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Intrahepatic Biliary Variations on Magnetic Resonance Cholangiopancreaticography: A Study From a Tertiary Centre in North East India

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Abstract

Objective: It is known that variations can occur in the insertion of biliary ducts in both right and left intrahepatic ductal systems. We undertake this study to evaluate the normal anatomy and variations of intrahepatic biliary system on magnetic resonance cholangiopancreaticography, classify them into typical and atypical right hepatic duct and left hepatic duct, and compare relationships between them.

Methods: This is a 10-year retrospective study (2008-2018). Magnetic resonance cholangiopancreaticography using a 1.5 T Siemens with breath-hold HASTE sequence, FS HASTE, thin slice FSE T2-WI with post processing volume rendered of maximum intensity projection (MIP) images. Drainage patterns were reviewed.

Results: A total of 347 cases in 10 years were analyzed (2008-2018), with age ranges from 1 year 11 months to 90 years, with a mean of 42.37 years and M : F: 145 : 202 = 0.71. Right posterior sectoral duct joining right anterior sectoral duct medially to form right hepatic duct was seen in 250 cases (72%), trifurcation in 59 (17%), right posterior sectoral duct joining the left hepatic duct in 20 (5.7%), right posterior sectoral duct to common hepatic duct in 10 (2.9%), aberrant right hepatic duct to cystic duct in 1 (0.3%), accessory right hepatic duct in 2(0.58%), segment II/III draining independently into common hepatic duct/ common bile duct (CBD) in 3 (0.86%), and unclassified in 2 (0.58%) cases. The common trunk of segment II and segment III joining segment IV forming left hepatic duct was seen in 325 cases (93.7%). Comparing right hepatic duct and left hepatic duct, the tabulated Chi-square value (critical value) was 51.18 (0.001) and calculated value was 1.958 (<value at 1% level of significance) at $df = 24$, The data collected were highly significant. Therefore, typical right hepatic duct drainage will also be likely to have typical left hepatic duct drainage.

Conclusion: Right posterior sectoral duct joining right anterior sectoral duct medially forming right hepatic duct and common branch of segment II and III joining the segment IV forming left hepatic duct are most common. A typical right hepatic duct insertion will most likely also be accompanied by typical drainage on the left side.

Keywords: Common hepatic duct, left hepatic duct, right anterior sectoral duct, right posterior sectoral duct, right hepatic duct, variations

INTRODUCTION

Biliary anatomy is complex, with variants seen in both intrahepatic and extrahepatic biliary ducts. Knowledge of anatomy is a prerequisite in preoperative biliary interventions, therapeutic biliary interventions liver resections, and liver transplants. Endoscopic retrograde cholangiopancreaticography (ERCP) and percutaneous cholangiography techniques can clearly picture the biliary anatomy. Magnetic resonance cholangiopancreaticography (MRCP), on the other hand, is a non-invasive imaging tool compared to ERCP and invasive cholangiography[1] for visualizing the biliary system. With author's experience it was found that the variants are not routinely documented on an MRCP report, probably being content with reporting of the various hepatobiliary pathologies only. Many authors have described different patterns of biliary anatomy drainage.[1] Normally a right posterior sectoral duct (RPSD) passes posterior to the right anterior sectoral duct (RASD) to insert on its medial aspect to finally form the right hepatic duct (RHD).[2] The left hepatic duct (LHD), on the other hand, is most commonly formed when a common trunk of segment II and segment III joins segment IV.[1,2] Though there are many patterns of classifying variants in anatomy, for simplicity, we classified the variants according to that compiled by Sureka et al[1] (Table 1).[2-6] With this knowledge in mind, we therefore undertook this study on the variations of the left and right intrahepatic ducts and to study their inter-relationships.

Purpose

To evaluate the normal anatomy and variations of intrahepatic biliary ductal system on MRCP, classify into typical and atypical RHD and LHD, and compare relationships between these variations.

Table 1. Anatomical Variants of the Intrahepatic Biliary Ductal System[1-6]

Right hepatic duct	Left hepatic duct
Type I: Typical: RPSD joining RASD medially to form RHD Type II: Trifurcation: Simultaneous emptying of the RASD, RPSD, and LHD into the CHD Type III: Anomalous drainage of RPSD (A) RPSD joining LHD (crossover anomaly) (B) RPSD joining CHD (C) RPSD joining cystic duct Type IV: Aberrant drainage of RHD into the cystic duct Type V: Accessory right hepatic duct Type VI: Segments II and III duct draining individually into the RHD or CHD Type VII: Others and unclassified variations	Type A: Common trunk of segment II and segment III joins segment IV Type B: Triconfluence of segments II, III, and IV Type C: Segment II duct drains into the common trunk of segment III and segment IV Type D: Others and unclassified variations

CHD, common hepatic duct; LHD, left hepatic duct; RASD, right anterior sectoral duct; RHD, right hepatic duct; RPSD, right posterior sectoral duct

METHODS

This is a retrospective study on MRCP performed at our institute in 10 years (2008-2018). The study was done with the approval of the institutional ethics committee IEC at North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences (Date: July 2, Number: NEIGR/IEC/M8/F12/19). Consent was waived as this was a retrospective study. Exclusion criteria are post-operative, grossly dilated biliary system distorting anatomy, malignant condition at the confluence and common hepatic duct (CHD), degraded images, post-transplant, pneumobilia, stents, traumatic conditions, and all other conditions that severely distort the anatomy and image quality.

Magnetic resonance imaging (MRI) was performed using 1.5 T units (Siemens MAGNETOM, Avanto, Belgium Made). The MRCP protocol includes breath-hold HASTE sequence, axial and coronal FS HASTE, thin slice fast spin echo T2-WI along with post processing volume rendered of MIP images.

The images were reviewed and variations of the RHD, LHD, and confluence were classified as in Table 1. The images were reviewed by consensus of 2 experienced radiologists at a time (minimum of 3 years experience in hepatobiliary imaging) on a Syngo.via reading solution in our MRI console.

Statistical Analysis

Descriptive statistics was done using chi-square test.

RESULTS

A total of 347 cases in 10 years were analyzed (2008-2018), with age ranges from 1 year 11 months to 90 years, with a mean of 42.37 years and M:F: 145:202 = 0.71. For the RHD, type I-typical RHD insertion was seen in 250 cases (72%) (Figure 1). The next common insertion is the type II—trifurcation in 59 cases (17%) (Figure 2), type IIIA—RPSD joining the LHD in 20 cases (5.7%) (Figure 3), RPSD to CHD in 10 cases (2.9%), aberrant RHD to cystic duct in 1 case (0.3%), accessory RHD in 2 cases (0.58%), segments II or III draining independently into CHD or common bile duct (CBD) in 3 cases (0.86%) and unclassified in 2 cases (0.58%). Typical (type A) LHD insertion—the common trunk of segment II and segment III joining segment IV (Figure 4) was seen in 325 cases (93.7%), type B—triconfluence of segments II, III, and IV was seen in 13 cases (3.7%), type C—segment II duct draining into the common trunk of segment III and segment IV in 3 cases (0.86%) and type D—others and unclassified variations in 6 cases (1.7%).

Statistically comparing RHD and LHD, the tabulated chi-square value (critical value) was 51.18 (0.001) and the calculated value was 1.958 at $df = 24$. The calculated value is much less compared to tabulated value at 1% level of significance; hence, the data collected are highly significant. Therefore, patients with type 1 (typical) RHD will

MAIN POINTS

- It is known that variations in the insertion of biliary ducts in both right and left intrahepatic ductal systems are common as also evident in our study.
- In our study, it is found that a typical right hepatic duct insertion is significantly associated with a typical left hepatic insertion.
- This finding can be important, especially for hepatobiliary preoperative imaging and also for the planning of biliary interventions like percutaneous transhepatic biliary drainage.

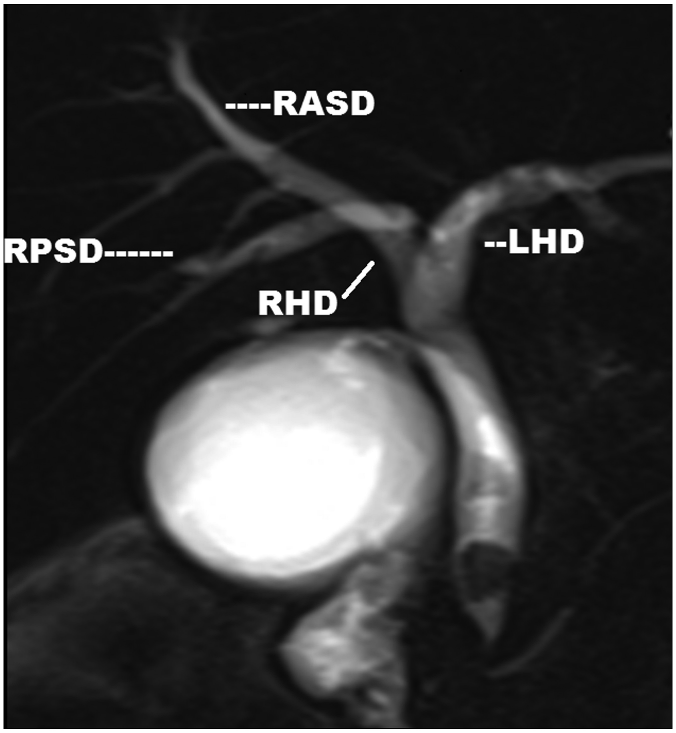

Figure 1. MRCP-T2 HASTE image showing typical insertion (type 1) of the right posterior sectoral duct (RPSD) into the medial of the right anterior sectoral duct (RASD) before becoming the right hepatic duct (RHD). MRCP, magnetic resonance cholangiopancreaticography.

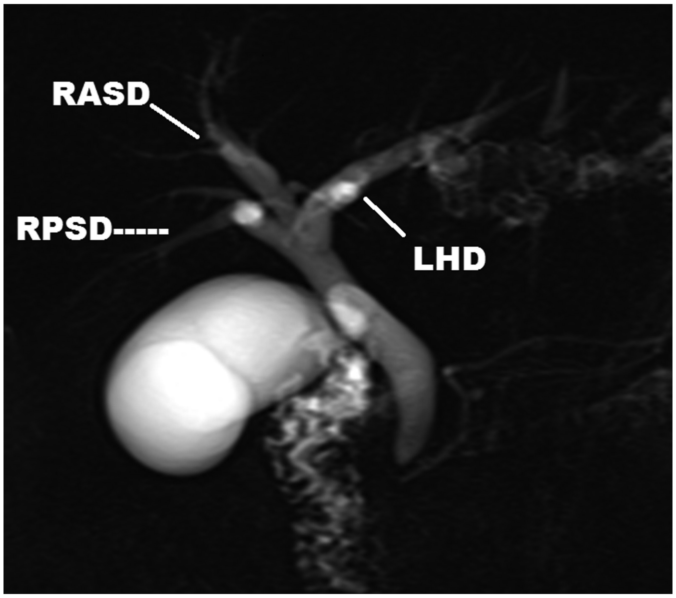

Figure 2. MRCP-T2 HASTE image showing triple confluence (type II) of the right posterior sectoral duct (RPSD), right anterior sectoral duct (RASD), and the left hepatic duct (LHD). MRCP, magnetic resonance cholangiopancreaticography.

also be likely to have type A (typical) LHD, thereby accepting the null hypothesis.

DISCUSSION

This study shows the variants in the intrahepatic biliary ductal system of both the left and right lobes. In all cases, the liver was normally seen on the right side indicating normal situs. The typical RHD insertion in our series is 72% which is comparable to other studies (Table 2). The most common atypical variant of RHD insertion is triple confluence (17%) followed by anomalous posterior sectoral duct draining to LHD (5.7%) together constituting 22.7% which together is comparable to other studies[2,3,7] (Table 2).

Type A LHD drainage is the commonest pattern where a duct formed by the union of segments 2 (II) and 3 (III) joins the segment 4 (IV) duct to form the LHD in agreement with previous studies.[2,5,8,9] Type A in our study is seen in 93.7% which is higher than reported in other literatures show that this pattern occurs in about 59% to 78%.[2,5,8,9] Our series shows a higher percentage of typical LHD.

Our study also proves that a typical RHD insertion will many times mean that there will be an associated typical LHD insertion as shown in our study, but the authors suggest that this be verified individually with each case.

While so many variants in both RHD and LHD patterns have been described in the literature as discussed, knowing the anatomy of the biliary anatomy has definite clinical implications especially as a preoperative workout for my surgical and biliary interventional procedures.[10] For example, variants like RPSD draining to the LHD and trifurcation can lead to inadvertent injuries on the donor during transplantation surgeries.[11]

Unclassified anatomy can be encountered infrequently but is very rare.[2,3,7] Our study also shows that the unclassified variants are very rare (Table 2).

The limitation was that this study was not done on disease individuals whereby the incidence of variations associated with the disease population might be variable compared to a healthy population. Another

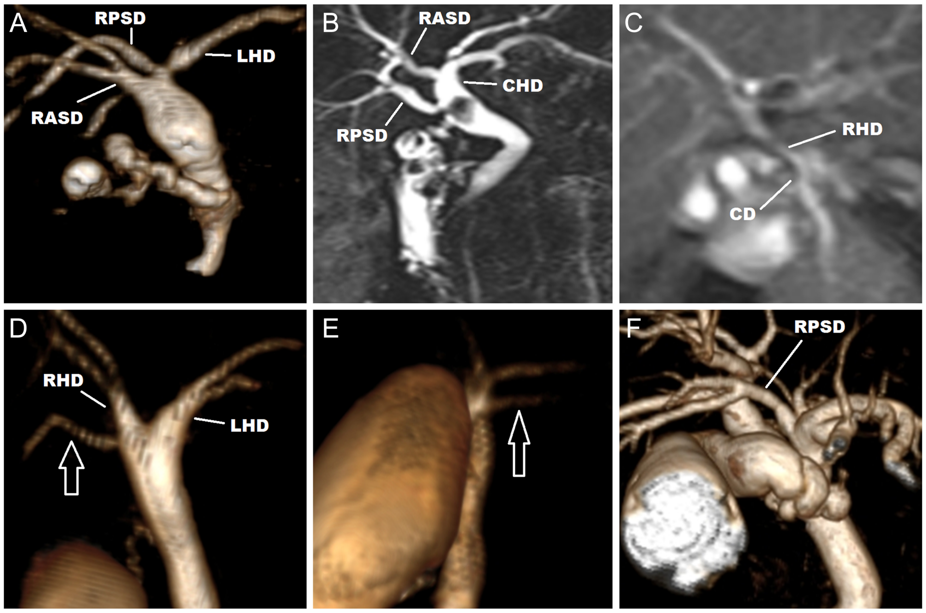

Figure 3. MRCP of variants of right hepatic duct insertion. (A) Volume rendered (VR) image showing right posterior sectoral duct (RPSD) joining LHD (type IIIA). (B) Thin slice T2-WI image showing RPSD joining common hepatic duct (CHD) (type IIIB). (C) Thin slice T2-WI showing the right hepatic duct (RHD) joining the cystic duct (CD) (type IV). (D) VR image showing accessory hepatic duct (open arrow) (type V). (E) Showing one of the left hepatic ducts (open arrow) joining the CHD (type VI). (F) Showing unclassified where the RPSD appear to join the confluence of the left hepatic ducts high inserted cystic duct (type VII). LHD, left hepatic duct; MRCP, magnetic resonance cholangiopancreaticography.

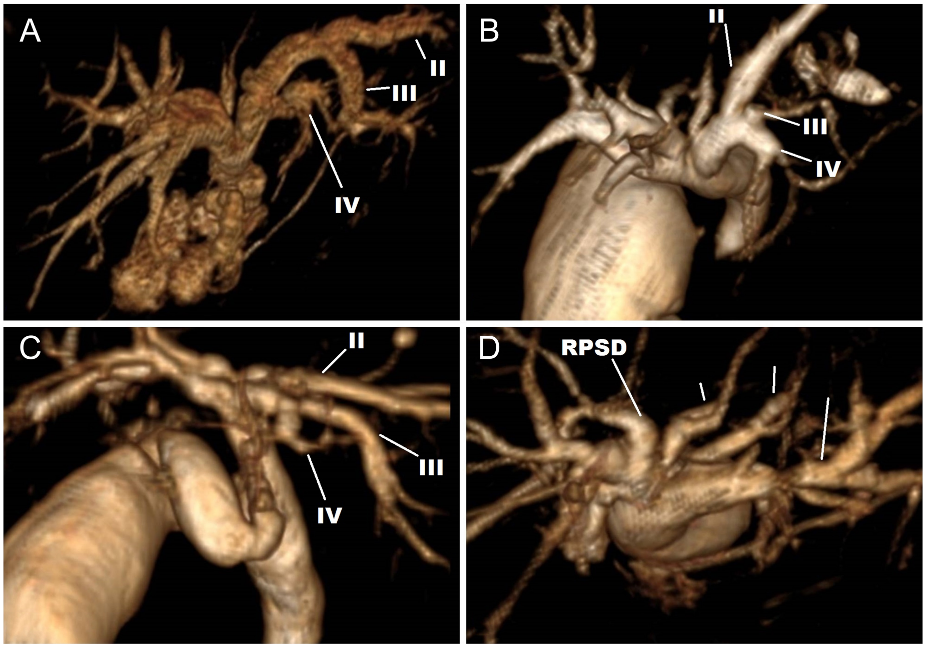

Figure 4. MRCP volume rendered images showing variants of left hepatic duct insertion. (A) The common trunk of segment II and III duct joins the segment IV duct to form the left hepatic duct. (B) Triconfluence of segment II, III, and IV. (C) Segment II joins the common trunk of segments III and IV. (D) Unclassified variant showing segments 3 ducts (white lines) from the left lobe independently draining to the CHD. CHD, common hepatic duct; MRCP, magnetic resonance cholangiopancreaticography.

limitation is that we did not have any comparison with intraoperative cholangiography or ERCP. Also cases were included only if anatomy was clearly depicted, due to which many variants might have been together been excluded.

MRCP being an accurate, safe and non invasive imaging modality in hepatobiliary can outline common anatomical intrahepatic biliary variants which will serve as a preoperative roadmap for surgical and radiological hepatobiliary interventions. Medial insertion of the right posterior sectoral duct to the right anterior sectoral duct to form the RHD is the most common drainage of the right lobe and common branch of segment II and III joining the segment IV is the most common left hepatic variant. This study also shows that visualizing a typical RHD insertion will reflect a possible typical LHD insertion in most cases.

Table 2. Variations in Intrahepatic Duct Anatomical Variations

	Our study, Lynser et al (n=347)	Choi et al.[3] 2003 (n=300)	Sarawagi et al.[2] 2015 (n=224)	Gupta et al.[7] 2016 (n=458)
Typical finding	72%	63%	55.3%	65.72%
Anomalous RPSD to LHD	5.7%	11%	27.6%	14%
Triple confluence	17%	10%	9.3%	12.23%
RPSD to common hepatic duct	2.9%	6%	4%	4.4%
RPSD to cystic duct	-	2%	0.8%	0.4%
RHD to cystic duct	0.3%	0.3%	1.3%	-
Accessory duct to CHD/CBD	0.58%	5%	4.9%	0.7%
Accessory duct to RHD	-	-	-	0.2%
Individual drainage of LHD to RHD or CHD	0.86%	1%	-	0.2%
Unclassified	0.58%	1%	-	2.2%

CHD, common hepatic duct; LHD, left hepatic duct; RASD, right anterior sectoral duct; RHD, right hepatic duct; RPSD, right posterior sectoral duct; CBD. common bile duct.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences (Date: July 2,2019, Number: NEIGR/IEC/M8/F12/19).

Informed Consent: Due to the retrospective design of the study, informed consent was not taken.

Peer-review: Externally peer-reviewed.

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Declaration of Interests: The authors have no conflicts of interest to declare.

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