

# Comparison of Ultrasonographic Findings and Magnetic Resonance Cholangiopancreatography with Endoscopic Retrograde Cholangiopancreatography for the Diagnosis of Choledocholithiasis

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## Abstract

**Background:** Gall stones in the common bile duct are known as choledocholithiasis. It is composed of either bile pigment or calcium and cholesterol salts. The prevalence of choledocholithiasis is between 10% and 20%. The exact frequency and prevalence of choledocholithiasis are unknown. **Objective:** The main objective of this study is to present the comparative analysis of diagnostic accuracy of ultrasonography and Magnetic resonance cholangiopancreatography with endoscopic retrograde cholangiopancreatography for diagnosis of choledocholithiasis. **Methodology:** One hundred twelve cases of choledocholithiasis included were referred to the department of radiology district headquarter/teaching hospital Gujranwala during the period of 9 months. Ultrasound, MRCP and ERCP were performed. An informed consent to include their data with the assurance of confidentiality was obtained from patients. **Results:** In this study, during the 9-month study period, a total of one hundred twelve patients ranging in age from 18 years to 85 years old were included, with average age of 48.18 years  $\pm$  16.82 years. The studied patients were of both Genders, including 67 (59.8%) female, and male 45 (40.2%). Choledocholithiasis had been diagnosed in 28 cases (25%), 44 cases (39.3%) and 54 cases (48.2%) out of total of 112 cases on ultrasonography, MRCP, and ERCP, correspondingly. MRCP shows improved diagnostic accuracy and higher sensitivity (88.39% and 78.18%) than that of ultrasonography (72.32%, and 47.27%), correspondingly. MRCP had provided better visualization of distal CBD stone in 23.2% than that of ultrasonography 14.3%. MRCP has shown better diagnostic accuracy in identifying (31.3%) single CBD than that of ultrasonography 19.6%. **Conclusion:** MRCP can be replaced with invasive therapeutic procedures like ERCP and preferably used due to high diagnostic accuracy, and high sensitivity than that of ultrasonography for the diagnosis of choledocholithiasis ultrasonography is the initial choice for investigation of choledocholithiasis.

**Keywords:** MRCP; ERCP; Ultrasonography; CBD; Choledocholithiasis; Diagnostic accuracy

## Introduction

Gall stones in the common bile duct are known as choledocholithiasis. [1] It is made of bile pigment or calcium and cholesterol salts. [2] Stone formation can be caused by bile produced in the liver and retained in the gallbladder. [3] It is the most frequent complication of biliary lithiasis. [4] Choledocholithiasis most frequently arises when gallstones pass via cystic duct into CBD and stones rarely form in CBD itself. [5,6] The symptoms of common bile duct stones include

biliary pain, jaundice, cholangitis, and acute pancreatitis. [7] The prevalence of choledocholithiasis is ranged from 10%-20%. [8] The accurate incidence and prevalence of choledocholithiasis are

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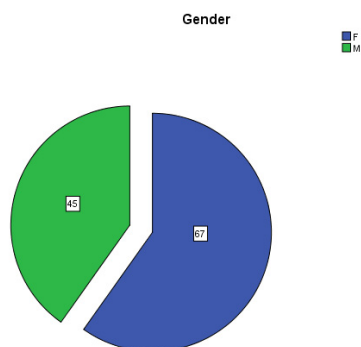
undetermined. <sup>[9]</sup> Choledocholithiasis is generally considered in patients who have elevated levels of serum albumin and alkaline phosphates. Obvious assessment is commonly gained by using the first choice ultrasonography. However, ultrasonography is very sensitive for choledocholithiasis. <sup>[10]</sup> Transabdominal ultrasound is taken as primary investigation in diagnosing biliary tract disease due to cost-effectiveness, easy availability. Magnetic resonance cholangiopancreatography is an excellent and non-invasive diagnostic technique for choledocholithiasis. It gives a complete picture of the biliary tract above and below the obstruction. Furthermore, no contrast agents are used in Magnetic resonance cholangiopancreatography. <sup>[2]</sup> Magnetic resonance cholangiopancreatography is an investigation without complication. <sup>[11]</sup> It is non invasive and precise for identifying choledocholithiasis. It has been demonstrated to have high specificity and sensitivity (over 90%) for choledocholithiasis diagnosis. <sup>[12]</sup> Ultrasound is widely accepted and used as the initial imaging technique after a clinical examination for a variety of reasons, including ease of use, rapidity, cost-effectiveness, the absence of contrast agent, and the absence of radiation exposure. Even though it is a basic diagnostic approach that examines the remarkable demonstration of the common hepatic duct and proximal common bile duct, the vision of the distal common bile duct and pancreas is one of the key limitations that are covered by covering bowel gas. <sup>[2]</sup> Magnetic resonance cholangiopancreatography is an excellent and noninvasive diagnostic technique for choledocholithiasis. It gives a complete picture of the biliary tract above and below the obstruction. Furthermore, no contrast agents are used in magnetic resonance cholangiopancreatography. So it is preferable for patients with allergy to materials containing iodine or with a history of atopic disease. Magnetic resonance cholangiopancreatography is an attractive alternative to diagnostic endoscopic retrograde cholangiopancreatography due to lower cost, absence of ionizing radiation, operator independence. <sup>[13]</sup> The problem state that accurate and safe diagnosis of choledocholithiasis has become a challenging task and usually, follow-up and invasive procedures are required. Using conventional radiography to discriminate biliary pathologies is often a very challenging task. Ultrasound and magnetic resonance cholangiopancreatography are noninvasive procedures that have shown increased sensitivity for the diagnosis of choledocholithiasis due to various advantages such as ease of availability, speed, cost benefits, no use of contrast dye, and lack of radiation exposure. It is preferable for patients who are allergic to certain materials. The study's goal is to evaluate the diagnostic accuracy of ultrasonography and MRCP for choledocholithiasis diagnosis utilizing sensitivity, specificity, positive predictive value, and negative predictive value, with Endoscopic retrograde cholangiopancreatography serving as the gold standard. The outcomes of my study will aid in the early and fast care of patients, as well as the more use magnetic resonance cholangiopancreatography. The purpose of this research is to provide a more precise and reliable diagnosis of choledocholithiasis by using noninvasive procedures like ultrasound and MRCP and to reduce complications related to invasive procedures like ERCP, unplanned procedures, unnecessary invasive exams and under treatment.

## Materials and Methods

After approval of synopsis from IRB, cross-sectional analytical study was done in the radiology, department, DHQ/ teaching hospital Gujranwala during the period of nine months from December 2019 to August 2020. Non-probability convenient sampling technique was used, all 112 cases of choledocholithiasis suspicious on clinical history and laboratory findings or imaging test referred to department of radiology DHQ/teaching hospital GRW, were taken after fulfilling the inclusion/exclusion criteria. Ultrasound, MRCP and ERCP was performed. Inclusion criteria were have patients of age 18 years-85 years and either gender, patients having signs and symptoms of obstructive jaundice as per operational definition with abnormal LFTs as per operational definition, and patients who fulfilling American society of gastrointestinal endoscopy criteria as per operational definition. Exclusion criteria were focused on patients with obstructive jaundice due to other causes like hepatobiliary or pancreatic malignancy or ascariasis etc., patients who are unfit for ERCP like patients with clotting disorders, severe cardiac and respiratory diseases and hypersensitivity to contrast agents, patients who are unfit for MRI like patients with cardiac pacemaker, claustrophobia, large patient size, patients with degenerative or ankylotic spine conditions. After approval of synopsis from IRB, cross sectional analytical study was done in radiology department, DHQ/teaching hospital Gujranwala. The qualitative variables like gender, presence of stone on ultrasound, stone appearance and location of stone on ultrasound, MRCP and ERCP and quantitative variables *i.e.* age, size of stones, no. of stones, diameter of CBD was recorded on data collection sheets as given in annex-I. All collected data was entered in SPSS (Statistical Package for Social Science) version 25.0. Analysis of data was done. The qualitative variables like gender, presence of stone on ultrasound, stone appearance and location of stone on ultrasound, MRCP and ERCP was presented in form of frequencies and percentages (%). Mean and standard deviation was calculated for quantitative variables *i.e.* age, size of stones, diameter of CBD. Qualitative data was represented by bar chart and pie chart. Histogram was used to represent quantitative data. Sensitivity, specificity, positive and negative predictive values of ultrasound and MRCP was calculated by taking ERCP as gold standard.

## Results

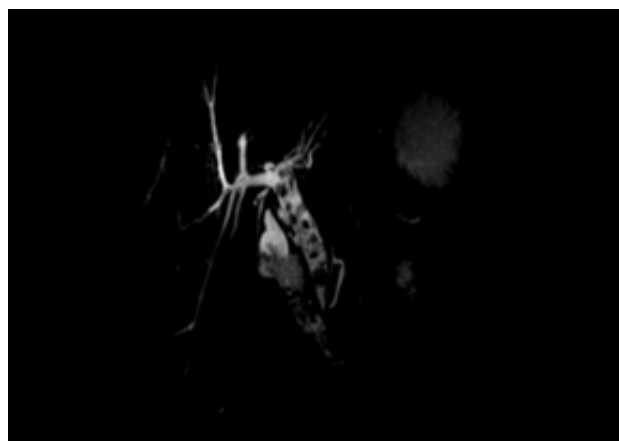
Total of one hundred twelve patients ranging in age from 18 years to 85 years old were included, with average age of 48.18 years  $\pm$  16.82 years. The studied Patients were of both genders, including 67 (59.8%) females and 45(40.2%) males out of a total of 112 who has involved shown in Figures 1-7. Ultrasonography and MRCP showed 19.6% and 31.3% single CBD stones, respectively as compared to ERCP (41.1%) and multiple CBD stones, 4.5% and 7.1%, as compared to ERCP (7.1%). Ultrasonography and MRCP showed 14.3% and 23.2% distal CBD stone, 4.5% and 5.4% middle CBD stone, 5.4% and 9.8% proximal CBD stones respectively as compared to ERCP (9.8% distal CBD stones, 4.5% middle CBD stones and 51.8% proximal CBD stone) on USG, MRCP and ERCP. Ultrasonography showed choledocholithiasis of 28 cases of



**Figure 1:** Graphic distribution of gender.



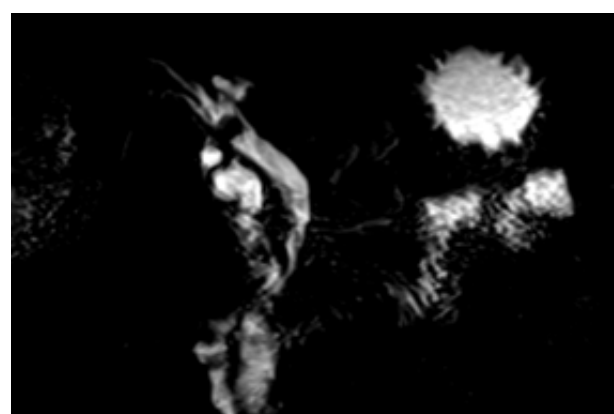
**Figure 2:** Multiple hyperechoic stone in common bile duct on USG.



**Figure 3:** Multiple void signals of CBD stone.



**Figure 4:** Single hyperechoic stone in common bile duct.



**Figure 5:** Single void signal of CBD stone.



**Figure 6:** Single hyperechoic stone in common bile duct.

which 26 cases were confirmed on ERCP, and ERCP did not show choledocholithiasis in 2 cases out of these 28 cases. Ultrasonography showed no choledocholithiasis in 84 cases out of 112 cases, but ERCP showed choledocholithiasis in 29 cases out of these 84 cases and no choledocholithiasis of 55 cases out of 84 cases. Choledocholithiasis had been seen in total 55 cases out of total of 112 cases, and no choledocholithiasis had been seen in total of 57 cases out of 112 cases on ERCP. There were total of 28 cases with choledocholithiasis seen, and 84 cases without choledocholithiasis on ultrasonography shown in Table 1. Ultrasonography has a sensitivity of 47.27% (95% CI=33.6% to 61.20%), a specificity of 96.49% (95% CI=87.89% to 99.57%), a positive predictive value of 92.86% (95% CI=76.41% to 98.12%), a negative predictive value of

65.48% (CI=59.51% to 70.99%), and an accuracy of 72.32% (95% CI=63.07% to 80.36%) shown in Table 2.

57 cases without choledocholithiasis were confirmed on ERCP out of 112 cases. There was of 44 cases with choledocholithiasis and 68 cases without choledocholithiasis were diagnosed on MRCP out of a total 112 shown in Table 3. MRCP has a sensitivity of 78.18% (95% CI=64.99% to 88.19%), a specificity of 98.25% (95% CI=90.61% to 99.96%), a positive predictive value of 97.73% (95% CI=85.98% to 99.67%), a negative predictive value of 82.35% (95% CI=73.86% to 88%) and an accuracy of 88.39% (95% CI=80.97% to 93.67%) shown in Table 4.

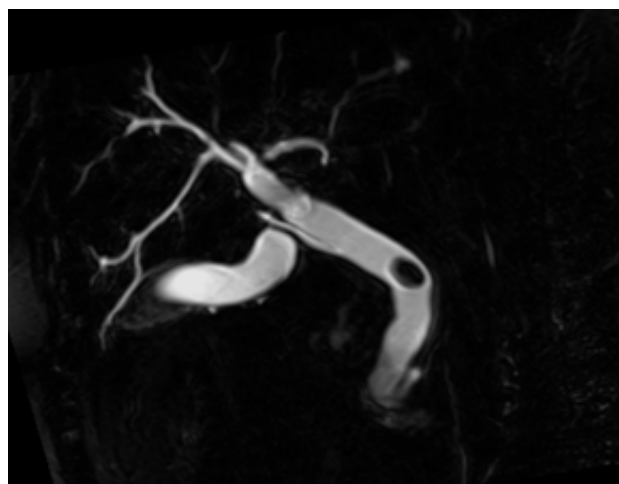


Figure 7: Showed void signals in common bile duct.

Table 1: USG results versus ERCP results.

		ERCP results		Total
		Present	Absent	
USG results	Present	26	2	28
	Absent	29	55	84
Total		55	57	112

Table 2: Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasonography.

Statistic	Value	95% CI
Sensitivity	47.27%	33.65% to 61.20%
Specificity	96.49%	87.89% to 99.57%
Positive Predictive Value (*)	92.86%	76.41% to 98.12%
Negative Predictive Value (*)	65.48%	59.51% to 70.99%
Accuracy (*)	72.32%	63.07% to 80.36%

Table 3: USG results versus ERCP results.

		ERCP results		Total
		Present	Absent	
MRCP results	Present	43	1	44
	Absent	12	56	68
Total		55	57	112

Table 4: Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRCP.

Statistic	Value	95% CI
Sensitivity	78.18%	64.99% to 88.19%
Specificity	98.25%	90.61% to 99.96%
Positive Predictive Value (*)	97.73%	85.98% to 99.67%
Negative Predictive Value (*)	82.35%	73.86% to 88.51%
Accuracy (*)	88.39%	80.97% to 93.67%

There were 84 cases (75%) out of total of 112 cases that were not diagnosed with choledocholithiasis on ultrasound, involving 47 cases (70.1%) in females and 37 cases (82.2%) in males. There were 28 cases (25%) out of total of 112 cases that were diagnosed with choledocholithiasis on ultrasonography involving 20 cases (29.9%) in females and 8 cases (17.8%) in males. There were 68 cases (60.7%) out of total of 112 cases that were not diagnosed with choledocholithiasis on MRCP involving

37 cases (55.2%) in females, and 31 cases (68.9%) in males. There were of 44 cases (39.3%) out of total of 112 cases that were diagnosed with choledocholithiasis on MRCP involving 30 cases (44.8%) in females and 14 cases (31.1%) in males. There were 57 cases (50.9%) out of total of 112 cases that were not diagnosed with choledocholithiasis on ERCP, involving 29 cases (43.3%) in females and 28 cases (62.2%) in males. There were 55 cases (49.1%) out of total of 112 cases that were diagnosed with choledocholithiasis on ERCP, involving 38 cases (56.7%) in females and 17 cases (37.8%) in males.

## Discussion

Choledocholithiasis results in life threatening problems. The majority of choledocholithiasis is spontaneously transferred to the duodenum. If this transition does not follow, ampullary bulb will be blocked and clinical conditions will occur, such as bile pancreatitis, mechanical jaundice and cholangitis. [14-16] A second study in the kathmandu medical journal by Karki et al. found that techniques commonly used include ultrasound, computed tomography, magnetic resonance cholangiopancreatography, endoscopic retrograde cholangiopancreatography, and transhepatic cholangiography. Invasive methods such as Endoscopic Retrograde Cholangio Pancreatography (ERCP) and trans-hepatic cholangiography were primarily based on the operator's skills, and were associated with high complications. However, ultrasound has been chosen as a first method because to its low cost, convenience of use, and non-invasive nature. [17] This prospective study was conducted in 112 patients in district headquarters/department of teaching hospital, Gujranwala, for clinical and diagnostic application diagnostic accuracy for ultrasound, magnetic resonance cholangiopancreatography and endoscopic retrograde cholangiopancreatography.

Jeon et al. revealed in a study in the journal gut and liver in 2017 that magnetic resonance cholangiopancreatography had lately acquired popularity. The overall sensitivity was 0.83 in a meta-analysis of five randomized studies. Aggregated specificity of MRCP was 0.93. The aggregated positive predictive value of magnetic resonance cholangiopancreatography was 0.87 and negative predictive value of magnetic resonance cholangiopancreatography was 0.92. [18] It is concordance to our study results. Positive predictive value was assessed to be 90% by Rahayu et al., Maharana et al., Yueniwati et al. Negative predictive value was evaluated to be 75% by Rahayu et al., Maharana et al., and Yueniwati et al. [19] It is similar to our study results. Ultrasonography was reported to be 72.5% successful in detecting Common Bile Duct (CBD) in a report published by Farrukh et al. According to this study; ultrasound had a 90% positive predictive value, and a 75% negative predictive value in finding stones in the biliary channel. [19] It is close our study findings. Samanta et al., Sarkar et al. and Bakshi et al. carried out a prospective, hospital-based, comparative, cross-sectional study. From March 2018 to August 2019, 130 patients with a mean age attended OPD at BSMCH medical college's general surgery department. There were 41 men and 89 women among the total of 130 participants. Choledocholithiasis was shown to be more common in females. At the time of the presentation, the average age of the participants was 49.27, 27 years  $\pm$  10.60 years. It is concordance our study, in our study, 112 patients



were included mean age 48.1786 years  $\pm$  16.82138 years for duration of 9 months. The studied patients were of both genders, including 67 females and 45 males. In this review study, ultrasonography was used to identify CBD stones in 57 individuals (43.84%). MRCP, on the other hand, detected CBD stones in 112 individuals (86.15%). While in our study, 28 cases (25%) had been diagnosed with choledocholithiasis on ultrasonography, and 44 cases (39.3%) had been diagnosed with choledocholithiasis on MRCP out of total of 112 cases. USG has 49.12% sensitivity. The specificity of ultrasonography is 93.75%. Results of this correlational study are similar to our study. The sensitivity and specificity of ultrasonography for the diagnosis of choledocholithiasis were calculated to be 47.27% (33.65% to 61.20%) and 92.86% (87.89% to 99.57%). Many studies have revealed that the accuracy of USG in finding CBD stone ranges from 20% to 80%. USG has a sensitivity of 49.12% and a specificity of 93.75%. The accuracy of MRCP was determined to be 95.38% in the review study. The majority of large research discovered 81%-100% sensitivity of MRCP. The accuracy of MRCP was estimated 89%-100% for the evaluation of choledocholithiasis. The specificity of MRCP was determined to be 87.500%. In this review analysis, the positive predictive value of MRCP was 98.214. In our study, the specificity and positive predictive value of magnetic resonance cholangiopancreatography were 98.25% (95% CI: 90.61% to 99.96%) and 97.73% (95% CI: 85.98 % to 99.67%) correspondingly. [20] These results of this review study are in concordance with our study results. The accuracy of MRCP in our study is found to be 88.39%. The sensitivity and accuracy are ranged from 64.99 % to 88.19%, with a 95% confidence interval and 80.97% to 93.97%, correspondingly. According to our findings, the sensitivity of magnetic resonance cholangiopancreatography was 78.18 percent (95% CI: 64.99% to 88.19%), the specificity was 98.25% (95% CI: 90.61% to 99.96%), the positive predictive value was 97.73% (95% CI: 85.98% to 99.67%), and the negative predictive value was 82.35% (95% CI: 73.86% to 88.51%).

In a review research conducted by Kushwah et al., Jain et al., Agarwal et al. and Tomar et al. showed the difficulty in imaging the distal CBD and pancreatic region was primarily owing to interference by intestinal gases, which reduced sonography's diagnostic performance. Vicary et al. made similar observations, assuming that limitations in the sonographic evaluation of the distal biliary tree and pancreas were linked to intestinal gases in addition to the operator's experience. MRCP was shown to be preferable to ultrasonography in evaluating the site of common bile duct stones. When compared to MRCP and ERCP, ultrasonography successfully identified CBD stones in (41%) of 16/39 cases. On ultrasonography and MRCP, the distal CBD stone was found in (67%) 26 cases and 39 cases respectively. As a consequence, when compared to ERCP, the capability of MRCP to define the presence of CBD stone is stronger. [21] Goud, Devi, Kale, Lakshmi and Reddy conducted a co-relational analysis and determined that MRCP had a diagnosis accuracy of 97.2%. MRCP has 96.5% specificity and an 88.8% Positive Predictive Value (PPV). The sensitivity, specificity, and positive predictive value of USG, respectively, were 50%, 96.4%, and 80.5%, respectively. This study's findings are comparable to

ours. The review study agreed with Soto et al work, which revealed a specificity of 100% for detecting biliary calculi in MRCP. Stephan et al researches the sensitivity of MRCP in identifying CBD calculus was found to be 87%. In their review study, Goud et al., Devi et al., Kale et al., Lakshmi et al. and Reddy et al. discovered that USG has 43.2% sensitivity in identifying CBD calculi, which is consistent with our findings. In 9 patients, USG had difficulties detecting distal CBD calculus, which was clearly detected with MRCP with 100% accuracy. It is similar to the findings of our investigation; thus, when it comes to seeing the location of common bile duct stones, MRCP has been demonstrated to be superior to ultrasonography. As a result, MRCP has a better ability to locate the level of CBD stone than ERCP. [22]

Al-Obaid et al., Al-Hilli et al. and Fadhel et al. conducted a review study and found 37.9%, sensitivity and 96.2% specificity of ultrasonography. They had estimated 77.2% accuracy. Our study results are comparable to this study. [23] The specificity, positive predictive values, negative predictive values, and diagnostic accuracy in choledocholithiasis diagnosis were 97.5%, 90.9%, 98.7%, and 97%, accordingly, in a review report. It is comparable to our study results. [24] While USG had challenges diagnosing distal CBD calculi; MRCP had no trouble identifying them.

In our study, 112 cases were included during the study period of 9 months from 18 years to 80 years with mean age 48.1786 years  $\pm$  16.82138 years. The studied patients were of both gender, including 67(59.8%) females and males 45(40.2%) out of total 112 cases. MRCP is more sensitive than ultrasonography and shows almost similar results like ERCP. Choledocholithiasis has been diagnosed in 28 cases (25%), 44 cases (39.3%) and 54 cases (48.2%) out of the total 112 cases on ultrasonography, MRCP, and ERCP, respectively. MRCP shows better sensitivity (78.18%) and diagnostic accuracy (88.39%) as compared to that of ultrasonography 47.27% and 72.32%, respectively. As a result, MRCP has been shown to be more effective than ultrasonography in determining the location and number of common bile duct stones. CBD stones has been seen in 16 cases (16%) in distal CBD, 5 cases (4.5%) in middle CBD and 6 cases (5.4%) in proximal CBD with 4.5% multiple CBD stones and 19.6% single CBD stone on ultrasonography. While MRCP shows CBD stone in 26 cases (23.2%) in distal CBD stone, 6 cases (5.4%) in middle CBD stone, and 11 cases (9.8%) in proximal CBD stone with 7.1% multiple CBD stones and (31.3%) a single CBD stone on MRCP. MRCP findings are similar to ERCP findings. There are 39 cases (34.8%) with distal CBD stone, 5 cases (4.5%) with middle CBD stone and 10 cases (8.9%) with proximal CBD stone on ERCP with 7.1% with multiple stone and 41.1% with single stone on ERCP. As a result of its excellent diagnostic accuracy (88.39%) and sensitivity, MRCP can substitute invasive treatment procedures such as ERCP for the assessment of choledocholithiasis (78.18%). While ERCP is considered ideal procedure, it is therapeutic procedure with a high rate of complications. Ultrasound is generally accepted and performed as the first choice imaging technique after clinical examination. Although it is a basic diagnostic tool that examines the outstanding demonstration of the common hepatic duct and proximal common bile duct,

one of the significant limitations that are masked by overlying bowel gas is the vision of the distal common bile duct and pancreas. Nevertheless MRCP is a preferable modality and more reliable modality due to high diagnostic and sensitivity as compared to ultrasonography. Magnetic resonance cholangiopancreatography is non-invasive diagnostic technique and provides a complete picture of the biliary tract above and below the obstruction. Furthermore, no contrast agents are used in MRCP. Instead of ERCP, MRCP can be utilized to diagnose of choledocholithiasis due to lower cost, absence of ionizing radiation, operator independence. MRCP has a high sensitivity, specificity, positive predictive value, negative predictive value, and accuracy (78.18%, 98.25%, 97.73%, 82.35%, and 88.39%, correspondingly when compared to ultrasonography for the diagnosis of choledocholithiasis (47.27%, 96.49%, 92.86, 65.48%, and 72.32 % correspondingly).

## Conclusion

MRCP can be replaced invasive therapeutic procedure like ERCP and preferably used due to high diagnostic accuracy and high sensitivity, as compared to ultrasonography for the diagnosis of choledocholithiasis. When compared to ultrasonography, MRCP has been proven to be more precise in determining the location and number of common bile duct stones. Ultrasonography is the initial choice for the investigation of choledocholithiasis.

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