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SPECTRUM OF INTRAHEPATIC AND EXTRAHEPATIC BILIARY TREE VARIATIONS BY MAGNETIC RESONANCE CHOLANGIOPANCREATOGRAPHY IN A TERTIARY CARE HOSPITAL OF NORTH EAST INDIA

Radio-Diagnosis

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ABSTRACT

Background: Biliary tree anatomy shows many variations. MRCP is a non–invasive and fast method for direct visualisation of the intra and extrahepatic biliary ducts and the pancreatic duct. Therefore, MRCP is increasingly used for preoperative planning since anatomic variants of biliary tree may increase the complexity of surgical procedures and biliary interventions. The purpose of the study is to know the prevalence of variations in our population and to provide a preoperative knowledge for planning of surgical interventions. **Materials and Methods:** MRCP was conducted on 100 adult patient and were evaluated retrospectively. All the patients underwent MRCP with a 1.5 Tesla MR machine (GE MR Signa) with 8- channel phased array coils. **Results:** In 100 adult patients 68 were female and 32 were male. Out of 100 patients Huang Type A1 were found in 68 patients [68%], type A2 in 12 patients [12%], type A3 in 9 patients [9%], type A4 in 4 patients [4%] and type A5 in 1 patient. 6 patients [6%] show other type of variations. **Conclusion:** Intrahepatic and extrahepatic bile duct anatomy is complex with many common and uncommon variations. Preoperative biliary mapping by MRCP is needed to plan the surgery and helpful in reducing biliary complications, postoperative morbidity and mortality.

KEYWORDS

MRCP, Biliary anatomical variation, Couinaud classification, Hepatobiliary intervention.

I. INTRODUCTION

MRCP is an exceptional non-invasive imaging technique for visualization of comprehensive biliary anatomy. Normal biliary anatomy is seen in only 58% of the population[1]. A precise knowledge of normal branching pattern of intrahepatic bile duct and their variations is of vital importance before hepatobiliary interventions such as laparoscopic cholecystectomy, living donor liver transplantation, hepatic tumour resection and therapeutic biliary drainage. In this article, we have discussed different patterns of right and left hepatic duct variations and anatomical disparities in cystic duct. The biliary drainage system runs parallel to the portal venous supply system. Hence, anatomy of the normal biliary system is similar to that of portal vein. Liver is divided into eight functional independent segments (I to VIII) based on Couinaud classification. The right hepatic duct (RHD) drains the segments of the right liver lobe. It has two major branches. The right posterior sectoral duct (RPSD) drains the posterior segments of right hepatic lobe, VI and VII. The right anterior sectoral duct (RASD) shows more of a vertical course, draining the anterior segments, V and VIII. The right posterior duct has an almost horizontal course, runs posterior to the right anterior duct and normally fuses with it from a medial approach forming the right hepatic duct (Type I). The left hepatic duct (LHD) is formed by segmental tributaries draining liver segments II to IV.

Right and left hepatic ducts join to form the common hepatic duct (CHD) at the confluence. The biliary confluence angle should not be less than 900. The bile duct draining the caudate lobe joins at the origin of RHD or LHD.

The cystic duct typically joins the common hepatic duct laterally below the level of hepatic ductal confluence. Normally, the cystic duct measures 2-3 cm in length and 2-3 mm in diameter. It contains the spiral valves of Heister and follows a tortuous course.

II. MATERIAL AND METHODS

The study is retrospective cohort study and executed on 100 patients referred to department of radiodiagnosis, Jorhat medical college hospital for Magnetic Resonance Cholangiopancreatography (MRCP) evaluation. These patients were assessed for MRCP from October 2021 to April 2022.

Study Design: Retrospective Cohort study

Study Location: This was a tertiary care teaching hospital based study done in Department of Radiodiagnosis, at Jorhat Medical College and Hospital.

Study Duration: October 2021 to April 2022.

Sample size: 100 patients.

Inclusion criteria:
1. All patients male and female aged 18 years and above.
2. Elective patients who were referred to the department of Radiodiagnosis for MRCP during the study period.

Exclusion criteria:
1. Patients with MRI incompatible prosthesis and implants;
2. Patients with motion artefacts;
3. Patients with large neoplastic lesion altering biliary anatomy;
4. Patients with Claustrophobia.

Procedure methodology

A retrospective cohort study was executed on 100 patients referred to department of radiodiagnosis, Jorhat medical college hospital for Magnetic Resonance Cholangiopancreatography (MRCP) evaluation. These patients were assessed for MRCP from October 2021 to April 2022. The study was completed on a 1.5 Tesla MR machine (GE Signa) using 8-channel phased array coils for the acquisition of images. MRCP was done utilizing TR-8,000 ms; TE-800 ms; flip angle 90 degrees and FOV of 250–300 mm. Commonly acquired sequences were axial T2 sequence, axial T2 fat sat (T2FS) sequence, coronal single shoot fast spine echo (SSFSE), axial 3D MRCP (T2 WI), Axial fat sat T1 sequence and Diffusion weighted imaging sequence (DWI). Post contrast study was not done as it is not required for biliary mapping. Biliary Mapping Cholangiograms were retrospectively evaluated and we reached to a conclusive agreement as to the branching patterns of biliary tree.

Classification was done (A1 to A5) as per to the ERCP findings of Huang et al.6 (Table 1). We classified the Cystic duct variations according to direction and site of CD joining the CHD (Table 2) [6, 7]. Values are expressed in percentages. The study was carried out after institutional research board and ethical committee approval.

Table 1 Classification of right and left hepatic duct variations according to Huang et al. and Karakas et al.

	Huang type	Karakas type
A1	Right posterior sectoral duct (RPSD) drains into the right anterior sectoral duct (RASD) to form RHD – Typical pattern.	K1 – distance of RPSD and RASD junction >1 cm from the confluence of RHD and LHD K2a – distance of RPSD and RASD junction ≤1 cm from the confluence of RHD and LHD
A2	Trifurcation pattern of simultaneous emptying of RPSD, RASD and LHD	K2b

A3	RPSD drains into LHD	K3a – junction of RPSD and LHD ≤1 cm from the confluence. K3b-junction of RPSD and LHD > 1 cm from confluence.
A4	RPSD drains into CHD	K4
A5	RPSD drains into the cystic duct	K5

Table 2. Types of Cystic duct variation (according to present study classification)

Type A	Anterior spiral insertion with middle third of CHD
Type B	Medial spiral CD insertion with middle third of CHD
Type C	Posterior spiral insertion with middle third CHD
Type D	Right lateral insertion of CD with middle third of CHD
Type E	Low medial insertion of CD with distal third of CHD
Type F	Low lateral insertion of CD with distal CHD
Type G	Proximal insertion of CBD into proximal third of CHD
Type H	CD joins the RHD (CD-RHD)

III. RESULT

A total of 100 patients referred for MRCP were studied out of which 68 were females and 32 were males.

Pathological diagnosis of patients: Common bile duct stone is the most common etiology found in 27 cases (27 %), gall bladder stone without mass in 25 cases (25 %), gall bladder carcinoma in 8 cases (8%) , Acute pancreatitis in 8 cases (8%), chronic pancreatitis in 7 cases (7%), choledochal cyst in 3 cases (3%), benign common bile duct stricture in 3 cases (3%) , periampullary mass in 2 cases (2%), pancreatic divisum in 2 cases (2%), cholangiocarcinoma in 3 cases (3 %), liver mass in 2 cases (2%), benign pancreatic cyst in 1 cases (1%), liver abscess in 1 case (1%), chronic liver disease in 1 case (1%) and 7 patients (7%) had no radiological evidence of hepatobiliary pathology. Anatomic variations of biliary system were classified according to Huang classification. Out of 100 patients, 68 patients show Type A1 branching pattern, 12 show Type A2, 9 show Type A3, 4 show Type A4 and 1 patient shows Type A5 pattern. In 6 (6%) patients other type of variations are seen (Figure 1).

We also classified different patterns of cystic duct variations. Out of 100 patients, 17 had anterior spiral insertion (17%), 1 had medial insertion to middle third of CHD (1%), 41 had posterior spiral insertion (41%), 33 had right lateral insertion (33%), low medial insertion in 4 cases (4%), low lateral parallel insertion in 2 cases (2%), proximal insertion of CD in 1 case (1%) and drainage of CD into RHD in 1 case (1%). No patient was seen with cystic duct insertion to RASD. (Figure 2).

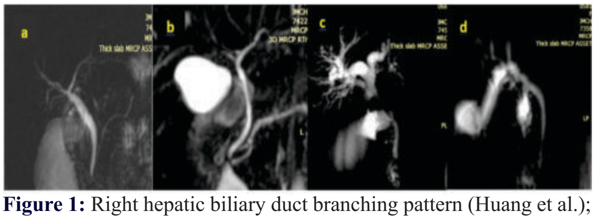

Figure 1: Right hepatic biliary duct branching pattern (Huang et al.); (a) to (d) show MRCP images of types A2, A3, A4 & A5 biliary duct branching. Trifurcation pattern (a), drainage of RPSD to LHD (b), drainage of RPSD to CHD (c) and drainage of RPSD to CD (d) are shown in images.

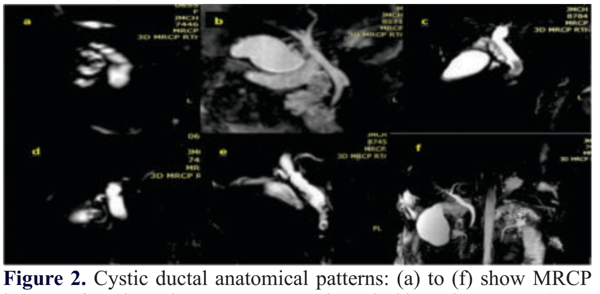

Figure 2. Cystic ductal anatomical patterns: (a) to (f) show MRCP images of CD insertion patterns. Anterior spiral insertion (Type A) (a); low medial insertion (Type E) (b); low lateral insertion (Type F) (c); proximal insertion (Type G) of CD to CHD (d); CD insertion to RHD (Type H) (e) are shown in the figure. (f) shows another rare variant with absent cystic duct.

IV. DISCUSSION

This study shows that MRCP can be used to evaluate IHBD anatomy and variations safely and noninvasively. Variations in arterial, venous, and ductal structures of the hepatopancreaticobiliary system are frequently observed. The reason for the frequency of IHBD variations in this system is clockwise rotation at the fourth to seventh embryologic weeks at the level of the midgut and foregut junction[2]. The number of hepatobiliary surgeries has increased, which particularly includes laparoscopic cholecystectomy, transplantation surgery, hepatic resection, and tumor surgery. Complications related to the biliary system constitute one of the most common reasons for morbidity and mortality in these surgeries.[3]

To minimize peri- and postoperative morbidity and mortality, a detailed evaluation of the biliary anatomy is essential before surgery. In traumatic or iatrogenic biliary damage, in which biliary drainage is disrupted, jaundice, bilioma, biliary peritonitis, sepsis, and biliary fistula may develop within 1–2 weeks[4,5]. Various diagnostic methods can be used to evaluate the biliary anatomy in the preoperative period (conventional T2-weighted MRCP, contrast-enhanced T1-weighted MRCP, and multidetector row CT cholangiography) or during surgery (intraoperative cholangiography). Among these, the most commonly used method is MRCP, since it is non-invasive and does not require a contrast material. MRCP relies on heavily T2-weighted images that produce a high signal from the static fluid. This method can noninvasively display the anatomy of the intra- and extrahepatic biliary tract, with a high sensitivity and specificity. The proper evaluation of the IHBD anatomy and its variations. before liver transplantation and extensive liver resection is very important [6]. Many studies reported that the variations of the biliary system were frequently observed, and these variations were not contraindicated for transplantation; however, an accurate pre- and intraoperative evaluation was required for successful transplantation planning. In a patient with Type A3 bile duct variations according to the Yoshida classification, the right posterior branch can be ligated during left hepatectomy, which can cause cirrhosis development at segments 6/7. However, studies have reported that Type A2 bile duct pattern is contraindicated for safe right lobe donation and the Huang type A3 bile duct pattern is also contraindicated for both right and left lobe donations [7,8]. In addition, biliary variations are a major source of morbidity and mortality after transplantation.[3,9] As biliary tract variations are observed quite often, an evaluation of bile duct variations with MRCP before laparoscopic cholecystectomy is very important to prevent biliary complications because of ductal injuries such as bile leakage, bile peritonitis, biliary stricture, obstructive jaundice, and liver abscess .[10.] Poor visualization of the cystic duct during surgery may cause accidental bile duct injury. An unnoticed bile duct during surgery may cause bile peritonitis or bilioma that develop 5–7 days postoperatively. If not treated, the mortality rate can be as high as 44%[11]. Except iatrogenic complications during surgery, other complications include bile duct calculi formation, pancreatitis, and cholangitis.

V. CONCLUSION

MRCP is a consistent, non-invasive method to evaluate the biliary anatomical patterns and variations in the presurgical period. Knowledge of these variations is critical for both the clinician and the surgeon. Biliary tract related complications in hepatobiliary interventions are important causes of morbidity and mortality. Preoperative biliary mapping by MRCP is very helpful in reducing biliary complications, post operative morbidity and mortality.

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