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**Current approaches and questions yet to be resolved for the prophylaxis of post-endoscopic retrograde cholangiopancreatography pancreatitis**

Saito H *et al*. Prophylaxis of post-ERCP pancreatitis

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**Abstract**

Prophylaxis is important for post-endoscopic retrograde cholangiopancreatography (ERCP) pancreatitis (PEP), which is the most common and serious complication of ERCP. Although the current guidelines include independent patient- and procedure-related risk factors for PEP and available PEP prophylactic measures, the synergistic effect of these risk factors on PEP should also be considered, given that patients often harbor multiple risk factors. Furthermore, a combination of prophylactic measures is often selected in clinical practice. However, established methods estimating the synergistic effect of independent risk factors on PEP incidence are lacking, and evidence on the impact of combining prophylactic measures on PEP should be discussed. Selection of appropriate candidate patients for ERCP is also important to reduce the incidence of PEP associated with unnecessary ERCP. ERCP indications in patients with asymptomatic common bile duct stones (CBDSs) and in those with suspected CBDSs with no imaging-based evidence of stones are controversial. Further studies are warranted to predict the synergistic effect of independent risk factors on PEP, determine the best prophylactic PEP measures, and identify appropriate candidates for ERCP in patients with asymptomatic CBDSs and those with suspected CBDSs.

**Key Words:** Endoscopic retrograde cholangiopancreatography; Post-endoscopic retrograde cholangiopancreatography pancreatitis; Prophylaxis; Guidelines

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**Core Tip:** To date, there are no established methods to estimate the synergistic effect of the independent risk factors on post-endoscopic retrograde cholangiopancreatography (ERCP) pancreatitis (PEP), and evidence of the efficacy of the combination of prophylactic measures for PEP should be discussed. Furthermore, ERCP indications in patients with asymptomatic common bile duct stones (CBDSs) and patients with suspected CBDS without evidence of stones by imaging are controversial. Further studies are warranted to estimate the synergistic effect of independent risk factors on PEP and to determine the best prophylactic measures as well as the appropriate candidates for ERCP among patients with asymptomatic CBDS and those with suspected CBDS.

**INTRODUCTION**

Endoscopic retrograde cholangiopancreatography (ERCP) is an essential therapeutic procedure for patients with biliopancreatic disorders. However, it is associated with high risks of procedure-related complications. Post-ERCP pancreatitis (PEP) is the most frequent complication, with an approximate rate of 3%-10%[1,2]. A meta-analysis of 108 randomized controlled trials revealed that the incidence of PEP was high at 14.7% [95% confidence interval (CI) 11.8%-17.7%] in high-risk patients, with one or more patient- and/or procedure-related risk factors for PEP[2]. Although most PEP cases are mild or moderate, severe PEP, which is potentially lethal, occurs in approximately 10% of the cases[1]. Therefore, it is important to reduce the incidence of PEP.

Recent guidelines published by the European Society of Gastrointestinal Endoscopy (ESGE) and the American Society for Gastrointestinal Endoscopy (ASGE) recommend prophylactic methods for reducing the incidence of PEP[3,4]. These guidelines encompass patient- and procedure-related risk factors associated with PEP and strategies for reducing the incidence of PEP, including patient selection, pharmacologic prophylaxis, and ERCP technique modifications. This opinion review discusses the current approaches used in PEP prevention and the questions yet to be resolved for the prophylaxis of PEP to further reduce the incidence of PEP.

**Risk factors for PEP**

Table 1 summarizes the independent risk factors for PEP included in the ESGE and ASGE guidelines for ERCP-related adverse events[3,4]. Specifically, the ESGE guideline categorizes independent PEP risk factors into definitive and likely risk factors, and patients with at least one definitive or two likely patient- or procedure-related risk factors are defined as those at a high risk for PEP[3].

Patients often harbor multiple risk factors for PEP; therefore, the potential synergistic effect of independent risk factors for PEP should be considered. A prospective multicenter study revealed the escalation of PEP risk in patients with multiple risk factors for PEP. The odds ratios in female gender alone, female gender plus normal serum bilirubin, and female gender plus normal serum bilirubin plus difficult cannulation were 2.5, 4.8 and 16.2, respectively[5]. Although scoring systems may be useful for estimating this synergistic effect[6-10], no established scoring system exists due to the limited number of studies. Furthermore, estimating the risk for PEP before ERCP is important for advanced counseling of patients on the specific risk for PEP. A recent study suggesting a disease-based PEP risk stratification approach for choledocholithiasis reported that the incidence rates of PEP were 13.7%, 7.3%, and 1.8% in patients with asymptomatic common bile duct stones (CBDSs), obstructive jaundice without cholangitis, and acute cholangitis, respectively[11]. Disease-based risk stratification may be a useful method for easily estimating the average risk for PEP before ERCP in patients with biliary and pancreatic diseases as the synergistic effect of the independent risk factors for PEP may differ among the wide range of diseases requiring ERCP. Furthermore, a study demonstrated that a large pancreatic volume was associated with high risk and increased severity of PEP[12]. Pancreatic volume based on pre-ERCP images may also be useful for predicting the risk for PEP prior to ERCP.

In summary, although several independent risk factors for PEP have been identified[3,4,13], further studies are warranted to establish the methods for estimating the synergistic effect of independent risk factors for PEP. If possible, advanced prediction of PEP before ERCP is desirable to properly counsel patients on the specific risk for PEP and to perform aggressive prophylaxis prior to ERCP based on the specific PEP risk of the patient.

**Patient selection**

Selection of appropriate candidates for ERCP is important to reduce the incidence of PEP associated with unnecessary ERCP. Patients with biliary and pancreatic diseases requiring drainage, such as malignant biliary and pancreatic strictures and symptomatic choledocholithiasis with imaging-based evidence of CBDSs, are strong candidates for ERCP. However, determining ERCP candidates may be difficult in patients with asymptomatic CBDSs and suspected choledocholithiasis with no imaging-based evidence of stones.

The ASGE and ESGE guidelines for the evaluation and management of choledocholithiasis recommend strategies for selecting ERCP candidates in patients with suspected CBDSs based on stratification into low-, intermediate-, and high-PEP-risk groups[14,15]. The criteria and treatment strategy for each risk group are presented in Table 2. In these guidelines, proceeding with ERCP is recommended in high-risk patients regardless of the imaging-based evidence of CBDSs. However, the high-diagnostic ability of imaging modalities, such as magnetic resonance cholangiopancreatography (MRCP) and endoscopic ultrasonography (EUS), has been recently described. Two meta-analyses reported that the sensitivity and specificity of EUS were 95%-97% and 87%-93%, and that the sensitivity and specificity of MRCP were 90%-97% and 92%-96%, respectively[16,17]. The rate of detecting even small CBDSs was high with EUS[16]. However, a systematic review and meta-analysis revealed that the mean sensitivity and specificity for the diagnosis of CBDSs were 23% (range, 18%-32%) and 89% (range, 70%-100%), respectively, when acute cholangitis was used to predict the presence of CBDSs in patients with suspected CBDSs[18]. Furthermore, one study reported that the sensitivity and specificity for the diagnosis of CBDSs were 19% and 96%, respectively, using the high-risk criteria of a total bilirubin level of above 4 mg/dL plus the presence of a dilated common bile duct (CBD) (> 6 mm in patients without cholecystectomy and > 8 mm in those with prior cholecystectomy)[19]. Therefore, high-risk criteria for diagnosis of CBDSs based on the clinical diagnosis, such as cholangitis features and dilated CBD with a total bilirubin level > 4 mg/dL without evidence of stones remains controversial. Patients with suspected CBDSs who exhibit imaging-based evidence of CBDSs are strong candidates for ERCP. However, it remains questionable whether ERCP is indicated in high-risk patients with no imaging-based evidence of stones, except for those with severe cholangitis requiring emergent biliary drainage.

Several studies have demonstrated that the incidence of PEP is significantly higher in patients with asymptomatic CBDSs, defined as the absence of abdominal symptoms and abnormal liver function tests, than in those with symptomatic CBDSs (12.5%-20.8% *vs* 3.7%-6.9%)[20-23], although only one study reported that the risk for PEP following ERCP performed by experienced endoscopists was comparable between patients with asymptomatic and symptomatic CBDSs[24]. Due to the absence of cholestasis, patients with asymptomatic CBDSs have normal total bilirubin levels and nondilated CBD, and can confound the assessment of patient-related risk factors for PEP[21]. Furthermore, floppy major duodenal papilla due to low bile duct pressure often results in difficult biliary cannulation in asymptomatic patients[21]. Therefore, the risk of PEP might be higher in patients with asymptomatic CBDSs, who are susceptible to the synergistic effect of the independent risk factors for PEP, than in those with symptomatic CBDSs.

Studies investigating the natural history of asymptomatic CBDSs have demonstrated that the cumulative incidence rate of biliary complications ranges from 0% to 29% during a median follow-up period of 30 days to 4.8 years[25-29]. Although available guidelines recommend endoscopic stone removal even in asymptomatic patients[14,15,30,31], prospective studies comparing the long-term outcomes between endoscopic treatment and the wait-and-see strategy for patients with asymptomatic CBDSs are warranted to determine whether routine endoscopic stone removal of asymptomatic CBDS is justified or not.

A recent study reported that the risk for PEP was lower in ERCP for choledocholithiasis with acute cholangitis than in ERCP for choledocholithiasis without acute cholangitis[32]. Although ESGE guideline for the endoscopic management of CBDS recommends elective ERCP for mild cholangitis, performing ERCP before improving cholangitis may be better in the view point of reducing the risk of PEP.

**Modifications in ERCP technique and pharmacological prophylaxis to reduce the incidence and severity of PEP**

***PEP prophylaxis during ERCP***

Recommendations for post-ERCP pancreatitis prophylaxis in ASGE and ESGE guidelines are presented in Table 3.

Prophylactic pancreatic stent placement is a well-known effective method for PEP prophylaxis. Several meta-analyses have indicated that prophylactic pancreatic stent is associated with the decreased overall incidence of PEP (odds ratio, 0.22-0.39) and decreased incidence of severe PEP[33-38]. However, evidence for the benefit of salvage pancreatic stenting in patients with PEP is lacking. Two studies demonstrated that salvage pancreatic stenting might be useful for the rapid resolution of PEP and halting progression to severe PEP[39,40]. The ESGE guidelines recommend against the use of salvage pancreatic stenting in patients with PEP due to the limited evidence; however, this approach has been recommended in select patients, such as those with PEP accompanied by severe abdominal pain and those with more than 10-fold increase in serum amylase levels[3].

Pancreatic injection is a procedure-related definitive risk factor for PEP[3]. The use of low-osmolality contrast media, which might be less harmful for the epithelium of pancreatic duct compared with high-osmolality contrast media[41], may be a possible approach to prevent PEP. However, studies evaluating the efficacy of low-osmolality contrast medium for PEP prevention have reported contradictory findings[41-44].

Difficult biliary cannulation is another definitive risk factor for PEP[3,4]. Although the definition of difficult cannulation varies among the previous studies, the ESGE guidelines for papillary cannulation and sphincterotomy technique in ERCP define difficult cannulation as cases fulfilling one or more of several criteria, such as more than five contacts with the major duodenal papilla during the cannulation attempt, cannulation attempt lasting more than 5 min after the visualization of the papilla, and more than one unintended cannulation or opacification of the pancreatic duct[45]. In cases with difficult biliary cannulation, pancreatic guidewire-assisted cannulation and precut sphincterotomy are used as well-known rescue techniques. Several studies have demonstrated the safety and efficacy of early precut sphincterotomy in reducing the risk of PEP. A recent systematic review and network meta-analysis revealed that early precut sphincterotomy was associated with increased successful biliary cannulation and reduced incidence of PEP compared with the standard cannulation technique and pancreatic guidewire-assisted cannulation[46]. Furthermore, a retrospective study demonstrated that the second ERCP after the failure of initial biliary cannulation following precut sphincterotomy should be performed at least 4 days after the first ERCP[47]. However, a few studies investigated the efficacy and safety of the early use of double-guidewire technique. A randomized controlled trial revealed that the early use of double-guidewire technique increased the rate of successful biliary cannulation and that the incidence of PEP was similar between the double-guidewire technique and the repeated use of single-guidewire technique[48]. Another randomized controlled trial demonstrated that the early use of double-guidewire technique did not facilitate successful biliary cannulation and did not reduce the incidence of PEP[49]. Further studies are warranted to evaluate the efficacy and safety of early use of pancreatic guidewire-assisted cannulation. Furthermore, the optimal timing for the rescue cannulation technique is unclear, although one study suggested that attempting biliary cannulation for 5 min might be a valid cutoff for the implementation of the rescue technique[50].

***Pharmacologic methods for PEP prophylaxis***

Rectal nonsteroidal anti-inflammatory drugs (NSAIDs) are consistently recommended as pharmacologic prophylaxis for PEP in the current guidelines[3,4]. Rectal diclofenac and indomethacin are considered to have a similar beneficial effect for the prophylaxis of PEP, and the rectal NSAID dose of 100 mg is recommended in the ASGE and ESGE guidelines[3,4]. However, the rectal NSAID dose of 100 mg may be too high for elderly patients or those with low body weight, especially among Asian populations. A randomized controlled trial revealed that the incidence of PEP was significantly lower in patients who were administrated 25-50-mg rectal NSAIDs than in those who were not administered rectal NSAIDs [3.9% (2/51) *vs* 18.9% (10/53)][51]. However, several retrospective and prospective studies demonstrated that low-dose rectal NSAIDs were not useful for reducing the risk for PEP[52-54]. Further studies are warranted to determine the optimal rectal NSAID dose in elderly patients and in those with low body weight. Studies investigating the combination of rectal NSAIDs with other prophylactic approaches for PEP found no difference in the PEP incidence between rectal NSAIDs alone and rectal NSAIDs in combination with prophylactic pancreatic stenting[55-57]. However, a recent study demonstrated that the combined approach of rectal NSIADs and prophylactic pancreatic stenting was useful for preventing PEP in patients undergoing ERCP using the double-guidewire technique[58].

Aggressive hydration is recognized as a useful method for PEP prophylaxis[3]. Recent meta-analyses revealed that aggressive hydration with the lactated Ringer’s solution of 35-45 mL/kg administrated during 8-10 h contributed to reduce the incidence of PEP with odds ratios of 0.29–0.47[59-61]. Furthermore, aggressive hydration was associated with the decreased moderate to severe PEP with the odds ratio of 0.16[59], and there were no differences in fluid overload-related complications[60,61]. While several studies reported that rectal NSAIDs plus hydration was an effective combination for the prevention of PEP[37,62-65], others reported no benefit with this approach[66,67]. A recent network meta-analysis of 24 randomized controlled trials demonstrated that a combination of rectal indomethacin and aggressive hydration is the best conservative approach for prophylaxis of PEP with preventive efficacy 70%-99% higher than that of single prophylaxis[64]. In recent years, with the increasing implementation of prophylactic measures for PEP, the combination of various approaches is often selected in clinical practice[68]. Further studies are warranted to solve the dilemma of combining specific approaches for PEP prophylaxis.

**CONCLUSION**

Estimation of the PEP risk based on patient- and procedure-related risk factors, patient selection for ERCP, and technical and pharmacological prophylaxis for PEP are important aspects to be considered to reduce the incidence of PEP following ERCP. Although several independent patient- and procedure-related risk factors for PEP have been identified, methods for estimating the synergistic effect of these risk factors on PEP incidence should be established in future studies. Regarding patient selection, whether routine ERCP in cases of asymptomatic CBDSs and highly suspected CBDSs without imaging-based evidence of stones is warranted should be discussed. Furthermore, although independent prophylactic measures such as rectal NSAIDs and prophylactic pancreatic stenting have been implemented, further studies are warranted to determine the best prophylactic measures for PEP, including the combination of independent prophylactic measures.

**REFERENCES**

1 **Andriulli A**, Loperfido S, Napolitano G, Niro G, Valvano MR, Spirito F, Pilotto A, Forlano R. Incidence rates of post-ERCP complications: a systematic survey of prospective studies. *Am J Gastroenterol* 2007; **102**: 1781-1788 [PMID: 17509029 DOI: 10.1111/j.1572-0241.2007.01279.x]

2 **Kochar B**, Akshintala VS, Afghani E, Elmunzer BJ, Kim KJ, Lennon AM, Khashab MA, Kalloo AN, Singh VK. Incidence, severity, and mortality of post-ERCP pancreatitis: a systematic review by using randomized, controlled trials. *Gastrointest Endosc* 2015; **81**: 143-149.e9 [PMID: 25088919 DOI: 10.1016/j.gie.2014.06.045]

3 **Dumonceau JM**, Kapral C, Aabakken L, Papanikolaou IS, Tringali A, Vanbiervliet G, Beyna T, Dinis-Ribeiro M, Hritz I, Mariani A, Paspatis G, Radaelli F, Lakhtakia S, Veitch AM, van Hooft JE. ERCP-related adverse events: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. *Endoscopy* 2020; **52**: 127-149 [PMID: 31863440 DOI: 10.1055/a-1075-4080]

4 **ASGE Standards of Practice Committee**, Chandrasekhara V, Khashab MA, Muthusamy VR, Acosta RD, Agrawal D, Bruining DH, Eloubeidi MA, Fanelli RD, Faulx AL, Gurudu SR, Kothari S, Lightdale JR, Qumseya BJ, Shaukat A, Wang A, Wani SB, Yang J, DeWitt JM. Adverse events associated with ERCP. *Gastrointest Endosc* 2017; **85**: 32-47 [PMID: 27546389 DOI: 10.1016/j.gie.2016.06.051]

5 **Freeman ML**, DiSario JA, Nelson DB, Fennerty MB, Lee JG, Bjorkman DJ, Overby CS, Aas J, Ryan ME, Bochna GS, Shaw MJ, Snady HW, Erickson RV, Moore JP, Roel JP. Risk factors for post-ERCP pancreatitis: a prospective, multicenter study. *Gastrointest Endosc* 2001; **54**: 425-434 [PMID: 11577302 DOI: 10.1067/mge.2001.117550]

6 **Friedland S**, Soetikno RM, Vandervoort J, Montes H, Tham T, Carr-Locke DL. Bedside scoring system to predict the risk of developing pancreatitis following ERCP. *Endoscopy* 2002; **34**: 483-488 [PMID: 12048633 DOI: 10.1055/s-2002-32004]

7 **Jeurnink SM**, Siersema PD, Steyerberg EW, Dees J, Poley JW, Haringsma J, Kuipers EJ. Predictors of complications after endoscopic retrograde cholangiopancreatography: a prognostic model for early discharge. *Surg Endosc* 2011; **25**: 2892-2900 [PMID: 21455806 DOI: 10.1007/s00464-011-1638-9]

8 **DiMagno MJ**, Spaete JP, Ballard DD, Wamsteker EJ, Saini SD. Risk models for post-endoscopic retrograde cholangiopancreatography pancreatitis (PEP): smoking and chronic liver disease are predictors of protection against PEP. *Pancreas* 2013; **42**: 996-1003 [PMID: 23532001 DOI: 10.1097/MPA.0b013e31827e95e9]

9 **Park CH**, Park SW, Yang MJ, Moon SH, Park DH. Pre- and post-procedure risk prediction models for post-endoscopic retrograde cholangiopancreatography pancreatitis. *Surg Endosc* 2022; **36**: 2052-2061 [PMID: 34231067 DOI: 10.1007/s00464-021-08491-1]

10 **Fujita K**, Yazumi S, Uza N, Kurita A, Asada M, Kodama Y, Goto M, Katayama T, Anami T, Watanabe A, Sugahara A, Mukai H, Kawamura T. New practical scoring system to predict post-endoscopic retrograde cholangiopancreatography pancreatitis: Development and validation. *JGH Open* 2021; **5**: 1078-1084 [PMID: 34584978 DOI: 10.1002/jgh3.12634]

11 **Saito H**, Sakaguchi M, Kadono Y, Shono T, Kamikawa K, Urata A, Nasu J, Imamura H, Matsushita I, Kakuma T, Tada S. Disease-Based Risk Stratification of Postendoscopic Retrograde Cholangiopancreatography Pancreatitis for Common Bile Duct Stones. *Dig Dis Sci* 2022; **67**: 305-314 [PMID: 33471253 DOI: 10.1007/s10620-021-06825-6]

12 **Maruyama H**, Shiba M, Ishikawa-Kakiya Y, Kato K, Ominami M, Fukunaga S, Otani K, Hosomi S, Tanaka F, Kamata N, Taira K, Nagami Y, Yamagami H, Tanigawa T, Watanabe T, Yamamoto A, Kabata D, Shintani A, Fujiwara Y. Positive correlation between pancreatic volume and post-endoscopic retrograde cholangiopancreatography pancreatitis. *J Gastroenterol Hepatol* 2020; **35**: 769-776 [PMID: 31618801 DOI: 10.1111/jgh.14878]

13 **Ding X**, Zhang F, Wang Y. Risk factors for post-ERCP pancreatitis: A systematic review and meta-analysis. *Surgeon* 2015; **13**: 218-229 [PMID: 25547802 DOI: 10.1016/j.surge.2014.11.005]

14 **ASGE Standards of Practice Committee**, Buxbaum JL, Abbas Fehmi SM, Sultan S, Fishman DS, Qumseya BJ, Cortessis VK, Schilperoort H, Kysh L, Matsuoka L, Yachimski P, Agrawal D, Gurudu SR, Jamil LH, Jue TL, Khashab MA, Law JK, Lee JK, Naveed M, Sawhney MS, Thosani N, Yang J, Wani SB. ASGE guideline on the role of endoscopy in the evaluation and management of choledocholithiasis. *Gastrointest Endosc* 2019; **89**: 1075-1105.e15 [PMID: 30979521 DOI: 10.1016/j.gie.2018.10.001]

15 **Manes G**, Paspatis G, Aabakken L, Anderloni A, Arvanitakis M, Ah-Soune P, Barthet M, Domagk D, Dumonceau JM, Gigot JF, Hritz I, Karamanolis G, Laghi A, Mariani A, Paraskeva K, Pohl J, Ponchon T, Swahn F, Ter Steege RWF, Tringali A, Vezakis A, Williams EJ, van Hooft JE. Endoscopic management of common bile duct stones: European Society of Gastrointestinal Endoscopy (ESGE) guideline. *Endoscopy* 2019; **51**: 472-491 [PMID: 30943551 DOI: 10.1055/a-0862-0346]

16 **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**: 986-993 [PMID: 28645544 DOI: 10.1016/j.gie.2017.06.009]

17 **Giljaca V**, Gurusamy KS, Takwoingi Y, Higgie D, Poropat G, Štimac D, Davidson BR. Endoscopic ultrasound *vs* magnetic resonance cholangiopancreatography for common bile duct stones. *Cochrane Database Syst Rev* 2015: CD011549 [PMID: 25719224 DOI: 10.1002/14651858.CD011549]

18 **Wang L**, Mirzaie S, Dunnsiri T, Chen F, Wilhalme H, MacQueen IT, Cryer H, Eastoak-Siletz A, Guan M, Cuff C, Tabibian JH. Systematic review and meta-analysis of the 2010 ASGE non-invasive predictors of choledocholithiasis and comparison to the 2019 ASGE predictors. *Clin J Gastroenterol* 2022; **15**: 286-300 [PMID: 35072902 DOI: 10.1007/s12328-021-01575-4]

19 **He H**, Tan C, Wu J, Dai N, Hu W, Zhang Y, Laine L, Scheiman J, Kim JJ. Accuracy of ASGE high-risk criteria in evaluation of patients with suspected common bile duct stones. *Gastrointest Endosc* 2017; **86**: 525-532 [PMID: 28174126 DOI: 10.1016/j.gie.2017.01.039]

20 **Kim SB**, Kim KH, Kim TN. Comparison of Outcomes and Complications of Endoscopic Common Bile Duct Stone Removal Between Asymptomatic and Symptomatic Patients. *Dig Dis Sci* 2016; **61**: 1172-1177 [PMID: 26589817 DOI: 10.1007/s10620-015-3965-5]

21 **Saito H**, Koga T, Sakaguchi M, Kadono Y, Kamikawa K, Urata A, Imamura H, Tada S, Kakuma T, Matsushita I. Post-endoscopic retrograde cholangiopancreatography pancreatitis in patients with asymptomatic common bile duct stones. *J Gastroenterol Hepatol* 2019; **34**: 1153-1159 [PMID: 30650203 DOI: 10.1111/jgh.14604]

22 **Xu XD**, Qian JQ, Dai JJ, Sun ZX. Endoscopic treatment for choledocholithiasis in asymptomatic patients. *J Gastroenterol Hepatol* 2020; **35**: 165-169 [PMID: 31334888 DOI: 10.1111/jgh.14790]

23 **Kadokura M**, Takenaka Y, Yoda H, Yasumura T, Okuwaki T, Tanaka K, Amemiya F. Asymptomatic Common Bile Duct Stones Are Associated with Increased Risk of Post-Endoscopic Retrograde Cholangiopancreatography Pancreatitis. *JMA J* 2021; **4**: 141-147 [PMID: 33997448 DOI: 10.31662/jmaj.2020-0123]

24 **Xiao L**, Geng C, Li X, Li Y, Wang C. Comparable safety of ERCP in symptomatic and asymptomatic patients with common bile duct stones: a propensity-matched analysis. *Scand J Gastroenterol* 2021; **56**: 111-117 [PMID: 33295209 DOI: 10.1080/00365521.2020.1853222]

25 **Ammori BJ**, Birbas K, Davides D, Vezakis A, Larvin M, McMahon MJ. Routine *vs* "on demand" postoperative ERCP for small bile duct calculi detected at intraoperative cholangiography. Clinical evaluation and cost analysis. *Surg Endosc* 2000; **14**: 1123-1126 [PMID: 11148780 DOI: 10.1007/s004640000146]

26 **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 [PMID: 14685097 DOI: 10.1097/01.sla.0000103069.00170.9c]

27 **Caddy GR**, Kirby J, Kirk SJ, Allen MJ, Moorehead RJ, Tham TC. Natural history of asymptomatic bile duct stones at time of cholecystectomy. *Ulster Med J* 2005; **74**: 108-112 [PMID: 16235763]

28 **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**: 1008-1013 [PMID: 25133326 DOI: 10.1001/jamasurg.2014.249]

29 **Hakuta R**, Hamada T, Nakai Y, Oyama H, Kanai S, Suzuki T, Sato T, Ishigaki K, Saito K, Saito T, Takahara N, Mizuno S, Kogure H, Watadani T, Tsujino T, Tada M, Abe O, Isayama H, Koike K. Natural history of asymptomatic bile duct stones and association of endoscopic treatment with clinical outcomes. *J Gastroenterol* 2020; **55**: 78-85 [PMID: 31473828 DOI: 10.1007/s00535-019-01612-7]

30 **Williams E**, Beckingham I, El Sayed G, Gurusamy K, Sturgess R, Webster G, Young T. Updated guideline on the management of common bile duct stones (CBDS). *Gut* 2017; **66**: 765-782 [PMID: 28122906 DOI: 10.1136/gutjnl-2016-312317]

31 **Tazuma S**, Unno M, Igarashi Y, Inui K, Uchiyama K, Kai M, Tsuyuguchi T, Maguchi H, Mori T, Yamaguchi K, Ryozawa S, Nimura Y, Fujita N, Kubota K, Shoda J, Tabata M, Mine T, Sugano K, Watanabe M, Shimosegawa T. Evidence-based clinical practice guidelines for cholelithiasis 2016. *J Gastroenterol* 2017; **52**: 276-300 [PMID: 27942871 DOI: 10.1007/s00535-016-1289-7]

32 **Saito H**, Kadono Y, Shono T, Kamikawa K, Urata A, Nasu J, Imamura H, Matsushita I, Kakuma T, Tada S. Increased post-endoscopic retrograde cholangiopancreatography pancreatitis for choledocholithiasis without acute cholangitis. *J Gastroenterol Hepatol* 2022; **37**: 327-334 [PMID: 34626433 DOI: 10.1111/jgh.15704]

33 **Vadalà di Prampero SF**, Faleschini G, Panic N, Bulajic M. Endoscopic and pharmacological treatment for prophylaxis against postendoscopic retrograde cholangiopancreatography pancreatitis: a meta-analysis and systematic review. *Eur J Gastroenterol Hepatol* 2016; **28**: 1415-1424 [PMID: 27580214 DOI: 10.1097/MEG.0000000000000734]

34 **Fan JH**, Qian JB, Wang YM, Shi RH, Zhao CJ. Updated meta-analysis of pancreatic stent placement in preventing post-endoscopic retrograde cholangiopancreatography pancreatitis. *World J Gastroenterol* 2015; **21**: 7577-7583 [PMID: 26140006 DOI: 10.3748/wjg.v21.i24.7577]

35 **Mazaki T**, Mado K, Masuda H, Shiono M. Prophylactic pancreatic stent placement and post-ERCP pancreatitis: an updated meta-analysis. *J Gastroenterol* 2014; **49**: 343-355 [PMID: 23612857 DOI: 10.1007/s00535-013-0806-1]

36 **Shi QQ**, Ning XY, Zhan LL, Tang GD, Lv XP. Placement of prophylactic pancreatic stents to prevent post-endoscopic retrograde cholangiopancreatography pancreatitis in high-risk patients: a meta-analysis. *World J Gastroenterol* 2014; **20**: 7040-7048 [PMID: 24944500 DOI: 10.3748/wjg.v20.i22.7040]

37 **Akshintala VS**, Sperna Weiland CJ, Bhullar FA, Kamal A, Kanthasamy K, Kuo A, Tomasetti C, Gurakar M, Drenth JPH, Yadav D, Elmunzer BJ, Reddy DN, Goenka MK, Kochhar R, Kalloo AN, Khashab MA, van Geenen EJM, Singh VK. Non-steroidal anti-inflammatory drugs, intravenous fluids, pancreatic stents, or their combinations for the prevention of post-endoscopic retrograde cholangiopancreatography pancreatitis: a systematic review and network meta-analysis. *Lancet Gastroenterol Hepatol* 2021; **6**: 733-742 [PMID: 34214449 DOI: 10.1016/S2468-1253(21)00170-9]

38 **Choudhary A**, Bechtold ML, Arif M, Szary NM, Puli SR, Othman MO, Pais WP, Antillon MR, Roy PK. Pancreatic stents for prophylaxis against post-ERCP pancreatitis: a meta-analysis and systematic review. *Gastrointest Endosc* 2011; **73**: 275-282 [PMID: 21295641 DOI: 10.1016/j.gie.2010.10.039]

39 **Kerdsirichairat T**, Attam R, Arain M, Bakman Y, Radosevich D, Freeman M. Urgent ERCP with pancreatic stent placement or replacement for salvage of post-ERCP pancreatitis. *Endoscopy* 2014; **46**: 1085-1094 [PMID: 25216326 DOI: 10.1055/s-0034-1377750]

40 **Madácsy L**, Kurucsai G, Joó I, Gódi S, Fejes R, Székely A. Rescue ERCP and insertion of a small-caliber pancreatic stent to prevent the evolution of severe post-ERCP pancreatitis: a case-controlled series. *Surg Endosc* 2009; **23**: 1887-1893 [PMID: 19057957 DOI: 10.1007/s00464-008-0199-z]

41 **Ogura T**, Imoto A, Okuda A, Fukunishi S, Higuchi K. Can Iodixanol Prevent Post-Endoscopic Retrograde Cholangiopancreatography Pancreatitis? A Prospective, Randomized, Controlled Trial. *Dig Dis* 2019; **37**: 255-261 [PMID: 30654370 DOI: 10.1159/000496349]

42 **Nagashima K**, Ijima M, Kimura K, Kurihara E, Tominaga K, Fukushi K, Kanamori A, Otake Y, Irisawa A. Does the Use of Low Osmolality Contrast Medium Reduce the Frequency of Post-Endoscopic Retrograde Cholangiopancreatography Pancreatitis: A Comparative Study between Use of Low and High Osmolality Contrast Media. *Digestion* 2021; **102**: 283-288 [PMID: 31770751 DOI: 10.1159/000504702]

43 **George S**, Kulkarni AA, Stevens G, Forsmark CE, Draganov P. Role of osmolality of contrast media in the development of post-ERCP pancreatitis: a metanalysis. *Dig Dis Sci* 2004; **49**: 503-508 [PMID: 15139506 DOI: 10.1023/b:ddas.0000020511.98230.20]

44 **Goebel C**, Hardt P, Doppl W, Temme H, Hackstein N, Klör HU. Frequency of pancreatitis after endoscopic retrograde cholangiopancreatography with iopromid or iotrolan: a randomized trial. *Eur Radiol* 2000; **10**: 677-680 [PMID: 10795554 DOI: 10.1007/s003300050983]

45 **Testoni PA**, Mariani A, Aabakken L, Arvanitakis M, Bories E, Costamagna G, Devière J, Dinis-Ribeiro M, Dumonceau JM, Giovannini M, Gyokeres T, Hafner M, Halttunen J, Hassan C, Lopes L, Papanikolaou IS, Tham TC, Tringali A, van Hooft J, Williams EJ. Papillary cannulation and sphincterotomy techniques at ERCP: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline. *Endoscopy* 2016; **48**: 657-683 [PMID: 27299638 DOI: 10.1055/s-0042-108641]

46 **Facciorusso A**, Ramai D, Gkolfakis P, Khan SR, Papanikolaou IS, Triantafyllou K, Tringali A, Chandan S, Mohan BP, Adler DG. Comparative efficacy of different methods for difficult biliary cannulation in ERCP: systematic review and network meta-analysis. *Gastrointest Endosc* 2022; **95**: 60-71.e12 [PMID: 34543649 DOI: 10.1016/j.gie.2021.09.010]

47 **Colan-Hernandez J**, Aldana A, Concepción M, Chavez K, Gómez C, Mendez-Bocanegra A, Martínez-Guillen M, Sendino O, Villanueva C, Llach J, Guarner-Argente C, Cárdenas A, Guarner C. Optimal timing for a second ERCP after failure of initial biliary cannulation following precut sphincterotomy: an analysis of experience at two tertiary centers. *Surg Endosc* 2017; **31**: 3711-3717 [PMID: 28127713 DOI: 10.1007/s00464-016-5410-z]

48 **Sasahira N**, Kawakami H, Isayama H, Uchino R, Nakai Y, Ito Y, Matsubara S, Ishiwatari H, Uebayashi M, Yagioka H, Togawa O, Toda N, Sakamoto N, Kato J, Koike K. Early use of double-guidewire technique to facilitate selective bile duct cannulation: the multicenter randomized controlled EDUCATION trial. *Endoscopy* 2015; **47**: 421-429 [PMID: 25590186 DOI: 10.1055/s-0034-1391228]

49 **Laquière A**, Privat J, Jacques J, Legros R, Urena-Campos R, Belkhodja H, Subtil C, Kanafi L, Lecomte L, Boustière C, Katsogiannou M, Karsenti D. Early double-guidewire *vs* repeated single-guidewire technique to facilitate selective bile duct cannulation: a randomized controlled trial. *Endoscopy* 2022; **54**: 120-127 [PMID: 33860484 DOI: 10.1055/a-1395-7485]

50 **Lee YS**, Cho CM, Cho KB, Heo J, Jung MK, Kim SB, Kim KH, Kim TN, Lee DW, Han J, Kim HG, Kim D, Kim H. Difficult Biliary Cannulation from the Perspective of Post-Endoscopic Retrograde Cholangiopancreatography Pancreatitis: Identifying the Optimal Timing for the Rescue Cannulation Technique. *Gut Liver* 2021; **15**: 459-465 [PMID: 32000469 DOI: 10.5009/gnl19304]

51 **Otsuka T**, Kawazoe S, Nakashita S, Kamachi S, Oeda S, Sumida C, Akiyama T, Ario K, Fujimoto M, Tabuchi M, Noda T. Low-dose rectal diclofenac for prevention of post-endoscopic retrograde cholangiopancreatography pancreatitis: a randomized controlled trial. *J Gastroenterol* 2012; **47**: 912-917 [PMID: 22350703 DOI: 10.1007/s00535-012-0554-7]

52 **Tomoda T**, Kato H, Miyamoto K, Matsumi A, Ueta E, Fujii Y, Saragai Y, Yamazaki T, Uchida D, Matsumoto K, Horiguchi S, Tsutsumi K, Okada H. Efficacy of low dose rectal diclofenac for preventing post-endoscopic retrograde cholangiopancreatography pancreatitis: Propensity score-matched analysis. *Dig Endosc* 2021; **33**: 656-662 [PMID: 32881078 DOI: 10.1111/den.13828]

53 **Katoh T**, Kawashima K, Fukuba N, Masuda S, Kobatake H, Masaki K, Araki Y, Kawano K, Nishi K, Takenaka M, Ishihara S, Kinoshita Y. Low-dose rectal diclofenac does not prevent post-ERCP pancreatitis in low- or high-risk patients. *J Gastroenterol Hepatol* 2020; **35**: 1247-1253 [PMID: 31788849 DOI: 10.1111/jgh.14948]

54 **Takaori A**, Ikeura T, Hori Y, Ito T, Nakamaru K, Masuda M, Mitsuyama T, Miyoshi H, Shimatani M, Takaoka M, Okazaki K, Naganuma M. Rectally Administered Low-Dose Diclofenac Has No Effect on Preventing Post-Endoscopic Retrograde Cholangiopancreatography Pancreatitis: A Propensity Score Analysis. *Pancreas* 2021; **50**: 1024-1029 [PMID: 34629455 DOI: 10.1097/MPA.0000000000001877]

55 **Elmunzer BJ**, Higgins PD, Saini SD, Scheiman JM, Parker RA, Chak A, Romagnuolo J, Mosler P, Hayward RA, Elta GH, Korsnes SJ, Schmidt SE, Sherman S, Lehman GA, Fogel EL; United States Cooperative for Outcomes Research in Endoscopy. Does rectal indomethacin eliminate the need for prophylactic pancreatic stent placement in patients undergoing high-risk ERCP? Post hoc efficacy and cost-benefit analyses using prospective clinical trial data. *Am J Gastroenterol* 2013; **108**: 410-415 [PMID: 23295278 DOI: 10.1038/ajg.2012.442]

56 **Abdelfatah MM**, Gochanour E, Koutlas NJ, Othman MO. Post-Endoscopic Retrograde Cholangiopancreatography Pancreatitis: Single Versus Dual Prophylactic Modalities. *Pancreas* 2019; **48**: e24 [PMID: 30973466 DOI: 10.1097/MPA.0000000000001281]

57 **Sotoudehmanesh R**, Ali-Asgari A, Khatibian M, Mohamadnejad M, Merat S, Sadeghi A, Keshtkar A, Bagheri M, Delavari A, Amani M, Vahedi H, Nasseri-Moghaddam S, Sima A, Eloubeidi MA, Malekzadeh R. Pharmacological prophylaxis *vs* pancreatic duct stenting plus pharmacological prophylaxis for prevention of post-ERCP pancreatitis in high risk patients: a randomized trial. *Endoscopy* 2019; **51**: 915-921 [PMID: 31454851 DOI: 10.1055/a-0977-3119]

58 **Wang X**, Luo H, Luo B, Ren G, Liang S, Wang X, Tao Q, Zhang L, Kang X, Guo X, Pan Y. Combination prevention of post-endoscopic retrograde cholangiopancreatography pancreatitis in patients undergoing double-guidewire assisted biliary cannulation: A case-control study with propensity score matching. *J Gastroenterol Hepatol* 2021; **36**: 1905-1912 [PMID: 33444486 DOI: 10.1111/jgh.15402]

59 **Wu D**, Wan J, Xia L, Chen J, Zhu Y, Lu N. The Efficiency of Aggressive Hydration With Lactated Ringer Solution for the Prevention of Post-ERCP Pancreatitis: A Systematic Review and Meta-analysis. *J Clin Gastroenterol* 2017; **51**: e68-e76 [PMID: 28609383 DOI: 10.1097/MCG.0000000000000856]

60 **Zhang ZF**, Duan ZJ, Wang LX, Zhao G, Deng WG. Aggressive Hydration With Lactated Ringer Solution in Prevention of Postendoscopic Retrograde Cholangiopancreatography Pancreatitis: A Meta-analysis of Randomized Controlled Trials. *J Clin Gastroenterol* 2017; **51**: e17-e26 [PMID: 28178088 DOI: 10.1097/MCG.0000000000000781]

61 **Radadiya D**, Devani K, Arora S, Charilaou P, Brahmbhatt B, Young M, Reddy C. Peri-Procedural Aggressive Hydration for Post Endoscopic Retrograde Cholangiopancreatography (ERCP) Pancreatitis Prophylaxsis: Meta-analysis of Randomized Controlled Trials. *Pancreatology* 2019; **19**: 819-827 [PMID: 31383573 DOI: 10.1016/j.pan.2019.07.046]

62 **Radadiya D**, Brahmbhatt B, Reddy C, Devani K. Efficacy of Combining Aggressive Hydration With Rectal Indomethacin in Preventing Post-ERCP Pancreatitis: A Systematic Review and Network Meta-Analysis. *J Clin Gastroenterol* 2022; **56**: e239-e249 [PMID: 33769395 DOI: 10.1097/MCG.0000000000001523]

63 **Oh HC**, Kang H, Park TY, Choi GJ, Lehman GA. Prevention of post-endoscopic retrograde cholangiopancreatography pancreatitis with a combination of pharmacological agents based on rectal non-steroidal anti-inflammatory drugs: A systematic review and network meta-analysis. *J Gastroenterol Hepatol* 2021; **36**: 1403-1413 [PMID: 33068012 DOI: 10.1111/jgh.15303]

64 **Márta K**, Gede N, Szakács Z, Solymár M, Hegyi PJ, Tél B, Erőss B, Vincze Á, Arvanitakis M, Boškoski I, Bruno MJ, Hegyi P. Combined use of indomethacin and hydration is the best conservative approach for post-ERCP pancreatitis prevention: A network meta-analysis. *Pancreatology* 2021; **21**: 1247-1255 [PMID: 34353727 DOI: 10.1016/j.pan.2021.07.005]

65 **Mok SRS**, Ho HC, Shah P, Patel M, Gaughan JP, Elfant AB. Lactated Ringer's solution in combination with rectal indomethacin for prevention of post-ERCP pancreatitis and readmission: a prospective randomized, double-blinded, placebo-controlled trial. *Gastrointest Endosc* 2017; **85**: 1005-1013 [PMID: 27816497 DOI: 10.1016/j.gie.2016.10.033]

66 **Sperna Weiland CJ**, Smeets XJNM, Kievit W, Verdonk RC, Poen AC, Bhalla A, Venneman NG, Witteman BJM, da Costa DW, van Eijck BC, Schwartz MP, Römkens TEH, Vrolijk JM, Hadithi M, Voorburg AMCJ, Baak LC, Thijs WJ, van Wanrooij RL, Tan ACITL, Seerden TCJ, Keulemans YCA, de Wijkerslooth TR, van de Vrie W, van der Schaar P, van Dijk SM, Hallensleben NDL, Sperna Weiland RL, Timmerhuis HC, Umans DS, van Hooft JE, van Goor H, van Santvoort HC, Besselink MG, Bruno MJ, Fockens P, Drenth JPH, van Geenen EJM; Dutch Pancreatitis Study Group. Aggressive fluid hydration plus non-steroidal anti-inflammatory drugs *vs* non-steroidal anti-inflammatory drugs alone for post-endoscopic retrograde cholangiopancreatography pancreatitis (FLUYT): a multicentre, open-label, randomised, controlled trial. *Lancet Gastroenterol Hepatol* 2021; **6**: 350-358 [PMID: 33740415 DOI: 10.1016/S2468-1253(21)00057-1]

67 **Del Olmo Martínez ML**, Velayos Jiménez B, Almaraz-Gómez A. Hydration with Lactated Ringer's solution combined with rectal diclofenac in the prevention of pancreatitis after endoscopic retrograde cholangiopancreatography. *Gastroenterol Hepatol* 2021; **44**: 20-26 [PMID: 32674877 DOI: 10.1016/j.gastrohep.2020.03.014]

68 **Sperna Weiland CJ**, Engels MML, Poen AC, Bhalla A, Venneman NG, van Hooft JE, Bruno MJ, Verdonk RC, Fockens P, Drenth JPH, van Geenen EJM; Dutch Pancreatitis Study Group. Increased Use of Prophylactic Measures in Preventing Post-Endoscopic Retrograde Cholangiopancreatography Pancreatitis. *Dig Dis Sci* 2021; **66**: 4457-4466 [PMID: 33630216 DOI: 10.1007/s10620-020-06796-0]

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**Table 1 Risk factors for post-endoscopic retrograde cholangiopancreatography pancreatitis in the European Society of Gastrointestinal Endoscopy and American Society for Gastrointestinal Endoscopy guidelines**

|  |  |
| --- | --- |
| **ESGE guideline** | **ASGE guideline** |
| **Patient-related definitive risk factors** | **Patient-related risk factors** |
| Suspected sphincter of Oddi dysfunction | Suspected sphincter of Oddi dysfunction |
| Female sex | Female sex |
| Previous pancreatitis | Previous recurrent pancreatitis |
| Previous post-ERCP pancreatitis | Previous post-ERCP pancreatitis |
| **Procedure-related definitive risk factors** | Younger age |
| Difficult cannulation | Absence of chronic pancreatitis |
| More than one pancreatic guidewire passage | Normal serum bilirubin |
| Pancreatic injection | **Procedure-related risk factors** |
| **Patient-related likely risk factors** | Difficult cannulation (> 10 min) |
| Younger age | Repeated pancreatic guidewire cannulation |
| Nondilated extrahepatic bile duct | Pancreatic injection |
| Absence of chronic pancreatitis | Endoscopic papillary large-balloon dilation of a native papilla |
| Normal serum bilirubin |  |
| End-stage renal failure |  |
| **Procedure-related likely risk factors** |  |
| Precut sphincterotomy |  |
| Pancreatic sphincterotomy |  |
| Papillary balloon dilation |  |
| Unsuccessful clearance of bile duct stones |  |
| Intraductal ultrasound |  |

ASGE: American Society for Gastrointestinal Endoscopy; ERCP: Endoscopic retrograde cholangiopancreatography; ESGE: European Society of Gastrointestinal Endoscopy.

**Table 2 Recommended strategies for suspected common bile duct stones in patients with symptomatic cholelithiasis based on the ESGE and ASGE guidelines**

|  |  |
| --- | --- |
| **ESGE guideline** | **ASGE guideline** |
| Likelihood | Predictors | Recommended strategy | Predictors | Recommended strategy |
| Low | Normal liver function tests and no CBD dilation at US | Proceed to cholecystectomy |  No predictors |  Cholecystectomy with/without laparoscopic cholangiography (IOC) or intraoperative US |
| Intermediate | Abnormal liver function tests and/or dilated CBD on US | Perform EUS/MRCP | Abnormal liver function tests or age > 55 years or dilated CBD on US/cross-sectional imaging | Perform EUS/MRCP, laparoscopic IOC, or intraoperative US |
| High | CBDSs identified at US or features of cholangitis | Proceed to ERCP  | CBDSs identified at US/cross-sectional imaging  | Proceed to ERCP |
| or features of cholangitis or dilated CBD with total bilirubin > 4 mg/dL on US/cross-sectional imaging |

ASGE: American Society for Gastrointestinal Endoscopy; CBD: Common bile duct; CBDSs: Common bile duct stones; ERCP: Endoscopic retrograde cholangiopancreatography; ESGE: European Society of Gastrointestinal Endoscopy; EUS: Endoscopic ultrasonography; MRCP: Magnetic resonance cholangiopancreatography; US: Ultrasonography.

**Table 3** **Recommendations for post-endoscopic retrograde cholangiopancreatography pancreatitis prophylaxis in American Society for Gastrointestinal Endoscopy and European Society of Gastrointestinal Endoscopy guidelines**

|  |  |
| --- | --- |
| **ASGE guideline**  | **ESGE guideline** |
| **PEP prophylaxis during ERCP** | **PEP prophylaxis during ERCP** |
| Pancreatic duct stenting in high-risk patients (high quality of evidence) | Pancreatic duct stenting in high-risk patients (strong recommendation, moderate quality of evidence) |
| Early precut sphincterotomy for difficult cannulation (moderate quality of evidence) |  |
| **Pharmacologic methods for PEP prophylaxis**  | **Pharmacologic methods for PEP prophylaxis**  |
| Rectal NSAIDs in high-risk patients without contraindication (moderate quality of evidence) | Routine rectal NSAIDs of 100 mg of diclofenac or indomethacin immediately before in all patients without contraindication (strong recommendation, moderate quality of evidence) |
| Rectal indomethacin in average-risk patients without contraindication (moderate quality of evidence) | Hydration with lactated ringers in patients with contraindication to NSAIDs without at risk of fluid overload and without prophylactic pancreatic stenting (strong recommendation, moderate quality of evidence) |
| Hydration with lactated ringers (very-low quality of evidence) | Not suggested for the routine combination of rectal NSAIDs with other prophylactic measures (weak recommendation, low quality of evidence) |
|  | Not recommended for protease inhibitors and epinephrine onto the papilla (strong recommendation, moderate quality of evidence) |
|  | Somatostatin and octoreotide (no recommendation) |

ERCP: Endoscopic retrograde cholangiopancreatography; ASGE: American Society for Gastrointestinal Endoscopy; ESGE: European Society of Gastrointestinal Endoscopy; PEP: Post-endoscopic retrograde cholangiopancreatography pancreatitis; NSAIDs: Nonsteroidal anti-inflammatory drugs.