Anatomic variants of Intrahepatic bile ducts and Cystic ducts in Saudi Arabia Magnetic Resonance Cholangiopancreatography Analysis in Liver Donors

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Background

The anatomy of the biliary tree is intricate, with many intrahepatic and extrahepatic variations. It has been reported that 58% of the population have a typical biliary structure. It is essential to understand in detail the normal branching patterns of the intrahepatic bile duct and cystic duct along with their variations to perform living liver donor transplantation, tumor resection and laparoscopic hepatobiliary surgeries. Endoscopic retrograde cholangiopancreatography (ERCP) and intraoperative cholangiography are invasive techniques used for imaging the biliary tree. Magnetic resonance cholangiopancreatography (MRCP) is an excellent non-invasive imaging technique that provides two-dimensional (2D) and three-dimensional (3D) projection images for visualization of the biliary anatomy in detail.

Huang et al. described the following biliary classifications: A1 corresponded to right and left hepatic ducts forming a common hepatic duct, A2 corresponded to trifurcation formed by the right anterior hepatic duct, A3 corresponded to drainage of the right posterior hepatic duct into the left hepatic duct, A4 corresponded to drainage of the right posterior hepatic duct into the common hepatic duct, A5 corresponded to drainage of the right posterior hepatic duct into the cystic duct, andA6 corresponded to all other cases and unclassified cases. Confluence patterns of B2, B3 and B4 in the left lobe of the liver for the left hepatic duct can be classified into three main types: Type A, in which the common trunk of B2 and B3 joins B4; Type B, which shows a triple confluence of B2, B3 and B4; and Type C, in which B2 joins the common trunk of B3 and B4.

Variations in cystic duct insertion are also frequently seen. Type A is a long cystic duct with low insertion into the distal third of the CBD, Type B is a duct with medial insertion of the cystic duct, Type C is a cystic duct running parallel to the common hepatic duct for at least a 2 cm segment, Type D is a cystic duct with abnormally high fusion with the CBD, Type E is a cystic duct entering the right hepatic duct, Type F is a cholecystohepatic duct, Type G is a cystic duct with a cystic malformation, and Type H is a cystic duct with lateral insertion .In this study, we intended to determine the anatomic variations in the branching patterns of the IHBD and cystic duct by performing magnetic resonance cholangiopancreatography (MRCP) in liver donors from Saudi Arabia and to explain the clinical significance of the fndings. Additional aberrant and accessory bile ducts and complex uncategorized configurations of biliary tree variants are described.

Methods

This descriptive study was performed at the Radiology Department of Prince Sultan Military Medical City in Riyadh , KSA between 2019 and 2020 after IRB approval was received (IRB no: 1404) and data were collected from liver donors (n=92). The study was carried out according to the principles of the Helsinki Declaration. Liver donors who underwent MRCP scans with adequate and clear images of the intrahepatic bile duct and cystic duct were included.

Donors whose biliary tree images were inadequate or had poor quality were excluded from the study. Demographic details, such as age, sex, and the clinical diagnosis, were obtained in addition to the branching patterns of the intrahepatic bile duct, cystic duct and their variations after experienced radiologists evaluated the magnetic resonance images. The data obtained were tabulated in an Excel sheet and analyzed by Statistical Package for Social Sciences for Windows, version 22(Armonk, NY: IBM Corp.). Descriptive statistics for the variations observed were calculated and the chi-square test was used to assess the differences in pattern distributions between males and females.

Results

This study included 92 liver donors (22=females, 70=males) who underwent MRCP scans. The following tables depict the biliary patterns in all the cases and within the females and males. The differences in these values between the males and females were statistically non-significant.

Table 1: Prevalence of pattern of Right Hepatic Duct

Subjects	A1	A2	A3	A4	A5	A6
All(n=92)	64(69.6%)	15(16.3%)	7(7.6%)	5(5.4%)	0	1(1.1%)
Females(22)	19(86.4%)	2(9.1%)	1(4.5%)	0	0	0
Males(70)	45(64.3%)	13(18.6%)	6(8.6%)	5(7.1%)	0	1(1.4%)

Table 2: Prevalence of pattern of Left Hepatic Duct

Subjects	A	B	C
All(n=92)	87(94.6%)	2(2.2%)	3(3.3%)
Females(22)	21(95.5%)	1(4.5%)	0
Males(70)	66(94.3%)	1(1.4%)	3(4.3%)

Table 3: Prevalence of pattern of Cystic Duct

Subjects	A	B	H
All(n=92)	1(1.1%)	1(1.1%)	90(97.8%)
Females(22)	0	0	22(100%)
Males(70)	1(1.4%)	1(1.4%)	68(97.1%)

Table 4: Prevalence of Accessory and Aberrant - Bile Duct and Cystic Duct

Subjects	Accessory Bile Duct			Accessory Cystic Duct	
	No	Yes-SEG 5 in CHD	Yes-SEG 5,8 to CHD	No	Ye-SEG 5 direct to CHD
Females(22)	21(95.5%)	0	1(4.5%)	22(100%)	0
Males(70)	69(98.6%)	1(1.4%)	0	69(98.6%)	1(1.4%)
	Aberrant Bile Duct			Aberrant Cystic Duct	
	No	Yes-SEG 5 in CHD		No	Yes
Females(22)	22(100%)	0		22(100%)	0
Males(70)	69(98.6%)	1(4.5%)		70(100%)	0

Fig 1: Standard biliary anatomy (Type A1): Coronal thick slap MRCP image showing a primary confluence (arrow) formed by fusion of the left main hepatic duct with the right main hepatic duct to form common

Fig 2: Trifurcation biliary anatomy (Type A2): Coronal thick slap MRCP image showing a primary confluence (arrow) formed by fusion of the left main hepatic duct, right anterior hepatic duct and right posterior hepatic duct.

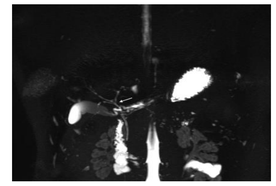
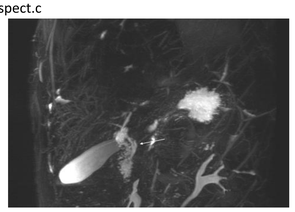


Fig.3. Right posterior hepatic duct draining into the left main hepatic duct: Coronal thick slap MRCP image showing a right posterior sectoral duct (arrow) draining into the left main hepatic duct

Fig6. Medial low insertion of the cystic duct: Coronal thick slap MRCP image showing the cystic duct (arrow) inserted into the lower third of the common hepatic duct at its medial aspect.c



Conclusion

Because the number of liver transplant surgeries being performed is increasing, magnetic resonance cholangiopancreatography (MRCP) is considered the optimal method for the noninvasive evaluation of abnormalities of the biliary tract.

Translational Potential

In 2019, Al Muhanna et al. reported that the typical right hepatic duct (RHD) configuration was observed in 56% of patients, the typical left hepatic duct (LHD) configuration was observed in 81.4% of patients and the typical cystic duct configuration was observed in 72% of patients, suggesting that the normal biliary tree anatomy is similar among the Saudi population and in other ethnic groups. The potential risk of developing biliary complications is 5.9 times higher in patients with a biliary anatomical pattern other than A1. Choi et al conducted a study on 300 liver donors and reported that the branching pattern of IHDs was atypical in 37% of cases. The two most common variations were drainage of the RPSD into the LHD (11%) and triple confluence of the RASD, RPSD and LHD (10%). There is a high incidence of biliary variants, as reported in many studies, but radiologists should assess patients' biliary anatomy carefully and report the findings to promote successful liver surgeries and transplantation. A lack of awareness of the variations will result in the diagnosis being missed completely or confused with other types of conditions, leading to inappropriate treatment.

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