



## OPEN ACCESS

### EDITED BY

Jiayu Yan,  
Capital Medical University, China

### REVIEWED BY

Levent Karakaş,  
Gaziosmanpaşa Training and Research  
Hospital, Türkiye  
Sukanya B.,  
Nizam's Institute of Medical Sciences,  
India  
Tarek Ibrahim,  
Fayoum University, Egypt

### \*CORRESPONDENCE

Zhipeng Zhou  
✉ bigbird\_zhou@hotmail.com

RECEIVED 03 December 2025

REVISED 02 February 2026

ACCEPTED 26 February 2026

PUBLISHED 09 March 2026

### CITATION

Xiao X, Shi X, Zhang Y, Li L and  
Zhou Z (2026) The application value of  
preoperative magnetic resonance  
cholangiopancreatography in predicting  
the success of endoscopic retrograde  
cholangiopancreatography stone  
removal.

*Front. Med.* 13:1759986.

doi: 10.3389/fmed.2026.1759986

### COPYRIGHT

© 2026 Xiao, Shi, Zhang, Li and Zhou.  
This is an open-access article distributed  
under the terms of the [Creative  
Commons Attribution License \(CC BY\)](#).  
The use, distribution or reproduction in  
other forums is permitted, provided the  
original author(s) and the copyright  
owner(s) are credited and that the  
original publication in this journal is  
cited, in accordance with accepted  
academic practice. No use, distribution  
or reproduction is permitted which does  
not comply with these terms.

# The application value of preoperative magnetic resonance cholangiopancreatography in predicting the success of endoscopic retrograde cholangiopancreatography stone removal

Xuhua Xiao<sup>1</sup>, Xiaoguang Shi<sup>1</sup>, Yan Zhang<sup>2</sup>, Linzhen Li<sup>2</sup> and  
Zhipeng Zhou<sup>3\*</sup>

<sup>1</sup>Departments of Gastroenterology, The Affiliated Hospital of Guilin Medical University, Guilin, China,

<sup>2</sup>Departments of Gastroenterology, First Affiliated Hospital of Wannan Medical College, Wuhu, Anhui  
Province, China, <sup>3</sup>Department of Radiology, The Affiliated Hospital of Guilin Medical University, Guilin,  
Guangxi, China

**Background and purpose:** Common bile duct stones (CBDS) are a common disease. Endoscopic retrograde cholangiopancreatography (ERCP) is currently recognized as the preferred treatment method for CBDS. However, there are cases that cannot be removed through ERCP. Therefore, the aim of this study is to explore the value of magnetic resonance cholangiopancreatography (MRCP) in assessing the success of CBDS removal through ERCP.

**Patients and methods:** A total of 432 CBDS patients were include in this study. According to whether the stone removal was successful in ERCP, the patients were divided into the successful stone removal group and the failed stone removal group. The differences in MRCP-related parameters between the two groups were analyzed.

**Results:** This multi-center study included a total of 175 male CBDS patients and 257 female CBDS patients. A total of 395 CBDS patients successfully removed stones through ERCP, with a success rate of 91.44%. There were significant differences in the stone diameter ( $p < 0.001$ ), the widest diameter of the CBD ( $p < 0.001$ ), and the widest diameter of the CBD/stone diameter ( $p < 0.001$ ) between success group and failure group. But, there was no significant difference in the number of single stone patients ( $p = 0.174$ ). Binary multivariate logistic regression analysis revealed that only stone diameter  $>15$  mm was significantly associated with ERCP stone extraction failure (OR = 11.229, 95% CI: 1.576–80.033,  $p = 0.016$ ). ROC curve analysis demonstrated that this cutoff value had excellent predictive performance, with an area under the curve (AUC) of 0.94, a maximum Youden's index of 0.749, 100% sensitivity, and 75% specificity.

**Conclusion:** The results of this study confirm that preoperative MRCP plays a significant role in assessing the success of ERCP stone removal in CBDS patients. The stone diameter  $>15$  mm was identified as an independent risk factor.

### KEYWORDS

common bile duct stones, ERCP, MRCP, removal, stone diameter

## 1 Introduction

Common bile duct stones (CBDS) are a frequent clinical condition. As the stones block the common bile duct (CBD), it leads to impaired bile excretion. Patients may experience abdominal pain, jaundice, and even acute cholangitis (1–3). Since CBDS are more common among the elderly population, with the aging of the global population, the incidence of CBDS is expected to increase in the future. Among the Asian population, primary CBDS are more common, usually caused by biliary tract infection and bile stasis (4). The latest guidelines recommend using endoscopic ultrasonography (EUS) or magnetic resonance cholangiopancreatography (MRCP) for the diagnosis of CBDS. A meta-analysis published in 2015 showed that the sensitivity and specificity for MRCP 93 and 96%, and for EUS were 95 and 97% (5). Although studies have shown that EUS has a higher overall diagnostic advantage than MRCP, and a higher detection rate for small stones than MRCP (6), EUS is not as convenient to operate as MRCP. It is not widely used in many hospitals, while MRCP is almost universally available in most hospitals. Although CT is also a diagnostic method for CBDS, due to the presence of radiation exposure and the lower diagnostic accuracy compared to MRCP and EUS, the current guidelines do not recommend it as the preferred method for diagnosing CBDS (7).

At present, endoscopic retrograde cholangiopancreatography (ERCP) has been widely recognized as the preferred treatment method for CBDS (7, 8). However, ERCP not only leads to complications such as postoperative acute pancreatitis, delayed bleeding, and biliary tract infection, but also in some cases, the stones may not be completely removed. In modern times, with the significant advancement of endoscopic technology, the clearance rate of CBDS should reach over 80%. Combined with mechanical lithotripsy, the success rate can be increased to over 90% (9). That is to say, there are still about 10% of the stones that cannot be removed through ERCP. For CBDS that cannot be removed by ERCP, a biliary stent can be placed first or surgical removal can be performed. If it is possible to determine before the operation which CBDS may not be completely removed by ERCP, it will be of great help in choosing the appropriate treatment method subsequently. Therefore, the aim of this study is to explore the value of MRCP in predicting the success of CBDS removal through ERCP.

## 2 Methods

### 2.1 Ethical considerations

The research was performed according to the Declaration of Helsinki including participants' consent. The study was approved by the local Ethics Committee.

### 2.2 Patients and study design

Since a small number of CBDS patients may experience failure in ERCP stone removal, if it is possible to predict which patients are highly likely to fail the procedure, it will not only facilitate the clinical doctors in informing the patients and their families in advance for communication, but also help them to discuss the subsequent treatment plans. The preoperative MRCP examination not only enables the

diagnosis of CBDS, but also can reveal the size and quantity of the stones, as well as the diameter of the CBD. Therefore, we conducted a multicenter retrospective study on the value of MRCP in assessing the success of ERCP in CBDS patients.

This study included CBDS patients who were hospitalized at First Affiliated Hospital of Wannan Medical College and Affiliated Hospital of Guilin Medical University, and underwent ERCP stone removal treatment from January 2020 to May 2025. The inclusion criteria were as follows: (1) patients who meet the diagnostic criteria for CBDS, (2) preoperative MRCP examination. The exclusion criteria were as follows: (1) ERCP intubation failed and was transferred to surgery, (2) no MRCP examination was conducted at this hospital prior to the surgery, (3) ERCP was performed by doctors with less than 5 years of experience, (4) MRCP did not provide complete information on the size, quantity of the stones, and the widest diameter of the CBD, (5) combined cholangiocarcinoma of the lower segment of the CBD, (6) patients with acute obstructive suppurative cholangitis who only received biliary stents or nasobiliary tubes. All ERCP operators were physicians with many years of experience, aiming to minimize stone extraction failure caused by the operators' own technical problems. All centers strictly followed the China Clinical Application Management Standards for Endoscopic Diagnosis and Treatment Technologies. During the stone extraction process, the operating physicians could use adjuvant techniques such as balloon dilation, mechanical lithotripsy, and laser lithotripsy according to the actual situation.

All patients who meet the inclusion and exclusion criteria need to record their gender and age. In addition, record the number and diameter of the stones shown by MRCP (for multiple stones, record the largest one), the widest diameter of the CBD, and whether the stone removal was successful during ERCP, as well as the subsequent therapeutic measures taken in case of failure.

According to whether ERCP was successful or not, the patients were divided into success group and failure group. Comparing whether there are differences in MRCP-related parameters (including stone diameter, the number of single stone patients, the widest diameter of the CBD, and the widest diameter of the CBD/stone length) between the two groups. Parameters with statistically significant differences were further analyzed using binary multivariate logistic regression (Figure 1).

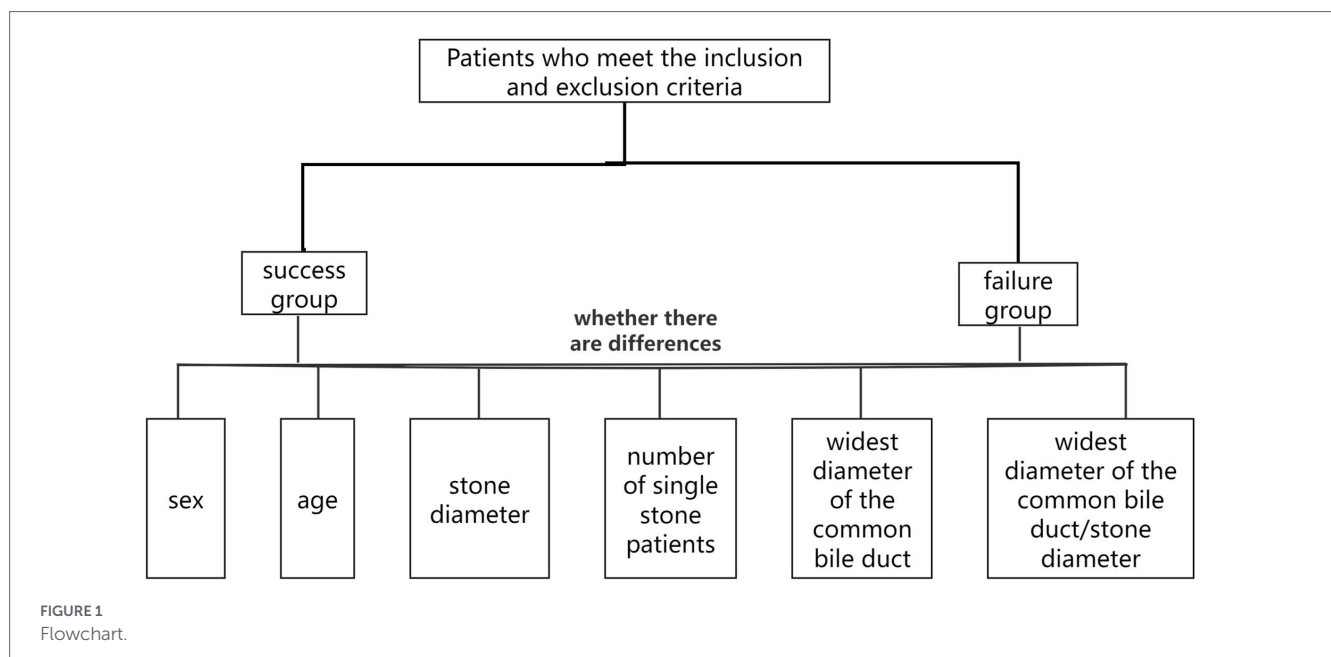
### 2.3 Statistical analysis

Descriptive data are expressed in terms of median (interquartile range) or counts and percentages. Mann–Whitney U test was used for nonparametric tests, and Chi-square test or Fisher's exact test was used for categorical variables. Binary multivariate logistic regression analysis was used to identify independent risk factors, and ROC curves with area under the curve (AUC) were used to evaluate predictive value. SPSS 22.0 software was used for statistical analysis. A  $p$ -value < 0.05 indicated statistical significance.

## 3 Results

### 3.1 General information of all CBDS patients

This study included a total of 432 CBDS patients, consisting of 175 males and 257 females. The median (interquartile distance) of age was



68 (57–75) years. The median (interquartile range) of the stone diameter for all patients were 10 (6–16) mm. While the median (interquartile range) of the widest diameter of the CBD for all patients were 14 (12–18) mm. The median (interquartile range) of widest diameter of CBD/stone diameter were 1.40 (1.06–2.00). Among the 432 CBDS patients, the number of patients with a single stone was 240 (55.55%). A total of 395 patients successfully removed all the stones by ERCP, while only 37 patients failed to have their stones removed. The success rate of ERCP stone removal was 91.44%. Among the 37 patients who failed to have stones removed through ERCP, except for one who underwent surgical stone removal, the rest were temporarily fitted with biliary stents and will be reattempted for stone removal after 3 to 6 months (Table 1).

### 3.2 Comparison of MRCP-related parameters between the success group and failure group

There was no significant difference in the gender ( $p = 0.16$ ) between the two groups. However, the average age of the failure group was generally higher than that of the success group, and the difference was statistically significant ( $p = 0.002$ ). The comparison of MRCP-related parameters between the two groups showed that, except for the number of single gallstone CBDS patients, which did not show statistically significant differences ( $p = 0.174$ ), there were significant differences in the stone diameter ( $p < 0.001$ ), the widest diameter of the CBD ( $p < 0.001$ ), and the widest diameter of the CBD/stone diameter ( $p < 0.001$ ). The stone diameter and the widest diameter of the CBD in the failure group were significantly higher than those in the success group, while the widest diameter of the CBD/stone diameter was significantly lower than that in the success group (Table 2).

### 3.3 Binary multivariate logistic regression analysis of independent risk factors for failure of ERCP-guided stone extraction

The parameters in Table 2 that showed significant statistical differences were included in a binary multivariate logistic regression analysis to identify the independent risk factors for predicting ERCP stone

TABLE 1 Clinical features of all CBDS patients.

Variables	Value
Sex (M/F)	175/257
Age (years): M(QR)	68 (57–75)
Stone length: M(QR), mm	10 (6–16)
Number of single stone patients: n(%)	240 (55.55%)
Widest diameter of the CBD: M(QR), mm	14 (12–18)
Widest diameter of the CBD/stone length: M(QR)	1.40 (1.06–2.00)
Number of successful stone removals: n(%)	395 (91.44%)
Treatment measures after failure	
Surgical stone removal: n(%)	1 (2.70%)
Biliary stent implantation: n(%)	36 (97.30%)

M, median; QR, Quartile Range; CBDS, common bile duct stones; CBD, common bile duct.

extraction failure. Binary multivariate logistic regression analysis revealed that only stone diameter >15 mm was significantly associated with ERCP stone extraction failure (OR = 11.229, 95% CI: 1.576–80.033,  $p = 0.016$ ). Age (OR = 1.027, 95% CI: 0.991–1.066,  $p = 0.145$ ), widest diameter of the CBD >15 mm (OR = 3.254, 95% CI: 0.708–14.951,  $p = 0.129$ ), and widest diameter of the CBD/stone diameter (OR = 0.193, 95% CI: 0.019–1.940,  $p = 0.162$ ) were not identified as independent risk factors. Therefore, stone diameter of CBD > 15 mm is an independent risk factor for ERCP stone extraction failure (Table 3).

### 3.4 ROC curve and area under the curve (AUC) for predicting ERCP stone extraction failure based on CBD stone diameter >15 mm

We constructed an ROC curve to evaluate the performance of CBD stone diameter >15 mm in predicting ERCP stone extraction

TABLE 2 Analysis of the differences between success group and failure group.

Variables	Success group <i>n</i> = 395	Failure group <i>n</i> = 37	<i>p</i>
Sex (M/F)	156/239	19/18	0.160
Age (years): M(QR)	66 (57–75)	73 (68–79)	0.002
Stone diameter: M(QR), mm	9 (6–15)	25 (18–32)	<0.001
Number of single stone patients: n(%)	233 (58.99%)	17 (45.95%)	0.174
Widest diameter of the CBD: M(QR), mm	14 (11–18)	21 (16–25.00)	<0.001
Widest diameter of the CBD/stone diameter: M(QR)	1.45 (1.14–2.00)	0.87 (0.64–1.10)	<0.001

M, median; QR, Quartile Range; CBD, common bile duct.

TABLE 3 Independent risk factors for ERCP-guided stone extraction failure: binary multivariate logistic regression analysis.

Variables	B	S. E	Wales	df	Sig.	Exp(B)	95%CI
Age	0.027	0.019	2.121	1	0.145	1.027	0.991–1.066
Stone length>15 mm	2.419	1.002	5.826	1	0.016	11.229	1.576–80.033
Widest diameter of the CBD>15 mm	1.080	0.778	2.300	1	0.129	3.254	0.708–14.951
Widest diameter of the CBD/stone length	−1.647	1.178	1.953	1	0.162	0.193	0.019–1.940

CBD, common bile duct.

failure. The analysis yielded an AUC of 0.94, indicating that this cutoff value has excellent discriminatory ability to identify patients at risk of ERCP failure. When the cutoff value of CBD stone diameter was set at 15 mm, the Youden's index reached its maximum value of 0.749, corresponding to a sensitivity of 100% and a specificity of 75% (Figure 2).

## 4 Discussion

CBDS is a common type of digestive tract disease. The incidence of CBDS varies by country, ranging from 8 to 18% (3, 10–13). Although most patients with CBDS have no symptoms throughout their lives, 10–25% of them still experience symptoms such as abdominal pain and fever (14, 15). ERCP is currently recognized as the preferred treatment method for CBDS (16, 17). A study published in 2019 showed that the success rate of stone removal through ERCP was 93.18% (18). In this study, the success rate of ERCP stone removal was 91.44%, similar to the aforementioned research. Although the success rate of ERCP in removing CBDS in this study was very high, there were still a few patients who experienced failed stone removal. Accurately analyzing before ERCP which CBDS patients have a high possibility of failing stone removal is beneficial for discussing with the patients and their families in advance about which subsequent treatment plan to choose. MRCP, as the currently recognized and reliable diagnostic method for CBDS, not only can clearly show the size and location of the stones, but also can display the quantity of the stones and the diameter of the CBD.

Previous studies have confirmed that the accuracy rate of MRCP in diagnosing CBDS is over 90% (19–21). This study is focused on the application value of MRCP in predicting whether ERCP can successfully remove all the stones. This study found that there were significant differences between the successful stone removal group and the failure

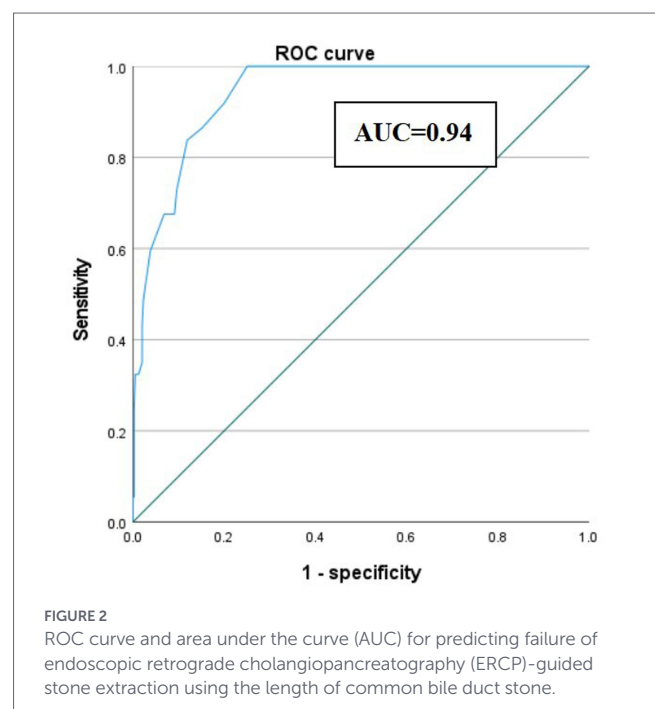


FIGURE 2 ROC curve and area under the curve (AUC) for predicting failure of endoscopic retrograde cholangiopancreatography (ERCP)-guided stone extraction using the length of common bile duct stone.

group in terms of the widest width of the CBD, the stone diameter, and the ratio of the two. Further binary multivariate logistic regression analysis showed that a stone diameter >15 mm was an independent risk factor for ERCP stone extraction failure. The sensitivity and specificity of a stone diameter >15 mm for predicting ERCP stone extraction failure were 100 and 75%, respectively. The sensitivity of 100% indicates that all patients who experienced ERCP stone extraction failure (true positive cases) had a CBD stone diameter >15 mm; in other words, if the CBD stone diameter is <15 mm, the probability of

successful ERCP stone extraction is extremely high. Some studies have defined stones with a diameter greater than 15 mm as difficult CBDS, indicating a high failure rate of stone removal through ERCP (22, 23). The results of this study are consistent with theirs.

The clinical significance of this study is mainly reflected in two aspects: first, it clarifies that CBD stone diameter >15 mm is the core independent risk factor for ERCP extraction failure, which helps clinicians focus on evaluating stone diameter during preoperative MRCP and formulate individualized treatment plans for high-risk patients. For example, for patients with CBD stone diameter >15 mm, preoperative preparation can be strengthened, such as full evaluation of ampullary function, selection of appropriate endoscopic instruments (such as large-diameter balloon catheters or laser lithotripters), or even consideration of alternative treatment strategies if necessary to improve the success rate. Second, the cutoff value of 15 mm for CBD stone diameter has excellent predictive efficiency, which can be popularized in clinical practice as a simple and easy-to-use predictive standard, especially in primary hospitals where endoscopic technology is relatively limited, helping to improve the level of preoperative risk assessment.

This study has some limitations. Firstly, it is a retrospective study and the number of cases is not large. Secondly, this study excluded some CBDS patients who underwent ERCP but did not have the purpose of stone removal. Furthermore, as this study involved multiple centers, the ERCP operators were not the same person, which might have certain impacts on the results. Therefore, we hope that in the future, more prospective studies involving a larger number of patients can be conducted.

## 5 Conclusion

Preoperative MRCP is of great value in predicting the success of ERCP stone removal. CBD stone diameter >15 mm is a simple, objective, and reliable preoperative predictor for ERCP extraction failure.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

The study protocol was in accordance with the Declaration of Helsinki Ethical Guidelines and was approved by the institutional

review board of Guilin Medical University (2023IITLL-20). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

## Author contributions

XX: Writing – original draft. XS: Methodology, Writing – original draft, Formal analysis. YZ: Writing – original draft, Project administration. LL: Data curation, Writing – original draft. ZZ: Writing – review & editing.

## Funding

The author(s) declared that financial support was not received for this work and/or its publication.

## Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The author(s) declared that Generative AI was not used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

## Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

## References

- Soltan HM, Kow L, Toouli J. A simple scoring system for predicting bile duct stones in patients with cholelithiasis. *J Gastrointest Surg.* (2001) 5:434–7. doi: 10.1016/s1091-255x(01)80073-1
- Williams EJ, Green J, Beckingham I. Guidelines on the management of common bile duct stones (CBDS). *Gut.* (2008) 57:1004–21. doi: 10.1136/gut.2007.121657
- Csendes A, Burdiles P, Diaz JC, Maluenda F, Korn O, Vallejo E, et al. Prevalence of common bile duct stones according to the increasing number of risk factors present. A prospective study employing routinely intraoperative cholangiography in 477 cases. *Hepato-Gastroenterology.* (1998) 45:1415–21.
- Tsui WM, Lam PW, Lee WK, Chan YK. Primary hepatolithiasis, recurrent pyogenic cholangitis, and oriental cholangiohepatitis: a tale of 3 countries. *Adv Anat Pathol.* (2011) 18:318–28. doi: 10.1097/PAP.0b013e318220fb75
- Giljaca V, Gurusamy KS, Takwoingi Y, Higgie D, Poropat G, Štimac D, et al. Endoscopic ultrasound versus magnetic resonance cholangiopancreatography for common bile duct

- stones. *Cochrane Database Syst Rev.* (2015) 2015:CD011549. doi: 10.1002/14651858.cd011549
6. Meeralam Y, Al-Shammari K, Yaghoobi M. Diagnostic accuracy of EUS compared with MRCP in detecting choledocholithiasis: a meta-analysis of diagnostic test accuracy in head-to-head studies. *Gastrointest Endosc.* (2017) 86:986–93. doi: 10.1016/j.gie.2017.06.009
7. Williams E, Beekingham I, El Sayed G, Gurusamy K, Sturgess R, Webster G, et al. Updated guideline on the management of common bile duct stones (CBDS). *Gut.* (2017) 66:28122906:765–82. doi: 10.1136/gutjnl-2016-312317
8. Saito H, Kadono Y, Shono T. Remaining issues of recommended management in current guidelines for asymptomatic common bile duct stones. *World J Gastroenterol.* (2021) 27:2131–40. doi: 10.3748/wjg.v27.i18.2131
9. Hess GF, Sedlacek P, Zeindler J, Muenst S, Schmitt AM, Däster S, et al. The short- and long-term outcome after the surgical management of common bile duct stones in a tertiary referral hospital. *Langenbeck's Arch Surg.* (2023) 408:288. doi: 10.1007/s00423-023-03011-2
10. Möller M, Gustafsson U, Rasmussen F, Persson G, Thorell A. Natural course vs interventions to clear common bile duct stones: data from the Swedish registry for gallstone surgery and endoscopic retrograde cholangiopancreatography (GallRiks). *JAMA Surg.* (2014) 149:1008–13. doi: 10.1001/jamasurg.2014.249
11. Collins C, Maguire D, Ireland A, Fitzgerald E, O'Sullivan GC. A prospective study of common bile duct calculi in patients undergoing laparoscopic cholecystectomy: natural history of choledocholithiasis revisited. *Ann Surg.* (2004) 239:28–33. doi: 10.1097/01.sla.0000103069.00170.9c
12. Murison MS, Gartell PC, McGinn FP. Does selective peroperative cholangiography result in missed common bile duct stones. *J R Coll Surg Edinb.* (1993) 38:220–4.
13. Ko CW, Lee SP. Epidemiology and natural history of common bile duct stones and prediction of disease. *Gastrointest Endosc.* (2002) 56:S165–9. doi: 10.1067/mge.2002.129005
14. Mansour S, Kluger Y, Khuri S. Primary recurrent common bile duct stones: timing of surgical intervention. *J Clin Med Res.* (2022) 14:441–7. doi: 10.14740/jocmr4826
15. Jang DK. Complete endoscopic clearance of common bile duct stones. *Korean J Gastroenterol.* (2022) 79:199–202. doi: 10.4166/kjg.2022.059
16. Millat B, Borie F, Decker G. Treatment of choledocholithiasis: therapeutic ERCP versus peroperative extraction during laparoscopic cholecystectomy. *Acta Gastroenterol Belg.* (2000) 63:301–3.
17. Lynn AP, Chong G, Thomson A. Endoscopic retrograde cholangiopancreatography in the treatment of intraoperatively demonstrated choledocholithiasis. *Ann R Coll Surg Engl.* (2014) 96:45–8. doi: 10.1308/003588414X13824511650290
18. Purbey BK, Gurung RB, Panday R, Shrestha A, Shah R. Outcomes of endoscopic sphincteroplasty using large balloon dilatation for difficult common bile duct stone removal at Dhulikhel hospital. *Kathmandu Univ Med J (KUMJ).* (2019) 17:9–13.
19. Lee SL, Kim HK, Choi HH. Diagnostic value of magnetic resonance cholangiopancreatography to detect bile duct stones in acute biliary pancreatitis. *Pancreatol.* (2018) 18:22–8. doi: 10.1016/j.pan.2017.12.004
20. Ward WH, Fluke LM, Hoagland BD, Zarow GJ, Held JM, Ricca RL. The role of magnetic resonance cholangiopancreatography in the diagnosis of Choledocholithiasis: do benefits outweigh the costs. *Am Surg.* (2015) 81:720–5. doi: 10.1177/000313481508100723
21. Chang JH, Lee IS, Lim YS. Role of magnetic resonance cholangiopancreatography for choledocholithiasis: analysis of patients with negative MRCP. *Scand J Gastroenterol.* (2012) 47:217–24. doi: 10.3109/00365521.2011.638394
22. Manes G, Paspatis G, Aabakken L. Endoscopic management of common bile duct stones: European Society of Gastrointestinal Endoscopy (ESGE) guideline. *Endoscopy.* (2019) 51:472–91. doi: 10.1055/a-0862-0346
23. Cominardi A, Aragona G, Cattaneo G, Arzù G, Capelli P, Banchini F. Current trends of minimally invasive therapy for cholecystocholedocholithiasis. *Front Med (Lausanne).* (2023) 10:1277410. doi: 10.3389/fmed.2023.1277410