

Review began 10/04/2026

Review ended 10/11/2026

Published 10/20/2026

© Copyright 2026

Rios Munoz et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

DOI: 10.7759/cureus.118274

Impact of Stone Size on the Technical Success of Endoscopic Retrograde Cholangiopancreatography for Common Bile Duct Stone Extraction in Older Adults: A Single-Center Retrospective Study at a Secondary Care Hospital in Mexico

Carlos F. Rios Munoz ¹, Daniela Medina Correa ¹, Sharon E. Carbajal Heredia ¹, Armando Guerra Morales ¹

¹. General Surgery, Hospital General Regional No. 220, Mexican Social Security Institute (IMSS), Toluca, MEX

Corresponding author: Carlos F. Rios Munoz, carlos.rm22@gmail.com

Abstract

Background

Common bile duct stone size is a recognized determinant of technical difficulty during endoscopic retrograde cholangiopancreatography (ERCP), but evidence focused on older adults in secondary-care settings remains limited. This study evaluated the association between maximum stone size and technical success of ERCP stone extraction in adults aged 60 years or older with choledocholithiasis.

Methods

This retrospective single-center study included 41 adults aged 60 years or older who underwent ERCP for choledocholithiasis at a secondary-care hospital in Mexico between January and December 2025. Maximum stone size was categorized as <15 mm or ≥15 mm. Technical success was defined as complete endoscopic stone extraction without the need for surgical bile duct exploration. Associations were evaluated using Fisher's exact test, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for technical failure.

Results

Technical success was achieved in 32 of 41 patients (78.0%). Success was significantly higher in patients with stones <15 mm than in those with stones ≥15 mm (89.7% vs. 50.0%; $p = 0.011$). Stones ≥15 mm were associated with greater odds of technical failure (OR, 8.67; 95% CI, 1.67-44.94). Median maximum stone size was 10 mm among successful procedures and 15 mm among failures ($p = 0.002$). Common bile duct diameter was also greater among patients with technical failure (15 vs. 12 mm; $p = 0.007$). Exploratory multivariable analyses produced imprecise estimates because only nine technical failures occurred.

Conclusions

In this cohort of older adults with choledocholithiasis, stones ≥ 15 mm were associated with substantially lower technical success of ERCP stone extraction. Stone size may therefore serve as a clinically useful marker of anticipated technical difficulty and help inform procedural planning. Larger prospective and multicenter studies are needed to determine the independent contribution of stone size to ERCP outcomes.

Categories: General Surgery, Geriatrics, Gastroenterology

Keywords: choledocholithiasis, common bile duct (cbd), difficult common bile duct stone, endoscopic retrograde cholangiopancreatography (ercp), older adult

Introduction

Choledocholithiasis is a common cause of biliary obstruction and may lead to clinically important complications, including acute cholangitis and biliary pancreatitis [1,2]. Endoscopic retrograde cholangiopancreatography (ERCP) is a cornerstone of therapeutic management because it permits biliary decompression and stone extraction during the same procedure [1,2]. Current guidelines recommend endoscopic stone extraction in patients with common bile duct stones who are appropriate candidates for intervention, while emphasizing the use of noninvasive or minimally invasive diagnostic modalities when the diagnosis remains uncertain [1,2].

Although conventional endoscopic sphincterotomy followed by balloon or basket extraction is effective for many common bile duct stones, complete duct clearance may be technically challenging in a subset of

How to cite this article

Rios Munoz C F, Medina Correa D, Carbajal Heredia S E, et al. (October 20, 2026) Impact of Stone Size on the Technical Success of Endoscopic Retrograde Cholangiopancreatography for Common Bile Duct Stone Extraction in Older Adults: A Single-Center Retrospective Study at a Secondary Care Hospital in Mexico. Cureus 18(10): e118274. DOI 10.7759/cureus.118274

patients. Stone size is one of the most consistently recognized determinants of procedural difficulty. The European Society of Gastrointestinal Endoscopy defines difficult biliary stones according to factors that include a diameter greater than 15 mm, multiple stones, unusual stone morphology, impaction, difficult location, and unfavorable biliary anatomy [1]. Similarly, the American Society for Gastrointestinal Endoscopy recognizes large or difficult stones as a group in which conventional extraction may be insufficient and additional techniques may be required [2].

For large or difficult stones, available endoscopic strategies include limited sphincterotomy combined with endoscopic papillary large-balloon dilation, mechanical lithotripsy, and cholangioscopy-guided electrohydraulic or laser lithotripsy [1–3]. Evidence comparing these approaches indicates that advanced techniques can achieve high rates of duct clearance, including in patients with stones larger than 15 mm [3]. However, access to cholangioscopy and other advanced interventions depends on local expertise, equipment, and institutional resources. Consequently, identifying characteristics associated with failure of conventional stone extraction may be particularly relevant in secondary-care hospitals, where advanced rescue techniques may not always be immediately available.

Older adults constitute an important population in this setting. ERCP is frequently performed for choledocholithiasis in older patients, and published series generally support its technical feasibility in advanced age [4–6]. Nevertheless, complete stone clearance is not universal, and older patients may present with larger stones, dilated bile ducts, altered anatomy, frailty, and comorbidities that can influence procedural planning and the consequences of repeat interventions [4–6]. Despite the clinical relevance of these considerations, evidence specifically examining the relationship between stone size and technical success of ERCP in older adults remains limited, particularly in secondary-care settings in Mexico.

Therefore, this study aimed to evaluate the association between common bile duct stone size and the technical success of ERCP for stone extraction in adults aged 60 years or older treated at a secondary-care hospital in Mexico. The primary comparison was between stones smaller than 15 mm and stones 15 mm or larger, using complete endoscopic stone extraction as the technical outcome.

Materials And Methods

Study design and setting

This single-center retrospective observational study included adults aged 60 years or older with choledocholithiasis who underwent ERCP at the Hospital General Regional No. 220, Mexican Social Security Institute (IMSS), a secondary-care referral hospital in Toluca, State of Mexico, Mexico. Eligible procedures were those performed from January through December 2025. The study was based exclusively on a review of existing electronic and physical medical records, ERCP reports, operative notes, and post-procedure documentation; there was no direct contact with patients.

Study population and eligibility criteria

All accessible records meeting the prespecified eligibility criteria during the study period were consecutively included. Patients of either sex were eligible if they were aged 60 years or older, had a diagnosis of choledocholithiasis, underwent ERCP at the study hospital between January and December 2025, and had sufficient clinical and procedural documentation for the study variables. Records were excluded when the ERCP was incomplete for reasons unrelated to stone size, including hemorrhage, hemodynamic instability, malignant obstruction, or non-lithiasic biliary stenosis. Incomplete records and patients with oncologic disease were excluded according to the original study protocol.

Endoscopic procedures

All ERCP procedures were performed by a single endoscopist with seven years of experience in ERCP, using an Olympus 190-series endoscopic system. The manufacturers of the endoscopic accessories varied according to institutional availability during the study period.

Conventional endoscopic techniques, including endoscopic sphincterotomy and papillary balloon dilation, were employed according to the clinical characteristics of each case. Mechanical and laser lithotripsy were not available at our secondary-care institution during the study period.

Data collection and study variables

Data were extracted by a single investigator using a standardized collection form developed for this study. Information was obtained from electronic and physical medical records, ERCP reports, operative notes, post-procedure findings, laboratory results, and pre-procedural ultrasonography reports. No independent duplicate data extraction or inter-rater reliability assessment was performed. The database was stored in a password-protected electronic file and anonymized before statistical analysis.

Exposure and outcome definitions

The primary exposure was the maximum common bile duct stone diameter, recorded in millimeters from the ERCP report. For the prespecified primary analysis, stone size was categorized as <15 mm or ≥15 mm. Stone size was also evaluated as a continuous variable in complementary analyses. Additional variables included age, sex, gallbladder status (in situ or previous cholecystectomy), total bilirubin concentration, stone size reported on pre-procedural ultrasonography, and common bile duct diameter.

The primary outcome was technical success of ERCP stone extraction. Technical success was defined as complete endoscopic removal of the common bile duct stone or stones, as documented in the procedural record, without the need for surgical bile duct exploration. Technical failure was defined as the persistence of one or more common bile duct stones despite attempted endoscopic extraction. In all nine cases of technical failure, a plastic biliary stent was placed, and patients were referred to a tertiary care center for further management. The principal comparison evaluated technical success between patients with stones < 15 mm and those with stones ≥ 15 mm.

Statistical analysis

Statistical analyses were performed using R version 4.5.1. Categorical variables were summarized as absolute frequencies and percentages. Continuous variables were summarized as means and standard deviations when approximately normally distributed and as medians and interquartile ranges (IQR) when non-normally distributed. Distributional assumptions were assessed using the Shapiro-Wilk test and graphical inspection.

For comparisons according to ERCP outcome, the Mann-Whitney U test was used for continuous variables when normality assumptions were not met, and Fisher's exact test was used for categorical variables when expected cell frequencies were small. For the primary analysis, the association between stone-size category (<15 mm vs ≥15 mm) and ERCP outcome was evaluated using Fisher's exact test. The magnitude of the association with technical failure was expressed as an odds ratio (OR) with a 95% confidence interval (CI). A two-sided p-value < 0.05 was considered statistically significant.

The relationship between maximum stone size and common bile duct diameter was explored using Pearson and Spearman correlation coefficients. Exploratory binary logistic regression models were also fitted to evaluate stone size and common bile duct diameter simultaneously in relation to technical failure. One model treated both variables as continuous measures; a second model used the prespecified stone-size category (<15 mm vs ≥15 mm) while adjusting for common bile duct diameter. Because only a small number of technical failures occurred, these multivariable models were considered exploratory, and their estimates were interpreted cautiously.

Ethical considerations

The study protocol was reviewed and approved on May 19, 2026, by the Research and Ethics Committee of Hospital General Regional No. 220, IMSS, under registration number R-2026-1503-069. The study involved the review of existing clinical records exclusively, with no direct contact with patients and no modification of clinical care. All records were coded and anonymized before analysis, and no directly identifying patient information was included in the study database or manuscript.

Use of artificial intelligence

OpenAI ChatGPT was used during manuscript preparation to assist with language editing, organization, and clarity of presentation. All scientific content, statistical results, interpretations, references, and the final manuscript were reviewed and approved by the authors, who assume full responsibility for the work.

Results

Study population

A total of 41 adults aged 60 years or older with choledocholithiasis who underwent ERCP met the study criteria. The mean age was 73.0 ± 8.0 years, and the median age was 72 years (IQR, 67-77; range, 62-94). Twenty-three patients (56.1%) were women, and 18 (43.9%) were men. The gallbladder was in situ in 25 patients (61.0%), whereas 16 (39.0%) had undergone previous cholecystectomy. Median total bilirubin was 4.66 mg/dL (IQR, 2.30-8.90), median common bile duct diameter was 12 mm (IQR, 10-15), and median maximum stone size was 10 mm (IQR, 7-15). Baseline characteristics are summarized in Table 1.

Variable	Overall (n = 41)
Age, mean $\pm$ SD, years	73.0 $\pm$ 8.0
Age, median (IQR), years	72 (67-77)
Female sex, n (%)	23 (56.1)
Male sex, n (%)	18 (43.9)
Gallbladder in situ, n (%)	25 (61.0)
Previous cholecystectomy, n (%)	16 (39.0)
Total bilirubin, median (IQR), mg/dL	4.66 (2.30-8.90)
Total bilirubin $\geq$ 4 mg/dL, n (%)	25 (61.0)
Common bile duct diameter, median (IQR), mm	12 (10-15)
Maximum stone size, median (IQR), mm	10 (7-15)

TABLE 1: Baseline characteristics of the study population

IQR, Interquartile range; SD, Standard deviation.

Overall technical success and stone size

Complete endoscopic stone extraction was achieved in 32 of 41 patients, corresponding to an overall technical success rate of 78.0%; technical failure occurred in nine patients (22.0%). When maximum stone size was analyzed as a continuous variable, patients with technical success had a median stone size of 10 mm (IQR, 7-12), compared with 15 mm (IQR, 13-20) among patients with technical failure (Mann-Whitney U = 48.5, $p = 0.002$).

Primary analysis according to the 15-mm threshold

Twenty-nine patients had stones < 15 mm and 12 had stones $\geq$ 15 mm. Technical success was achieved in 26 of 29 patients (89.7%) with stones < 15 mm and in six of 12 patients (50.0%) with stones $\geq$ 15 mm, an absolute difference in success of 39.7 percentage points. Stone-size category was significantly associated with ERCP outcome (Fisher's exact test, $p = 0.011$). When technical failure was used as the outcome, stones $\geq$ 15 mm were associated with higher odds of failure than stones < 15 mm (OR, 8.67; 95% CI, 1.67-44.94). These results are summarized in Table 2.

Stone size	Technical success, n (%)	Technical failure, n (%)	Total, n
<15 mm	26 (89.7)	3 (10.3)	29
$\geq$ 15 mm	6 (50.0)	6 (50.0)	12
Total	32 (78.0)	9 (22.0)	41

TABLE 2: Technical outcome of ERCP according to maximum stone size

Fisher's exact test for the <15 mm versus $\geq$ 15 mm comparison: $p = 0.011$.

ERCP, Endoscopic retrograde cholangiopancreatography.

Other factors associated with technical outcome

Age, sex, gallbladder status, and total bilirubin did not differ significantly according to technical outcome. In contrast, common bile duct diameter was greater among patients with technical failure (median, 15 mm; IQR, 14-20) than among those with technical success (median, 12 mm; IQR, 10-13.2; Mann-Whitney U = 59.0, $p = 0.007$). Maximum stone size also differed between outcome groups (Mann-Whitney U = 48.5, $p = 0.002$). These comparisons are shown in Table 3.

Variable	Technical success (n = 32)	Technical failure (n = 9)	p-value
Age, median (IQR), years	71 (67-76.2)	73 (66-84)	0.987
Female sex, n (%)	18 (56.3)	5 (55.6)	1.000
Gallbladder in situ, n (%)	22 (68.8)	3 (33.3)	0.119
Total bilirubin, median (IQR), mg/dL	4.35 (1.8-8.9)	6.20 (2.89-7.7)	0.560
Common bile duct diameter, median (IQR), mm	12 (10-13.2)	15 (14-20)	0.007
Maximum stone size, median (IQR), mm	10 (7-12)	15 (13-20)	0.002

TABLE 3: Clinical and anatomical characteristics according to ERCP technical outcome

Continuous variables were compared using the Mann-Whitney U test, with U statistics of 145.0 for age, 125.0 for total bilirubin, 59.0 for common bile duct diameter, and 48.5 for maximum stone size. Categorical variables were compared using Fisher's exact test.

ERCP, Endoscopic retrograde cholangiopancreatography; IQR, Interquartile range.

Exploratory relationship between stone size and common bile duct diameter

Maximum stone size was positively correlated with common bile duct diameter (Pearson $r = 0.690$, $p < 0.001$; Spearman $\rho = 0.680$, $p < 0.001$). In an exploratory binary logistic regression model including both variables as continuous measures, the adjusted OR for technical failure was 1.17 per 1-mm increase in stone size (95% CI, 0.94-1.46; $p = 0.164$) and 1.18 per 1-mm increase in common bile duct diameter (95% CI, 0.90-1.53; $p = 0.227$).

In a second exploratory model using the prespecified stone-size category and adjusting for common bile duct diameter, stones ≥ 15 mm had an adjusted OR for technical failure of 4.28 (95% CI, 0.69-26.57; $p = 0.119$), while common bile duct diameter had an adjusted OR of 1.23 per 1-mm increase (95% CI, 0.98-1.55; $p = 0.071$). Given the small number of technical failures and the correlation between stone size and common bile duct diameter, these multivariable estimates were considered exploratory and do not establish independent effects.

Discussion

In this single-center cohort of older adults undergoing ERCP for choledocholithiasis, complete endoscopic stone extraction was achieved in 78.0% of patients. The principal finding was the marked difference in technical success according to stone size: clearance was achieved in 89.7% of patients with stones < 15 mm compared with 50.0% of those with stones ≥ 15 mm. Accordingly, stones ≥ 15 mm were associated with greater odds of technical failure (OR, 8.67; 95% CI, 1.67-44.94). The same pattern was observed when stone size was analyzed continuously, with a median maximum stone diameter of 10 mm among successful procedures and 15 mm among failures. These findings support an association between increasing stone size and technical difficulty, although the observational design and wide CI preclude causal or precise predictive interpretation.

The 15-mm threshold is clinically relevant because contemporary guidance and reviews recognize large stones as a major component of difficult bile duct stone disease. The European Society of Gastrointestinal Endoscopy (ESGE) guideline identifies stone diameter > 15 mm, together with factors such as impaction, multiplicity, difficult location, and unfavorable ductal anatomy, as features that can make conventional extraction challenging [1]. The American Society for Gastrointestinal Endoscopy (ASGE) guideline similarly supports escalation beyond conventional sphincterotomy and balloon or basket extraction for large or difficult stones, including endoscopic papillary large-balloon dilation and intraductal therapy when appropriate [2]. A systematic review and network meta-analysis by Facciorusso et al. further showed that several advanced endoscopic strategies can achieve high clearance rates for large bile duct stones [3]. Our results are therefore directionally consistent with the broader evidence that stone size is an important marker of procedural complexity.

The study population also deserves consideration. All participants were aged 60 years or older, with a mean age of 73 years. ERCP remains feasible in advanced age, but technical outcomes can vary according to patient and stone characteristics. Gardenyes et al. evaluated ERCP for choledocholithiasis in older patients and emphasized the importance of outcomes beyond procedural feasibility in this population [4]. In a multicenter study of patients aged ≥ 90 years, Saito et al. reported a complete stone-removal rate of 81.0%, lower than the 94.9% observed among patients aged 75-89 years, despite similarly high rates of successful

biliary cannulation and sphincter intervention [5]. More recently, Wang et al. also reported the feasibility of ERCP for choledocholithiasis in patients aged ≥ 90 years [6]. These studies are not directly comparable with our cohort because of differences in age thresholds, case selection, techniques, and definitions of success, but they illustrate that advanced age does not by itself preclude endoscopic treatment and that complete clearance remains a clinically meaningful endpoint.

Evidence focused specifically on large stones in older adults also supports the need for individualized procedural planning. Meng et al. retrospectively studied high-risk older patients with large common bile duct stones and found higher clearance after temporary biliary stenting followed by elective extraction than with immediate stone removal (89.5% vs. 75.3%) [7]. In a subsequent prospective randomized study of high-risk older patients with large or multiple stones, a staged strategy with temporary stenting and delayed extraction achieved higher clearance than immediate extraction (94% vs. 80%) [8]. Although our study did not compare treatment strategies, these data are relevant because they show that failure of immediate or conventional extraction does not necessarily imply definitive endoscopic failure; rather, large stones may require staged or advanced therapy.

Common bile duct diameter was also associated with procedural outcome in the bivariate analysis: patients with technical failure had a median duct diameter of 15 mm compared with 12 mm among those with successful extraction. Stone size and duct diameter were moderately to strongly correlated (Pearson $r = 0.690$; Spearman $\rho = 0.680$). This relationship complicates interpretation of their independent contributions. In the exploratory adjusted models, neither stone size nor duct diameter retained statistical significance, and the adjusted OR for stones ≥ 15 mm decreased to 4.28 with a wide 95% CI (0.69–26.57). Given only nine technical failures, these models have limited precision and should not be interpreted as demonstrating absence of an independent association. Rather, they suggest that stone and duct characteristics may coexist as components of technical complexity. Reviews of difficult bile duct stones likewise emphasize that difficulty is determined by the interaction of stone characteristics and biliary anatomy rather than by stone diameter alone [9].

Age, sex, gallbladder status, and total bilirubin were not significantly associated with technical success in this cohort. The absence of statistical significance should be interpreted cautiously because the sample was small and the study was not powered to exclude clinically relevant associations for these variables. In particular, serum bilirubin is useful in the diagnostic risk stratification of suspected choledocholithiasis [2], but its diagnostic role does not necessarily imply an association with the technical success of stone extraction once choledocholithiasis has been established.

From a practical standpoint, the main implication of these findings is procedural planning rather than prediction of an individual patient's outcome. Identification of a stone ≥ 15 mm before or during ERCP may prompt consideration of whether the necessary equipment and expertise for large-balloon dilation, mechanical lithotripsy, cholangioscopy-guided lithotripsy, or temporary biliary stenting are available [1–3,9,10]. This may be particularly relevant in secondary-care settings where access to advanced endoscopic rescue techniques can be limited. Our data do not establish which advanced technique should be selected, but they support recognizing stone size as an accessible marker of potential technical difficulty.

Strengths and limitations

A strength of this study is its focused evaluation of a clinically relevant and easily measurable characteristic – maximum stone diameter – in a defined population of older adults treated in a secondary-care hospital. Stone size was examined both categorically using a prespecified 15-mm threshold and as a continuous variable, and both analyses showed a consistent relationship with technical outcome. The study also explored common bile duct diameter, allowing the observed association with stone size to be interpreted in the context of biliary anatomy.

Several limitations should be acknowledged. First, the retrospective, single-center design limits control of confounding and restricts generalizability to other institutions, particularly tertiary centers with routine access to advanced lithotripsy or cholangioscopy. Furthermore, all procedures were performed by a single endoscopist, potentially limiting the generalizability of our findings to operators with different levels of experience. The unavailability of mechanical and laser lithotripsy may also have influenced technical success rates, particularly among patients with stones ≥ 15 mm.

Second, the sample size was small ($n = 41$), with only nine technical failures; consequently, effect estimates were imprecise, and the multivariable analyses were exploratory.

Third, the available database did not include several recognized determinants of difficult stone extraction, such as stone number, impaction, distal duct configuration, stone-to-duct diameter ratio, perampullary diverticula, cannulation difficulty, or the specific extraction and rescue techniques used in each procedure. Residual confounding by these unmeasured factors is therefore possible.

Fourth, stone size was obtained from measurements documented in the clinical records without independent

reassessment. Variability in imaging modalities and measurement techniques may have introduced misclassification, particularly for stones near the 15-mm threshold. Additionally, data extraction was conducted by a single investigator without independent verification, which may have introduced data abstraction bias.

Fifth, selection bias cannot be excluded because the study included only patients who underwent ERCP at our institution. Patients who were considered unsuitable for the procedure or referred directly to tertiary care were not represented, potentially affecting the observed technical success rates.

Finally, technical success was defined from retrospective procedural documentation, which may be subject to variability in reporting. The study evaluated technical clearance rather than adverse events, repeat ERCP, long-term recurrence, hospital stay, or mortality; therefore, the findings should not be extrapolated to overall safety or long-term clinical effectiveness.

Conclusions

In this cohort of adults aged 60 years or older with choledocholithiasis, ERCP achieved complete endoscopic stone extraction in 78.0% of patients. Stones ≥ 15 mm were associated with substantially lower technical success than stones < 15 mm (50.0% vs. 89.7%; $p = 0.011$), and larger stone size was also associated with failure when analyzed as a continuous variable. These findings support stone size as a clinically relevant marker of technical difficulty in this setting. Because the study was retrospective and included only 41 patients with nine technical failures, the magnitude and independence of this association require confirmation in larger prospective or multicenter cohorts. Recognition of large stones before or during ERCP may nevertheless help inform procedural planning and anticipated need for advanced or staged extraction strategies.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Carlos F. Rios Munoz

Acquisition, analysis, or interpretation of data: Carlos F. Rios Munoz, Daniela Medina Correa, Sharon E. Carbajal Heredia, Armando Guerra Morales

Drafting of the manuscript: Carlos F. Rios Munoz

Critical review of the manuscript for important intellectual content: Carlos F. Rios Munoz, Daniela Medina Correa, Sharon E. Carbajal Heredia, Armando Guerra Morales

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Research and Ethics Committee of Hospital General Regional No. 220, Mexican Social Security Institute (IMSS) issued approval R-2026-1503-069. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Manes G, Paspatis G, Aabakken L, et al.: Endoscopic management of common bile duct stones: European Society of Gastrointestinal Endoscopy (ESGE) guideline. *Endoscopy*. 2019, 51:472-91. [10.1055/a-0862-0346](#)
2. Buxbaum JL, Fehmi SMA, Sultan S, et al.: ASGE guideline on the role of endoscopy in the evaluation and management of choledocholithiasis. *Gastrointest Endosc*. 2019, 89:1075-1105. [10.1016/j.gie.2018.10.001](#)
3. Facciorusso A, Gkolfakis P, Ramai D, et al.: Endoscopic treatment of large bile duct stones: a systematic review and network meta-analysis. *Clin Gastroenterol Hepatol*. 2023, 21:33-44. [10.1016/j.cgh.2021.10.013](#)
4. Gardenyes J, Roura P, Vallverdú-Cartie H, et al.: Endoscopic retrograde cholangiopancreatography for the management of choledocholithiasis in older patients. *Rev Esp Enferm Dig*. 2024, 116:244-9. [10.17235/reed.2023.10051/2023](#)
5. Saito H, Koga T, Sakaguchi M, et al.: Safety and efficacy of endoscopic removal of common bile duct stones in elderly patients ≥ 90 years of age. *Intern Med*. 2019, 58:2125-32. [10.2169/internalmedicine.2546-18](#)
6. Wang L, Li ZY, Wu F, Tan GQ, Wang BL: Endoscopic retrograde cholangiopancreatography for patients aged

- ninety and older with choledocholithiasis: a single-center experience in South China. *World J Gastrointest Endosc.* 2025, 17:102010. [10.4253/wjge.v17.i1.102010](https://doi.org/10.4253/wjge.v17.i1.102010)
7. Meng K, Zhang DY, Chen DX, et al.: Large common bile duct stones in high-risk elderly patients: immediate endoscopic stone removal or elective stone removal? A single-center retrospective study. *BMC Gastroenterol.* 2023, 23:344. [10.1186/s12876-023-02976-0](https://doi.org/10.1186/s12876-023-02976-0)
 8. Alhaddad O, Elsabaawy M, El-Azab G, Edrees A, Amer M, Eissa M: Efficacy and safety of immediate vs. delayed endoscopic retrieval of large or multiple common bile duct stones in high-risk elderly patients: a prospective, randomized comparative study. *Clin Exp Med.* 2025, 25:183. [10.1007/s10238-025-01712-0](https://doi.org/10.1007/s10238-025-01712-0)
 9. Nakai Y, Sato T, Hakuta R, et al.: Management of difficult bile duct stones by large balloon, cholangioscopy, enteroscopy and endosonography. *Gut Liver.* 2020, 14:297-305. [10.5009/gnl19157](https://doi.org/10.5009/gnl19157)
 10. Rubiano AMR, González-Teshima LY, Arango L, et al.: Clinical practice guideline on the use of single-operator cholangioscopy in the diagnosis of indeterminate biliary stricture and the treatment of difficult biliary stones. *Surg Endosc.* 2024, 38:499-510. [10.1007/s00464-023-10569-x](https://doi.org/10.1007/s00464-023-10569-x)