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Role of magnetic resonance cholangiography in the diagnosis of lithiasis in the common bile duct: experience at the Hospital de Clinicas "Dr. Manuel Quintela"

Abstract

Introduction: Lithiasis of the common bile duct (CBD) is a frequent cause of morbidity. Early and accurate diagnosis is essential to determine the appropriate treatment. Ultrasound is the first line in the diagnostic approach, but its sensitivity for detecting choledocholithiasis is limited. Computed tomography (CT) also has limitations in detecting small stones. In this context, magnetic resonance cholangiography (MRC) has emerged as a highly accurate, non-invasive tool for evaluating the bile duct.

Objective: To determine the usefulness of MRC as a diagnostic method for lithiasis in the main bile duct in patients treated at the Hospital de Clinicas "Dr. Manuel Quintela" during 2023.

Methodology: A descriptive, cross-sectional, observational study was conducted. All patients who underwent magnetic resonance cholangiography (MRC) between January 1 and December 31, 2023, at the Hospital de Clínicas "Dr. Manuel Quintela" were included. The information was obtained from the medical records of these patients. The data and results of the MRIs were collected and analyzed, as well as previous studies, with the aim of comparing them and determining why the role of magnetic resonance cholangiography is so relevant for diagnosis.

Results: Of the total of 123 MRIs performed and considered in the study, only 29 (23.6%) indicated a diagnosis of gallstones in the main bile duct. Of the 97 (78.9%) ultrasounds performed, only 3 (3.1%) diagnosed the pathology, and of the 51 (41.5%) CT scans, 6 (11.8%) detected lithiasis of the common bile duct.

Conclusions: MRCP is the imaging method par excellence for assessing the anatomy of the CBD and its level of obstruction. When there is diagnostic uncertainty regarding occupation in US and CT, due to their low sensitivity and specificity, as demonstrated in this study, MRCP is used. It reduces the need for unnecessary interventions and facilitates appropriate therapeutic planning.

Keywords: Common bile duct lithiasis, MRCP, cholangioresonance, gallstones, cholangitis, ERCP, ultrasound, bile ducts, diagnostic imaging, cholangiopancreatography

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Introduction

Gallstones in the common bile duct (CBD) are a common reason for visits to the emergency department. Timely and accurate diagnosis is essential to avoid complications and guide appropriate treatment. Conventional imaging studies, such as abdominal ultrasound and computed tomography (CT), are usually the first line of diagnosis. However, they have significant limitations in detecting small stones or when technical conditions make visualization of the biliary tree difficult. Endoscopic retrograde cholangiopancreatography (ERCP) is considered the therapeutic standard, but as it is an invasive procedure, it carries risks such as bleeding, perforation, post-ERCP pancreatitis, and significant morbidity and mortality (reported morbidity and mortality between 6-10% and mortality close to 1%).

In this context, CRM has emerged as a non-invasive tool with high sensitivity and specificity for evaluating the biliary tree, allowing visualization of stones in the common bile duct and defining the therapeutic indication with less risk to the patient.Despite its advantages, its systematic implementation is limited by high cost and restrictions in health coverage, such as its exclusion from the Comprehensive Health Care Plan (PIAS) in Uruguay. At the Hospital de Clinicas, CMR is frequently requested in patients with clinical suspicion of choledocholithiasis, especially when ultrasound or CT findings are inconclusive.[1–3]

Given this reality, it is important to analyze the diagnostic performance of MRCP in our institution, evaluate its impact on clinical decision-making, and determine its value as a complementary tool in the management of gallstones.

Objectives

General objective

To determine the usefulness of MRC as a diagnostic method for lithiasis in the common bile duct in patients treated at the Hospital de Clinicas "Dr. Manuel Quintela" during 2023.

Specific objectives

To determine how many patients were diagnosed with choledocholithiasis using MR cholangiography.

To evaluate the results of laboratory tests, ultrasound, and tomography performed prior to MRCP.

Hypothesis

General hypothesis

MRCP is decisive for the diagnosis of choledocholithiasis in patients with doubtful or negative findings in previous imaging studies.

MR cholangiography confirms the presence of choledocholithiasis in most cases where it was suspected by other imaging studies.

i. MR cholangiography allows the diagnosis of choledocholithiasis in a significant proportion of patients without suggestive findings in previous studies.

ii. MRCP MR cholangiography allows rule out choledocholithiasis and/or identify alternative diagnoses in patients with clinical suspicion.

Methodology

This study did not involve any financial expense, nor was the physical presence of the patients required; therefore, they did not run any risk. With regard to ethical aspects, all patients' personal data was treated confidentially, as it was coded anonymously to protect their identity, thus complying with Law No. 18331, the Personal Data Protection Law. Reference is also made to the national regulations of Decree No. 158/019.

A descriptive, cross-sectional, observational study was conducted on patients who underwent MR cholangiography between January 1 and December 31, 2023, at the Hospital de Clínicas "Dr. Manuel Quintela."

The study population included all patients who underwent MR cholangiography during the established period.

As exclusion criteria, patients who did not have clinical laboratory information and those with neoplastic pathologies were excluded. Data collection was performed using spreadsheets, based on a review of medical records, once the protocol had been approved by the Ethics Committee.[4,5]

The results for each patient were considered, including the following studies: MRCP, ultrasound, computed tomography, and paraclinical tests such as complete blood count and liver function tests. Relevant data such as age, sex, and symptoms reported at the time of hospital admission were also recorded. The relevant variables corresponding to the patient data were tabulated, including age, sex, and reason for consultation, such as right-sided abdominal pain, fever, and jaundice. Patients who presented at least one of these symptoms upon admission were considered symptomatic, and those who did not report any were considered asymptomatic.

Based on the results obtained from the studies performed prior to MR cholangiography, a table was constructed for each imaging method and laboratory analysis, evaluating whether or not it was possible to establish a diagnosis of choledocholithiasis. The blood count was analyzed for the presence of leukocytosis, while the liver function test evaluated the levels of total, direct, and indirect bilirubin, as well as gamma-glutamyl transferase (GGT), in order to identify abnormal values.

The ultrasound (US) recorded the presence or absence of dilation of the main bile duct, and the computed tomography (CT) scan recorded the presence or absence of lithiasis. For each study, a "yes" or "no" was recorded according to the possibility of establishing a diagnosis of choledocholithiasis.[6–8]

Statistical analysis

Once the research protocol was approved by the ethics committee of the Hospital de Clínicas (ref: Annex No. 2: Approval by the ethics committee of the Hospital de Clínicas).

A total of 155 patients qualified for inclusion in the study; however, after applying the exclusion criteria, 123 were finally included. The exclusion criteria were, first, the absence of laboratory test data for some patients and, second, evidence of another pathology not related to choledocholithiasis, but rather to neoplasms.

The data mentioned above in the methodology regarding the medical records were extracted using an electronic spreadsheet. Subsequently, statistical analysis was performed using the JASP program (v0.17).

The median and interquartile range (Q1-Q3) were used to describe the quantitative variables, as the variables did not have a normal distribution. For the same reason, the comparison between categories of quantitative variables was performed using the Mann-Whitney U test (a non-parametric alternative to the Student's t-test). Qualitative variables were described using their absolute and relative percentage frequencies, and comparisons between variables of this type were performed using the chi-square test or Fisher's exact test, in cases where the sample sizes were insufficient to apply the chi-square test.[9,10]

The p-value represents the probability of obtaining results equal to or more extreme than those observed, assuming that the null hypothesis (H0) is true. P-values less than 0.05 were considered significant. The results of patients who had been diagnosed with gallstones according to the CRM were compared. Based on these results, the sample was divided into two groups of variables.

On the one hand, the only quantitative variable corresponds to the age of the patients, where the Mann Whitney test was used to compare the medians of the results of yes (diagnosis of choledocholithiasis) with the median of the ages of the patients and no (no diagnosis of choledocholithiasis) from the MRC, with the median of each age according to the diagnosis. On the other hand, among the categorical variables, the only one to which the chi-square test was applied to compare proportions was the "sex" variable. For the rest of the categorical variables, the Z test was preferred. In relation to the sex variable, no statistically significant association was found with the diagnosis of choledocholithiasis.

Results

Table 1 Age of patients who underwent CABG in 2023.

	Total n = 123	No n = 94 (76.4%)	Yes n = 29 (23.6%)	p-value
Age (years), median (Q1–Q3)	48 (28 - 61)	48.5 (27.3 - 61)	46 (28 - 61)	0.777

No statistically significant differences were found for age between those who had choledocholithiasis and those who did not.

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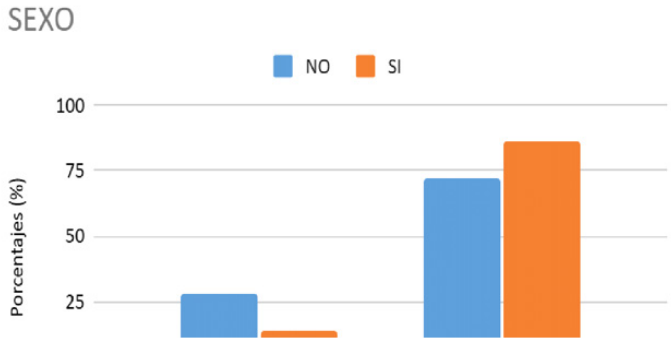
Table 2 Gender of patients who underwent RME in 2023

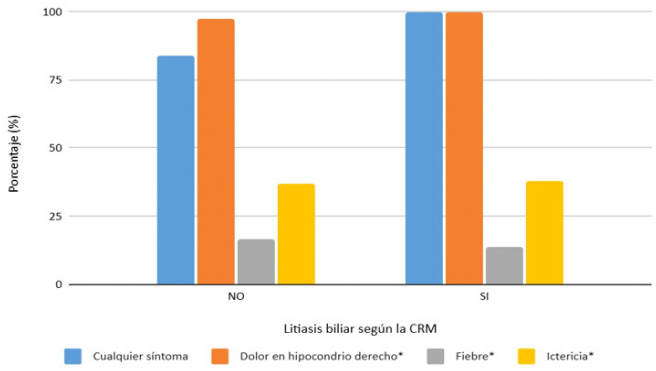
	Total n: 123	No LIT(V.B)	Yes LIT(V.B)	p-value
Gender				0.128
Male	30 (24.4)	26 (27.7)	4 (13.8)	
Female	93 (75.6)	68 (72.3)	25 (86.2)	

*The number of male patients is 30 (24.4%), of whom 26 tested negative (27.7%) and 4 tested positive (13.8%).

The number of female patients is 93 (75.6%), of whom 68 (72.3%) tested negative and 25 (86.2%) tested positive at diagnosis.

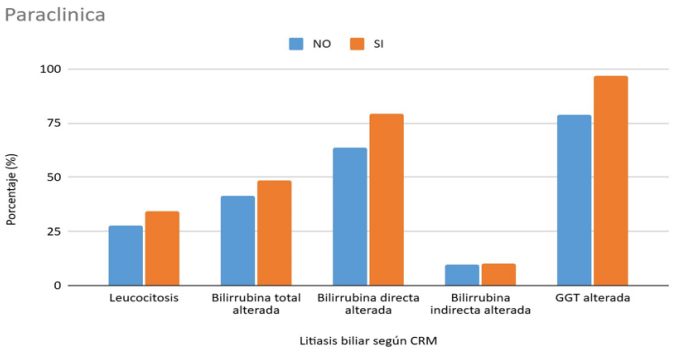


Graph 1 Sex of patients who underwent CRM in 2023.



Graph 2 Symptoms presented by patients who underwent CABG in 2023.

*Only the total number of patients who presented symptoms in general was statistically significant.



Graph 3 Laboratory results of patients who underwent CABG in 2023.

Table 3 Symptoms presented by patients who underwent CABG in 2023

	Total	No LIT(V.B)	Yes LIT(V.B)	p-Value
Symptoms	108 (87.8)	79 (84.0)	29 (100)	0.021
Right upper quadrant pain*	106 (98.1)	77 (97.5)	29 (100)	0.39
Fever*	17 (15.7)	13 (16.5)	4 (13.8)	0.728
Jaundice*	40 (37.0)	29 (36.7)	11 (37.9)	0.904

Table 4 Laboratory results of patients who underwent CABG in 2023.

Laboratory	Total (%)	No (Gallstones in CABG) n = 94 (76.4%)	Yes (Gallstones in CRM) n = 29 (23.6%)	Value P
Leukocytosis	36 (29.3)	26 (27.7)	10 (34.5)	0.478
Elevated total bilirubin	53 (43.1)	39 (41.5)	14 (48.3)	0.516
Altered direct bilirubin	83 (67.5)	60 (63.8)	23 (79.3)	0.119
Altered indirect bilirubin	12 (9.8)	9 (9.6)	3 (10.3)	0.904
Altered GGT	102 (82.9)	74 (78.7)	28 (96.6)	0.026

The only result that gave a significant p-value

Below, we describe the results of other previous imaging studies in the same patients. The results of the ultrasound and CT scan are compared with the results of the MRA.

Table 5 Results of the imaging studies of patients who underwent MRCP in 2023.

Study	Total (%)	No (Biliary tract stones CABG) n = 94 (76.4%)	Yes (VBP lithiasis CRM) n = 29 (23.6%)	Value P
Ultrasound	97 (78.9)	72 (76.6)	25 (86.2)	0.267
Biliary tract dilation**	15 (15.5)	10 (13.9)	5 (20.0)	0.465
Gallbladder stones**	3 (3.1)	2 (2.8)	1 (4.0)	0.764
Gallbladder lithiasis**	68 (70.1)	50 (69.4)	18 (72.0)	0.81
Tomography	51 (41.5)	38 (40.4)	13 (44.8)	0.674
Bile duct dilation***	23 (45.1)	12 (31.6)	11 (84.6)	<0.001
Gallbladder stones***	6 (11.8)	2 (5.3)	4 (30.8)	0.014
Gallbladder stones***	21 (41.2)	17 (44.7)	4 (30.8)	0.379
CRM				
Bile duct dilation	43 (35.0)	14 (14.9)	29 (100)	<0.001
Biliary tract stones	29 (23.6)	0 (0)	29 (100)	nd
Gallbladder lithiasis	78 (63.4)	58 (61.7)	20 (69.0)	0.478

*With regard to the p-value, the statistically significant value was less than 0.05 in the variable of dilation and lithiasis of the bile duct in the CT scan study and only dilation in the bile duct in the MRCP study.

A total of 51 patients underwent the CT scan. In addition, in CT and ECO we have two cases where there was lithiasis in the common bile duct and according to CRM there was not, these cases being possible false positives.

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We found statistically significant differences between the groups with bile duct dilatation and lithiasis in the CBD compared to those who had LB and did not have LB according to MRCP.

Evaluation of the sensitivity and specificity of MRCP compared to CT and US.

Since the results shown above do not conclusively demonstrate the relevance of MRCP, taking into account the results obtained from the medical records of the patients described above, the sensitivity and specificity of MRCP were calculated in relation to US and CT, taking MRCP as the gold standard.

Sensitivity and specificity are expressed as probabilities. Sensitivity is the probability that the study will detect whether the patient has the disease in question, as already mentioned. On the other hand, specificity is the probability that the diagnosis will be negative if the patient does not have the disease.[11,12]

Ultrasound compared to MR cholangiography

Table 6 Sensitivity and specificity for diagnosing gallbladder stones for ultrasound compared to MRCP.

		MRCP		
Lithiasis		LVB	No LVB	Total
VBP				
Ultrasound	T+	1	2	3
	T-	25	71	96
	Total	26	73	99
	Sensitivity = P(T+|LVB) = 1/26 = 3.85%			
	Specificity = P(T-|No LVB) = 71/73 = 97.3%			

Table 7 Sensitivity and specificity for diagnosing dilation in the PBV for ultrasound compared to MRC.

		CRM		
Dilation		**DVB**	**No DVB**	**Total**
VBP				
Ultrasound	T+	9	6	15
	T-	26	56	82
	Total	35	62	97
	Sensitivity = P(T+|DVB) = 9/35 = 25.7%			
	Specificity = P(T-|No DVB) = 56/62 = 90.3%			

Sensitivity was 3.85% for lithiasis in the common bile duct and specificity was 97.3%. For bile duct dilation on ultrasound, sensitivity was 25.7% and specificity was

90.3%

CT scan compared to MR cholangiography

Table 8 Based on choledocholithiasis.

		CRM		
VBP Lithiasis		**LVB**	**No LVB**	**Total**
Tomography	T+	4	10	14
	T-	2	36	38
	Total	6	46	52
	Sensitivity = P(T+|LVB) = 4/6 = 66.7%			
	Specificity = P(T-|No LVB) = 36/46 = 78.3%			

Table 9 Based on expansion.

		CRM		
Dilation		**DVB**	**No**	**Total**
VBP			DVB	
Tomography	T+	14	9	23
	T-	4	25	29
	Total	18	34	52
	Sensitivity = P(T+|DVB) = 14/18 = 77.8%			
	Specificity = P(T-|No DVB) = 25/34 = 74.5%			

In tomography for choledocholithiasis, sensitivity was 67.7% and specificity was 78.3%.

And dilation on CT had a sensitivity of 77.8% and a specificity of 74.5%.

Discussion

A comprehensive review of the current scientific literature was conducted, focusing on studies that consider magnetic resonance cholangiography (MRC) as the reference imaging method for the diagnosis of choledocholithiasis. Most of the studies found used ERCP as the gold standard, comparing this surgical approach with MRCP. For this reason, the originality and exclusivity of this study is noteworthy, as it considers MRCP as the gold standard, using ERCP only as a post-diagnostic surgical treatment.

The timely performance of MRCP before any surgical intervention is of utmost importance, as it allows for adequate preoperative mapping of the main bile duct, thus contributing to a reduction in patient morbidity and mortality. Although paraclinical studies and ultrasound are usually the first to be performed due to their accessibility and speed, MRCP provides superior diagnostic accuracy and is decisive in cases where clinical or imaging doubts persist.

First, once the data had been obtained and tabulated, the relationships between the variables were analyzed with the aim of reaching a common point, i.e., a positive diagnosis. Of the total of 123 MRIs considered in the study, 29 (23.6%) indicated a diagnosis of common bile duct stones. The size of the population analyzed was

smaller than initially expected due to the exclusion of patients with incomplete data (particularly those treated at other centers), as well as patients with unrelated pathologies who also required CABG. Most of the variables analyzed showed no significant association with the diagnosis, except for gender and GGT enzyme levels, which did show a significant relationship.

In terms of sex, of the 29 patients with a positive diagnosis, 25 (86.2%) were women and 4 (13.8%) were men (Table 2). This prevalence in women is highlighted in other articles reviewed. The article by Dr. Andrés Salon on gallstones, from the Faculty of Medicine, states that "most series show a prevalence in women of 5% to 20% between the ages of 20 and 55 and 25% to 30% at age 50".[4] Similarly, Dr. SN Singh's article discusses the higher prevalence of gallstone disease in females.[13]

It was statistically demonstrated that neither the symptoms (Table 3) nor the paraclinical findings (Table 4) are definitive indicators for a positive diagnosis of the disease, given that numerous patients presented abnormalities without being diagnosed with the disease.

Among patients with a positive diagnosis, 100% presented with pain in the right hypochondrium, 37.9% with jaundice, and 13.8% with fever. However, the isolated presence of these symptoms does not confirm choledocholithiasis, as they may be present in other pathologies. Therefore, it is essential to consider the set of symptoms together with the imaging studies performed before magnetic resonance cholangiography (MRC).[14]

With regard to GGT, a statistically significant difference was observed ($p = 0.026$; 78.7% vs. 96.6%). Several studies[14] have demonstrated a higher prevalence of choledocholithiasis in patients with elevated GGT levels, reinforcing its value as an indirect indicator of biliary obstruction. Although this enzyme can be altered in other liver diseases, its elevation together with normal bilirubin levels is associated with lithiasis, constituting an important preoperative finding that coincides with international parameters.

With regard to imaging methods, a significantly greater difference was observed in the results obtained from ultrasound and computed tomography compared to MRCP (**Table 5**). It should be noted that ultrasound was performed more frequently than tomography due to its low cost, wide availability in the service, and speed in obtaining results, in addition to not involving exposure to ionizing radiation.

When analyzing the data obtained in the ultrasounds, the presence of evaluator or observer bias was identified, which occurs when the experience, training, or expectations of the observer (in this case, the intern) influence the collection or interpretation of information. A less experienced observer may make mistakes due to a lack of clinical judgment, which can distort results or diagnoses.

As this is a university hospital, both the studies and the reports are carried out by doctors in training, who may make mistakes in interpreting the images or overlook certain aspects. Proper preparation of the patient is essential for the adequate evaluation of imaging studies; otherwise, the presence of intestinal gas can make it difficult to visualize stones in the bile duct, as well as detect various relevant signs that could go unnoticed. The timely identification of these signs helps to avoid unnecessary repetition of studies and the occurrence of false negatives.

The sensitivity and specificity of ultrasound depend on the operator, the characteristics of the image, and the preparation of the patient, so this method is considered an initial tool that guides the need to supplement with other diagnostic techniques.[14]

Time is critical from diagnosis by CMR to biliary drainage treatment, as the stone may migrate and not be detected, which can be interpreted as a false positive. This is evident in Table 5 above, where it can be seen that of the 51 patients who underwent tomography, only 6 tested positive. However, of these 6, only 4 had the same diagnosis in the MRCP, with the remaining 2 testing negative. The same is true for the ultrasound results: 3 results were positive for LB, and only 1 was positive in the MRCP. Because of this, according to the article,[1] it is explained that the MRCP should be performed 4 or 5 days after the patient's admission.

It can be said that there is no common ground between the variables to reach a positive diagnosis as a whole. The only way to diagnose gallstones is through MRCP. An attempt was made to generate a logistic regression model to find sets of predictor variables for gallstones in the main bile duct, but none achieved acceptable levels of discrimination. After evaluating the best way to approach the work, taking into account the data obtained, the sensitivity and specificity of ultrasound and tomography for the diagnosis of common bile duct stones were calculated in relation to MRCP.

Sensitivity values for ultrasound were obtained of 3.85% for lithiasis in the common bile duct and specificity was 97.3%. For bile duct dilation on ultrasound, sensitivity was 25.7% and specificity was 90.3%. For choledocholithiasis, CT had a sensitivity of 67.7% and a specificity of 78.3%. For dilatation, CT had a sensitivity of 77.8% and a specificity of 74.5%. As shown in the specificity and sensitivity table (**Table 6**), the accuracy of ultrasound was not optimal due to its low values; however, CT showed an improvement in these values, but they are still not representative.

Conclusion

No single clinical or laboratory indicator can accurately predict the presence of choledocholithiasis. It is necessary to consider the combination of signs, symptoms, biochemical parameters, and imaging studies prior to performing magnetic resonance cholangiography (MRC). There was a clear predominance of females among patients with a positive diagnosis of choledocholithiasis by MRCP, especially from middle age onwards, which is consistent with the findings reported in the literature. This trend reinforces the known epidemiological pattern, where the prevalence of the disease is higher in women, constituting a relevant risk factor to consider during the diagnostic process. The results obtained reinforce the idea that MRCP is indispensable and highly useful for the accurate diagnosis of common bile duct stones, particularly considering that neither clinical characteristics nor laboratory values allow adequate discrimination between positive and negative cases.

MRCP is the imaging method par excellence for assessing the anatomy of the common bile duct and its level of obstruction. When ultrasound and CT scans raise diagnostic doubts due to their low sensitivity and specificity, as demonstrated in this study, MRCP is used. This study could be useful for other researchers to investigate diagnostic protocols and criteria, and thus continue to deepen their understanding of the role of MR cholangiography. This remains an important topic of discussion in the field of health given the high morbidity and mortality of this pathology, as well as the costs associated with late diagnosis.

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Conflicts of interest

The authors declare no conflicts of interest. Approved by the Ethics Committee of Hospital de Clinicas Montevideo – Uruguay.

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