EVALUATION OF THE VARIANTS OF BILIARY TREE BY MRCP IN PATIENTS WITH PRIMARY HEPATO-BILIARY DISEASES AND OTHER ABDOMINOPELVIC CONDITIONS

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ABSTRACT

Introduction: Magnetic resonance cholangiopancreatography (MRCP) is an excellent non-invasive imaging technique for the visualization of the detailed biliary anatomy.

Methodology: 200 patients with primary hepatobiliary diseases and 200 patients referred for other abdominopelvic conditions were evaluated by MRCP.

Results: There was no statistically significant difference in these two groups in anatomic variation in hepatobiliary (p value=0.18) and cystic duct (p value=0.81)

Conclusion: MRCP helps in pre-operative evaluation of the bile ducts, cystic ducts so as to avoid the possible operative complications related to variant anatomy.

KEY WORDS: MRCP, hepatobiliary diseases, anatomic variations

INTRODUCTION:
Magnetic resonance cholangiopancreatography (MRCP) is a special type of magnetic resonance imaging (MRI) examination which provides the detailed imaging evaluation of the hepatobiliary and pancreatic systems. Magnetic resonance imaging (MRI) is a noninvasive investigation which clinicians use to diagnose medical conditions.

The MRCP is the investigation of choice for the study of the hepatobiliary system which includes the biliary calculi, tumors, inflammation or infection. It is useful to evaluate the patients with pancreatitis for the detection of the underlying cause. It is also useful in diagnosing the unexplained abdominal pain and also provides a less invasive alternative to endoscopic retrograde cholangiopancreatography (ERCP). It has replaced the Endoscopic Retrograde Cholangiopancreatography (ERCP) as a modality of choice to study the pancreatobiliary tract.

High resolution cross-sectional Two-dimensional (2D) and three-dimensional (3D) projection images gives an excellent detailed anatomy of biliary tree. We commonly get with the anatomic variations of the intra and extra-hepatic biliary tree. There are different patterns of the variations of intra-hepatic biliary tree and of the cystic duct anatomy. Though these anatomic variations of biliary tree are not pathological per se, but these are of clinical significance in specific situations like hepatobiliary or gall bladder interventional procedures and surgeries.

This study was conducted to determine such anatomic variations of both intra-hepatic and extra-hepatic biliary tree on MRCP.

OBJECTIVES:
1. To study the anatomic variations of intra-hepatic and extra-hepatic biliary tree in patients with the primary diseases of the hepatobiliary system
2. To study the anatomic variations of intra-hepatic and extra-hepatic biliary tree in patients with other abdominal and pelvic organs diseases

MATERIAL AND METHODS

Study design:
The present study was observational study undertaken to study the anatomic variations of intra-hepatic and extra-hepatic biliary tree on MRCP.

Study setting:
The study was conducted in department of Radiology of a tertiary care hospital setting.

Study period:
The present study period was from November 2016 to October 2018.

Study population:
The study population was patients presenting to the department of Radiology for MRCP, MRI abdomen and MRI pelvis.

Sample size:
A total sample size of 400 patients presenting to the department of Radiology for MRCP, MRI abdomen and MRI pelvis was included in the study population.

Sample size estimation:
The variations in normal biliary tree anatomy with 95% confidence interval and precision of 5% variance around true variation with prevalence of anatomic variations of biliary tract. i.e. 42% (Normal biliary anatomy is seen in 58% population). 

\[ n = \frac{4pq}{L^2} \]

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Table No. 1: Anatomy of the intra-hepatic biliary tree in group B & C patients

<table>
<thead>
<tr>
<th>Anatomic variations (Type)</th>
<th>No. of Patients (%) Group B n=200</th>
<th>No. of Patients (%) Group C n=200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I (Typical or normal anatomy)</td>
<td>RPSD enters RASD medially to form RHD</td>
<td>128 (64)</td>
</tr>
<tr>
<td>Type II</td>
<td>Trifurcation: Confluence of RASD, RPSD and LHD into the CHD</td>
<td>27 (13.5)</td>
</tr>
<tr>
<td>Type III</td>
<td>Anomalous drainage of RPSD</td>
<td>44 (22)</td>
</tr>
<tr>
<td>a- RPSD entering into LHD (crossover anomaly)</td>
<td>21</td>
<td>38</td>
</tr>
<tr>
<td>b- RPSD into CHD</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>c- RPSD into cystic duct</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Type IV</td>
<td>Aberrant drainage of RHD into the cystic duct</td>
<td>01 (0.5)</td>
</tr>
<tr>
<td>Type V</td>
<td>Accessory right hepatic duct</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type VI</td>
<td>Segments II and III duct draining individually</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type VII</td>
<td>Other unclassified variations</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 2.05, df=1, p=0.18 \]

Table no. 1 shows that total anatomical variations in intrahepatic biliary tree is seen 72 (36%) and 86 (43%) in group B and C patients respectively. There is no statistically significant difference between the two groups.

Table No. 2: Distribution according to anatomic variations of cystic duct in Group B & C patients

<table>
<thead>
<tr>
<th>Anatomic variations (Type)</th>
<th>No. of Patients (%) Group B n=200</th>
<th>No. of Patients (%) Group C n=200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A: low insertion into the distal third of CBD</td>
<td>17 (8.5)</td>
<td>21 (10.5)</td>
</tr>
<tr>
<td>Type B: Medial insertion of cystic duct into CBD</td>
<td>27 (13.5)</td>
<td>22 (11)</td>
</tr>
<tr>
<td>Type C: Parallel course with common hepatic duct</td>
<td>01 (0.5)</td>
<td>00 (0)</td>
</tr>
<tr>
<td>Type D: High insertion of cystic duct into common hepatic duct</td>
<td>00 (0)</td>
<td>00 (0)</td>
</tr>
<tr>
<td>Type E: Cystic duct draining to right hepatic duct</td>
<td>00 (0)</td>
<td>00 (0)</td>
</tr>
<tr>
<td>Type F: Cholecystohepatic duct</td>
<td>00 (0)</td>
<td>00 (0)</td>
</tr>
<tr>
<td>Type G: Cystic malformations of cystic duct</td>
<td>00 (0)</td>
<td>00 (0)</td>
</tr>
<tr>
<td>Type H: Other unclassified variations</td>
<td>00 (0)</td>
<td>00 (0)</td>
</tr>
<tr>
<td>No Anatomical Variation in cystic duct</td>
<td>155 (77.5)</td>
<td>157 (78.5)</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 0.06, df=1, p=0.81 \]

Table no. 2 shows that total anatomical variations in cystic duct is seen 45 (22.5%) and 43 (21.5%) in group B and C patients respectively. There is no statistically significant difference between the two groups.

DISCUSSION:
The indication for MRCP among group B patients showed that the majority of patients had indication of Cholelithiasis (31.5%), followed by Obstructive jaundice (28%), Cholecystitis (27.5%), Acute cholecystitis (6.5%), Acute pancreatitis (5.5%), Liver mass (3.5%), Pancreatic mass (2.5%), Chronic pancreatitis (1.5%), and Acute cholangitis (1.5%). In a study by AlAaddin Nayman et al on MRCP evaluation of intrahepatic bile duct variations observed major indication for MRCP was Cholelithiasis (preoperative assessment) (29.2%) followed by obstructive jaundice (27.6%).

In the present study, anatomy of the intra-hepatic biliary tree among all patients (Group B and C) showed that the majority of patients had normal anatomy (Type I) (60.5%). The variation of intrahepatic biliary tree of anomalous drainage of RPSD was seen in 25.25% patients of which RPSD entering into LHD i.e. type IIa was 14.25% and RPSD into CHD i.e. type IIb in 11.25% patients. Trifurcation (Type II) was seen in 11.25% and the aberrant drainage of RHD into the cystic duct seen 0.5%.

STUDY GROUPS:
The patients were divided into 2 groups:
- Group B: Patients with primary diseases of hepatobiliary system
- Group C: Patients referred for other abdominal and pelvic MRI studies.

Each of the groups contains 200 patients.

Selection criteria:
Inclusion criteria:
- All patients referred from various departments for MRCP, MRI abdomen and MRI pelvis

Exclusion criteria:
- Lack of adequate quality of magnetic resonance imaging
- Distortion of biliary tree due to tumour or any space occupying lesion or any surgery of biliary tree.

Ethical consideration:
The study was approved by the Ethical Committee of the Medical College.

METHODOLOGY
MRCP Protocol
All patients must fast for 6 hours prior to examination to reduce fluid secretions within the stomach and duodenum, reduce bowel peristalsis and promote gallbladder distension.

MRCP procedure was performed with Magnetom Symphony 1.5 Tesla. With coronal and axial T2-weighted (T2W) single-shot fast spin-echo (FSE) sequence, axial respiratory-triggered fat-suppressed T2W FSE sequence.

DATA COLLECTION:
All patients in fulfilling inclusion criteria were selected. Informed consent was taken from the patients. The selected subjects were assessed for MRCP. Data was collected, images were evaluated in picture archiving communication system (PACS) and variations intrahepatic and extrahepatic biliary radicles were studies in both the groups.

Statistical analysis:
All data analysis had been done by using SPSS (version 22) for windows. The initial measures of each group were compared with the final measures of the study period and compared by using chi square test.

RESULTS:
Table No. 1: Anatomy of the intra-hepatic biliary tree in group B & C patients

<table>
<thead>
<tr>
<th>Biliary anatomy (Type)</th>
<th>Interpretations</th>
<th>No. of Patients (%) Group B n=200</th>
<th>No. of Patients (%) Group C n=200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I (Typical or normal anatomy)</td>
<td>RPSD enters RASD medially to form RHD</td>
<td>128 (64)</td>
<td>114 (57)</td>
</tr>
<tr>
<td>Type II</td>
<td>Trifurcation: Confluence of RASD, RPSD and LHD into the CHD</td>
<td>27 (13.5)</td>
<td>18 (9)</td>
</tr>
<tr>
<td>Type III</td>
<td>Anomalous drainage of RPSD</td>
<td>44 (22)</td>
<td>65 (32.5)</td>
</tr>
<tr>
<td>a- RPSD entering into LHD (crossover anomaly)</td>
<td>21</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>b- RPSD into CHD</td>
<td>23</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>c- RPSD into cystic duct</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Type IV</td>
<td>Aberrant drainage of RHD into the cystic duct</td>
<td>01 (0.5)</td>
<td>03 (1.5)</td>
</tr>
<tr>
<td>Type V</td>
<td>Accessory right hepatic duct</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type VI</td>
<td>Segments II and III duct draining individually</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type VII</td>
<td>Other unclassified variations</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
The anatomy of the intra-hepatic biliary tree among group B patients showed majority of patients had normal anatomy (Type I) (64%). The variation of intra-hepatic biliary tree of anomalous drainage of RPSD (Type III) seen in 22% patients (of which RPSD entering into LHD i.e.type IIIa was 10.5% and RPSD into CHD i.e.type IIIb in 11.5%, trifurcation (Type II) was seen in 13.5% and the aberrant drainage of RHD into the cystic duct was seen in 1 (0.5%) patient.

The anatomy of the intra-hepatic biliary tree among group C patients showed majority of patients had normal anatomy (Type I) (57%). The variation of intra-hepatic biliary tree of anomalous drainage of RPSD (Type III) seen in 32.5% patients (of which RPSD entering into LHD i.e.type IIIa was 19.0% and RPSD into CHD i.e.type IIIb in 13.5%, trifurcation (Type II)was seen in 9.0% and the aberrant drainage of RHD into the cystic duct was seen in 3 (1.5%) patients.

The majority of all study population (Group B and C) had normal anatomy i.e. absent anatomic variations (60.5%), while variation of intra-hepatic biliary tree was present seen in 158 (39.5%) patients.

Similar findings were seen in a study by Binit Sureka, et al on Magnetic resonance cholangiographic evaluation of intrahepatic and extrahepatic bile duct variations that, hepatic bile duct variation with anomalous drainage of RPSD (Type III) in 17% patients followed trifurcation (Type II)(5%).

In a study by Alaaddin Nayman et al on MRCP evaluation of intrahepatic bile duct variations observed intrahepatic bile duct anatomy i.e. absent anatomic variations (60.5%), while variation with anomalous drainage of RPSD (Type III) in 17% patients followed trifurcation (Type II)(5%).

The anatomy of the intra-hepatic biliary tree were seen in 22 % all patients (both group B and C), of which majority of patients had medial insertion of cystic duct into CBD (Type B) (12.25%) followed by low insertion into the distal third of CBD (9.5%) and Parallel course with Common hepatic duct (Type C) (0.25%) Similarly, in Group B the majority of patients had medial insertion of cystic duct into CBD (Type B) (13.5%) followed by low insertion into the distal third of CBD (8.5%) and Parallel course with Common hepatic duct (Type C) (0.5%) in group C, majority of patients had medial insertion of cystic duct into CBD (Type B) (11%) followed by low insertion into the distal third of CBD (10%).

Similar findings were seen in a study by Binit Sureka, et al where majority of patients had medial insertion of cystic duct into CBD (Type B) (10-17%) followed by low insertion into the distal third of CBD (9%) and Parallel course with Common hepatic duct (Type C) (1.5%) in 51% of cases. Medical insertion was seen in 16% of cases, of which 4% were low medial insertions. Low insertion of CD was noted in 9% of cases. Parallel course of CD was present in 7.5% of cases. High insertion was noted in 6% and short CD in 1% of cases. In 1 case, CD was draining into right hepatic duct.

The anatomic variations of intra-hepatic biliary tree in the patients without the diseases of the hepatobiliary system (Group C) were more (22.5%) as compared to the variations of extra-hepatic biliary tree in the patients without the diseases of the hepatobiliary system Group C (21.5%). However there was no statistically significant difference between the two groups. (P=0.81)

In a study by K.A.H.Talpure et al classical anatomy of cystic duct joining the CHD at its middle third from lateral aspect is seen in 58%–75% of cases.

In a study by H. Onder et al medial insertion of cystic duct was reported in 10–18% of cases and low insertion of cystic duct (LICD) was reported in 8 to 11% of cases.

MRCP is a noninvasive imaging modality which optimally images the bile ducts and cystic duct. MRCP provides important information regarding cystic duct anatomy and has a significant safeguarding effect on laparoscopic cholecystectomy. Prior to laparoscopic surgery, the knowledge of the cystic duct anatomy and its variants helps in proper interpretation of disease process and avoids iatrogenic injuries. In medicolegal purposes, preoperative documentation of bile duct anatomy may also help.

It is important to recognize the anatomical variations of cystic ducts which are common. MRCP begin an excellent imaging modality for the demonstration of cystic duct anatomy and its variations, which not only helps in proper interpretation of the disease process but also provides a roadmap before any percutaneous, endoscopic, and surgical interventions.

Recently, percutaneous transcholecystic biliary interventions are being performed through the cystic duct, pre-surgical knowledge of the cystic duct anatomy and its variations helps in planning the procedure and helps to avoid the possible surgical complications.

CONCLUSIONS:
In all study population, normal biliary anatomy was seen. The anatomic variations of intra-hepatic biliary tree were seen 39.5% and those of cystic ducts were 22%. MRCP being non-invasive imaging modality, can optimally image the bile ducts and cystic duct.

With the accurate demonstration of the bile ducts, cystic ducts with their anatomical variation, MRCP helps in pre-operative evaluation. It avoids the possible operative complications related to this variant anatomy.

Limitations:
In our study, we could not get the uncommon anatomical variations of intrahepatic biliary tree (Type V, VI, and VII) and that of cystic duct (Types D, E, F, G, and H), possibly due to our small sample size in comparison with the reference studies.

Conflict of interest: None
Funding: None
Acknowledgement: REPRESENTATIVE STUDY IMAGES

Image 1: Normal anatomy (Type I/ typical): Coronal MRCP images
showing joining of right posterior sectoral duct (RPSD) joining right anterior sectoral duct (RASD) posteriorly and medially (arrow).

Image 2: Type II anatomy (Trifurcation) - Confluence of RASD, RPSD and LHD to form CHD.

Image 3: Type IIIa- Anomalous drainage of right posterior sectoral duct (RPSD) (arrow) entering into left hepatic duct (LHD) (Crossover anomaly)

Image 4: Type IIIb anatomy- Right posterior sectoral duct (arrow) entering into common hepatic duct.

Images 5 and 6: Medial Insertion of cystic duct (Type B)

Image 7: Trifurcation (type II) and low insertion of cystic duct (arrow) into distal 3° CBD (type A)

Image 8: Lateral insertion of cystic duct

REFERENCES: