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Original Article

Anatomy Section

Anatomical Variations of Intrahepatic Bile Ducts on MRCP in Himachal Pradesh, North India

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ABSTRACT

Introduction: Assessment of branching pattern of intrahepatic bile duct seems to be important before performing surgeries related to liver and biliary tract.

Aim: To determine the normal anatomical variations in branching pattern of intrahepatic bile duct (IHBD) on MRCP (Magnetic Resonance Cholangiopancreatography) in subjects from Himachal Pradesh, North India.

Materials and Methods: Present study was conducted on 100 adult patients who were routinely assessed for MR abdomen along with MRCP. Classification of intrahepatic bile ducts was as per to the branching pattern of both right anterior and posterior segmental ducts as well as that of left hepatic duct.

Results: Anatomy of the intrahepatic bile ducts was typical in 63% of 100 cases. Total 37 % frequency of atypical configuration was due to 18% of A2, 9 % A3, 8% A4 and 0% of A5 types. Whereas, 2% of the patients had other types of biliary configurations. On comparing the values belonging to females and males, it was found that incidence of atypical patterns was significantly more in males, and vice versa was true for typical pattern. The same was found to be true when comparison was done between 33 females and 23 males without any detectable pathologies.

Conclusion: The difference in branching pattern of typical and atypical pattern in the population, and the difference between males and females seem to be important in surgical managements.

Keywords: Biliary variants, Branching pattern, Huang classification

INTRODUCTION

An accurate knowledge of normal branching pattern of intrahepatic bile duct and their variations is of crucial importance for liver and biliary tract surgery including liver transplantation, tumor resection and laparoscopic hepatobiliary surgeries [1]. Drainage of the right posterior duct into the left hepatic duct or at its confluence with the right anterior duct is the most common anatomic variant of the biliary system and is reported in about 30% of cases [2]. Most of the complications in these surgeries are caused by the presence of anatomical variation of bile ducts which lead to difficult anastomosis thus increased morbidity [3]. While the epidemiology of extrahepatic biliary abnormalities is well described in the literature, especially as regards pancreaticobiliary duct maljunction few data is available regarding the epidemiology of intrahepatic biliary abnormalities [4,5]. In fact, in opposition to what has been observed for extrahepatic biliary anatomy, very few data is reported about regional or ethnical disparities, or correlation with other demographical characteristics.

There are several reports from the West and the far East describing the anatomical variations in IHBD visualized by direct or magnetic resonance cholangiography in patients with suspected pancreatobiliary diseases [6,7]. There are few reports from India which has used a database of patients undergoing ERCP for various indications to determine the anatomic variation in branching patterns of IHBDs [8]. Such information is essential since these anatomical variations are influenced by multiple factors, including geographical location. In view of this we analyzed the magnetic resonance and magnetic resonance Cholangiopancreatography images of patients who were referred for the procedures to the Radiological Department of Government Medical College, Shimla, HP, India. Frequencies of branching pattern of intrahepatic biliary ducts were determined in one hundred such patients.

MATERIALS AND METHODS

The present retrorespective study was performed on 100 (a number more than required sample size for a descriptive

radiological study) adult patients from Himachal Pradesh. These patients were assessed for Magnetic Resonance (MR) imaging of abdomen along with Magnetic Resonance Cholangiopancreatography (MRCP) at Indira Gandhi Medical College, Shimla, HP, during 2009-2012. This study was approved by the Hospital Ethics Committee. Patients with cardiac pacemaker, bypass surgery, aneurismal clips, Iron rods/plates in bones, nails in bones, joint replacement, cochlear implants, and metallic implants of any kind were excluded from the study. Chi square test was used to assess the difference in pattern distribution between males and females.

MRI of upper abdomen followed by MRCP was done on a 1.5T MR machine (Magnetom Avanto). One bowl of banana mixed with iron preparation (ferrous sulphate) was given to the patient prior to the examination.

Biliary Mapping

Cholangiograms were retrospectively evaluated by two radiologists and a consensus was reached as to the branching pattern of the Right anterior hepatic duct (RAHD), Right posterior hepatic duct (RPHD), and the Left hepatic duct (LHD). Biliary classification was done as per to the ERCP findings of Huang et al., [9]. These were A1 (right and left hepatic ducts forming a common hepatic duct), A2 (trifurcation formed by the right anterior hepatic duct), A3 (drainage of the right posterior hepatic duct into the left hepatic duct), A4 (drainage of the right posterior hepatic duct into the common hepatic duct) and A5 (right posterior hepatic duct into the cystic duct).

RESULTS

This study included 100 patients (60 females and 40 males) referred for MRCP. The age range of the patients in the group was 19 years to 84 years; whereas the age range of females and males was 20 to 84 years and 19 to 75 years respectively.

Pathological Findings

Out of 100 patients, 56 had no radiological evidence of hepatobiliary pathology [Table/Fig-1], in the remaining 44 patients, number of patients with cholelithiasis, hepatolithiasis, dilated ducts, choledocholithiasis and choledochal cyst are as shown in the [Table/Fig-1]. Five patients with cholelithiasis also had choledocholithiasis, and one had dilated bile ducts. Out of 60 females and 40 males, evidence of pathologies was 33 and 23 respectively. Two male patients with cholelithiasis had choledocholithiasis, and in one patient bile duct was dilated. In one male patient with cholelithiasis RPHD could not be visualized. Statistically, difference in these values in males and females was non-significant.

Bile duct: Configurational Variations

Anatomic variations of biliary system were classified according to Huang classification. Out of 100 patients, 63 had Type A1 [Table/Fig-2], biliary branching pattern, 18 had Type A2 [Table/Fig-3], 9 had Type A3 [Table/Fig-4], 8 had Type A4 [Table/Fig-5], Type A5 was not found in any patient whereas, in 2 (2%) patients right posterior duct was not visualized [Table/Fig-6]. In 60 females, number of type A1, Type A2, Type A3, Type A4 and other types were found to be 39, 10, 6, 4 and 1 respectively. In females the predominance of type A1 was followed by Type A2 and the remaining. Type A1 and Type A2 combined together were 81.67% of the total. Out of 40 males, 24 had Type A1 configuration. However, number of patients with Type A2, A3, A4 and other types were 8, 3, 4 and 1 respectively. The incidence of Type A1 was found to

Subjects	WHP	Cholelithiasis	Hepatolithiasis	Dialated Ducts	Cholodocolithiasis	Cholodocal cyst
All (100)	56	29	1	8	5	1
Female (60)	33	16	1	5	5	0
Male (40)	23	13	0	3	0	1

[Table/Fig-1]: Disease Pattern in population of 100 patients (females and males) included in the study.
WHP: Without hepatobiliary pathology

[Table/Fig-2]: Type A1 right and left hepatic ducts forming a commonhepatic duct. **[Table/Fig-3]:** Trifurcation formed by the right anterior sectoral branch, right posterior sectoral branch, and left hepatic duct. **[Table/Fig-4]:** Type A3drainage of the right posterior sectoral branch into the left hepatic duct. **[Table/Fig-5]:** Type A4drainage of the right posterior sectoral branch into the common hepatic duct.

Subjects	Type A1	Type A2	Type A3	Type A4	Type A5	Others
All (100)	63	18	9	8	0	2
Female (60)	39 (65%)	10 (16.66%)	6 (10%)	4 (6.67%)	0	1(1.67%)
Male (40)*	24 (60%)	8 (20%)	3 (7.5%)	4 (10%)	0	1(2.5%)

[Table/Fig-6]: Prevalence of different types of biliary patterns in all the subjects included in the study.
*p< 0.05 in comparison to female group

Subjects	Type A1	Type A2	Type A3	Type A4	Type A5	Others
All (56)	34 (60.7%)	8 (14.3%)	7 (12.5%)	6 (10.7%)	0	1 (1.8%)
Female (33)	21 (63.6%)	4 (12.1%)	5 (15.2%)	2 (6.1%)	0	1(3%)
Male (23)*	13 (56.5%)*	4 (17.4%)*	2 (8.7%)*	4 (17.4%)*	0	0

[Table/Fig-7]: Configurational variation in females and males without any hepatobiliary pathology.
*p< 0.05 in comparison to the same type configuration in female group

be 60.0% followed by 20% Type A2, 7.5% Type A3 and 10% Type A4. Whereas, the prevalence of other types in terms of percentage was quite low. Type A1and Type A2 combined together constituted 80%.

Fifty six patients without any hepatobiliary pathology were subdivided into females and males to find the deviation, if any, in configuration due to sex [Table/Fig-7]. Percentage of females having Type A1, Type A2, Type A3, Type A4 and other types were 63.6%, 12.1%, 15.2%, 6.1% and 3% respectively. Whereas, percentage of males having Type A1, Type A2, Type A3 and Type A4 were 56.5%, 17.4%, 8.7% and 17.4%.

DISCUSSION

Like in our study, Type A1 [Table/Fig-2] predominance was also encountered in many other races [10-13]. In Chinese and Japanese, Huang type A1 pattern is the predominant type (63–73%) followed by type A2 predominance in Chinese whereas type A3 is predominance in Japanese [3]. The only exception was for Germans, however, the number of subjects in that study were quite low (n = 18) [6].The frequency of type A1 variation is very similar in North Americans (57%) and in Anatolian Caucasian population (55%) [12]. In another study this observation was not changed when taking intraoperative findings of 29 donors into account [3]. This anatomical similarity adds to the ones that are known to exist between Anatolian Caucasians and white North Americans [14]. Like in other reports, in our study on adult population of North India, the frequency of variation of type A1 was found to be 63% in 100 subjects.

Earlier study in the literature has reported approximately 6% incidence of accessory hepatic ducts [8]. However, in the present study these hepatic ducts have not been found in any patients. These might be present as a solitary finding or in conjunction with other types of IHBD variations [6,15,16]. Though one may overlook the variations in accessory bile duct, but these ducts are important in surgical procedures to avoid serious complications due to biloma and bile leaks [17].

Incidence of A5 configuration has been found to be 1-2% [9,16,18,19] with the only exception for Germans where the frequency was 28% [6]. However, Hamlin reported that in his experience, an anomalous right hepatic duct emptying into the CHD or cystic duct was the most common biliary anomaly [20]. In contrast, in our study we did not encounter this type of variant. It is crucial that in laparoscopic cholecystectomy, this variation is recognized: ligation or resection of an aberrant duct will lead to complications, such as biloma, biliary cirrhosis, or bile leakage [15].

However, these data may be more representative of the general population than data from intraoperative cholangiograms obtained in carefully-selected liver donors. The risk of developing biliary complications is 5.9 times higher if the biliary anatomy was of any type other than A1, further when allowed by the anatomy of the right hepatic duct in the donor, obtaining only one biliary orifice for the anastomosis in the graft seems to be an important factor in reducing the incidence of complications. It has been reported that recipients (10 out of 14) who had two or more anastomosis had a complication [21]. It is therefore always advisable to have accurate preoperative imaging for trouble free intraoperative planning [22-24].

CONCLUSION

The branching patterns of typical and atypical patterns differed in male and female subjects, particularly of A5 in subjects without any hepatobiliary pathology. This seems to be crucial for surgical managements of hepatobiliary system. However, more studies on greater number of patients and on patients from different regions are required to establish this finding in general.

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