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Diagnostic Value of Magnetic Resonance Cholangio-Pancreatography for Common Bile Duct Stone Identification

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ABSTRACT

Introduction: Magnetic Resonance Cholangio-Pancreatography (MRCP) is a non-invasive radiological investigation which can be performed rapidly and which does not expose the patients to ionised radiations or iodinated contrast material. The present study was conducted to evaluate the role of MRCP in detection of Common Bile Duct (CBD) stones in patients with suspected choledocholithiasis.

Material and Methods: This prospective study included 30 patients with a suspicion of choledocholithiasis which was based on clinical evaluation, biochemical or radiological investigations. Ultrasonography and MRCP were performed in all patients. All patients underwent open surgery. CBD exploration was performed in all patients, either due to presence of palpable stones or due to the presence of dilated CBD (> 7 mm). Demonstration of CBD stones intra-operatively was considered the 'gold standard'.

Results: Intra-operatively, 21 (70%) out of 30 patients had cholelithiasis. 26 (86.67%) had dilated CBD. In 20 (66.67%) patients, choledocholithiasis was detected. Sensitivity, specificity, positive predictive value and negative predictive value of ultrasonography were 65%, 60%, 76.47% and 46.15%. For MRCP they were 95%, 90%, 95% and 90% respectively.

Conclusions: MRCP is non-invasive and highly accurate in detection of CBD stones. It should be performed in all suspected cases where facilities and expertise are available.

I. INTRODUCTION

Cholelithiasis is the most common biliary pathology. The incidence of choledocholithiasis in patients with cholelithiasis varies between 5–15%, out of which 5% are asymptomatic [1]. Though CBD stones may be silent, complications such as cholangitis and acute pancreatitis increase morbidity and mortality, therefore detection and treatment are mandatory.

Diagnosis is based on clinical suspicion (biliary colic, jaundice, cholangitis), biochemical tests (raised conjugated bilirubin, ALP), and imaging. However, none alone is completely reliable [2].

Intra-operative cholangiography detects CBD stones with high sensitivity (98%) and specificity (100%) but is invasive and increases cost and operative time [3].

Endoscopic Retrograde Cholangio-Pancreatography (ERCP) is accurate and therapeutic but carries 1% mortality and 7% morbidity [1], and is difficult after surgeries such as Billroth-II gastrectomy and hepatico-enterostomy.

MRCP is replacing ERCP as a diagnostic tool for benign biliary obstruction and chronic pancreatitis. It is non-invasive, requires no contrast, provides high soft-tissue resolution, and avoids ionising radiation. The present study evaluates the role of MRCP in detecting CBD stones in suspected cases.

II. MATERIAL AND METHODS

A prospective study of 30 patients (July 2024–January 2025) after ethics approval. Informed consent was obtained.

Inclusion criteria (any of the following):

1. **History/presence of:**
   - Intermittent jaundice
   - Cholangitis: fever (>37.3°C), chills, RUQ pain, leucocytosis
   - Post biliary pancreatitis (within 2 months)
2. **Post cholecystectomy syndrome**
3. **Biochemistry:**
   - Total bilirubin > 1.2 mg/dL
   - ALP > 220 IU/L
4. **Ultrasound:**
   - CBD > 7 mm
   - Suspected/diagnosed CBD stones

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Exclusion: obstructive jaundice due to pancreatic cancer, periampullary carcinoma, strictures, cholangiocarcinoma etc.

Clinical Evaluation
Full history, exam, CBC, LFTs.

Ultrasound Equipment

Ultrasonography was performed using a **Philips Affiniti 70G** system equipped with standard abdominal transducers. A curvilinear probe (3.5–5 MHz) was utilised for all hepatobiliary evaluations. Scans were obtained in longitudinal, transverse, and oblique planes after an adequate fasting period to reduce bowel gas interference and optimise biliary tract visualisation.

MRI Equipment

MRCP Imaging was performed on 1.5-T Siemens Sempra and GE SIGNA systems available at the institution:

Both scanners employed phased-array body coils. The imaging protocol included heavily T2-weighted sequences, multi-planar SSFE and SSE acquisitions, and 3D MRCP sequences with maximum intensity projection (MIP) reconstructions.

Imaging parameters (slice thickness, breath-hold technique, free-breathing T2 sequences) were standardised across both machines to maintain diagnostic uniformity.

Radiographs were interpreted by a radiologist. All patients were followed for complications.

III. RESULTS

Thirty patients were included, ranging from 26 to 79 years of age (mean 55 years). Individuals older than 50 years formed the majority (60%). Females accounted for 18 cases (60%), while 12 were males (40%), producing a female-to-male ratio of 1.5:1.

Upper abdominal pain remained the most frequent presenting feature, reported by 28 patients (93.3%). Dyspeptic symptoms were noted in 22 patients (73.3%). Twelve patients (40%) gave a history of intermittent jaundice, and a smaller proportion described pale stools (20%) or pruritus (16.7%). Fever with chills was documented in four cases. Four patients had undergone cholecystectomy previously, and five had a history suggestive of past cholangitis.

Biochemical Findings

Abnormal liver enzymes were observed in a large proportion of patients. Elevated ALP was the most consistent abnormality (70%), followed by increases in AST (56.7%) and ALT (50%). Hyperbilirubinemia occurred in roughly one-third of patients. Leucocytosis was present in eight individuals (26.7%).

Ultrasonography and MRCP Findings

Ultrasound identified gallbladder stones in 20 patients (66.7%) and suggested choledocholithiasis in 12 (40%). CBD dilatation was recorded in 22 patients (73.3%).

MRCP demonstrated cholelithiasis in 21 patients (70%) and revealed CBD stones in 18 patients (60%). Dilatation of the CBD was observed in 24 patients (80%).

Operative Findings

Intra-operative assessment confirmed gallstones in 22 individuals (73.3%). CBD dilatation was evident in 25 patients (83.3%), and CBD calculi were removed or visualised in 19 cases (63.3%). The prevalence of confirmed choledocholithiasis was highest in the population older than 50 years.

Diagnostic Accuracy
Using operative findings as the reference, the diagnostic parameters for ultrasound were:
• Sensitivity 63%
• Specificity 58%
• PPV 73%
• NPV 45%
For MRCP, the following values were obtained:
• Sensitivity 94%
• Specificity 88%
• PPV 94%
• NPV 88%

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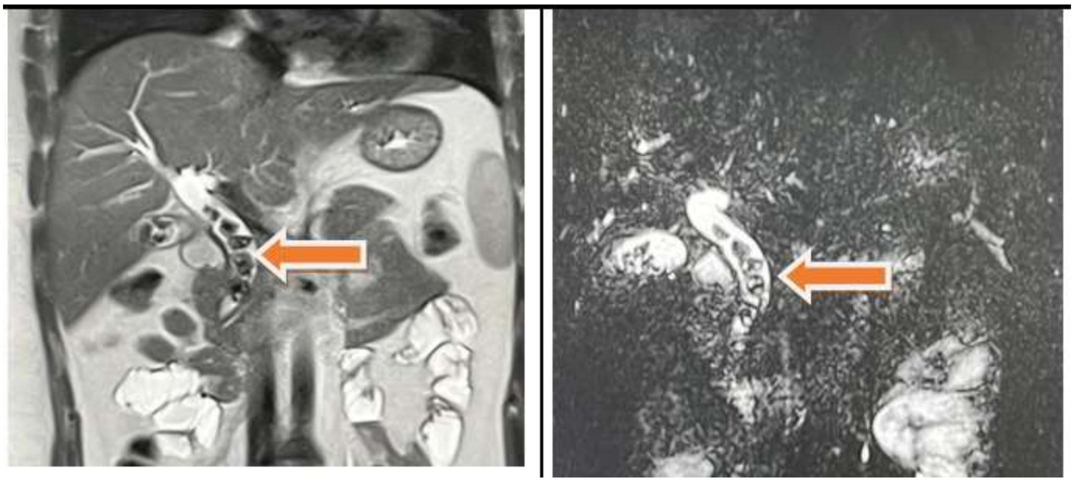

Figure 1
CORONAL T2 SSFE AND 3D MRCP showing multiple filling defects in a dilated CBD suggestive of choledocholithiasis.

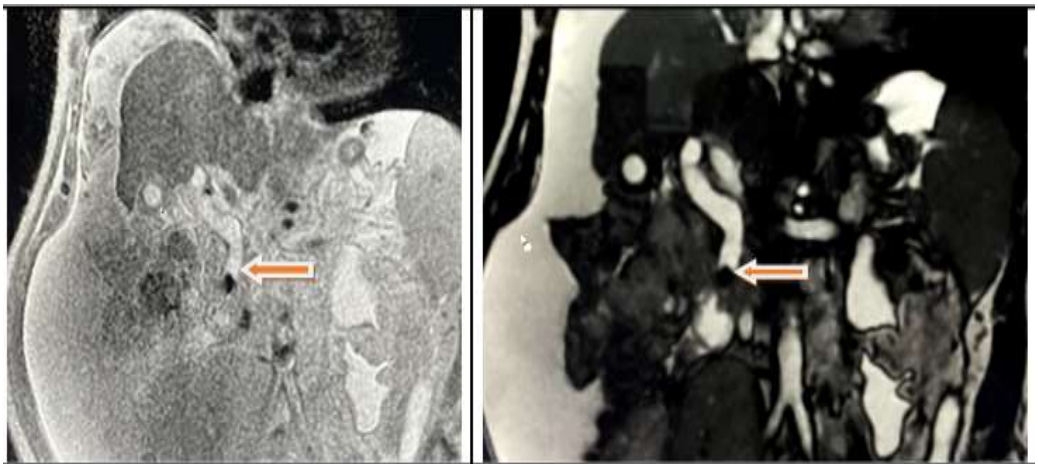

Figure 2.
CORONAL T2 SSFE AND CORONAL FIESTA showing single filling defect in a distal CBD causing proximal biliary dilatation.

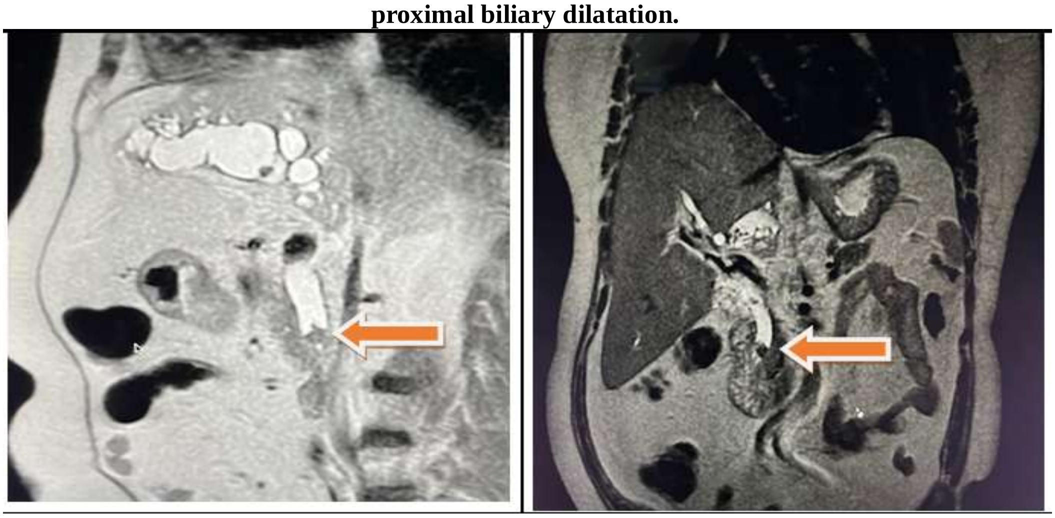

Figure 3
SAGGITAL SSFE AND CORONAL SSFE showing single filling defect in a distal CBD causing proximal biliary dilatation

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Table 1. Age–Sex Distribution of Study Participants

Age Group (years)	Male (n)	Female (n)	Total (n)	Percentage (%)
<30	2	2	4	13.3
30–50	3	5	8	26.7
>50	7	11	18	60.0
Total	**12**	**18**	**30**	**100**

Comment:

Most patients presenting with suspected choledocholithiasis were above 50 years of age, consistent with the known increase in biliary stone disease with advancing age. The slight female predominance also aligns with the established higher rate of gallstone disease in women.

Table 2. Chief Clinical Complaints

Symptom	Number of Patients	Percentage (%)
Upper abdominal pain	28	93.3
Dyspepsia	22	73.3
Intermittent jaundice	12	40.0
Clay-coloured stools	6	20.0
Pruritus	5	16.7
Fever with chills	4	13.3

Comment:

Pain and dyspeptic symptoms dominated the clinical presentation, reflecting partial or intermittent biliary obstruction. Only a minority exhibited classic obstructive features such as pale stools and pruritus.

Table 3. Pattern of Biochemical Abnormalities

Parameter (Normal Range)	Abnormal Range	Number (n)	Percentage (%)
TLC (4,000–11,000/mm³)	11,200–15,100	8	26.7
Serum Bilirubin (0.1–1.2 mg%)	4.2–16.8	9	30.0
Serum ALP (20–230 IU/L)	240–2250	21	70.0
Serum ALT (10–43 IU/L)	48–210	15	50.0
Serum AST (10–36 IU/L)	41–230	17	56.7
Serum Amylase (0–175 IU/L)	190–540	3	10.0

Comment:

ALP emerged as the most frequently deranged parameter, supporting its role as a sensitive marker of biliary obstruction. Isolated enzyme elevation without jaundice was not uncommon, emphasizing that stone disease may precede overt cholestasis.

Table 4. Comparative Findings on USG and MRCP

Imaging Finding	USG n (%)	MRCP n (%)
Normal Study	7 (23.3%)	6 (20.0%)
Cholelithiasis	20 (66.7%)	21 (70.0%)
Choledocholithiasis	12 (40.0%)	18 (60.0%)
Dilated CBD (>7 mm)	22 (73.3%)	24 (80.0%)

Comment:

MRCP consistently outperformed ultrasonography, particularly in the detection of CBD stones and ductal dilatation. These differences are clinically significant because USG frequently misses distal CBD pathology due to overlying bowel gas.

Table 5. Intra-operative Findings by Age Group

Age Group	Normal n (%)	Cholelithiasis n (%)	CBD Stones n (%)	Dilated CBD n (%)
<30	1	3	1	3
30–50	1	4	3	5
>50	2	15	15	17
Total	**4 (13.3%)**	**22 (73.3%)**	**19 (63.3%)**	**25 (83.3%)**

Comment:

The burden of both gallbladder and CBD stones was disproportionately higher in older individuals. Nearly all patients above 50 years demonstrated some degree of ductal abnormality, reinforcing age as a strong clinical predictor.

Table 6. Correlation of Clinical, Biochemical, and Imaging Tests With Operative Findings

Variable / Test	Cholelithiasis (%)	CBD Stones (%)	Dilated CBD (%)
Pain	21 (95.4%)	16 (84.2%)	23 (92%)
Jaundice	4 (18.1%)	8 (42.1%)	10 (40%)
ALP > 220 IU/L	11 (52.3%)	12 (63.1%)	18 (72%)
USG	20 (90.9%)	12 (63.1%)	22 (88%)
MRCP	21 (95.4%)	18 (94.7%)	24 (96%)

Comment:

Among clinical findings, pain had very high sensitivity but poor specificity. Biochemistry added moderate predictive value. MRCP had the strongest correlation with surgical outcomes, reinforcing its diagnostic reliability.

Table 7. Diagnostic Accuracy of USG and MRCP (Using Surgery as Gold Standard)

Modality	Sensitivity	Specificity	PPV	NPV
MRCP	94%	88%	94%	88%
USG	63%	58%	73%	45%

Comment:

MRCP clearly demonstrated superior diagnostic performance across all parameters, particularly PPV and NPV. The relatively low NPV of ultrasound highlights its limitations as a stand-alone diagnostic test for CBD stones.

IV. DISCUSSION

MRCP provides an accurate diagnosis of CBD stones; however, its exact preoperative role is still debated. Some recommend MRCP only for moderate-risk patients [4,5], others recommend MRCP for both high- and moderate-risk patients while reserving ERCP for therapeutic purposes [6].

Clinical predictors alone had poor diagnostic accuracy. Age >50 had modest sensitivity (55%), specificity (80%), PPV (84.62%) and NPV (47.06%). Female sex had even poorer predictive power.

Raised serum ALP was the most sensitive biochemical marker (65%), with specificity 40%. Literature shows ALP often predicts choledocholithiasis better than bilirubin [9–11].

Ultrasonography is the initial imaging modality, but its sensitivity is variable (20–80%) [12–15]. Poor visualisation of distal CBD due to bowel gas and lack of bile pooling explains lower performance.

MRCP is non-invasive, accurate and fast. Reported sensitivity ranges 81–100%, specificity 85–100% [16–20]. Single-shot half Fourier sequences enhance detection. Small stones or intrahepatic stones may be missed [21]. MIP reconstructions can obscure small filling defects; source images are essential.

MRCP cannot provide therapy; if ERCP is needed afterward, it may represent an extra step.

V. CONCLUSION

MRCP is an excellent primary tool for detecting CBD stones before cholecystectomy. In this study, MRCP avoided invasive procedures in 90% of patients where suspicion was high but stones were absent. MRCP provides high diagnostic accuracy, avoids ERCP complications, and should be used whenever available. Ultrasound remains the initial screening modality.

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