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Diagnostic Accuracy of Magnetic Resonance Cholangiopancreatography in Patients with Extrahepatic Cholestasis: A Retrospective Cohort Study

Ekstrahepatik Kolestazlı Hastalarda Manyetik Rezonans Kolanjiyopankreatografinin Tanısal Doğruluğu: Retrospektif Bir Kohort Çalışması

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ÖZ

Amaç: Ekstrahepatik kolestazın ayırıcı tanısı, görüntüleme tekniklerinin değişken duyarlılık ve özgüllük oranları nedeniyle zor olabilir. Manyetik rezonans kolanjiyopankreatografi (MRCP), safra yollarının değerlendirilmesinde kullanılan non-invaziv bir yöntemdir. Biliyer obstrüksiyonda MRCP'nin tanısal doğruluğunu araştırmayı amaçladık.
Araçlar ve Yöntem: Ocak 2012 ile Aralık 2016 arasında ekstrahepatik kolestaz ile Atatürk Üniversitesi Gastroenteroloji Bölümü'ne başvuran hastaların tıbbi kayıtları geriye dönük olarak incelendi. MRCP sonrası endoskopik retrograd kolanjiyopankreatografi (ERCP) yapılan hastalar çalışmaya dahil edildi. Hastaların demografik ve klinik özellikleri not edildi. ERCP altın standart tanı yöntemi olarak kabul edildi. MRCP'nin tanısal etkinliği, ERCP ile karşılaştırıldığında duyarlılık, özgüllük, doğruluk, negatif ve pozitif prediktif değerler hesaplanarak değerlendirildi.
Bulgular: Yaş ortalaması 60.1±17.5 yıl olan 615 hasta çalışmaya dahil edildi. MRCP kullanılarak sırasıyla 337(%54.8), 101(%16.4) ve 39(%6.3) hastada koledokolitiazis, malign ve benign darlıklar teşhis edildi. 65 hastada (%10.6) normal MRCP bulguları mevcuttu. ERCP ile kesin tanılar koledokolitiazis (n=390, %63.4), malign darlık (n=152, %24.7), benign darlık (n=62, %10.1) ve normal bulgular (n=11, %1.8) olarak belirlendi. MRCP'nin sensitivite ve spesifitesi koledokolitiyazis için %70.8 ve %72.9, malign darlık için %55.9 ve %96.5, benign darlık için ise %16.1 ve %94.8 idi. Koledokolitiazis, malign ve benign darlıklar için genel doğruluk oranları sırasıyla %71.5, %86.5 ve %86.8 idi.
Sonuç: MRCP'nin tanısal doğruluğu, farklı biliyer/kolestatik etiyolojiler için değişkendir. Koledokolitiaziste duyarlılığının daha düşük olması nedeniyle, özellikle biliyer obstrüksiyon için klinik bir şüphe olduğunda normal MRCP bulguları dikkatle ele alınmalıdır.

Anahtar Kelimeler: ERCP; kolestaz; MRCP; sensitivite; spesifite

ABSTRACT

Purpose: Differential diagnosis of extrahepatic cholestasis can be challenging due to the variable sensitivity and specificity rates of imaging techniques. Magnetic resonance cholangiopancreatography (MRCP) is a non-invasive method used for the evaluation of biliary tree. We aimed to investigate the diagnostic accuracy of MRCP in biliary obstruction.
Materials and Methods: Medical records of patients admitted with extrahepatic cholestasis between January 2012 and December 2016 were retrospectively reviewed. Patients who had endoscopic retrograde cholangiopancreatography (ERCP) following MRCP were included. The final diagnosis of ERCP was accepted as gold standard. The diagnostic efficiency of MRCP was evaluated by calculating sensitivity, specificity, accuracy, negative and positive predictive values as compared with ERCP.
Results: There were 615 patients with a mean age of 60.1±17.5 years. Using MRCP, choledocholithiasis, malignant and benign strictures were diagnosed in 337(54.8%), 101(16.4%), and 39 patients (6.3%), respectively. Normal MRCP findings were present in 65 patients (10.6%). Final diagnoses via ERCP were: choledocholithiasis (n=390, 63.4%), malignant stricture (n=152, 24.7%), benign stricture (n=62, 10.1%), and normal findings (n=11, 1.8%). The sensitivity and specificity of MRCP were 70.8% and 72.9% for choledocholithiasis, 55.9% and 96.5% for malign stricture, 16.1% and 94.8% for benign stricture, respectively. Overall accuracy rates were 71.5%, 86.5%, and 86.8% for choledocholithiasis, malign and benign strictures, respectively.
Conclusion: Diagnostic accuracy of MRCP is variable for different biliary/cholestatic etiologies. Due to a lower sensitivity for chole docholithiasis, normal MRCP findings should be handled with caution, especially when there is a clinical suspicion of biliary obstruction.

Keywords: cholestasis; ERCP; MRCP; sensitivity, specificity

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INTRODUCTION

Multiple imaging modalities are used in the differential diagnosis of cholestasis.[1,2] Due to the variable sensitivity and specificity of such modalities, challenges still exist in determining the cause and degree of obstruction, as well as differentiating the benign from malign etiology.[3] Magnetic resonance cholangiopancreatography (MRCP) is one of the essential diagnostic tools used in cholestasis. Generally, it is regarded as a non-invasive, efficient, and cost-effective method for hepatopancreatobiliary tree evaluation. Diverse causes leading to biliary tract obstruction might be critical limitations of MRCP due to an inherent inadequacy of the method for providing a histological diagnosis.[2] MRCP for patients with suspected biliary obstruction has been recommended in recent NICE (National Institute for Clinical Excellence) guidelines.[4,5] Nevertheless, under the presumption of a normal variant of the biliary tree, there might be difficulties in deciding whether to use further tests or stop all investigations in cases with a mildly dilated biliary tree detected via MRCP.[2]

Endoscopic retrograde cholangiopancreatography (ERCP), which is regarded as the gold standard for the diagnosis and treatment of choledocholithiasis, is usually the method of choice after positive results are obtained in other laboratory and diagnostic tests.[6] ERCP is a highly operator-dependent intervention associated with several complications, including pancreatitis, perforation, and bleeding.[2,3] Because of its invasiveness and inadequacy to visualize small stones, it is generally recommended to reserve ERCP exclusively for therapeutic purposes following the confirmation of the diagnosis by other imaging modalities.[2,6]

Although the sensitivity and specificity of MRCP have been reported as ranging between 80% to 90%, its potential use is still being questioned in several studies.[1,7,8] Thus, further studies are needed to determine the predictive value of MRCP for the diagnosis of biliary obstruction.[9,10]

In this study, we aimed to investigate the accuracy of MRCP for the diagnosis of biliary system obstruction as confirmed via ERCP.

MATERIALS and METHODS

Study Design and Ethical Approval

This study was a retrospective analysis of patients with extrahepatic cholestasis admitted to the Gastroenterology Division, Department of Internal Medicine, Atatürk University, between January 2012 and December 2016. Atatürk University Faculty of Medicine Clinical Research Ethics Committee approved the study (05.05.2017 date and 2/5 issue). The authors declared that they performed the study in accordance with the Declaration of Helsinki. The informed written consent was waived by the institutional ethics committee due to data anonymity and the retrospective design of the study.

Study Population and Protocol

The medical records of all patients aged ≥18 years with extrahepatic cholestasis were consecutively reviewed. Cholestasis was defined as either the presence of yellowish skin or sclera color or raised bilirubin levels of 2–2.5 mg/dL that lasted for at least two weeks.[11] As per the institutional policy, the medical records of all patients consisted of a detailed medical history, physical examination notes, and results of biochemical laboratory tests, including alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), amylase, lactate dehydrogenase (LDH), direct and total bilirubin. Imaging studies, i.e., transabdominal ultrasound (TUS), MRCP, and ERCP, were performed based on the discretion of the attending physician.

After demographic and clinical data were retrospectively collected from the medical records using the hospital and radiology information systems, the patients who underwent ERCP following MRCP were determined for inclusion in the study. The history of previous cholestatic attacks, chronic liver disease, clinical presentation suggesting hemolysis, and lack of relevant medical data was accepted as the exclusion criteria. The patients whose imaging studies (MRCP and ERCP) were conducted more than 72 hours apart were excluded.[6]

The patients were grouped considering their age (<65 and ≥65 years) and the results of biochemical tests (within normal limits and higher than the maximum of the normal range).

Diagnostic Investigations

All MRCP examinations were performed using a 1.5-T MRI scanner (Magnetom Avanto, Siemens Healthcare, Erlangen/Germany) with an 18-channel body coil and high-performance gradients (maximum gradient, 45 mT/m; maximum slew rate, 200 T/m/s). Fasting of at least four to six hours was required. For MRCP images, the coronal and sagittal T2-weighted breath-hold HASTE (half-Fourier acquisition single-shot turbo spin echo) (HASTE-bh) (axis: coronal, time repetition-TR/time echo-TE: 900/80, slice thickness: 5 mm, interslice gap: 5 mm, number of slices: 30, field of view: 570X570 mm^2, matrix: 256X146), sagittal T2-weighted fat suppression thick slab HASTE bh (axis: sagittal, time repetition-TR/time echo-TE: 4500/789, slice thickness: 40 mm, interslice gap: not applicable, number of slices: 6, field of view: 570X570 mm^2, matrix: 384X380), and coronal T2-weighted 3D breath triggered turbo spin echo (TSE) (time repetition-TR/time echo-TE: 2566/622, slice thickness: 15 mm, interslice gap: 0 mm, number of slices: 72, field of view: 570X570 mm^2, matrix: 384X380) images were used to obtain MIP (maximum intensity projection) images.

The biliary ductal system dilatation (intrahepatic: 2 mm≤ or extrahepatic: 4 mm≤) during TUS was regarded as the diagnostic finding for extrahepatic cholestasis.[11]

The outcome of initial MRCP images was described as positive for extrahepatic cholestasis in the presence of bile duct dilatation (intrahepatic: 2 mm ≤ and extrahepatic: 6 mm ≤).[11] Positive MRCP findings were classified as normal, choledocholithiasis, malignant stricture, and benign stricture.

Choledocholithiasis was diagnosed when a hypointense filling defect was present in the common bile duct. Focal, luminal, and segmental narrowings of the common bile duct were described as a stricture.[4]

All MRCP images were evaluated by radiologists with at least five years of clinical performance in abdominal imaging via MRI and MRCP.

After the ERCP decision was made by the attending physician based on clinical signs, biochemical test and imaging study results, the detection of a dilatation >7 mm of the extrahepatic bile ducts and direct visualization of the obstructed lesion via ERCP was interpreted as positive for biliary obstruction.[4] Patients were grouped according to the ERCP findings as normal, choledocholithiasis, malignant stricture, and benign stricture. The diagnoses underlying the malignant and benign strictures were also noted.

Statistical Analysis

The ERCP recordings of the endoscopy unit were used for the final diagnosis of the patients.

The diagnoses via MRCP were compared with those via ERCP.

Descriptive statistics were given as mean ± standard deviation and median with minimum-maximum values for continuous variables depending on their distribution. Numbers (n) with the corresponding percentages (%) were used for categorical variables.

The diagnostic efficiency of MRCP was assessed by calculating sensitivity, specificity, accuracy, and negative and positive predictive values.

For statistical analysis, "Jamovi project (2020), Jamovi (Version 1.8.1.0) [Computer Software] (Retrieved from https://www.jamovi.org) and JASP (Version 0.14.1) (Retrieved from https://jasp-stats.org) were used. The significance level (p-value) was set at 0.05 in all statistical analyses.

RESULTS

The demographics of the study group are presented in Table 1. The study included 615 patients with a mean age of 60.1±17.5 years. The number of patients <65 and ≥65 years of age was 316 (51.4%) and 299 (48.6%), respectively. The female-to-male ratio in the study was 1.27.

The results of laboratory tests and imaging studies are detailed in Table 1. For the initial diagnostic procedure, TUS was performed in 260 patients (42.3%). TUS findings showed cholestasis in 156 patients (25.4%). MRCP images showed cholestasis in 550 patients (89.4%) (Table 1). The distribution of the diagnoses according to MRCP findings was as follows: choledocholithiasis in 337 (54.8%), malignant stricture in 101 (16.4%), and benign stricture in 39 (6.3%) patients (Table 2).

Table 1. Demographic and clinical characteristics of the patients (n=615).

Feature	Value ‡
Age (year)†	60.1 ± 17.5
<65 years‡	316 (51.4)
≥65 years‡	299 (48.6)
Sex‡	
Male	271 (44.1)
Female	344 (55.9)
Biochemical parameters§	
ALT (IU/L)	108 [4 – 1722]
AST (IU/L)	84 [8 – 2376]
ALP (IU/L)	245 [44 – 2458]
GGT (IU/L)	294 [7 – 2456]
LDH (IU/L)	283 [113 – 5105]
Amylase (IU/L)	60 [2 – 7029]
Direct bilirubin (mg/dL)	1.53 [0 – 25.7]
Total bilirubin (mg/dL)	3 [0.2 – 40.4]
Imaging techniques‡	
TUS	
NA	355 (57.7)
Normal	104 (16.9)
Positive	156 (25.4)
MRCP	
Normal	65 (10.6)
Positive	550 (89.4)
ERCP	
Normal	11 (1.8)
Positive	604 (98.2)

†: mean±standarddeviation, ‡: n (%), §: median [min-max].
ALT: alanine aminotransferase, AST: aspartate aminotransferase, ALP: alkaline phosphatase, GGT: gamma-glutamyl transferase, LDH: lactate dehydrogenase, TUS: transabdominal ultra-sound, MRCP: magnetic resonance cholangiopancreatography, ERCP: endoscopic retrograde cholangiopancreatography.

Based on ERCP findings, the etiology of cholestasis in 604 patients (98.2%) had been diagnosed. A total of 11 patients (1.8%) had normal ERCP findings (Table 1). Choledocholithiasis was responsible for 390 cases (63.4%). Malignant and benign strictures were detected in 152 (24.7%) and 62 (10.1%) of the cases (Table 2). Among 152 cases with malignant stricture, cholangiocarcinoma observed in 84 patients was the most frequent diagnosis. Other diagnoses in malignant and benign stricture groups are detailed in Table 2.

Table 2. Distribution of the final diagnoses based on MRCP and ECRP (n=615).

Imaging technique	Diagnosis group	Disease	Value ‡
MRCP‡			
	Normal findings		65 (10.6)
	Choledocholithiasis		337 (54.8)
	Malignant stricture		101 (16.4)
	Benign stricture		39 (6.3)
ERCP‡			
	Normal findings		11 (1.8)
	Choledocholithiasis		390 (63.4)
	Malignant stricture		152 (24.7)
		Cholangiocarcinoma	84
		Pancreatic carcinoma	33
		Periampullary tumors	25
		Other malignant pathologies*	10
	Benign stricture		62 (10.1)
		Post-cholecystectomy	4
		Inflammatory **	22
		Primary sclerosing cholangitis	12
		Choledochal cysts	6
		Pancreatitis	1
		Others***	17

‡: n (%). MRCP: magnetic resonance cholangiopancreatography, ERCP: endoscopic retrograde cholangiopancreatography.
*: obstruction of the common bile duct due to external lesions
**: cholangitis in 13, biliary fistulization of the hydatid cyst in nine.
***: anastomotic stricture following liver transplantation in 11, diverticular obstruction in two, and dysfunction of the Oddi sphincter in four.

The correlation of MRCP findings with the final diagnosis via ERCP revealed that the sensitivity and specificity of MRCP for choledocholithiasis was 71.5%. The specificity of MRCP in the evaluation of malignant and benign strictures was 96.5% and 94.8%, respectively. The accuracy rates of MRCP in the evaluation of malignant and benign strictures were 86.5% and 86.8%, which were higher than in choledocholithiasis (71.5%) (Table 3). The PPVs and NPVs of MRCP were higher in patients with malignant stricture (84.2% and 87.0%) than those with choledocholithiasis (81.9% and 59.0%) and benign stricture (25.6% and 91.0%).

There were 65 cases of normal MRCP images that did not show a stone, stricture, injury, mass, or filling defect. In those patients, ERCP revealed the following diagnoses: choledocholithiasis in 50 (76.9%), malignant stricture in eight (12.3%), benign stricture in six (9.2%), and normal anatomy without any discrete.

Table 3. Diagnostic efficiency of MRCP for choledocholithiasis, malignant and benign strictures.

	ERCP		Sensitivity (%)	Specificity (%)	Accuracy (%)	Prevalence (%)	PPV (%)	NPV (%)
	(+)	(-)						
Choledocholithiasis								
MRCP								
(+)	276 (70.8)	61 (27.1)	70.8	72.9	71.5	63.4	81.9	59.0
(-)	114 (29.2)	164 (72.9)						
Malignant stricture								
MRCP								
(+)	85 (55.9)	16 (3.5)	55.9	96.5	86.5	24.7	84.2	87.0
(-)	67 (44.1)	447 (96.5)						
Benign stricture								
MRCP								
(+)	10 (16.1)	29 (5.2)	16.1	94.8	86.8	10.1	25.6	91.0
(-)	52 (83.9)	524 (94.8)						

MRCP: magnetic resonance cholangiopancreatography, PPV: positive predictive value, NPV: negative predictive value, ERCP: endoscopic retrograde cholangiopancreatography.

Stratification was performed for age groups, sex, and laboratory findings. The results are shown in Tables 4 to 6 for choledocholithiasis, malignant and benign strictures. For choledocholithiasis, MRCP had a higher specificity rate (76.4%) in patients whose age <65 years than in the overall patient group (72.9%). The diagnostic accuracy of MRCP for malignant stricture was higher in younger (<65 years) and female patients compared with the overall group (89.6% and 88.1% vs 86.5%). We detected a higher diagnostic accuracy rate to detect benign diagnosis in older patients (91.0%) than the overall patients (86.8%).

Grouping based on the age groups, sex distribution, and higher laboratory results revealed that MRCP had PPVs and NPVs close to each other to diagnose choledocholithiasis and malignant stricture (Table 4, 5). However, NPVs of MRCP for benign stricture were considerably higher than PPVs in patients with different age groups, sex distribution, and various biochemical results (Table 6).

Table 4. Diagnostic efficiency of MRCP for choledocholithiasis: subgroup analysis.

Variables	Sensitivity (%)	Specificity (%)	Accuracy (%)	Prevalence (%)	PPV (%)	NPV (%)
Age groups						
<65 years (n=316)	66.8	76.4	70.6	61.1	81.6	59.5
≥65 years (n=299)	74.6	68.6	72.6	65.9	82.1	58.3
Sex						
Male (n=271)	67.3	73.2	69.7	58.7	78.1	61.2
Female (n=344)	73.2	72.6	73.0	67.2	84.5	56.9
Patients with higher-than-normal values of						
ALT (n=447)	70.8	70.5	70.7	62.9	80.2	58.8
AST (n=413)	71.9	70.7	71.4	60.3	78.9	62.4
ALP (n=513)	72.2	73.0	72.5	60.2	80.2	63.4
GGT (n=569)	71.3	71.9	71.5	63.1	81.3	59.4
Amylase (n=159)	61.5	71.4	64.2	73.6	85.7	40.0
LDH (n=399)	68.9	74.3	70.9	62.9	82.0	58.5
Direct bilirubin (n=481)	73.9	71.2	72.8	58.8	78.6	65.6
Total bilirubin (n=458)	72.9	71.9	72.5	58.1	78.2	65.7

MRCP: magnetic resonance cholangiopancreatography, PPV: positive predictive value, NPV: negative predictive value, ALT: alanine aminotransferase, AST: aspartate aminotransferase, ALP: alkaline phosphatase, GGT: gamma-glutamyl transferase, LDH: lactate dehydrogenase.

Table 5. Diagnostic efficiency of MRCP for malignant stricture: subgroup analysis.

Variables	Sensitivity (%)	Specificity (%)	Accuracy (%)	Prevalence (%)	PPV (%)	NPV (%)
Age groups						
<65 years (n=316)	62.9	97.2	89.6	22.2	86.3	90.2
≥65 years (n=299)	50.0	95.9	83.3	27.4	82.0	83.5
Sex						
Male (n=271)	55.8	95.9	84.5	28.4	84.3	84.5
Female (n=344)	56.0	97.0	88.1	21.8	84.0	88.8
Patients with higher-than-normal values of						
ALT (n=447)	53.4	96.7	85.5	26.0	84.9	85.6
AST (n=413)	57.7	97.2	85.5	29.8	89.9	84.4
ALP (n=513)	56.8	96.7	85.4	28.5	87.4	84.9
GGT (n=569)	55.6	96.5	86.1	25.3	84.2	86.5
Amylase (n=159)	44.8	95.4	86.2	18.2	68.4	88.6
LDH (n=399)	62.0	96.2	87.0	27.1	85.9	87.2
Direct bilirubin (n=481)	55.7	96.5	84.6	29.1	86.7	84.1
Total bilirubin (n=458)	56.1	96.9	84.5	30.3	88.6	83.5

MRCP: magnetic resonance cholangiopancreatography, PPV: positive predictive value, NPV: negative predictive value, ALT: alanine aminotransferase, AST: aspartate aminotransferase, ALP: alkaline phosphatase, GGT: gamma-glutamyl transferase, LDH: lactate dehydrogenase.

Table 6. Diagnostic efficiency of MRCP for benign stricture: subgroup analysis.

Variables	Sensitivity (%)	Specificity (%)	Accuracy (%)	Prevalence (%)	PPV (%)	NPV (%)
Age groups						
<65 years (n=316)	18.2	93.4	82.9	13.9	30.8	87.6
≥65 years(n=299)	11.1	96.1	91.0	6.0	15.4	94.4
Sex						
Male (n=271)	20.0	95.0	86.7	11.1	33.3	90.5
Female (n=344)	12.5	94.6	86.9	9.3	19.0	91.3
Patients with higher-than-normal values of						
ALT (n=447)	14.0	95.3	87.5	9.6	24.0	91.2
AST (n=413)	13.5	95.7	88.4	9.0	23.8	91.8
ALP (n=513)	18.0	95.0	87.5	9.7	28.1	91.5
GGT (n=569)	16.1	94.7	87.0	9.8	25.0	91.2
Amylase (n=159)	27.3	91.2	86.8	6.9	18.8	94.4
LDH (n=399)	20.6	95.1	88.7	8.5	28.0	92.8
Direct bilirubin (n=481)	15.7	94.9	86.5	10.6	26.7	90.5
Total bilirubin (n=458)	14.6	94.6	86.2	10.5	24.1	90.4

MRCP: magnetic resonance cholangiopancreatography, PPV: positive predictive value, NPV: negative predictive value, ALT: alanine aminotransferase, AST: aspartate aminotransferase, ALP: alkaline phosphatase, GGT: gamma-glutamyl transferase, LDH: lactate dehydrogenase.

DISCUSSION

In this study, we showed a variable predictive power of MRCP in detecting choledocholithiasis and malignant and benign strictures. While the accuracy of MRCP in diagnosing choledocholithiasis was 71.5%, it had higher accuracy rates for malignant and benign strictures.

In the literature, several studies compared the diagnostic efficiency of TUS, EUS, intraoperative cholangiogram, and MRCP.[6,9,12,13] Different rates have been reported favoring any of the modalities in those studies. When Hanif et al. compared the diagnostic accuracy of TUS with MRCP as the gold standard, they found 84.57%, 79.1%, and 83.06% for sensitivity, specificity, and overall diagnostic accuracy, respectively.[11] As a general institutional policy, an intraoperative cholangiogram has not been used. Although EUS was performed in selected cases based on the discretion of the attending physician, we did not include the EUS cases in the final evaluation. Prospective studies are needed to give exact rates of the diagnostic efficiency of such imaging modalities.

Significant heterogeneity concerning the demographic and clinical characteristics of the patients and the technical availability of the imaging modalities are present in those studies. So, we think that it is challenging to reach a meaningful conclusion about the superiority of any. It has been reported that MRCP has higher sensitivity and specificity rates of up to 97% in the preoperative evaluation of patients with jaundice or hepatobiliary lesions.[1,4,10,14,15] Contrary to those previously published results, the sensitivity of MRCP for choledocholithiasis was 70.8% in the current study. Almost similar to our results, several authors presented MRCP predictive rates, ranging from 40% to 81%.[2,3] There are several possible reasons to explain the relatively lower predictive power of MRCP in cases with choledocholithiasis. Makmun et al. reported that lower specificity rates than sensitivity and accuracy or MRCP might reflect the difficulty in diagnosing small stones in the biliary tree.[2] It is generally speculated that the detection of stones <5 mm via MRCP can be tricky.[2,16] The stones lodged in the ampulla of Vater during biliary pancreatitis are another factor.[7] The lower diagnostic accuracy of MRCP may also be related to the interobserver variability of the physicians.[13] In light of those possible explanations, we recommend that a re-review of MRCP images may help physicians avoid false-negative results in the clinical and biochemical suspicion of extrahepatic cholestasis.

In a review by Badger et al., they questioned the use of MRCP in patients with choledocholithiasis.[14] Although the predictive power of MRCP (sensitivity 90%, specificity 86%) was found to be higher in that study, the authors concluded that MRCP did not impact clinical decision-making in patients who nevertheless proceeded to ERCP or laparoscopic cholecystectomy. O'Neill et al. reported that the relatively lower sensitivity and specificity of MRCP caused higher rates of non-therapeutic ERCP.[1] Although we did not evaluate the impact of MRCP findings on the decision to proceed with ERCP in our study, it seems reasonable to further investigate the impact of MRCP, especially considering its lower sensitivity, on the management of patients.

In the current study, the NPV values were 59%, 87%, and 91% for choledocholithiasis, malignant and benign strictures, respectively. Hjartarson et al. reported that MRCP with a high NPV (63%) was an essential diagnostic tool to exclude choledocholithiasis.[7] Therefore, we support the previous recommendations for using MRCP in the evaluation process of patients with extrahepatic cholestasis to reduce the number of unnecessary ERCP procedures.[7]

The diagnostic accuracy of MRCP has also been studied in differentiating benign and malign causes of biliary obstruction. However, we suggest that it is critical to consider various clinical features in the interpretation of those results. An overall accuracy rate of 93.3% for MRCP in biliary obstruction with both the malignant and benign etiologies was shown in the study of Suthar et al., in which choledocholithiasis was included in the benign group with an accuracy rate of 100%.[12] On the contrary, Tamir et al. reported a 57.4% diagnostic efficiency of MRCP in asymptomatic patients with biliary duct dilatation.[17] We detected a higher predictive power of MRCP in patients with benign and malignant strictures compared to the rates of previous studies. We also diagnosed choledocholithiasis and malignant and benign strictures in 76.9%, 12.3%, and 9.2% of the patients with normal MRCP, respectively. Similar findings to ours have been reported by Aydelotte et al., who detected lesions via ERCP in 13 out of 28 patients after a normal MRCP.[8] The authors even recommended that MRCP be abandoned as a diagnostic tool in patients with biliary duct pathology.[8] We may conclude that the final clinical decision in patients with extrahepatic cholestasis should not be based on MRCP findings only. In cases with clinical suspicion, various diagnostic imaging and interventional techniques would better be used to avoid false-negative results.

The biochemical test results have been used to increase the diagnostic efficiency of the imaging methods in some studies,[18-20] while no role of those tests in predicting a diagnosis of biliary obstruction was shown in others.[4] For instance, Wee et al. did not find any clinical or laboratory factors predictive of choledocholithiasis on univariate analysis in the EUS plus negative MRCP group.[13] Contrastingly, low ALP and bilirubin levels were used to exclude choledocholithiasis in another study, in which significant variations in the levels of biochemical markers and their corresponding predictive values were mentioned.[7] As the diagnostic accuracy of MRCP for different etiologies

varied in patients with higher than normal laboratory test results in our study, we are not able to firmly recommend their superiority to other diagnostic modalities and suggest further large-scale studies are needed for a conclusion on the impact of biochemical tests for an accurate diagnosis. On the other hand, subgroup analysis for the predictive value of MRCP revealed higher specificity in younger patients with choledocholithiasis and higher diagnostic accuracy in younger female patients with malignant stricture and older patients with a benign stricture. As the generalizability of our results is not clear, further studies in age, gender, and laboratory test subgroups are warranted.

Some limitations of the study need to be considered. The retrospective design and the data sourcing from a single center generate an inherent bias. Second, the inclusion of multiple pathologies might have caused a heterogeneous study group. Different radiologists attended the study to evaluate the MRCP images. Although they were experienced in abdominal radiology via MRI and MRCP, this issue might be regarded as a bias for our results. Lastly, the small size of the individual cases with various diagnoses prevented subgroup analyses in detail.

In conclusion, MRCP has variable diagnostic accuracy for extrahepatic cholestasis with different etiologies. Both the sensitivity and specificity of MRCP for malignant and benign strictures were higher than for choledocholithiasis. Normal MRCP results should be handled with caution, especially when there is clinical suspicion of extrahepatic cholestasis. Re-evaluation of MRCP by experienced physicians or proceeding with further imaging or diagnostic techniques should be considered.

Main Points

Imaging techniques such as magnetic resonance cholangiopancreatography have variable sensitivity and specificity rates for differential diagnosis of extrahepatic cholestasis. Magnetic resonance cholangiopancreatography had higher specificity and overall accuracy rates for malignant and benign strictures than choledocholithiasis. In patients with normal magnetic resonance cholangiopancreatography images, it can be possible to show a stone, stricture, mass, or filling defect via endoscopic retrograde cholangiopancreatography in the majority of the cases.

Normal magnetic resonance cholangiopancreatography results should be handled with caution in the presence of clinical suspicion for extrahepatic cholestasis.

Conflict of Interest

The authors declare that there is not any conflict of interest regarding the publication of this manuscript.

Ethics Committee Permission

Atatürk University Faculty of Medicine Clinical Research Ethics Committee approved the study (05.05.2017 date and 2/5 issue).

Authors' Contributions

Concept/Design: BY, NO. Data Collection and/or Processing: BY, NO. Data analysis and interpretation: BY, NO. Literature Search: BY. Drafting manuscript: BY. Critical revision of manuscript: BY, NO.

REFERENCES

1. O'Neill AM, Anderson K, Baker LK, Schurr MJ. The Overall Poor Specificity of MRCP in the Preoperative Evaluation of the Jaundiced Patient Will Increase the Incidence of Nontherapeutic ERCP. Am Surg. 2020;86(8):1022-1025.
2. Makmun D, Fauzi A, Shatri H. Sensitivity and Specificity of Magnetic Resonance Cholangiopancreatography versus Endoscopic Ultrasonography against Endoscopic Retrograde Cholangiopancreatography in Diagnosing Choledocholithiasis: The Indonesian Experience. Clin Endosc. 2017;50(5):486-490.
3. Alsaigh S, Aldhubayb MA, Alobaid AS, et al. Diagnostic Reliability of Ultrasound Compared to Magnetic Resonance Cholangiopancreatography and Endoscopic Retrograde Cholangiopancreatography in the Detection of Obstructive Jaundice: A Retrospective Medical Records Review. Cureus. 2020;12:10.
4. Hacım NA, Akbas A, Meric S, et al. Predictive value of ultrasonography and magnetic resonance cholangiopancreatography in the diagnosis of biliary obstruction. Ann Ital Chir. 2020;91(3):277-282.
5. Warttig S, Ward S, Rogers G. Diagnosis and management of gallstone disease: summary of NICE guidance. BMJ. 2014;349:33-35.
6. Anwer M, Asghar MS, Rahman S, et al. Diagnostic Accuracy of Endoscopic Ultrasonography Versus the Gold Standard Endoscopic Retrograde Cholangiopancreatography in Detecting Common Bile Duct Stones. Cureus. 2020;12(12).
7. Hjartarson JH, Hannesson P, Sverrisson I, Blöndal S, Ívarsson B, Björnsson ES. The value of magnetic resonance cholangiopancreatography for the exclusion of choledocholithiasis. Scand J Gastroenterol. 2016;51 (10):1249-1256.
8. Aydelotte JD, Ali J, Huynh PT, Coopwood TB, Uecker JM, Brown CVR. Use of Magnetic Resonance Cholangiopancreatography in Clinical Practice: Not as

Good as We Once Thought. J Am Coll Surg. 2015;221 (1):215-219.
9. Mesihović R, Mehmedović A. Better non-invasive endoscopic procedure: Endoscopic ultrasound or magnetic resonance cholangiopancreatography? Med Glas. 2019;16(1):40-44.
10. Epelboym I, Winner M, Allendorf JD. MRCP is Not a Cost-Effective Strategy in the Management of Silent Common Bile Duct Stones. J Gastrointest Surg. 2013;17(5):863-871.
11. Hanif H, Khan SA, Muneer S, Adil SO. Diagnostic accuracy of ultrasound in evaluation of obstructive jaundice with MRCP as gold standard. Pakistan J Med Sci. 2020;36(4):652-656.
12. Suthar M. Role of MRCP in Differentiation of Benign and Malignant Causes of Biliary Obstruction. J Clin Diagn Res. 2015;9(11):8-12.
13. Wee D, Izard S, Grimaldi G, Raphael K, Lee T-P, Trindade A. EUS assessment for intermediate risk of choledocholithiasis after a negative magnetic resonance cholangiopancreatography. Endosc Ultrasound. 2020;9(5):337.
14. Badger WR, Borgert AJ, Kallies KJ, Kothari SN. Utility of MRCP in clinical decision making of suspected choledocholithiasis: An institutional analysis and literature review. Am J Surg. 2017;214(2):251-255.
15. Zytoon AA, Mohammed HH, Hosny DM. The Role of Magnetic Resonance Cholangiopancreatography in Diagnosis of Hepatobiliary Lesions. J Med Imaging Radiat Sci. 2016;47(1):66-73.
16. Inan I, Sirik M. Diagnostic value of the choledochal sphericity index in the diagnosis of obstructive cholestasis using magnetic resonance cholangiopancreatography. Acta Gastroenterol Belg. 2020;83(4):571-575.
17. Tamir S, Braun M, Issachar A, Bachar GN, Benjaminov O. Yield of magnetic resonance cholangiopancreatography for the investigation of bile duct dilatation in asymptomatic patients. United Eur Gastroenterol J. 2017;5(3):408-414.
18. Abraham S, Rivero HG, Erlikh I V., Griffith LF, Kondamudi VK. Surgical and nonsurgical management of gallstones. Am Fam Physician. 2014;89(10):795-802.
19. Bose SM, Mazumdar A, Prakash S V, Kocher R, Katariya S, Pathak CM. Evaluation of the Predictors of Choledocholithiasis: Comparative Analysis of Clinical, Biochemical, Radiological, Radionuclear, and Intraoperative Parameters. Surg Today. 2001;31(2):117-122.
20. Yu CY, Roth N, Jani N, et al. Dynamic liver test patterns do not predict bile duct stones. Surg Endosc. 2019;33(10):3300-3313.