ISSN: 2091-2331 (Print) 2091-234X (Online)

Journal of Nobel Medical College

Volume 13, Number 01, Issue 24, January-June 2024, 25-29

Original Article

Study of Anatomical Variation of Intrahepatic Biliary Tree by Magnetic Resonance Cholangiopancreatography in Patients Attending Tertiary Hospital of Eastern Nepal

Mahesh Gautam*, Robinson Shrestha, Bipin Khanal, Sameen Khatiwada

Department of Radiology, Nobel Medical College Teaching Hospital, Biratnagar, Nepal

Article Received: 5th March, 2024; Accepted: 28th May, 2024; Published: 30th June, 2024

DOI: https://doi.org/10.3126/jonmc.v13i1.68098

Abstract

Background

There are several variations in the complex anatomy of intrahepatic bile ducts. Magnetic resonance cholangiopancreatographyis a safer imaging modality that effectively shows these variations, aiding in surgical planning and preventing iatrogenic injuries. This study aims to evaluate these anatomical variations using magnetic resonance cholangiopancreatography.

Materials and Methods

This cross-sectional prospective study was performed in the Radiology Department of Nobel Medical College for one year using a convenient sampling technique. A total of 165 cases meeting the inclusion criteria were selected and magnetic resonance cholangiopancreatography was performed to evaluate the anatomical variations.

Results

The mean age of patients was 34.32±10.22 years out of which 51.5%were male and 48.5%were female. The branching pattern of right hepatic duct was typical in 66.7% of cases. The right posterior sectoral duct joining left hepatic duct was the most common variation seen in 15.2%. Right posterior sectoral duct joining the common bile duct was present in 6.7%. 6.1% of cases had unclassified variation whereas a trifurcation pattern was found in 5.5%. Left hepatic duct showed the typical branching pattern in 70.9% of cases. Segment II duct draining into the common trunk of segments III and IV was seen in 20%. Triconfluence among segments II, III, and IV was seen in 8.5% and 0.6% of cases had unclassified variation.

Conclusion

This study revealed wide variation in branching patterns of intrahepatic biliary ducts. The typical branching pattern of right and left hepatic ducts were seen in majority of cases.

Keywords: *Anatomic variation, Intrahepatic bile ducts, Magnetic Resonance cholangiopancreatography*

***Corresponding Author:**
Dr. Mahesh Gautam
Assistant Professor
Email: mahes.gautam07@gmail.com
ORCID: https://orcid.org/0000-0003-3978-3770

Citation
Gautam M, Shrestha R, Khanal B, Khatiwada S, Study of Anatomical Variation of Intrahepatic Biliary Tree by Magnetic Resonance Cholangiopancreatography in Patients Attending Tertiary Hospital of Eastern Nepal, JoNMC 13:1 (2024) 25-29. DOI:https://doi.org/10.3126/jonmc.v13i1.68098

Introduction

The complexity of the biliary channel anatomy arises from the presence of intrahepatic and extrahepatic variations. Because of the recent advancement, the frequency of complex hepatobiliary surgeries including bile duct interventions, partial liver resections, and partial liver transplantation are increasing trends and in-depth accurate anatomical study of these branching patterns of bile duct is crucial before these surgeries [1, 2].

Magnetic resonance cholangiopancreatography (MRCP) is an ideal non-invasiveimaging modality for the visualization of bile ducts which is safe, more accurate and devoid of ionising radiations [3-5].The right posterior duct draining to the left hepatic duct or at its confluence with the right anterior duct is the most common anatomic variation of the bile duct; reported in about 30% of cases [6]. These variations can complicate surgeries, leading to difficult anastomosis and increased morbidity [7]. The epidemiology of extra-hepatic biliary abnormalities like pancreaticobiliary duct maljunction is well studied, but data on intrahepatic variations with regional differences, and demographic correlations remain limited [8].

This study aims to evaluate the anatomical variations of intrahepatic biliary tree using MRCP in a tertiary teaching hospital in Eastern Nepal. This will further aid radiologists and clinicians in accurately interpreting MRCP images and guiding therapeutic interventions.

Material and Methods

This cross-sectional prospective observational study was conducted in the Department of Radiology Nobel Medical College for one year from June 2022 to 2023 after getting ethical clearance from the institutional review committee (IRC; Reference no. 630/2022). Informed consent was taken from all the enrolled patients after a detailed explanation of the study.

All consecutive patients of age more than 18 years irrespective of gender undergoing MRCP for evaluation of hepatobiliary disease were included in this study. Patients with a prior history of liver surgery, malignant or benign hepatic lesions making the biliary tree difficult to visualize, severe biliary tree obstruction, motion artifacts and poor-quality images were excluded from the study.

A convenient sampling technique was used for patient selection. The sample size was calculated using the following formula: $n=Z^2 p \times q/e^2 = (1.96)^2 \times 0.63 \times 0.37 / (0.075)^2 \sim 160$. ; Where, n= minimum required sample size, Z= 1.96 at 95% Confidence Interval (CI)p= prevalence of anatomical variations of biliary tree taken from previous studies 63%. Based on a study conducted by Choi et al. for anatomic variation in intrahepatic bile ducts the prevalence was found to be 63%, q= 1-p and e= margin of error, 7.5% [9]. Thus, a total of 165 patients were included in this study.

MRCP was performed in a 3-Tesla MRI system (Skyra, Siemens). Images were acquired using body coil using the parameters: Time of relaxation (TR) of 8,000 ms, Time of excitation (TE) of 800 ms, flip angle of 90 degrees, and field of view (FOV) 250–300 mm. For the maximum intensity projections images 40 mm thick oblique coronal slices at 0.4-mm interval on breath hold were obtained. Respiratory gated 3D images were obtained using TR-1,204 ms; TE-650 ms; flip angle 90 degrees and FOV 280mm. Image interpretation was done by two radiologists conjointly without any discrepancies and the presence of any common or uncommon variants was documented. The classification of right hepatic duct variations was done according to the classification by Sureka et al. and the left hepatic duct variation was done according to the classification done by Choi et al [9, 10].Additional anomalies such as aberrant and accessory bile ducts, as well as complex variations in the pattern of the biliary tree that cannot be easily categorized, are described in further detail.

Data was analyzed using SPSS version 22. Descriptive statistics was used to determine the type of anatomical variations and branching pattern. The different branching patterns of RHD (Types I, II, IIIA, IIIB, IIIc, IV, V, VI and VII) and LHD (Types A, B, C and D) were determined. The RHD and LHD variations across genders were compared through cross-tabulation. The Chi-square test was applied for the statistical significance of IHBD variations in males and females.

Results

A total of 165 patients undergoing MRCP were selected in this study, with ages ranging from 18 years to 62 years. The mean age of patients undergoing MRCP was 34.32±10.22 years. Regarding gender 85 (51.5%) were male and 80 (48.5%) were female. The anatomical variation of the right hepatic duct was done according to the classification given by Sureka et al and is shown in Table 1. The frequency of variation of RHD among males and females is shown in Table 2. Also, the Chi-square Statistic value obtained by Chi-square test via SPSS was 0.087 i.e. the difference in RHD variation between males and females was not statistically significant.

Table 1: Anatomical variations of Right intra-hepatic Biliary Ductal System (Sureka et al)

Classification	Frequency (n=165)	Percentage (%)
Type I: Typical: RPSD joining RASD medially to from RHD	110	66.7
Type II: Trifurcation: Simultaneous emptying of the RASD, RPSD and LHD into the CHD	9	5.5
Type III: Anomalous drainage of RPSD		
A: RPSD joining LHD (crossover anomaly)	25	15.2
	11	6.7
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 RHS or CHD	-	-
Type VII: Others and unclassified variations.	10	6.1

Table 2: Cross Tabulation of Sex and RHD Type.

RHD Type	Male	Female	Total
I	56 (50.9%)	54 (49.1%)	110
II	5 (55.4%)	4(44.6%)	9
IIIA	14 (56%)	11(44%)	25
IIIB	4(36.4%)	7 (63.6%)	11
VII	6 (60%)	4 (40%)	10
Total	85 (51.5%)	80 (48.5%)	165

The anatomical variation of the left hepatic duct was done according to the classification given by Choi et al and is shown in Table 3. The frequency of variation of LHD among male and female is shown in Table 4. Also, the Chi-square Statistic value obtained by Chi-square test via SPSS was 0.01i.e. the difference in LHD variation between males and females was statistically significant.

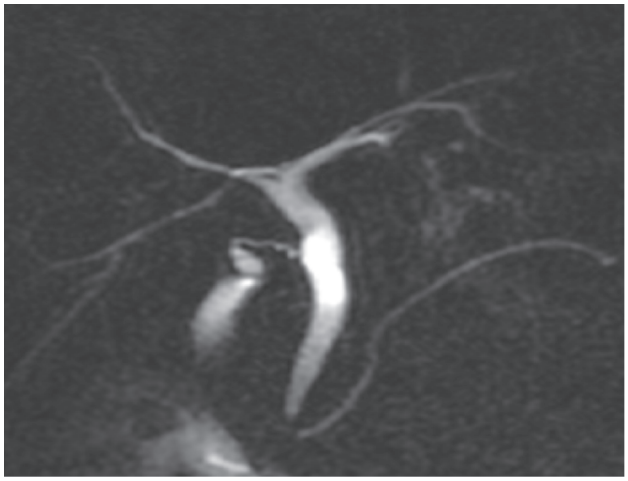

Figure 1: Typical right intrahepatic biliary duct branching pattern- RPSD joining RASD medially to from RHD (Type I).

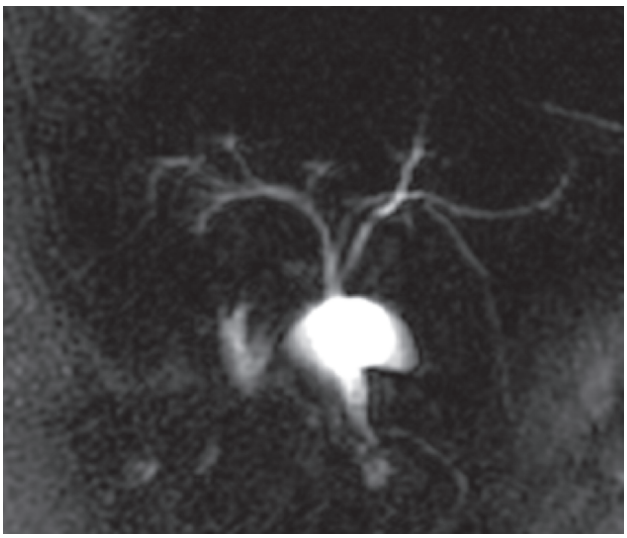

Figure 2: Trifurcation: Simultaneous emptying of the RASD, RPSD and LHD into the CHD. (Type II).

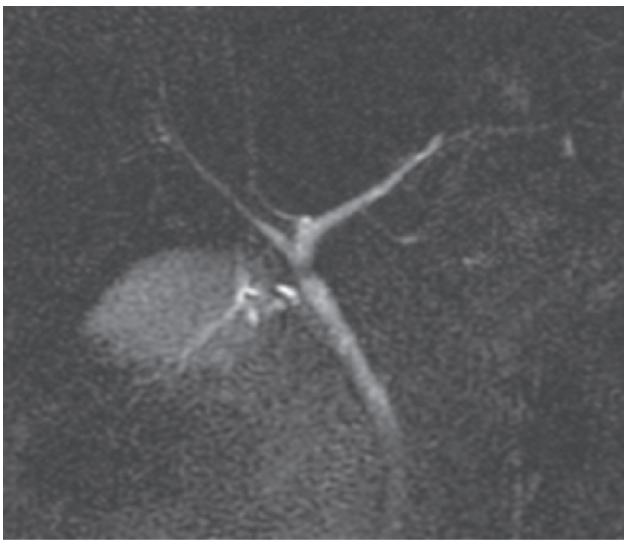

Figure 3: Projection reformatted MRCP image showing Right posterior sectoral duct opening into the left hepatic duct (Type IIIA).

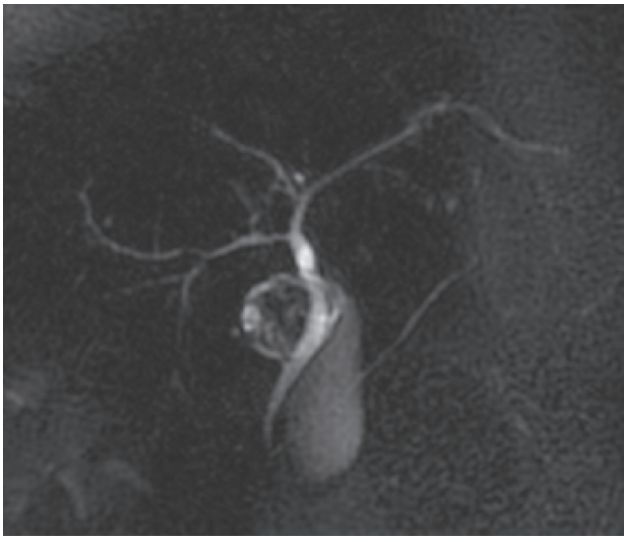

Figure 4: Right posterior sectoral duct opening into the common hepatic duct (Type IIIB)

Table 3: Anatomical variations of Left intra-hepatic Biliary Ductal System (Choi et al)

Classification	Frequency (n=165)	Percentage (%)
Type A: Common trunk of segment II and segment III joins segment IV	117	70.9%
Type B: Tri-confluence of segments II, III and IV	14	8.5%
Type C: Segment II duct drains into the common trunk of segment III and segment IV	33	20%
Type D: Others and unclassified variations	1	0.6%

Table 4: Cross Tabulation of Sex and LHD Type.

LHD Type	Male	Female	Total
A	58 (49.6%)	59 (50.4%)	117
B	9 (64.3%)	5 (35.7%)	14
C	18 (54.5%)	15 (45.5%)	33
D	0 (0%)	1 (100%)	1
Total	85 (51.5%)	80 (48.5%)	165

Discussion

MRCP is the gold standard for the study of the biliary tree owing to its high sensitivity, non-invasive nature as well as the absence of ionizing radiation. Due to several technical improvements introduced in its protocol over recent years, MRCP allows us to investigate the morphology of intra-hepatic bile ducts and cystic ducts.

There are different classifications used to describe anatomical variations of bile ducts. The branching pattern of RHD was done according to the classification by Sureka et al, which consisted of seven different types. RPSD joining RASD medially forming RHD was considered the typical branching pattern i.e. Type I and was the commonest branching pattern, which was seen in 64% of cases. Type III was anomalous drainage of RPSD seen in 17% of cases. In Type II RASD, RPSD, and LHD simultaneously empty into the CHD also called the trifurcation pattern seen in 5% of cases. In type IV RHD drains into the cystic duct, seen in 3% cases. Accessory RHD(type V) was present in 1.4% of cases. In type VI segments II and III duct drains individually into RHD or CHD and Type VII was considered as others or unclassified variations which were seen in none of the cases [10].The present study also concluded that Type-I typical branching pattern was the most common type of RHD variation seen in 110 (66.7%) of cases.

A study using the same classification references was conducted by Lynser et al in 347 cases was in line with the present study which revealed that for right hepatic duct, Type I was the most common comprising 72% cases, followed by Type II (17%), Type IIIA (5.7%), Type IIIB (2.9%), Type VI (0.86), Type V and VII (0.58%) and least one was Type IV (0.3%). For left hepatic duct, Type I was the commonest one seen in 93.7 % of cases, followed by Type B (3.7%), Type D (1.7%) and the least common was Type C (0.86%) [11]. The present study also showed that in left hepatic branching pattern Type A i.e., common trunk of segment II and segment III joining segment IV was the most common variation seen in 117 (70.9%) cases.

A similar study conducted in North India was in line with the finding of the present study which revealed that regarding the right hepatic duct, 63% of patients had Type-I typical branching pattern and for left hepatic duct variations, the most common type of classification was Type-I seen in 34% of the patients [12].

Another study conducted in India also showed similar findings to the present study which concluded that the most common right hepatic duct variation was typical in 55.3% and the most common type of left hepatic duct branching was Type-I common trunk of segment II and III ducts joining the segment IV duct seen in 67.8% of cases [13].

Another study conducted by Paudel et al in Nepal also supported the findings of the present study which revealed that the most common right hepatic duct variation was Type-I seen in 47.8% of cases and the most common left hepatic variation was Type-I noted in 67.4% of cases. However, the variation of LHD between males and females was significant in our study, unlike their study [14].

Another study conducted in Korea also supported the findings of this study which showed the typical anatomy in 63% of cases, trifurcation in 10%, RPSD draining into the LHD in 11%, RPSD emptying into the CHD and cystic duct was seen in 6% and 2% respectively, drainage of the RHD into the cystic duct and accessory duct draining into CHD or RHD in 5%, LHD draining individually into the CHD or RHD in 1%, and unclassified variation in 1% [9].

A similar study conducted in Iran was similar to the findings of this study. The study showed the right dominant A1 Huang pattern as the most common type seen in 45% which is also the most common type seen in this study. Type A2 Huang or trifurcation was seen in 21.5% of patients. Left dominant or Type A3 Huang was seen in 13.3% of patients. Type A4 was seen in 3.6% of patients [15].Hence the findings of the present study were

supported by the findings of various other studies, we can conclude that the majority of the patients have normal anatomical variations. It is crucial to take these variations into account prior before any liver transplants or other hepatobiliary surgeries.

Conclusion

MRCP is the ideal imaging modality for the evaluation of the biliary ducts. Along with other anatomical variations, typical branching patterns of the right and left hepatic duct were seen in 66.7% and 70.9% of cases respectively. Accurate preoperative identification of these variations is crucial to effectively plan hepatobiliary surgeries.

Acknowlegment: None.

Conflict of interest: None.

References

[1] Mortelé KJ, Ros PR. Anatomic variants of the biliary tree: MR cholangiographic findings and clinical applications. AJR Am J Roentgenol. 177:2 (2001) 389-94. PMID: 11461869

[2] Hyodo T, Kumano S, Kushihata F, Okada M, Hirata M, Tsuda T, et al. CT and MR cholangiography: advantages and pitfalls in perioperative evaluation of biliary tree. Br J Radiol.85:1015 (2012) 887-96. PMID: 22422383

[3] Catalano OA, Singh AH, Uppot RN, Hahn PF, Ferrone CR, Sahani DV. Vascular and biliary variants in the liver: implications for liver surgery. Radiographics. 28:2 (2008) 359-78. PMID: 18349445

[4] Xu YB, Bai YL, Min ZG, Qin SY. Magnetic resonance cholangiography in assessing biliary anatomy in living donors: a meta-analysis. World J Gastroenterol. 19:45 (2013) 8427-34. PMID: 24363536

[5] Nayman A, Özbek O, Erol S, Karaku? H, Kaya HE. Magnetic resonance cholangiopancreatography evaluation of intrahepatic bile duct variations with updated classification. Diagn Interv Radiol. 22:6 (2016) 489-94. PMID: 27538048.

[6] Puente SG, Bannura GC. Radiological anatomy of the biliary tract: variations and congenital abnormalities. World J Surg. 7:2 (1983) 271-6.PMID: 6868640

[7] Karakas HM, Celik T, Alicioglu B. Bile duct anatomy of the Anatolian Caucasian population: Huang classification revisited. SurgRadiol Anat. 30:7 (2008) 539-45.PMID: 18491027

[8] Kamisawa T, Takuma K, Anjiki H, Egawa N, Kurata M, Honda G, et al. PancreaticobiliaryMaljunction.Clin Gastroenterol Hepatol. 7:11 (2009) S84-8. PMID: 19896105

[9] Choi JW, Kim TK, Kim KW, Kim AY, Kim PN, Ha HK, et al. Anatomic Variation in Intrahepatic Bile Ducts: an Analysis of Intraoperative Cholangiograms in 300 Consecutive Donors for Living Donor Liver Transplantation.Korean J Radiol. 4:2 (2003) 85. PMID: 12845303

[10] Sureka B, Bansal K, Patidar Y, Arora A. Magnetic resonance cholangiographic evaluation of intrahepatic and extrahepatic bile duct variations. Indian J Radiol Imaging. 26:1 (2016) 22-32.PMID: 27081220

[11] Lynser D, Daniala C, Panchasanguparakalarajan R, Chinniah, PK. Intrahepatic biliary variations on magnetic resonance cholangiopancreaticography: A study from a tertiary centre in North East India. Current Research in MRI. 2:1 (2023) 1-5. DOI: 10.5152/CurrResMRI.2023.23051

[12] Khanduja N, Chauhan RS, Jobta A, Sood RG, Kaundal AP, Chawla K, Diwan Y.Anatomical variations of intrahepatic bile ducts on MRCP in Himachal Pradesh, North India. Int. j. anat. radiol. surg.5:4 (2016) AO21-24.DOI:10.7860/IJARS/2016/20879.2204

[13] Sarawagi R, Sundar S, Raghuvanshi S, Gupta SK, Jayaraman G. Common and Uncommon Anatomical Variants of Intrahepatic Bile Ducts in Magnetic Resonance Cholangiopancreatography and its Clinical Implication.Pol J Radiol. 81 (2016) 250-5.PMID: 27298653

[14] Paudel S, Joshi BR, Chand RB. Evaluation of intrahepatic bile duct variations in magnetic resonance cholangiopancreatography. Nep J Radiology. 10:1 (2020) 27-33.DOI: https://doi.org/10.3126/njr.v10i1.28949

[15] Taghavi SA, Niknam R, Alavi SE, Ejtehadi F, Sivandzadeh GR, Eshraghian A. Anatomical variations of the biliary tree found with endoscopic retrograde cholangiopancreatography in a referral center in southern Iran. Middle East J Dig Dis. 9:4 (2017) 201-205. PMID: 29255577