REVIEW ARTICLE

Evaluation of Biliary Tract Variations Using Magnetic Resonance Cholangiopancreatography

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Abstract

The biliary tract is known for its intra- and extrahepatic variations. Magnetic resonance cholangiopancreatography (MRCP) is the best noninvasive modality to study its branching patterns. Apart from identifying pathologies, MRCP helps to identify the anatomical variations, which aids in preplanning in surgery. The aim of this article is to review the various anatomical variations in the biliary tract using MRCP. A literature search was conducted using the keywords "MRCP evaluation of biliary tract variations,""uses of MRCP in preoperative mapping," and "anatomy of biliary tract." A total of 10 studies met our inclusion criteria and were included in this analysis. On the basis of results it can be concluded that MRCP serves as a good noninvasive method to analyze the biliary tract and hepatic artery variations.

Keywords: Biliary tract variations, Cystic duct variations, Magnetic resonance cholangiopancreatography.

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Introduction

The biliary tract is known for its intra- and extrahepatic variations. The normal anatomy of the bile ducts is present only in 58% of the population.[1] The presence of anomalies in the intra- and extrahepatic biliary tract is the leading cause of biliary radical injury during the time of surgery.[2] This has become important in recent advances in laparoscopic cholecystectomy where the incidence of iatrogenic injury to the bile duct is increasing three-fold when compared with open cholecystectomy.[3] Hence, we would like to review the anatomical variations of the biliary tract with MRCP.

Materials and Methods

A comprehensive search was carried out in PubMed and Google Scholar with the following keywords "biliary tract variations," "magnetic resonance cholangiopancreatography," and "cystic duct variations." A detailed study was conducted from the results of the standard articles with these keywords. Some latest articles about MRCP were also reviewed.

Results

Taourel et al. evaluated the accuracy of MRCP in the variants of biliary radicals. This study was done in comparison with contrast-enhanced cholangiography in a total of 171 patients. Magnetic resonance cholangiopancreatography showed a cystic duct in 126 patients (74%). Of these 126 patients, MRCP successfully depicted the low cystic duct insertion in 10 of the 12 cases; false-negative results and inadequate data accounted for one sample each. MRCP also displayed 11 cases of cystic duct insertion on the medial side; MRCP successfully depicted the course of common hepatic duct (CHD) and cystic duct in a parallel manner in 20 of 22 samples. Overall, MRCP achieved higher specificity than sensitivity in the diagnosis of the variants of the cystic duct. The biliary duct junctions were depicted in 81% of samples, and an aberrant right hepatic duct (RHD) were demonstrated in 9% of samples. Contrast-enhanced cholangiography described the biliary tract confluence in 93 patients of which aberrant RHD was noticed in seven cases (8%). Magnetic resonance cholangiopancreatography correctly diagnosed cases of aberrant RHD in five of seven cases. In the false-negative cases, the aberrant duct was short and smaller in caliber. MRCP had a higher specificity than sensitivity for diagnosing the RHD.[4]

Soto et al. assessed the value of MRCP in 37 patients in whom endoscopic retrograde cholangiopancreatography (ERCP) was unsuccessful or did not completely delineate biliary ductal anatomy. Magnetic resonance cholangiopancreatography was successful in all patients. Magnetic resonance cholangiopancreatography showed normal findings in 11 patients and required no further intervention. An abnormality was detected in eight patients with MRCP, but was followed up clinically. Laparotomy was performed in 11 patients, therapeutic percutaneous transhepatic cholangiography was needed in three patients, diagnostic percutaneous transhepatic cholangiography was performed in two patients, and one patient underwent ultrasound-guided biopsy.[5]

Reuther et al. compared the efficacy of bile duct imaging in magnetic resonance cholangiography (MRC) compared with intravenous cholangiography (IVC) in 60 patients before surgery. They found that the gall bladder (GB) was adequately visualized with IVC in 77% of patients and with MRC in 88%. Rates of visualization of the common bile duct (CBD) were 97% for IVC and 100% for MRC, for the visualization of cystic duct was 27% and 75%, and

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intrahepatic ducts was 28% and 77%, respectively. With both techniques, GB calculi were correctly diagnosed in approximately 80% of patients. CBD calculi were correctly diagnosed with this technique in five cases, cystic duct calculi were diagnosed with MRC alone in two cases.[6]

Vanbeckevoort et al. studied the combined methods of Half-Fourier Acquisition Single-Shot Turbo-Spin-Echo (HASTE) and single-shot rapid acquisition relaxation enhancement sequences in MRCP for imaging the GB and the biliary tract and thus compared with IVC as preoperative evaluation in 20 patients undergoing laparoscopic cholecystectomy. Magnetic resonance cholangiopancreatography was considered superior to IVC images for various imaging of GB.[7]

Limanond et al., in 27 potential liver donors, assessed the use of MRCP in preoperative imaging of biliary anatomy in adult living donor liver transplantation (LDLT) and compared the results with intraoperative cholangiogram findings. They concluded that MRCP has apotential role in the preoperative imaging of nondilated biliary passage in LDLT donors; however, further improvement is still required.[8]

Dusunceli et al. studied the frequency of common anatomical variations of the biliary tree by MRCP in 487 patients. In 115 patients (24.2%), anatomical variations were found at different levels. They concluded that MRCP is a relatively safe and better modality for depicting the bile duct anatomy and its variations, and to prevent iatrogenic bile duct injury during procedures.[9]

Jingbo Zhang et al. compared the efficacy of the fast 3D T2-weighted TSE MRCP sequences and conventional 2D MRCP images in 30 patients who underwent scanning with 1.5 T MRI. Results showed that the 3D TSE images had strikingly high sensitivity when compared with its 2D counterpart in delineating bile duct anatomy and better quality, and thus gaining a significant edge over the other.[10]

Nadine et al. studied the use of MRCP in the assessment of bile duct anatomy and variants in liver donor in 50 patients. They assessed the CBD, left hepatic duct (LHD) and RHD, and the data were categorized according to Huang and Hakki's classifications.[11]

According to their study, the need for more detailed Hakki reclassification of biliary anatomy was the distance from the joining of the right posterior hepatic duct into the junction of the right anterior sectoral duct (RASD) and LHD. This distance necessitates the modification of the bile duct anastomosis procedure. Similarly, in many samples in which the single anastomosis technique was considered prior to surgery complicated anastomosis techniques became necessary.

Other associated biliary anomalies were encountered in their study in 16 patients. When the findings of MRCP were compared with cholangiography intraoperatively, there was almost 98% accuracy of the verified results. So MRCP serves as the best noninvasive modality for the study of biliary ducts.[12]

Vikas et al. studied the usefulness of MRCP as the main diagnostic test for the evaluation of pathologies like choledochal cysts in 80 patients. Type IV choledochal cysts were noted in six patients, type I was noted in one patient, and another patient had the dilatation of both CBD and cystic duct as a whole. Abnormal pancreaticobiliary junction was noted in seven patients and three of them were found to have a long common channel.[13]

In 2017, a study conducted by Frisch et al. found that using negative oral contrast agents like iron or manganese-rich fruit juices causes shortening of the T2 relaxation time. Hence, it reduces the signal intensities that are produced by upper gastrointestinal tract fluids. This provides better visualization of the biliary tract.[14]

Discussion

The advancement of MRCP helps in diagnosing both pathologies and anatomical variations with the optimized protocols. Initially, ERCP was used, which is an invasive technique. Since the advent of MRCP, it has replaced ERCP in many clinical scenarios for diagnosis.

Normal Anatomy of Biliary Tract

The intrahepatic bile ducts from each lobe unite to from the left and right main hepatic ducts, which are located anterior to the portal veins. The right and left main hepatic ducts unite to form the CHD at the hilum. The CHD usually courses along a 45° oblique manner in association with the midline sagittal plane, which lies to the right and lateral to the proper hepatic artery. The CBD forms when CHD is joined by the cystic duct. The CBD drains into the ampulla of water.[15]

Anatomical Variations

The normal anatomy of RHD is formed by the right posterior sectoral duct (RPSD) and RASD. The LHD is formed by the union of common trunks of two and three joining segments of four ducts. The variations in the intrahepatic ducts are as follows:

- RPSD drains into LHD,
- RASD drains into LHD,
- RPSD drains into the anterior part of RASD,
- "Triple confluence" formed by the union of RPSD, RASD, and LHD to form CHD,
- Aberrant hepatic duct,
- Low insertion of RHD into CHD, and
- Accessory hepatic ducts.[16]

The formation of CBD by the lateral insertion of the cystic duct into CHD is seen in a majority of the cases and is considered normal. The variations seen in cystic duct are as follows:

- Medial insertion,
- Long cystic duct inserting at a low level in distal one third of CBD,
- Parallel course along with CHD,
- High insertion into CHD,
- Insertion of cystic duct into RHD, and
- Other variations.[16]

Role of MRCP

The knowledge of biliary tract anatomy is essential to proceed with the surgery. In laparoscopic cholecystectomy particularly, there are high chances of injuring bile ducts that could turn out to be fatal. Before the advent of MRCP, contrast-enhanced cholangiogram was used in evaluating the biliary tract variations. On reviewing the articles mentioned above, we came to know that MRCP is superior to all other diagnostic facilities in the evaluation of pathologies as well as anatomical variations in the biliary tract. In some cases, ERCP failed to identify the clear anatomy of the biliary tract that was made possible by MRCP.[5]

With the advent of new imaging techniques such as HASTE and 3D T2 weighted sequences, better visualization of the biliary tract is possible.[7] Administration of negative oral contrast like dates syrup

suppresses the signals produced by the upper gastrointestinal tract and gives clear imaging of the biliary tract.[14]

In some groups of population, other variations have also been identified, which may require newer classification in the near future.[12]

Clinical Significance

MRCP is also used to diagnose cholelithiasis, choledocholithiasis, choledochal cysts, primary sclerosing cholangitis, and many others pathologies for which it is mainly indicated. The knowledge about anatomical variations of the biliary tract also has clinical significance.

Gall Bladder Surgeries

With the knowledge about the anatomy of GB and biliary tract, iatrogenic injuries can be reduced significantly.

Liver Transplant

Liver transplant is an emerging field in medicine that requires a thorough imaging of the anatomy of the biliary tract and hepatic artery variations before proceeding to surgery. The intrahepatic biliary tract variations should be taken into consideration while planning for the resection of the liver.

Biliary Interventional Procedures

In cases of biliary tract obstruction, the interventional radiologist evaluates the biliary tract variations to plan for drainage.

Limitations

The major limitation of our study is that in a few studies that were reviewed, surgical correlation to confirm the anatomical variations was not seen.

Conclusion

Magnetic resonance cholangiopancreatography is considered to be the investigation of choice in the evaluation of biliary tract and GB pathologies. Apart from providing an idea about pathologies, it also helps in identifying the biliary tract variations, which in turn help in planning surgery. Being noninvasive, MRCP also entails less discomfort to patients.

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