431 (p<0.001)

สรุป: ความชุกของลักษณะทางกายวิภาคของท่อน้ำดีผิดปกติร้อยละ 25.6 ดังนั้นการใช้คลื่นแม่เหล็กไฟฟ้าทางเดินน้ำดี เพื่อเป็นเครื่องมือในการประเมินลักษณะทางกายวิภาคของท่อน้ำดีเป็นสิ่งที่สำคัญใน การผ่าตัดรวมทั้งการส่องกล้องตรวจและรักษาของระบบตับและทางเดินท่อน้ำดี

21 patients (5.4 %), all of whom had accessory hepatic ducts, were classified as "other variations." The Kappa agreement of MRCP readings by two radiologists was 0.431 (p<0.001).

Conclusion: There was variation from the typical pattern in 25.6% of cases. This study showed that MRCP is a non-invasive tool that can be used to evaluate anatomical variations of the intraheptatic ducts before surgical procedures.

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Introduction

The growing recognition and awareness of the hepatobiliary disease has led to an increase in the number of surgical procedures, such as liver transplantation, liver resection, and laparo-scopic cholecystectomy[1-3.] It has been shown that the frequency of bile duct injuries during laparoscopic cholecystectomy is twice as high as those that occur during open cholecystectomy.[4] Both intra and extrahepatic biliary anatomy is complex and there are many common and uncommon anatomic variations[3]. Appropriate knowledge of these anatomic variants is crucial for the success of surgical procedures.

Endoscopic retrograde cholangiopancreatography (ERCP) is the standard reference for imaging the pancreaticobiliary system. However, recent studies have shown that the less invasive technique of MRCP yields results that are comparable with ERCP for diagnosis of abnormalities in the biliary system.

MRCP is a non-invasive imaging technique that is useful in evaluating the biliary system and has come to be performed with increased frequency[4,5]. Magnetic resonance cholangiopancreatography using thick and thin slabs and heavily T2W sequences has been widely employed to depict the biliary tree[3,4,6]. The advantages of MRCP are that it is non-invasive, more cost effective, uses no radiation, requires no anesthesia, is less operator dependent, allows better visualization of ducts proximal to any obstruction, and, when combined with conventional T1W and T2W sequences, allows for detection of extraductal disease. The disadvantages of MRCP include decreased spatial resolution (making MRCP less sensitive in detecting abnormalities of the peripheral intrahepatic ducts than ERCP and physiologic imaging) and decreased sensitivity in detecting subtle non- distended ductal abnormalities[6].

Northeast Thailand has the highest incidence of cholangiocarcinoma, which corresponds to it being an endemic area for the liver fluke, Opisthorchis viverini (ov)[7]. This makes hepatobiliary diseases very common in this area. However, there have not been any studies on biliary variation in northeast Thailand. Therefore, we aimed to study the variations in biliary anatomy in the general population in this region.

Materials and Methods

Patients

We retrospectively reviewed all the patients who underwent MRCP at the Department of Radiology from Nov 2nd 2012 to Nov 5th 2013.

We excluded cases in which patients had undergone surgery involving the liver or biliary tree (such as liver resection), patients who had abnormalities that could distort biliary depiction (such as tumor or stones), or in which there were image artifacts due to technical failure.

MRCP technique

All MRCP scans were conducted using a 1.5T scanner (Siemens MAGNETOM Aera) and 3T scanner (PHILIPS 3.0 TX Achiva). The MR examination includes T1- and T2-weighted imaging and MRCP imaging using MRI protocol as shown in Table 1.

Magnetic resonance cholangiopancreatography images were retrieved from a PACS (Picture Archiving Computed System).

Imaging and Statistical Analyses

Two radiologists specialized in Gastrointestinal Radiology and experienced in MRCP classified the reconstructed MR images at the work station using Couinaud classification[11]. The interobserver agreement was analyzed using a Kappa agreement score.

Interobserver agreement was interpreted as described by Landis and Koch: K = 0.21-0.40, poor agreement; K=0.41-0.80, good agreement; and K=0.81-1.00, excellent agreement. Discrepancies were resolved based on agreement between the two radiologists.

The categorical variables were described as numbers and percentages. The continuous variables were described as mean (standard deviation). Statistical analysis was conducted using statistical package SPSS version[11].

Figure. 1 shows labeled diagrams of biliary anatomy including the configuration of the main division and drainage of the second order branch, as classified using the Couinaud classification system[11]. In cases of typical duct anatomy (type A), the right posterior duct (RPD) fuses with the right anterior duct (RAD) to form the right hepatic duct (RHD) and the common hepatic duct is formed by fusion of the RHD and LHD[11] (Fig. 2).

Type B: trifurcation of the RPD, RAD, and left hepatic duct (LHD), which drain into common hepatic duct (CHD)[11] (Fig. 3).

Type C: ectopic drainage of the right sectoral duct (C1 RAD draining into the CHD, C2 right posterior duct draining into the CHD; [11] (Fig. 4).

Type D: ectopic drainage of the right sectoral duct into the left hepatic ductal system (D1 RPD draining

Table 1 MRCP protocol

MR Scanner	T2W technique (50 mm section thickness in coronal)	3D MRCP in coronal plane (3D SSTSE) with section thickness 1 mm					
		TR(ms)	Effective TE(ms)	Image matrix	FOV	Refocusing flip angle(°)	Scan time(min)
PHILIPS 3.0TX Achiva	SSTSE , radial 5 slices	4,500	800	236x236	260x260	90	3.4
Siemens Magnetom aera	2D HASTE , radial 4 slices	4,000	700	384x353	320x320	140	5

Note: SSTSE= single shot turbo spin echo, HASTE= Half-Fourier Acquisition Single-shot Turbo Spin Echo, TR= Relaxation time is shortest, TE = echo time, FOV= field of view into the left hepatic duct system; D2, RAD draining into the left hepatic duct system;[11] (Fig. 5).

Type E: absence of the hepatic duct confluence11 (Fig.6).

Type F: absence of right hepatic duct and ectopic drainage of the right posterior duct into the cystic duct.[11]

Findings other than those listed above were classified as "other variation."

Results

We included 542 patients who underwent MRCP, 155 of whom were excluded due to the exclusion criteria mentioned above. Our eventual study group consisted of 387 patients (212 males and 175 females) with a mean age (SD) of 58.95 (15.00) years.

The Kappa agreement of MRCP readings by two radiologists according to Couinaud classification was 0.431 (p value <0.001), which is considered moderate agreement according to Landis and Koch[12].

The prevalence of the typical duct anatomy (type A) was 74.4% (n=288), and 25.6% (n=99) of cases exhibited variations from the conventional pattern. Type B or trifurcation, which was the most common type of variation, was found in 34 patients (8.8 %). The frequencies of other types were as follows: type C1, 0.3 % (n= 1); type C2, 3.1% (n=12); type D1, 6.2% (n= 24); type D2, 1.3% (n=5), type E1, 0% (n=0), type E2, 0.5 % (n=2), and type F, 0% (n=0). The remaining 21 patients (5.4 %), all of whom had accessory hepatic ducts, were classified as "other variations," as shown in Table 2.

Discussion

Understanding of anatomical variation is critical during surgical procedures, especially when it comes to anatomic areas with high rates of variation, such as the hepatobiliary system.[6,8]

One study conducted by Choi et al.9 which consisted of 300 consecutive donors for liver transplantation who underwent intraoperative cholangiography, found that 63% of cases displayed typical intrahepatic bile duct anatomy. Atypical intrahepatic duct anatomy types were as follows: triple confluence in 10% (n=29), anomalous drainage of the RPD in to the LHD in 11 % (n=34), and anomalous drainage of the RPD into the CHD in 6% (n= 19) of cases.

A study conducted by Thungsuppawattanakit et al.[2] in Thailand, which included 163 cases, found typical intrahepatic bile duct anatomy in 65 % of cases (n=106). Variations from this conventional pattern were seen in the remaining 57 patients, whith trifurcation in 17.2 %(n=28), anomalous drainage of the RPD into the CHD in 5.5% (n=9), and drainage of the RPD into the LHD in 9.2% (n=15).

In this study, we use the Couinaud classification system to classify the variations of biliary anatomy because of its greater applicability and simplicity compared to other classification systems. Deka et al.[10] who compared six classification systems, found the system used by Ohkubo et al.13and the Couinaud classification to be the most applicable. The percentages of cases in which these classification systems were not applicable were 3.1% for the system used by Ohkubo et al. and 3.3% for the Couinaud system.

In our study, typical intrahepatic duct anatomy (type A) was found in 74.4 % of subjects, a higher prevalence than those found in other studies.

Couinaud classification B or trifurcation, the second most predominate type, was found in 8.8 % of subjects. This finding is consistent with those of

Table 2 Numbers and frequencies (%) of biliary variants according to Couinaud classification[11]

Type	A	B	C1	C2	D1	D2	E1	E2	F	Others
Number	288	34	1	12	24	5	0	2	0	21
Frequency (%)	74.4	8.8	0.3	3.1	6.2	1.3	0	0.5	0	5.4

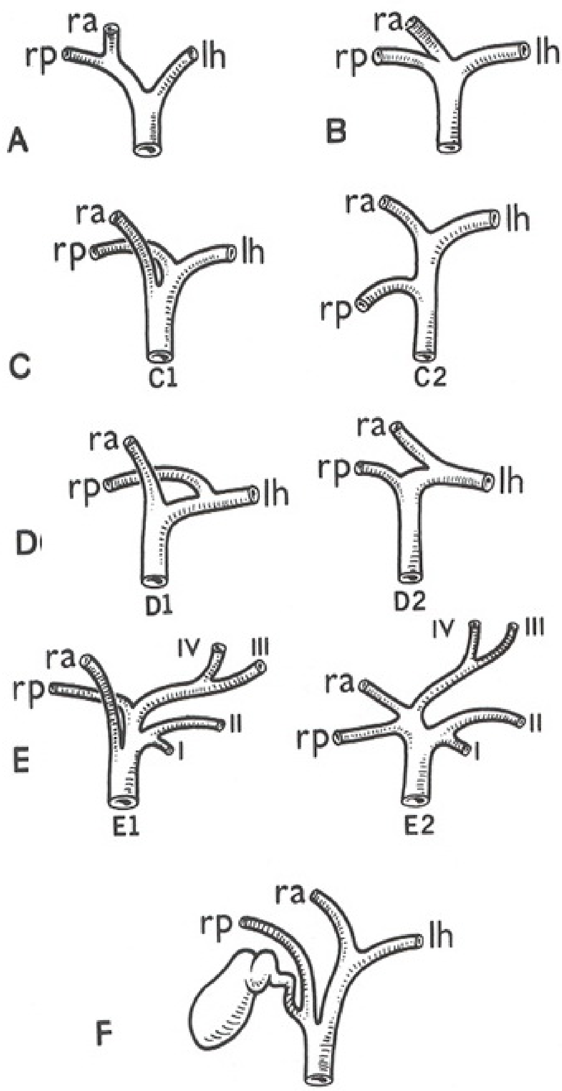

Figure 1 Diagrams of the variation of biliary anatomy as described by Couinaud[11].

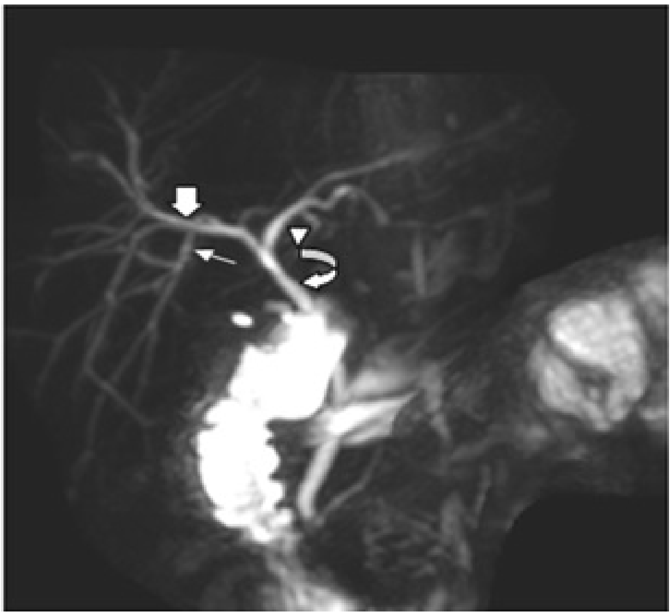

Figure 2 The typical pattern for hepatic ductal anatomy (type A). The right posterior duct (small arrow) fuses with the right anterior duct (large arrow) to form the right hepatic duct, and the common hepatic duct (curved arrow) is formed by fusion of the right hepatic duct and left hepatic duct (arrowhead).

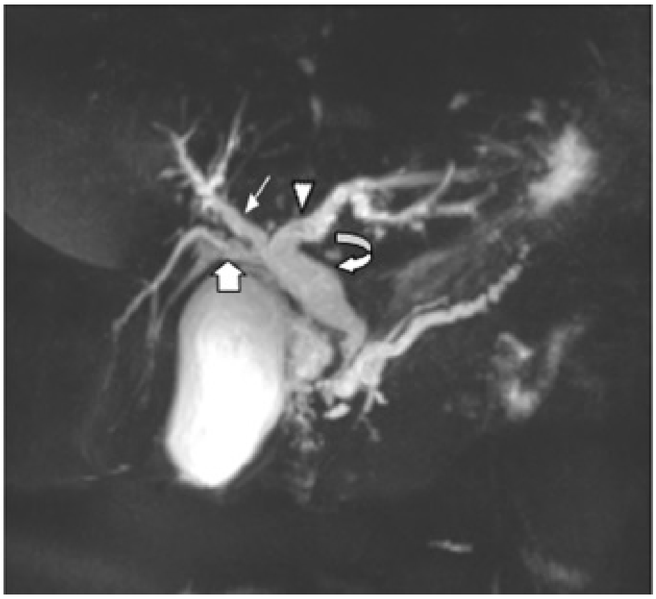

Figure 3 Trifurcation (type B): emptying of the right posterior duct (large arrow), right anterior duct (small arrow), and left hepatic duct (arrowhead) into the common hepatic duct (curved arrow).

other studies.[2,9]

In Couinaud type C the right sectoral ducts, or more commonly the anterior sectoral duct, may enter the common hepatic duct distal to the confluence. If this is not recognized it can be very dangerous, and is a common cause of injury during laparoscopic cholecystectomy.[11] In this study, type C was found in 3.4 % (C1=0.3% and C2=3.1%) of cases.

In Couinaud type D, the right posterior sectoral duct (and rarely the right anterior sectoral duct), may cross to enter the intrahepatic duct portion of the left hepatic duct. Failure to recognize this prior to

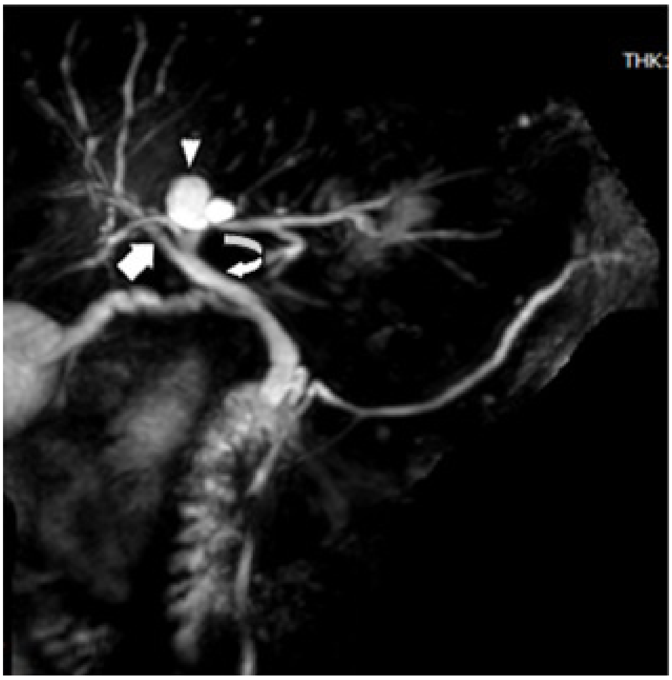

Figure 4 Type C1. The right anterior duct (thick arrow) drains into the common hepatic duct (curved arrow). A liver cyst (arrow head) is noted.

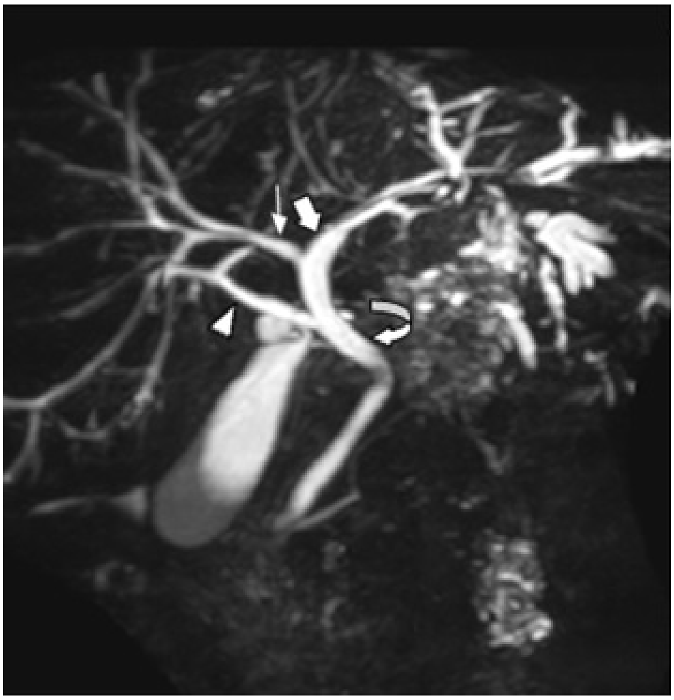

Figure 5 Type C2. Ectopic drainage right of the posterior duct (arrowhead) into the common bile duct (curved arrow). Small arrow= right anterior duct, large arrow= left hepatic duct.

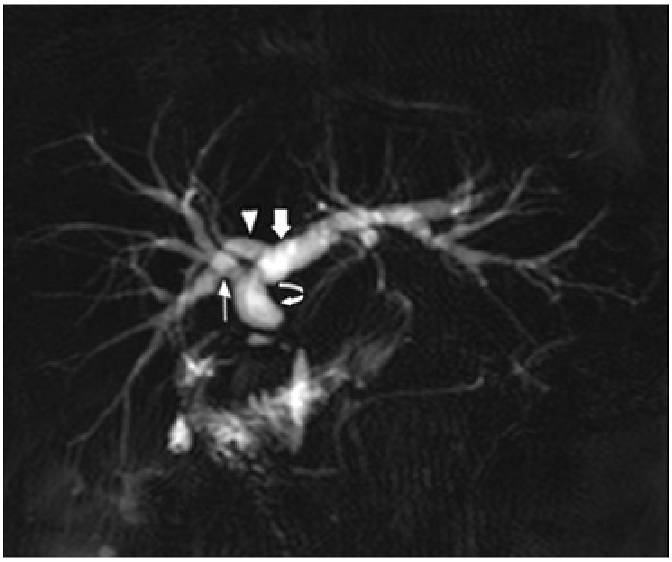

Figure 6 Type D1. Ectopic drainage of the right posterior duct (arrowhead) into the left hepatic duct system (thick arrow). Small arrow= right anterior duct, curved arrow= common hepatic duct.

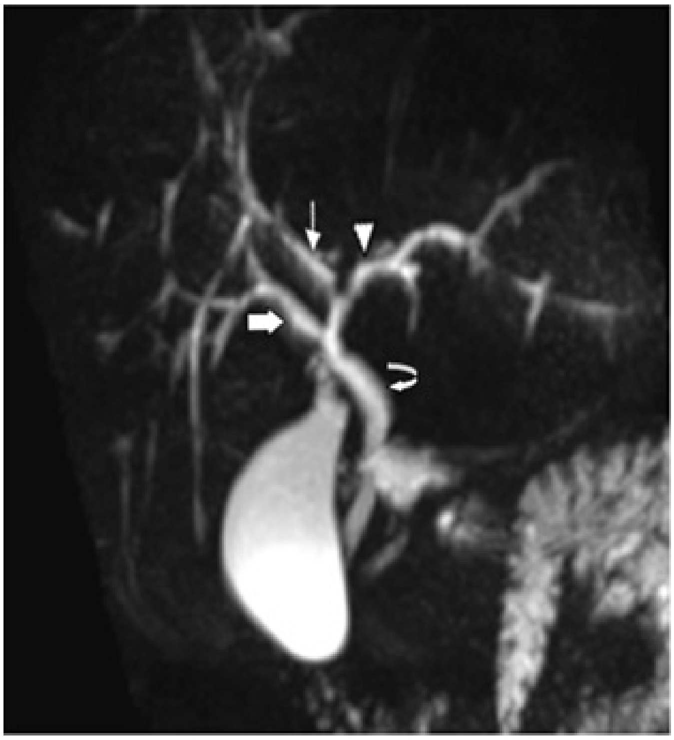

Figure 7 Type D2. Ectopic drainage of the right anterior duct (small arrow) into the left hepatic duct system (arrowhead). Thick arrow= right posterior duct, curved arrow = common bile duct.

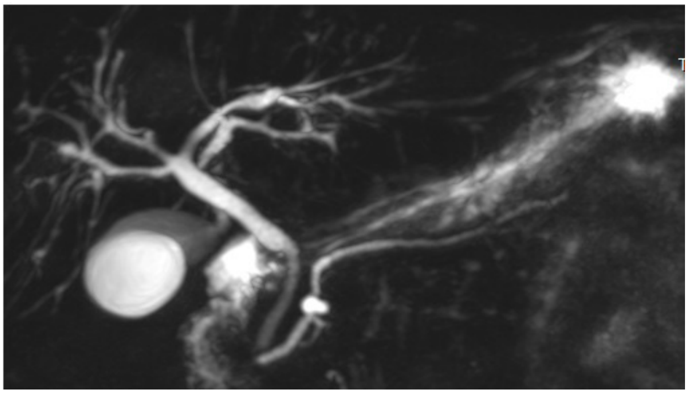

Figure 8 Type E2. Absence of hepatic duct confluence

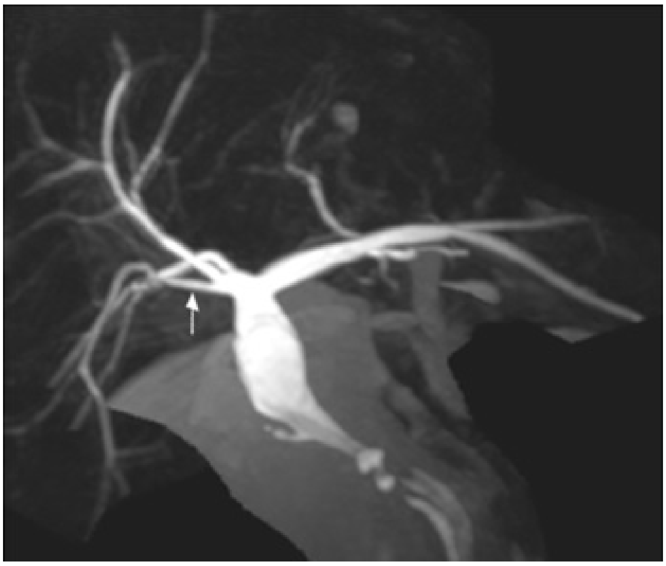

Figure 9 The accessory right posterior duct draining into right hepatic duct (other).

right or left hepatectomy can lead to significant post-operative problems, as ligation of these ducts will produce biliary cirrhosis of the segment corresponding to the ducts ligated.2 In this study, type D was observed in 7.5% (D1= 6.2% and D2=1.3 %) of cases.

Accessory hepatic ducts are observed in approximately 2% of patients. These may originate from and run along both the left and right ductal systems. They may present as solitary findings or in conjunction with aberrant bile ducts.[3] In this study, we found accessory hepatic ducts in 5.4% of patients, which was higher than in the other studies. Although accessory ducts are a minor aspect of variation, they should not be overlooked in cases of liver transplantation or hepatic resection. Identification of accessory ducts is important if serious complications such as biloma or bile duct leakage are to be avoided. Because electrocautery may seal an accessory duct temporarily, even with careful inspection of the cut margin of the liver, an awareness of possible variation in an accessory duct is important.[2]

The Kappa agreement of MRCP readings was 0.431, which is considered to represent moderate agreement according to Landis and Koch[12]. In this study, the biggest discrepancies were found between type A (typical) and type B. This low Kappa may result from the low resolution and the volume average of MRCP, which may interfere the MRCP readings.

Our study was limited in that it was likely to have suffered from selection bias, as only patients suspected of having biliary disease were indicated for MRCP in the first place. In addition, there was no confirmation of biliary configuration from either cholangiography or surgery.

Conclusion

The typical intrahepatic duct, which is the simplest configuration in cases of hepatobiliary surgery,[1,9] was the most commonly found anatomical type in our population. However, the use of non-invasive MRCP for evaluation of biliary disease and pre-operative planning is crucial.

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