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Research Article

A Cross-sectional Study of Variations of Intrahepatic Bile Ducts in Magnetic Resonance Cholangiopancreatography

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ABSTRACT

Background- Many variations of the right hepatic duct (RHD) have been reported. The anatomy of the left hepatic duct (LHD) is relatively constant. The knowledge of variations of intrahepatic bile duct help in liver transplantation and surgical resection of liver. Objectives- The present study has been carried out to study the intrahepatic bile duct variations through magnetic resonance cholangiopancreatography (MRCP) in our population. Materials and methods- The MRCP plates of 300 patients were collected from the Department of Radiology, Gauhati Medical College and Hospital, Guwahati, after obtaining ethical clearance from the Institutional Ethical Committee and were studied for intrahepatic bile duct variations. Results- Normal type 1 RHD was noted in 192 (64%) cases, type 2 RHD was noted in 26 (8.7%) cases, type 3A RHD was present in 46 (15.3%) and type 3B RHD was present in 20 (6.7%) cases. Type 5A RHD was observed in 2 (0.7%) cases and type 5B RHD was present in 3 (1%) cases. Conclusion- The knowledge of intrahepatic bile duct variations are important to prevent iatrogenic injuries and postoperative complications during liver surgery.

Keywords*: hepatic duct, liver transplantation, magnetic resonance cholangiopancreatography.*

INTRODUCTION

The anatomy of the biliary tract is complex [1]. The pattern of segmental duct of left lobe of liver is relatively constant. The left hepatic duct is formed by the union of segments II and III ducts. The right hepatic duct is formed by the union of right anterior and posterior sectoral ducts. The right anterior sectoral duct drains segments V and VIII and right posterior sectoral duct drains segments VI and VII. The right posterior sectoral duct usually curves around the posterior aspect of the right anterior sectoral duct [2]. Many variations of the intrahepatic bile ducts have been reported in the literature. These variations may cause complication in 7-10% of donors in living donor liver transplantation and biliary complication in 3.6-8.1% of patients after hepatic tumour resection [3]. So, knowledge of these variations are of importance during surgical resection of liver and living donor liver transplantation to minimize postoperative complications. Magnetic resonance cholangiopancreatography (MRCP) is a safer imaging modality for investigating biliary tree anatomy accurately [4]. Moreover, there is no study on intrahepatic bile ducts from our region.

Thus, the present study has been carried out to describe anatomic variations of intrahepatic bile ducts, and to determine the frequency of each variation in MRCP in our population.

MATERIALS AND METHODS

Type of study: Observational retrospective study.
Place of study: Department of Radiology, Gauhati Medical College and Hospital, Guwahati, Assam.
Duration of study: From April 2024 to March 2025.
Sample size: 300.
Sample collection: The MRCP plates were collected from the Department of Radiology, Gauhati Medical College and Hospital, Guwahati, after obtaining ethical clearance from the Institutional Ethical Committee (IEC letter number: MC/190/2007/Pt-11/13; dated 24.08.2018).

Inclusion criteria: Patients aged between 18 and 70 years, of both sexes and referred with provisional diagnosis of cholecystitis and choledocholithiasis.
Exclusion criteria: Cases with liver resection, ductal pathology and overlapping of structures were excluded from the study.

Method: MRCP was performed with heavily T2-weighted sequences by using fast spin-echo or single-shot fast spin-echo software and both a thick-collimation (singlesection) and thin-collimation (multi-section) technique with a torso phased-array coil. Machine used for MRCP 1.5 Tesla MRI Machine Somatom (TIN) Avanto, Make: Siemens.

The variations of the right hepatic duct were noted according to Choi et al [5]. **Type 1** was considered typical where RPSD joins the RASD to form the RHD. **Type 2** involves triple confluence, the simultaneous emptying of the RASD, RPSD and LHD into the CHD. In **type 3**, the RPSD drains anomalously, in **type 3A,** RPSD drains into LHD, in **type 3B**, RPSD drains into CHD, in **type 3C**, RPSD drains into the cystic duct, in **type 4**, the RHD drains into the cystic duct. In **type 5**, an accessory duct is present, in **type 5A**, an accessory duct opens into CHD, in **type 5B**, an accessory duct opens into RHD, in **type 6**, segments II and III drain individually into the RHD or CHD. **Type 7** shows unclassified or complex variation. Type 1 to type 3C comes under Huang classification based on RPHD insertion [6]. (RHD=right hepatic duct, LHD=left hepatic duct, RASD=right anterior segmental duct, RPSD=right posterior segmental duct, CHD=common hepatic duct).

Statistical analysis: Tabulation and analysis of the data was done in Microsoft Excel sheets. In the study specialized statistical methods were not used as the study was an observational retrospective study and no comparison was performed.
Funding: The study was self-financed.

RESULTS
We evaluated MRCP images of 300 patients. Among 300 patients, 157 (52.3%) cases were male patients and 143 (47.7%) were female patients (mean age, 44 years; range, 18–70 years). As presented in table no.1, normal type 1 RHD was noted in 192 (64%) cases and type 2 RHD was noted in 26 (8.7%) cases. Moreover, type 3A RHD was present in 46 (15.3%) and type 3B RHD was present in 20 (6.7%) cases. Type 5A RHD was observed in 2 (0.7%) cases and type 5B RHD was present in 3 (1%) cases. Type 7 RHD was noted in 11 (3.7%) cases (table no. 1). No cases of type 3C RHD, type 4 RHD and type 6 RHD were found.

Table 1: Distribution of normal and anatomical variations of right hepatic duct (RHD)

Sl no.	Type of RHD	Frequency (n=300)	Percentage (%)
1.	Type 1	192	64
2.	Type 2	26	8.7
3.	Type 3A	46	15.3
4.	Type 3B	20	6.7
5.	Type 3C	0	0
6.	Type 4	0	0
7.	Type 5A	2	0.7
8.	Type 5B	3	1
9.	Type 6	0	0
10.	Type 7		
a)	RASD joining LHD	5	1.7
b)	RASD joining CHD	2	0.7
c)	Trifurcation of bile duct & accessory duct draining into CHD	1	0.3
d)	RPSD joining LHD & accessory duct joining CHD	1	0.3
e)	Quadrifurcation of the ductal confluence	2	0.7

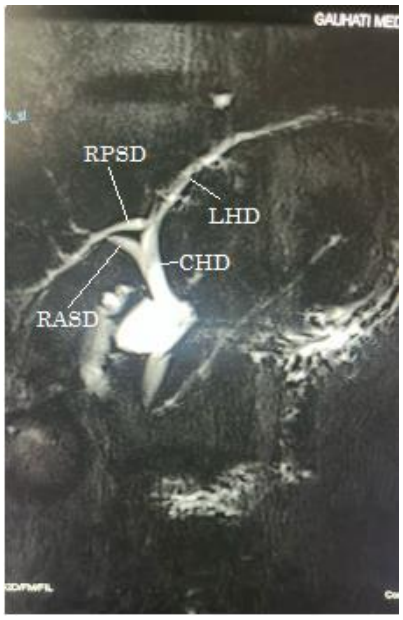

Figure 1: Type 3A (RPSD opening into LHD).

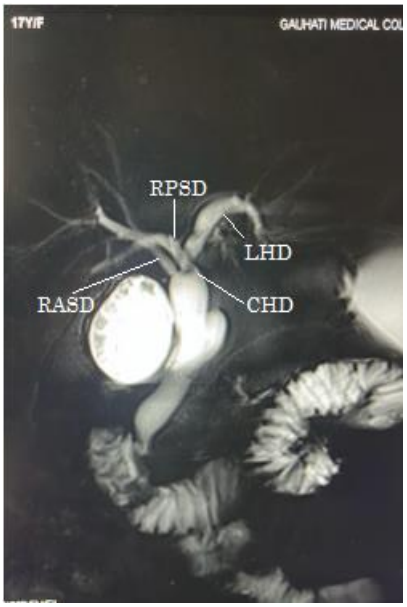

Figure 2: Type 2 (Triple confluence)

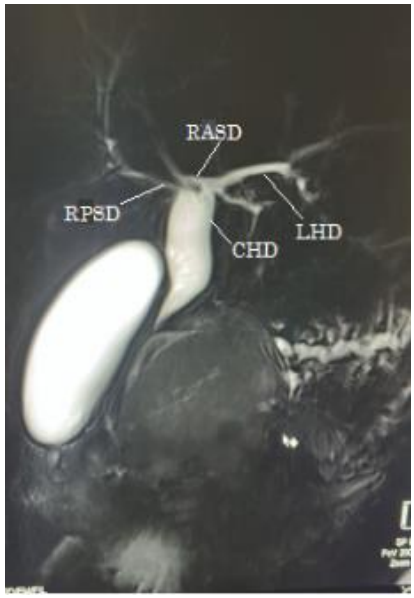

Figure 3: Type 3B (RPSD opening into CHD)

DISCUSSION

Normal bile duct anatomy is found in 53-63% of people [6]. In the present study, typical type I RHD is found in 192 (64%) cases. Though different authors have reported anatomical variation of bile duct in the literature, several uncommon variations are reported in many studies. Knowledge of intrahepatic bile duct variations are important prior to living donor liver transplantation, segmental, lobar resection and biliary interventions. Presence of these variations makes the surgery difficult and increases chances of postoperative complications such as ligation of aberrant RAHD or RPHD drainage into LHD may cause cirrhosis [7]. Also, during right lobe transplantation, multiple biliary anastomoses in the recipient may be needed to prevent biliary obstruction [8].

MRCP is a noninvasive imaging technique which does not have radiation hazard, it avoids the hazards of contrast media and ERCP. It shows high signals of biliary secretions with dark background [9]. Breath-hold imaging can eliminate the artifacts of respiratory motion [10].

Drainage of RPSD into LHD (type 3A) was the most common type of variation (15.3%) followed by triple confluence (type 2) (8.7%) and drainage of RPSD into CHD (type 3B) (6.7%) in the present study. This finding is similar to other previous studies [5,11-14]. Different studies have also shown varied incidence of hepatic duct variations in different populations [11].

Accessory hepatic duct was reported in 2-6% cases [5]. An accessory hepatic duct is an additional duct draining a segment in addition to normal duct [1]. Accessory ducts are important surgically. Injury of accessory hepatic ducts leads to bile leakage [7]. In the present study, accessory duct draining into CHD (type 5A) was present in 0.7% and accessory duct draining into RHD (type 5B) was present in 1% cases.

Many unclassified variations (type 7) have been reported in the literature [15]. We reported such variation in 11 (3.7%) cases. In 1.7% cases, RASD drained into LHD, 0.7% cases, RASD drained into CHD, 0.3% cases, there was trifurcation of bile duct and an accessory duct drained into CHD. Moreover, in 0.3% cases, RPSD drained into LHD and an accessory duct joined CHD, and in 0.7% cases, there was quadrifurcation of the ductal confluence.

Limitation of the present study was that we did not compare the result with any other type of investigation like intraoperative cholangiogram. Identification of small accessory ducts may not be possible in unenhanced MRCP [16]. Hepatocyte specific gadolinium enhanced MRCP is proven to be accurate in identifying anatomical variations of hepatic ducts [17,18].

CONCLUSION

Many common and uncommon variations of hepatic ducts have been reported in the present study. Normal type I RHD was highest followed by type 3A RHD, type 2 RHD and type 3B RHD in our population. Knowledge of such variations is important prior to liver resection, living donor liver transplantation and preoperative evaluation to prevent iatrogenic injuries and postoperative complications.

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