MAGNETIC RESONANCE CHOLANGIO PANCREATOGRAPHY EVALUATION OF BILIARY TRACT AND HEPATIC ARTERY VARIATIONS

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ABSTRACT

Aim: This study was made to determine the efficacy of visualization of hepatic artery without contrast and to determine the branching patterns of biliary tract by using MRCP.

Methods: This was an observational cross sectional study in the department of Radio-diagnosis, Dr. D.Y. Patil Medical College and Hospital, Pune. All the patients who were referred to the Radiology department for routine MRCP were considered as study population. The data collection for the study was done from January 2021 to June 2022. Consecutive sampling was done and the sample size achieved was 30.

Results: The normal course of common hepatic duct was found in 80% of patients where the remaining 20% were variants formed by RAHD and LHD and the other being RPHD and LHD. Considering the cystic duct, the normal lateral insertion was found in 76.7% of the study population whereas medial insertion was found in 13.3%. In case of hepatic artery, Michel's type I was found in 86.7% of the study population. Other variants found are Michel's type III and IX. In 6.7% of subjects, the hepatic artery could not be visualized. Normal anatomy of left hepatic duct was seen in 66.7% of females and 33.3% of males with a significant p value of 0.0135. Right hepatic duct was normal in 69.6% females and 30.4% of males with a significant p value of 0.05. The lateral insertion of cystic duct which is considered normal is found in 52.2% of females and 47.8% of males with a significant p value of 0.56. Michel's type I variant was observed in 61.5% of females and 38.5% of males with a p value of 0.5.

Conclusion: Our study described the prevalence of anatomical variations of biliary tract in our study population and also delineated the hepatic artery and its variations to some extent without using contrast.

Keywords: hepatic artery, MRCP, biliary tract

INTRODUCTION

The biliary tract is complicated, as there is a lot of intra and extra hepatic variations. The usual anatomy of the bile ducts are present only in 58% of the populace.[1] The presence of anomalies in the intra-hepatic and extra-hepatic biliary tract were the leading causes of biliary radicals injury during the time of surgery.[2] This has become important in recent advances of laparoscopic cholecystectomy where the incidence of iatrogenic injury to the bile ducts is increased three folds when compared to open cholecystectomy.[3-5]

Live liver transplant is a recent advancement replacing the transplantation from cadaver due to shortage of cadaveric liver and increasing demand of liver transplantation. Preoperative knowledge of biliary tree anatomical variants is demanding for formulating the plan for liver and biliary tract surgeries. The usual choice of transplantation includes the right lobe of the adult liver so as to provide adequate functional liver volume for the recipients.[6] Magnetic resonance cholangiopancreatography (MRCP) is a relatively new technique; it has provided a robust andnon-invasive images of the biliary passage and pancreatic duct. MRCP was first introduced in 1991 by Wallner et al; this technique has been dramatically improved.[7] MRCP is performed with T2-weight sequences and it readily characterize the stationary fluid present within the pancreatic duct and biliary duct. Current practice utilizes MRCP to provide a detailed map of anatomic variation in preoperative patients at high likelihood of biliary tract injuries including patients with obesity, acute cholecystitis, prior abdominal surgery, or patients scheduled to undergo complicated biliary reconstruction.[3-5] MRCP is highly accurate in diagnosing anatomic variants of biliary tract. This technique is a useful alternative to more invasive procedures like Endoscopic Retrograde Cholangiopancreatography (ERCP) which should be used only in case any intervention is needed.

ERCP can be complicated by pancreatitis, bleeding, sepsis, and duodenal perforation. In addition, ERCP is unsuccessful in as many as 5% to 10% of procedures, and often cannot define the anatomy proximal to a severe obstruction or after certain operative procedure. Though ERCP is the established modality for imaging the bile ducts, there is always an upper hand of Magnetic Resonance Cholangiopancreatography. In addition artifacts might happen at routine MRCP that may resemble various diseases. This adds to the artifacts due to pulsating compression by gastroduodenal or right hepatic artery, signal voids because of the flow of bile, any of that lead to a false-positive result.[8-10]

This study was made to determine the efficacy of visualization of hepatic artery without contrast and to determine the branching patterns of biliary tract by using MRCP.

MATERIALS AND METHODS

The present study was conducted at Dr. D.Y. Patil Medical College and Hospital, Pune from January 2021 to July 2022 and 30 patients were included in the study.

Siemens 3T Vida was used in the study. SSFP - BTFE (Steady State Free Precision - Balanced Turbo Field Echo) was used in the study in addition to the regular T1 and T2 sequences. Both axial and coronal sections are planned and scans are taken. It is a fully balanced steady state coherent imaging pulse sequence which was designed to produced high SNR images with strong signal from fluid tissues while suppressing background tissue for contras and anatomical detail of small structures. In addition, the ultra-short TR and TE enable extreme short acquisition times, shorter than FSE and the images were post processed

using MIP and 3D navigator techniques. This is used to visualize the biliary anatomy and the hepatic artery.

Inclusion criteria: All patients who were referred to Radio-diagnosis department for MRCP

Exclusion criteria:

- Patients who are claustrophobic
- Patients who have metallic implants, cochlear implants, cardiac pacemakers
- Early pregnancy

RESULTS

Table 1: Gender distribution

Gender	Frequency	Percent
Female	18	60.0
Male	12	40.0
Total	30	100.0

There were 18 females and 12 males in the study.

Table 2: Representation of frequency of left and right hepatic duct's anatomical variations in the study group

Left hepatic duct	Frequency	Percent
Accessory RAHD draining into LHD NORMAL	1	3.3
NORMAL	21	70.0
RAHD DRAINS INTO LHD	3	10.0
RPHD DRAINS INTO LHD	5	16.7
Right hepatic duct		
Formed by RPHD	7	23.3
NORMAL	23	76.7
Common hepatic duct		
Formed by RAHD and LHD	4	13.3
Formed by union of RPHD AND LHD	2	6.7
NORMAL	24	80.0

RAHD drains into LHD in 10% of subjects whereas RPHD into LHD variation was found in 16.7% of subjects. The right hepatic duct was found to have a normal anatomy in 76.5% of our study population. The remaining was formed by RPHD (23.3%).The normal course of common hepatic duct was found in 80% of patients where the remaining 20% were variants formed by RAHD and LHD and the other being RPHD and LHD.

Table 3: Representation of cystic duct's anatomical variations in the study group

Cystic duct	Frequency	Percent
lateral insertion	23	76.7
Medial and posterior insertion	1	3.3
Medial insertion	4	13.3
parallel course with medial insertion	1	3.3

Posterior insertion	1	3.3
Total	30	100.0

Considering the cystic duct, the normal lateral insertion was found in 76.7% of the study population whereas medial insertion was found in 13.3%. The remaining variants which constitute <4% each are medial and posterior insertion, parallel course with medial insertion and posterior insertion.

Table 4: Showing the frequency of anatomical variations of hepatic artery by Michel's classification in the study group

Hepatic artery	Frequency	Percent
Michel type I	26	86.7
Michel type III	1	3.3
Michel type IX	1	3.3
NA	2	6.7
Total	30	100.0

In case of hepatic artery, Michel's type I was found in 86.7% of the study population. Other variants found are Michel's type III and IX. In 6.7% of subjects, the hepatic artery could not be visualized.

Table 5: Representation of anatomical variations of left right and hepatic duct in males and females in the study group

Left hepatic duct	Female	Male	Total
NORMAL	14	7	21
	66.7%	33.3%	100.0%
Accessory RAHD draining into LHD NORMAL	1	0	1
	100.0%	0.0%	100.0%
RAHD DRAINS INTO LHD	0	3	3
	0.0%	100.0%	100.0%
RPHD DRAINS INTO LHD	3	2	5
	60.0%	40.0%	100.0%
Total	18	12	30
P value	0.135		

Right hepatic duct	Female	Male	Total
Formed by RPHD	2	5	7
	28.6%	71.4%	100.0%
NORMAL	16	7	23
	69.6%	30.4%	100.0%
Total	18	12	30
P value			0.05

Common hepatic duct			
Formed by RAHD and LHD	2	2	4
	50.0%	50.0%	100.0%
Formed by union of RPHD AND LHD	0	2	2
	0.0%	100.0%	100.0%
NORMAL	16	8	24
	66.7%	33.3%	100.0%
Total	18	12	30
P value	0.16		

Normal anatomy of left hepatic duct was seen in 66.7% of females and 33.3% of males with a significant p value of 0.0135. Right hepatic duct was normal in 69.6% females and 30.4% of males with a significant p value of 0.05. The common hepatic duct was normal in 66.7% of females and 33.3% of males with a significant p value of 0.16.

Table 6: Representation of anatomical variations of cystic duct and hepatic artery in males and females in the study group

Cystic duct	Female	Male	Total
lateral insertion	12	11	23
	52.2%	47.8%	100.0%
Medial and posterior insertion	1	0	1
	100.0%	0.0%	100.0%
Medial insertion	3	1	4
	75.0%	25.0%	100.0%
parallel course with medial insertion	1	0	1
	100.0%	0.0%	100.0%
Posterior insertion	1	0	1
	100.0%	0.0%	100.0%
Total	18	12	30
P value			0.56
Hepatic artery	Female	Male	Total
Michel type I	16	10	26
	61.5%	38.5%	100.0%
Michel type III	1	0	1
	100.0%	0.0%	100.0%
Michel type IX	0	1	1
	0.0%	100.0%	100.0%
NA	1	1	2
	50.0%	50.0%	100.0%
Total	18	12	30
P value			0.51

The lateral insertion of cystic duct which is considered normal is found in 52.2% of females and 47.8% of males with a significant p value of 0.56. Michel's type I variant was observed in 61.5% of females and 38.5% of males with a p value of 0.5.

DISCUSSION

The biliary tract is conventionally studied by various modalities like Ultrasound, Computed tomography. They are of limited value because only the pathologies of the same can be studied to some extent. Intravenous cholangiography is able to delineate CHD but opacification of bifurcation and cystic duct are not up to the mark. The right hepatic duct drains the segments of the right liver lobe (V–VIII). The right hepatic duct has two major branches: The right posterior duct draining the posterior segments, VI and VII, and the right anterior duct draining the anterior segments, V and VIII.[7,11,12]

The left hepatic duct is usually longer than the right. The caudate lobe is drained by the bile duct which joins the origin of right and left hepatic duct.[1,3] The cystic duct usually enters the CHD a few centimeters down to the confluence of the left and right hepatic ducts. The cystic duct measures 2-4 cm in length and 1-5 mm in diameter. It contains the spiral valves of Heister and frequently follows a tortuous course. The common biliary anatomy is established in 58% of the people.[6]The normal cystic duct measures 2‑ 4 cm in length and 1‑ 5 mm in diameter. It contains the spiral valves of Heister and frequently follows a tortuous course. This normal biliary anatomy is thought to be present in 58% of the population.[13]

Usually the right anterior sectoral duct is joined posteriorly by right posterior sectoral duct and thus forms the right hepatic duct. Usually, the right posterior sectoral duct courses posterior to right anterior sectoral duct and unites with it from the left side to form right hepatic duct. In our study we got about 76.7% of normal anatomy of RHD. In 23.3% of cases, right hepatic duct is formed exclusively by right posterior sectoral duct. The other anatomic variations includes the joining of left hepatic duct by the right posterior sectoral duct (16.7% in our study) , cystic duct or CHD is drained by right posterior sectoral duct and trifurcation at confluence variations (0%). With the help of work done by Choi et al., Benson et al., previous eminent researchers, and our own experience, we have tried to simplify the classification of biliary anatomy and its variations.[13,14]

Variations in cystic duct insertion are also frequently seen. Parallel course of cystic duct is one of the commonest variations in cystic duct insertion. It is defined as cystic duct coursing parallel to the common hepatic duct for at least a 2 cm segment. Next most common variation is medial insertion of the cystic duct, i.e. drainage of the cystic duct into the left side of the common hepatic duct followed by low cystic duct insertion, which is seen as fusion of the cystic duct with the distal third of the extrahepatic bile duct. Other variations in cystic duct insertion are spiral course of the cystic duct and high fusion of the cystic duct with the common hepatic duct. Short cystic duct is defined as cystic duct having a length of less than 5 mm. Cystic duct hypertrophy is seen when the diameter of cystic duct is more than 5 mm. Maheshwari et al. have defined a new entity known as cystic malformation of the cystic duct which could be a distinct Type VI choledochal cyst.[15]Hepaticocystic duct is an anomalous duct draining directly into the cystic duct.[16]Cholecystohepatic duct is a term given to a duct passing through the

gallbladder fossa. Other uncommon variations are double cystic duct, absent cystic duct, and cystic duct entering the right hepatic duct.

Knowledge of biliary anatomy is extremely important in hepatobiliary surgeries.[17] Preoperative assessment of potential liver donors requires detailed hepatic vascular and biliary anatomy. Currently, right lobe is most commonly used for adults and either the entire left lobe or liver segments II and III (left lateral segment) is used for pediatric recipients. So, detailed understanding of the biliary tree, especially the distance of primary confluence from right and left secondary confluence, distance of segment IV duct to primary confluence along with anatomy of segment II and III ducts is of pivotal significance to avoid biliary complications in the intraoperative and early postoperative period.[18,19] It is also crucial to recognize aberrant and accessory drainage of the ducts, crossover and trifurcation anomalies because ligation of these ducts may result in biliary cirrhosis. Anatomic variations of the biliary tract are usually also accompanied by variations in the portal venous system and the hepatic arterial system, which are also important in hepatobiliary surgeries. More specifically, portal venous anomalies have been demonstrated to significantly correlate with anomalous biliary drainage.[20]

CONCLUSION

Our study described the prevalence of anatomical variations of biliary tract in our study population and also delineated the hepatic artery and its variations to some extent without using contrast. Increasing trend in advancements in hepatobiliary surgeries and liver transplantation procedures requires aggressive workup of biliary anatomy in these patients. Detailed knowledge of normal anatomy, and common and uncommon variations is of utmost importance for radiologists who are reporting these MRCP images. One should not only look at 2D and 3D MRCP images but also correlate these findings in multiplanar reconstruction planes and source images. Hence, future studies should be large scaled with technological developments which might eliminate the use of contrast agents for the visualization of hepatic arteries, thus eliminating its side effects.

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