Diagnostic Contribution of Magnetic Resonance Cholangiopancreatography in Biliary Obstruction: Additional Findings and Misdiagnosis

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ABSTRACT

Objective: In this study, the diagnostic value of magnetic resonance cholangiopancreatography (MRCP) in patients with biliary obstruction was compared with that of endoscopic retrograde cholangiopancreatography (ERCP), to detect the additional findings provided by MRCP and possible misdiagnosis were aimed.

Methods: MRCP and ERCP findings of 47 patients with biliary obstruction were analyzed retrospectively. The Kappa test was used to assess the relationship between the diagnostic accuracy of MRCP and ERCP. The significance limit was taken as $p < 0.05$ and two-sided.

Results: Diagnostic values of MRCP for choledocholithiasis in the 95% confidence interval were as: Sensitivity: 86-100%, specificity: 56-97%, positive predictive value: 78-99%, negative predictive value: 70-100%, and accuracy: 96%. For periampullary masses, these values were within the 95% confidence interval: Sensitivity: 89-100%, specificity: 56-100%, positive predictive value: 89-100%, negative predictive value: 56-100% and accuracy: 100%.

Conclusion: In addition to the known advantages of not using ionized radiation and contrast agent compared to ERCP, MRCP is an important part of the diagnosis of biliary tract diseases with the exception of being able to identify biliary tract pathologies with very high sensitivity and specificity, showing intraperitoneal additional pathologies outside the biliary tract. However, intraabdominal diffuse free fluid and choledochal stents make it difficult to evaluate MRCP.

Keywords: Bile duct obstruction, periampullary mass, choledocholithiasis, magnetic resonance cholangiopancreatography

INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) and magnetic resonance cholangiopancreatography (MRCP) are complementary examination techniques in the diagnosis and differential diagnosis of biliary obstruction (1). ERCP comes into prominence by allowing histopathological diagnosis and providing applications for treatment and for the duodenum and biliary tracts. However, the application of ERCP is restricted because it is an invasive method in which radiation is used and that it may cause some severe complications, such as pancreatitis. On the other hand, MRCP is a radiation-independent imaging technique that can be applied in a short time without requiring contrast media. Demonstration of choledocholithiasis, stricture, malignancy, or external compression on the biliary tracts through MRCP provides an advantage to the practitioner of ERCP in terms of planning before the procedure and management of diagnosis and treatment (2).

Choledochal stones, which are the most frequent causes of biliary tract obstruction, are also the most common causes of indications for ERCP. The sensitivity and specificity of ERCP for this condition are both 90%-100%. Similar results have been reported for MRCP (3-5). In MRCP, the diagnostic value decreases in parallel with a decrease in the choledochal diameter. In ERCP, false-negative results can be obtained when small stones are covered with an opaque substance. In benign stenoses, which are the second most frequent causes of biliary tract obstructions, ERCP is successfully performed, and the success rate of stent insertion following the dilatation of narrowing with a balloon or bougie ranges between 80% and 90% in experienced centers (1). On the other hand, in malignant stenoses, the diagnostic rate approaches 100% with cholangioscopy performed with MRCP and ERCP (6, 7).

MRCP is a non-invasive imaging technique that has been used for the last 20 years and is efficient in the investigation of the pancreaticobiliary system (8). In MRCP, heavily T2-weighted "pulse" sequences are used, and fluids with stationary or slow flow in the biliary tree and pancreatic duct are viewed as hyperintense because of a long relaxation time; there is no need for the use of a contrast agent. Technically, heavily T2-weighted images are

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made with gradient echo (GRE) equalized *steady state free precession* (SSFP) technique. Subsequently, *fast spin echo* (FSE) is used, and images are obtained with the sequences such as modified *rapid acquisition refocused echo* (RARE) and *half-Fourier acquisition single-shot turbo spin-echo* (HASTE) (9). In a normal patient, central intrahepatic biliary tracts can be viewed in MRCP, and their diameters generally do not exceed 3 mm. On the other hand, the diameter of extrahepatic biliary tract does not exceed 7 mm. After cholecystectomy, a mild biliary dilatation occurs, and the diameter of the choledoch does not exceed 10 mm. Congenital anomalies of the cystic and hepatic duct, postoperative biliary anatomy and complications, pancreatic divisum, abnormal pancreaticobiliary junction, choledocholithiasis, benign or malignant biliary obstructions, chronic pancreatitis, cystic pancreatic tumors, and biliary injuries can be demonstrated through MRCP.

In this study, we aimed to investigate the contribution of MRCP in the diagnosis of biliary tract obstruction and to determine its limitations and errors.

METHODS

After receiving approval from the Ethics Committee (01.27.2016 Approval no: 2), 49 patients (28 female and 21 male) undergoing first MRCP and then ERCP in a week due to the diagnosis of biliary obstruction between January 2015 and March 2016 in GaziosmanpaşaTaksim Training and Research Hospital at Health Sciences University were retrospectively evaluated. Two of them were excluded from the study, and a total of 47 patients were examined. The exclusion criterion was an inadequate unevaluable ERCP level. In our study, ERCP could not be applied in 2 patients. In one of them, a full cannulation at the level of the ampulla of Vater could not be performed. In the other patient, duodenoscope could not be advanced because of external compression. These patients were excluded. The study continued with 47 patients.

MRCP technique*:* Two radiologists performed the evaluation of MRCP by reaching a simultaneous consensus. The upper limit of the choledochal diameter was accepted as 6 mm, and in cholecystectomy cases, a diameter up to 10 mm was considered to be normal.

The procedure is performed with a respiratory-adjusted system and body bandage, and there is no need for holding breath. A 1.5 Tesla magnetic resonance device (Signa HDxt; GE Medical systems, Carrollton, TX, USA) was used. In addition, 3D MRCP (GE) from T2-A fat-suppressed coronal and axial FSE sequences (TR:1074, TE: 450, Nex: 2, FOV: 40 cm, matrix: 320×256, section thickness: 2 mm) and T2-A coronal non-fat suppressed sequence (TR: 880, TE: 90, FOV: 42 cm, matrix: 320×288, section thickness: 4 mm) were used.

ERCP technique: After receiving informed consent from patients following 8-hour fasting, this procedure was applied in the prone position with sedo-analgesia using ERCP device (Olympus TJF Q180V, Isikava) and duodenoscopy (Olympus TJF 160 VR, Japan). After selective choledoch cannulation, the contrast media were given through this way, and the choledoch and intrahepatic biliary tracts were viewed with a scope (Philips BV Pubera 2,3, Holland). Sedo-analgesia was administered in cooperation with an anesthesiologist, and all ERCP procedures were performed by a single experienced endoscopist. The contrast media were given in the ratio of 1/1 by mixing physiological saline solution.

Statistical Analysis

The inspection of normality was performed with the Shapiro-Wilk test, histogram, QQ plot, and box plot graph. The data were presented as mean, standard deviation, median, minimum, maximum, frequency, and percentage. The agreement between ERCP and MRCP and choledochal diameter was evaluated by drawing the Bland-Altman graph. The agreement level of ERCP and MRCP according to mass and choledocholithiasis results was evaluated with the Kappa test. Diagnostic values (sensitivity, specificity, positive predictive value, negative predictive value, and accuracy) were calculated. The significance level was considered as $p<0.05$ and bilateral. The analyses were performed using NCSS 10 software and Clinical Calculator 1 available at http://vassarstats.net/clin1.html.

RESULTS

MRCP and ERCP findings of 47 patients (28 female and 19 male) were retrospectively analyzed. The mean age was 60.8 (27-85) years.

While choledocholithiasis (Figure 1) was detected in 31 patients in MRCP, it was found in 29 patients in ERCP. Low signal intensities observed in the choledoch of 2 patients in MRCP were found to be associated with air image related to the previous ERCP procedure. The agreement of choledocholithiasis between MRCP and ERCP was evaluated with the Kappa test (0.89+/− 0.07 SE, $p<0.001$).

Diagnostic values of choledocholithiasis for MRCP (in the confidence interval of 95%) were as follows: sensitivity: 86%-100%; specificity: 56%-97%; positive predictive value: 78%-99%; negative predictive value: 70%-100%; and accuracy: 96%.

In MRCP, periampullary mass was suspected in 7 patients (Figure 2a, b), which was confirmed by ERCP. Two of the masses were

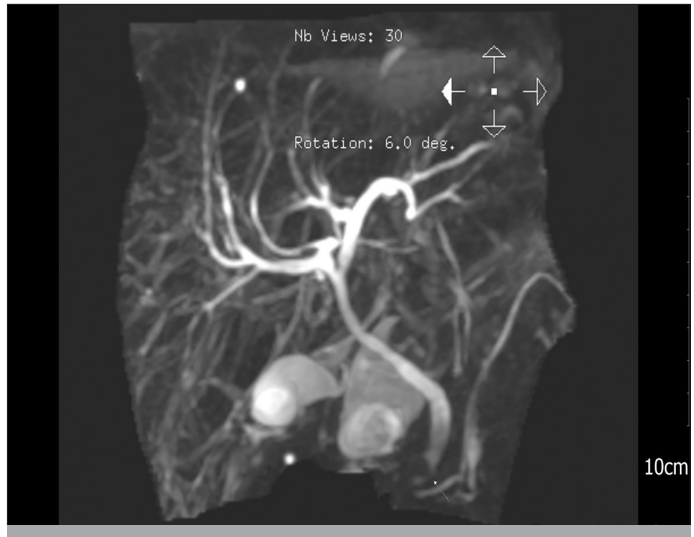

Figure 1. In a 32-year-old female patient, hypointense and round-contoured calculus (choledocholithiasis) and dilatation in the choledoch and intrahepatic biliary tracts are observed in coronal 3D MRCP section.

carcinoma of the pancreas head. The agreement level of MRCP and ERCP for periampullary masses was evaluated with the Kappa test (1.0+/−0 SD; p<0.001). The analyses of diagnostic values for periampullary masses in MRCP in the confidence interval of 95% were as follows: sensitivity: 89%-100%, specificity: 56%-100%, positive predictive value: 89%-100%, negative predictive value: 56%-100%, and accuracy: 100%.

The difference of the choledochal diameter between MRCP and ERCP was 2.2 mm. The mean diameter was measured as 13.8 mm in MRCP. In ERCP, the mean diameter was 12.1 mm (in the confidence interval of 95%).

Gallstones was detected in 29 patients (Figure 3). In 2 cases, they were accompanied by acute cholecystitis (Figure 4).

In other 9 patients, there were 3 cases of stenosis associated with cholangitis sequela, 1 case with stone in the intrahepatic biliary tracts, 1 case with papillary cyst (Figure 5), 2 cases with a stone causing external compression to the choledoch in MRCP (Mirizzi syndrome) (Figure 6) were detected. Moreover, in 1 patient, while MRCP revealed perforated gallbladder (Figure 7) and abscess, ERCP demonstrated purulent matter in the choledoch. In 1 patient, biliary leakage from the cystic duct was found in MRCP, and it was confirmed by ERCP. Additional findings: Different from ERCP, additional findings were detected in MRCP. Acute cholecystitis in 2 cases, dilated intrahepatic biliary tracts in 21 cases, pleural effusion in 3 cases, pericardial effusion in 2 cases, hiatal hernia in 1 case, spleen metastasis in 1 case, gastric carcinoma in 1 case, and little intra-abdominal free fluid in 2 cases were detected. In 1 patient, there was fluid which was so intense that it led to technical incompetence.

DISCUSSION

What is the diagnostic value of MRCP that we define as guiding? In the literature, many studies on the diagnostic value of MRCP

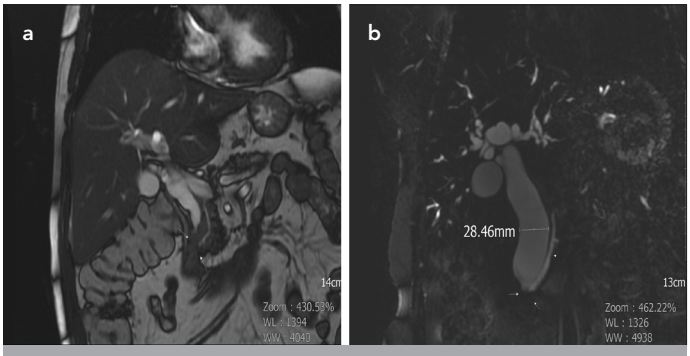

Figure 2. a, b. In the coronal T2-A FSE section of a 72-year-old male patient (a) and the coronal 3D MRCP section of a 65-year-old female patient, massive areas (arrow) characterized by sudden ending in the periampullary region, choledoch, and Wirsung duct, viewed as soft tissue intensity displaying apparent dilatation, are observed.

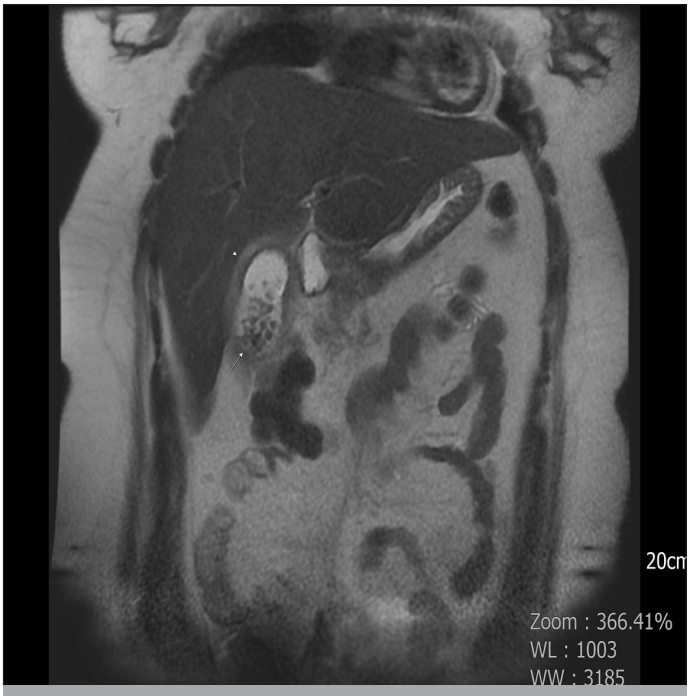

Figure 4. In the coronal T2-A FSE section of a 38-year-old female patient, increased thickness of the wall of the gallbladder, pericholecystic edema and inflammation, and multiple millimetric calculi in the lumen of the gallbladder are viewed, which is consistent with acute calculus cholecystitis.

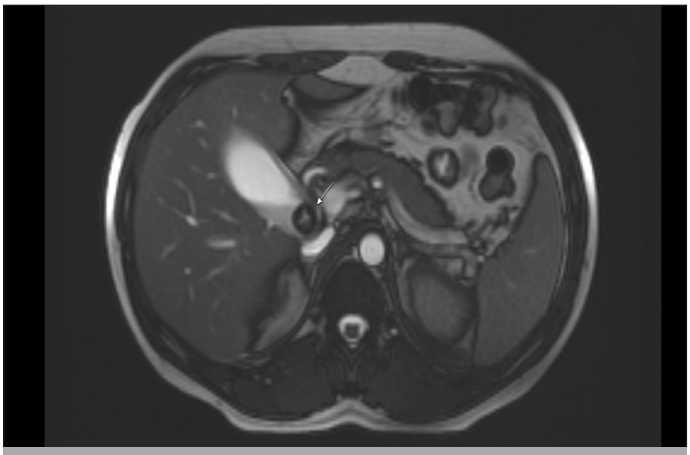

Figure 3. In the axial T2-A FSE section of a 36-year-old male patient, biliary sludge in the neighborhood of calculus (Mercedes sign) with central cholesterol content in the lumen of the gallbladder is observed.

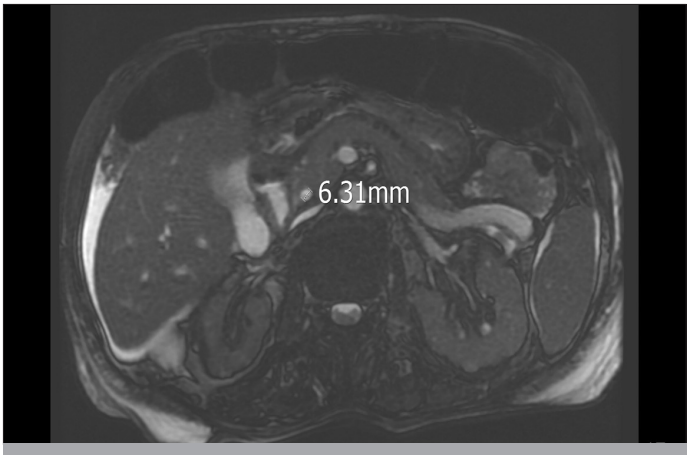

Figure 5. In the axial T2-A FSE fat-suppressed section of a 56-year-old male patient, a millimetric cyst (arrow) is viewed in the papillary entry of the pancreas. Moreover, intra-abdominal mild ascites appear.

Figure 6. In the coronal T2-A FSE section of a 47-year-old male patient, calculus on the junction of the cystic duct and the choledoch and its compression-induced dilatation in the choledoch and intrahepatic biliary tracts are viewed. Distal choledoch calibration was evaluated to be normal (Mirizzi syndrome). Moreover, multiple millimetric calculi are viewed in the lumen of the gallbladder.

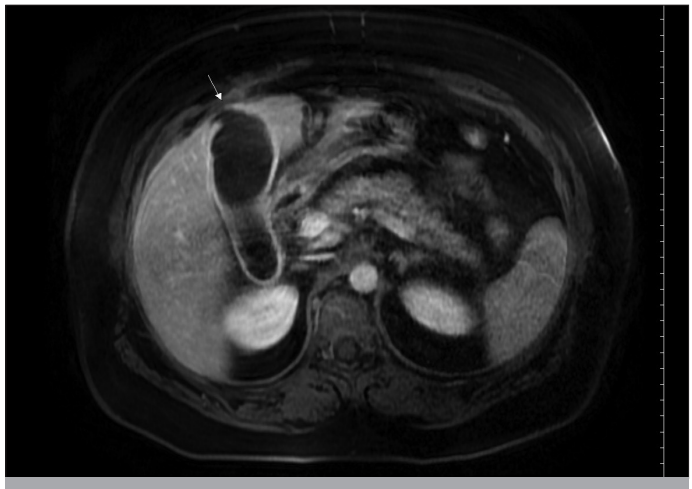

Figure 7. In the axial contrast-enhanced fat-suppressed T1-A FSE section of a 77-year-old male patient with long-lasting pain in the right upper quadrant, intense contrast involvement in the wall of the gallbladder and defect (arrow) found to be consistent with perforation in the wall of the gallbladder at the level of fundus are seen.

have been conducted up to now. In the review of Kalthantaner et al. (1), there were 1,437 studies examined, and ERCP and MRCP were compared in 28 of these studies. According to these studies, while the sensitivity of MRCP for choledocholithiasis was observed to be in a wide range from 0.50 to 1, the specificity varied between 0.83 and 1. For malignant obstructions, the sensitivity of MRCP was defined between 0.81 and 0.94, and the specificity was between 0.92 and 1. It was concluded that the diagnostic value of MRCP, which was more significant in the diagnosis of biliary pathologies, particularly in choledocholithiasis, was quite high for biliary obstruction, and it was stated that it could decrease the rate of invasive ERCP examinations, especially diagnostic ones, to a great extent. In the study by Parashari et al. (10), sensitivity and specificity of MRCP were found to be 91.66% and 90.46% for choledocholithiasis and 85% and 71% for malignant obstructions. Suthar et al. (11) reported sensitivity and specificity of MRCP as 100% and 100% for choledocholithiasis and 85.7% and 96.3% for malignant obstructions. In our study, wherein all the patients underwent ERCP and some underwent an additional surgery, although the sensitivity, specificity, and accuracy of MRCP for choledocholithiasis were found to be 100%, 86%, and 96%, respectively, for periampullary tumor, these values were 100%, 100%, and 100%, respectively. Although these rates are higher than those in the literature, the low number of periampullary malignancy cases should be considered.

Limitations of MRCP

MRCP completely lost its diagnostic value because of diffuse intra-abdominal free fluid found in 1 patient. A diffuse intra-abdominal free-fluid signal overlaps with other stationary fluid signals, and the biliary tracts cannot be differentiated. In addition, the second important patient group for which MRCP examination is restricted consists of patients that have undergone ERCP previously and applied choledochal stent insertion. The choledoch, the passage of which is provided due to stent, approaches its normal diameter to a great extent, and intraluminal evaluation is restricted. It can cause confusion in vascular compressions mimicking biliary tract obstructions (such as the hepatic artery and gastroduodenal artery) and pseudo-obstruction. Moreover, artifacts that can mimic air and stone in the choledoch can be confused with stone in MRCP. In patients having undergone ERCP, examining clinical data becomes more important in the evaluation of MRCP. In our study, a 3-mm diametered stone was suspected in the distal region of the choledoch in 1 patient in MRCP, but no stone was found in ERCP. In the follow-up examination that considered laboratory findings, it was decided that the MRCP image was consistent with air in the choledoch in the patient who had undergone ERCP 7 days before, and it was evaluated as a false positive. Because of technical incompetence and limitations that are sometimes encountered in our MR unit, which is very busy, some of procedures had to be repeated.

MRCP as a Guide

First of all, MRCP is useful for making a rapid decision during the procedure and technical approach in patients for whom ERCP cannot be performed due to mass or external compression. In our patient, who was found to have biliary tracts dilatation due to the compression of a mass localized in the antrum upon MRCP examination, stenting was decided to be performed with ERCP, but full cannulation could not be done. In another patient who was diagnosed with enlarged intrahepatic biliary tracts in association with an intra-abdominal giant mass in MRCP, the diagnosis was confirmed by ERCP, and stent was placed. In our 2 patients having MRCP findings consistent with the Mirizzi syndrome, which is defined as the external compression of stone in the cystic duct or gallbladder on the extrahepatic biliary tracts, no stone was found in the choledoch in ERCP. However, an external compression on the choledoch was observed, which was

consistent with MRCP. Stent was inserted, and the patients were followed up (10 months, 1 year). Collection in the neighborhood of the cystic duct and intra-abdominal free fluid were observed in a patient who was applied MRCP due to suspected biliary leakage after cholecystectomy. The suspicion of biliary leakage was reported, and it was confirmed by ERCP.

Another advantage of MRCP is that additional information related to general health condition of patient can be provided with T2-weighted non-fat suppressed sequence in which the abdomen is transversely scanned involving the lower thoracic aperture, which has a short time for examination. In our study, additional findings such as duodenum diverticulum, hiatus hernia, many pleural and pericardial effusion, intra-abdominal free fluid, and intra-abdominal organ metastases, helped general evaluation of patients before ERCP, particularly in patients with emergency. We suggest that coronal T2-weighted non-fat suppressed sequence, which does not lead to an apparent time extension, should definitely be added to all MRCP examinations.

Our limitation is that the number of patients was low considering that the patient group for which MRCP and ERCP would be performed together in a short time interval was targeted.

CONCLUSION

MRCP is a radiation-independent and easily applicable guiding technique that has high sensitivity and specificity and requires no use of contrast media in the diagnosis of biliary tract obstruction. With MRCP, systemic additional findings of patient can be viewed as well as the biliary tract pathology. Intra-abdominal diffuse free fluid, previous application of ERCP, and the presence of stent make MRCP evaluation difficult.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of University of Health Sciences Gaziosmanpaşa Taksim Training and Research Hospital.

Informed Consent: Due to the retrospective design of the study, informed consent was not taken.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - G.T.A., H.K.Y., G.Ş., E.E.E.; Design - G.T.A., H.K.., G.Ş., E.E.E.; Supervision - G.T.A., H.K.Y., E.E.E.; Resources - H.K.Y., G.Ş.; Materials - H.K.Y, G.Ş.; Data Collection and/or Processing - H.K.Y., E.E.E.; Analysis and/or Interpretation - H.K.Y., E.E.E., G.Ş.; Literature Search - H.K.Y., E.E.E., B.E.; Writing Manuscript - H.K.Y., E.E.E.; Critical Review - G.T.A., H.K.Y., E.E.E., G.Ş.; Other - B.E.

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Conflict of Interest: No conflict of interest was declared by the authors.

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