



Research article

Predictors of failure of endoscopic retrograde pancreatocholangiography during common bile duct stones

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ABSTRACT

Introduction: Endoscopic retrograde cholangiopancreatography associated with sphincterotomy and stone extraction with balloon or Dormia basket represents the gold standard for the management of common bile duct stones. The aim of our study were to investigate the predictors of failure of standard endoscopic techniques during the management of common bile duct stones.**Methods:** A retrospective study including all endoscopic retrograde cholangiopancreatography for common bile duct stones between January 2014 and December 2017 was conducted. First line treatment was based on endoscopic retrograde cholangiopancreatography with endoscopic sphincterotomy and balloon or Dormia extraction. Second line endoscopic treatment was based on macrodilatation of Oddi sphincter, mechanical lithotripsy, biliary stent or nasobiliary drain placement. Predictors of failure of standard endoscopic techniques were sought by uni and multivariate analysis (SPSS software, p significant if < 0.05).**Results:** One hundred eighty one patients (mean age 64 years and sex ratio M/W = 0.4) were included. Main indications for endoscopic retrograde cholangiopancreatography were residual or recurrent lithiasis (67.4%, n = 122). Cholangiography revealed multiple stones in 53 patients with an average size of 12.5mm [3–40]. The success rate of first line treatment was 61.9%. Independent predictors of failure of standard endoscopic techniques (failure of papillary cannulation or stone extraction) according to multivariate analysis were: an age greater than 65 years OR 0.516 [0.272–0.979], an intra-diverticular papilla OR 0.179 [0.035–0.914], a common bile duct diameter greater than 15 mm OR 0.161 [0.068–0.385] and a stenosis of the common bile duct OR 0.068 [0.008–0.605]. The success rate of the second line treatment was 73%.**Conclusion:** Endoscopic retrograde cholangiopancreatography results in a successful clearance of the common bile duct in almost two-thirds of patients. In case of predictors of failure, alternative techniques can increase this rate.

1. Introduction

Standard endoscopic treatment of common bile duct (CBD) stone is based on endoscopic sphincterotomy during endoscopic retrograde cholangiopancreatography (ERCP) with extraction of stones by balloon or basket catheters. Schematically, this treatment requires four steps: (1) reaching the papilla by the endoscope (2) cannulation of the CBD, (3) performing an endoscopic sphincterotomy (ES) and (4) extracting the stones by balloon or basket catheters. This approach achieves the clearance of the CBD in 80–90% of the cases [1, 2, 3, 4, 5]. Stones requiring interventions other than the standard ERCP are called difficult lithiasis.

The ESGE recommends limited sphincterotomy combined with endoscopic papillary large-balloon dilation as the first-line approach to remove difficult CBD stones [6]. Thus determining the predictors of difficult CBD stone is useful to immediately adapt the therapeutic management. The difficulties that may be encountered during the first step are essentially surgical reconstruction (Billroth II, Roux-en-Y gastrojejunostomy). Other factors can be linked either to a difficult cannulation of the CBD (2nd step), or to a difficulty in extracting stones (4th step, difficult stone). The aim of our study was to determine the predictors of non-clearance of CBD by standard techniques (failure of catheterization and failure of stone extraction).

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2. Methods

We conducted a retrospective study that included patients who had ERCP for CBD stones with naive papilla in the Gastroenterology Department of Habib Thameur Hospital, during the period from January 2014 to December 2017. Patients with Bilio-pancreatic tumor or having coagulation disorders were not included. ERCP was performed under general anesthesia. As advocated by the American and European guidelines, the administration of rectal indomethacin for the prevention of post ERCP pancreatitis was systematic [7, 8].

Patient management was as follows: a guidewire assisted cannulation of the CBD was first performed. In case of difficult cannulation, needle-knife fistulotomy or a precutting was realised.

First line treatment was based on endoscopic sphincterotomy followed by extraction of the gallstones with an extraction balloon or a stone extraction basket. In case of difficult stones, an alternative method was proposed (nasobiliary drain, mechanical lithotripsy, papillary large-balloon dilation or insertion of a plastic stent). In case of failure of endoscopic stones extraction surgical treatment was performed. Intra-hospital monitoring of at least 24 h was recommended after the procedure. If there were no complications, the patients were discharged the next day. Predictors of failure of standard endoscopic techniques were sought by uni and multivariate analysis (SPSS software, p significant if < 0.05): potential predictors were: age, a small papilla, a dysfunction of the sphincter of Oddi, an intra or paradiverticular papilla, a tortuous papilla, difficulty in positioning the duodenoscope in a large duodenum, infiltration by a malignant tumor of the duodenum and the papilla, edema and distortion of the duodenum caused by acute pancreatitis, a papilla located in the 3rd or 4th portion of the duodenum, a surgical reconstruction (access to the papilla will be done in the opposite direction and/or with an axial endoscope), a patient who is not very cooperative when he is not properly sedated and when the endoscopist is not in his best mood ("Bad day endoscopist"), high bilirubine level, stone size, stone size/CBD diameter ratio >1, impacted stone, CBD stenosis, stone number, angulation of the CBD <135°, precutting, interventions in the pancreatic duct, diameter of CBD, stone location and the form of the stone.

The predictors that were significantly associated with failure of endoscopic first-line treatment in the univariate analysis (p < 0.05) were selected to perform the multivariate analysis.

Written informed consent was obtained from all the participants for this study. Ethical approval was obtained from « Habib Thameur Hospital ethics committee » under the number HTHET-2019-23.

3. Results

One hundred eighty one patients (mean age 64 years and sex ratio M/W = 0.4) were included.

Two thirds of the patients had a history of cholecystectomy.

Main indications for ERCP were residual lithiasis (67.4%, n = 122) or sequential treatment (n = 31, 17.1%). The remaining 28 patients underwent ERCP and bile duct clearance for CBD stones without gallbladder removal (contraindication to surgical procedures). The patients characteristics are summarized in Table 1.

Catheterization of the papilla by standard techniques was performed in 127 patients (70.1%). In patients whose papilla could not be catheterized by standard techniques, a precutting was successfully performed in 15 patients. Eleven patients had a needle-knife fistulotomy and five patients had a cannulation of the CBD through a bilio-digestive fistula. In total, the CBD was cannulated in 87.3% (n = 158) of the cases (Figure 1). Cholangiography found dilation of extrahepatic bile duct and intrahepatic bile duct in 90.3% and 60.8% of cases, respectively. The mean diameter of the CBD was 14.16 mm [6–30]. CBD stones were found in 87% of the cases with an average size of 12.5 mm [3–40]. Lithiasis was multiple in 43 cases. In the presence of multiple stones, the average number of stones was 2.7 [2, 3, 4, 5, 6]. Twenty patients (12.9%) had

Table 1. Patients characteristics.

Variable	Patients
Age (year)	64
Gender: men/women	0.4
Indication for ERCP (%)	Residual lithiasis (67.4%)
	Sequential treatment (17.1%)
	Clearance of CBD stones without gallbladder removal (15.5%)
Laboratory findings	
Total bilirubin (ymol/l)	51 (2–282)
AST (ULN)	3.1 (1–48)
ALT (ULN)	3.6 (1–28)
GGT (ULN)	6.5 (1–29)
ALP (ULN)	2.4 (1–10)
Lipase (ULN)	7.4 (1–85)
Endoscopic/radiological findings	
Small papilla (%)	30.1%
Eccentric papilla (%)	3.9%
Papilla hidden by a fold (%)	1.1%
Intra-diverticular papilla (%)	4.4%
Para-diverticular papilla (%)	14.9%
Dilated CBD (%)	90.3%
Average stone size (mm)	12.5mm (3–40)
Number of stone >3 (%)	12.9%
Impacted stones (%)	3.9%
CBD stenosis (%)	3.9%
Intra-hepatic stone (%)	2.4%
Stone in the common hepatic duct (%)	14.5%

ALAT: Alanine amino-transferase/ALP: alkaline phosphatase/ASAT: Aspartate amino-transferase/GGT: Gamma-glutamyl transpeptidase/ULN: upper limit of normal.

more than 3 stones. Endoscopic sphincterotomy was performed in 142 patients (78.45%).

The clearance of CBD by first-line techniques was obtained in 61.9% of the cases (Figure 2).

In univariate analysis, we found three predictors of difficult cannulation of the CBD: a small papilla (p = <10⁻³), an eccentric papilla (p = 0.001) and a papilla hidden by a fold (p = 0.025) (Table 2). We also found nine predictors of difficult lithiasis in patients whose CBD had been cannulated: an age greater than 65 years (p = 0.006), a diameter of the CBD greater than 15 mm (p < 10⁻³), more than 3 stones (p < 10⁻³), a size of the stone greater than 12 mm (p = 0.008), an impacted stone (p = 0.030), a small papilla (p = 0.008), an intradiverticular papilla (p = 0.010), a CBD stenosis (p = 0.002), intrahepatic stone or a stone in the common hepatic duct (p = 0.026 and p = 0.048 respectively) and the use of a basket catheter compared to the balloon (p = 0.042) (Table 3).

Independent predictors of failure of standard endoscopic techniques (failure of papillary cannulation or stone extraction) according to multivariate analysis were: an age greater than 65 years (OR 0.516 [0.272–0.979]), an intra-diverticular papilla (OR 0.179 [0.035–0.914]), a common bile duct diameter greater than 15 mm (OR 0.161 [0.068–0.385]) and a stenosis of the common bile duct (OR 0.068 [0.008–0.605]) (Table 4).

4. Discussion

CBD stone is a frequent pathology. Indeed, 10–20% of the population have gallbladder stones. Among these patients 10–20% have an associated CBD stone [9, 10, 11, 12]. Its treatment must include an evacuation of the stones of the CBD and a cholecystectomy. Standard endoscopic treatment is based on endoscopic sphincterotomy during an ERCP with

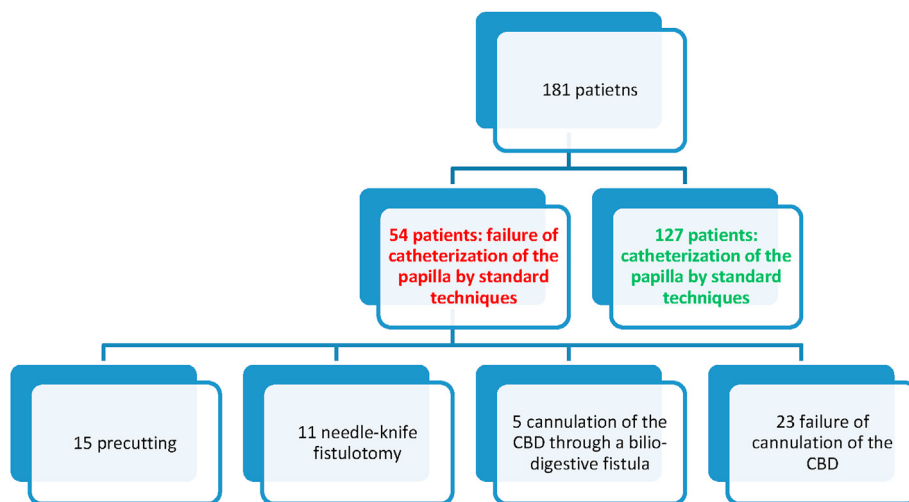


Figure 1. Diagram summarizing the catheterisation of the CBD.

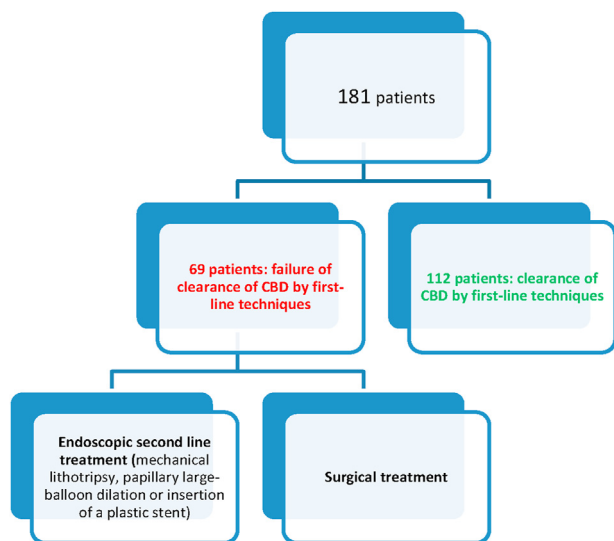


Figure 2. Diagram summarizing the clearance of CBD by first-line techniques.

extraction of stones by balloon or basket catheters. However, it only allows the clearance of the CBD in 80–90% of cases [1, 2, 3, 4, 5]. In our series, the success rate is 61.9%. Our department is a reference center in Tunisia. Thus, difficult ERCP are referred to our center which explains the low success rate. Stones requiring interventions other than the standard ERCP are called difficult lithiasis. The ESGE recommends limited sphincterotomy combined with endoscopic papillary large-balloon dilation as the first-line approach to remove difficult CBD

stones [6]. Thus determining the predictors of difficult CBD stone is useful to immediately adapt the therapeutic management. The predictors of first-line treatment failure are linked either to difficulty in CBD cannulation (difficult cannulation), or to difficulty in extracting stones (difficult stone).

In the literature, various factors have been associated with the failure of cannulation of the papilla: a small papilla, a dysfunction of the sphincter of Oddi, an intra or paradiverticular papilla, a tortuous papilla, difficulty in positioning the duodenoscope in a large duodenum, infiltration by a malignant tumor of the duodenum and the papilla, edema and distortion of the duodenum caused by acute pancreatitis, a papilla located in the 3rd or 4th portion of the duodenum, a surgical reconstruction (access to the papilla will be done in the opposite direction and/or with an axial endoscope), a patient who is not very cooperative when he is not properly sedated and when the endoscopist is not in his best mood (“Bad day endoscopist”) [13, 14, 15]. We found in our series three predictors of difficult cannulation: a small papilla ($p < 10^{-3}$), an eccentric papilla ($p = 0.001$) and a papilla hidden by a fold ($p = 0.025$).

The Scandinavian association of digestive endoscopy proposed a validated classification of the appearance of the papilla: type 1 papilla of normal appearance, type 2 small papilla, type 3 protruding papilla and type 4 rough papilla [16].

Prospective multicenter work concluded that type 2 and 3 were significantly associated with difficult cannulation [17].

In patients whose CBD was cannulated, we found nine predictors of difficult stones: an age greater than 65 years ($p = 0.006$), a diameter of the CBD greater than 15 mm ($p < 10^{-3}$), more than 3 stones ($p < 10^{-3}$), a size of the stone greater than 12 mm ($p = 0.008$), an impacted stone ($p = 0.030$), a small papilla ($p = 0.008$), an intradiverticular papilla ($p = 0.010$), a CBD stenosis ($p = 0.002$), intrahepatic stone or a stone in the common hepatic duct ($p = 0.026$ and $p = 0.048$ respectively) and the use of a basket catheter compared to the balloon ($p = 0.042$). Many of these predictors have been cited in the literature as predictors of difficult stones: an older age [18, 19], a peri-diverticular papilla [18, 20], an impacted stone [1, 5], a CBD stenosis [1, 18, 20], a number of stones greater than 3 [18,21], a diameter of the CBD greater than 15 mm [1, 22], a large stone [1, 18, 19, 20, 23].

There is no consensus in the literature to define a large stone: most authors use a cut-off between 10 and 15mm [20, 24]. Sharma et al recommend including the diameter of the CBD to define a large calculus and thus speaking of a large stone if the size of the stone is greater than the diameter of the CBD by more than 2 mm (ratio of the stone size/diameter of CBD > 1) [24]. This ratio (stone size/diameter of the CBD > 1) was found as a predictor of failure in multivariate analysis [1]. In our series, this factor was not significantly associated with ERCP failure ($p = 0.276$).

Table 2. Predictors of difficult cannulation.

Parameters		Failure of cannulation (n = 54)	Success of cannulation (n = 127)	P
Small papilla	Yes	27	26	<10⁻³
	No	23	100	
Papilla hidden by a fold	Yes	2	0	0,025
	No	49	129	
Eccentric papilla	Yes	6	1	0,001
	No	47	125	

Significative p values (lower than 0.05) are in bold.

Table 3. Predictors of difficult stone extraction.

Parameters		Non clearance CBD (n =)	Clearance of CBD (n =)	P
Age ≤65 years		12	56	0,006
>65 years		29	47	
Intra-diverticular papilla	Yes	5	2	0,010
	No	40	110	
Diameter of CBD	<15mm	18	85	<10⁻³
	≥15mm	18	13	
>3 stones	Yes	16	4	<10⁻³
	No	27	108	
Size of stone	<12mm	6	26	0,001
	≥12mm	14	9	
Impacted stone	Yes	4	2	0,030
	No	39	110	
Stenosis of CBD	Yes	5	1	0,002
	No	38	111	
Stone in the intrahepatic bile duct	Yes	2	0	0,026
	No	22	58	
Stone in the common hepatic duc	Yes	6	5	0,048
	No	18	53	
Basket catheter	Yes	19	41	0,041
	No	24	68	

CBD: common bile duct. Significant p values (lower than 0.05) are in bold.

Table 4. Independent predictors of failure of standard endoscopic treatment.

Predictors	p	OR [IC]
Age >65 years	0,015	0,516 [0,272–0,979]
Intradiverticular papille	0,019	0,179 [0,035–0,914]
CBD>15mm	0,016	0,161 [0,068–0,385]
Stenosis of CBD	0,037	0,068 [0,008–0,605]

CBD: common bile duct.

In the literature, a stone located in intrahepatic bile duct or in cystic duct has been cited as being a cause of difficult lithiasis [25, 26]. Mirizzi syndrome, which is defined as a stone of the cystic duct that exerts compression on the CBD, is also a cause of difficult lithiasis [27]. No patient in our study had Mirizzi syndrome. In a study published by Hong et al, angulation of the distal CBD $\leq 135^\circ$ was associated with failure of ERCP [19]. The influence of this parameter could not be studied in our series since it was not specified on the ERCP reports. Other predictors have been cited in the literature: a papilla localized in the bulb or in the 3rd portion

Table 5. The predictors of failure of CBD clearance found in the literature.

Authors (country) [references]	Year	Type of the study et number of patient	Independent predictors of failure of endoscopic treatment
Uskudar et al (Turkey) [1]	2012	Prospective study (N = 1805)	<ul style="list-style-type: none"> · Higher bilirubine levels · Stone size · Stone size/CBD diameter ratio >1 · Impacted stone · CBD stenosis
Christoforidis et al (Greece) [18]	2014	Retrospective study (N = 1390)	<ul style="list-style-type: none"> · Age >85 years · >4 stones · Stone >15mm
Kim et al (South Korea) [19]	2007	Prospective study (N = 102)	<ul style="list-style-type: none"> · Angulation CBD <135° · Age > 65 years
Garcia et al (Peru) [21]	2011	Prospective study (N = 90)	<ul style="list-style-type: none"> · Stone >15mm · CBD >15mm · Mechanical lithotripsy
Williams et al (United Kingdom) [24]	2010	Prospective study (N = 3209)	<ul style="list-style-type: none"> · Billroth surgery · Stone size · Stone number · Precutting · Interventions in the pancreatic duct · CBD stenting
Ödemi et al (Turkey) [5]	2016	Retrospective study (n = 1529)	<ul style="list-style-type: none"> · Diameter of CBD · Stone size
Eltayeb et al (Saudi Arabia) [20]	2016	Retrospective study (N = 426)	<ul style="list-style-type: none"> · Stone >15mm · CBD stenosis
Our study (Tunisia)	2017	Retrospective study (n = 181)	<ul style="list-style-type: none"> · Age >65 years · Intradiverticular papilla · Diameter of CBD >15mm · CBD stenosis

CBD: common bile duct.

of the duodenum [1, 5], a surgical reconstruction (Billroth II or Y-branch of Roux) [1, 19, 24] and a cuboid or barrel form of the stones [25, 26].

The predictors of failure of CBD clearance found in the literature are summarized in Table 5.

5. Conclusion

The predictors of first-line treatment failure are linked either to difficulty in CBD cannulation (difficult cannulation) or to difficulty in extracting stones (difficult stone). These factors should be sought in order to immediately adapt the therapeutic management. The availability of new therapeutic options such as intracorporeal lithotripsy using a minicholangioscope (Spyglass) would improve the performance of endoscopic treatment of CBD stone.

Declarations

Author contribution statement

M. Sabbah: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

N. Abdelwahab: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

D. Gargouri, H. Elloumi, A. Ouakaa, N. Bibani and D. Trad: Performed the experiments.

B. Nawel: Analyzed and interpreted the data.

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Declaration of interests statement

The authors declare no conflict of interest.

Additional information

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References

- [1] O. Üsküdar, E. Parlak, S. Dışibeyaz, A.S. Köksal, B. Çiçek, Z.M.Y. Kılıç, et al., Major predictors for difficult common bile duct stone, *Turk. J. Gastroenterol.* 24 (5) (2013) 423–429.
- [2] A. Lauri, R.C. Horton, B.R. Davidson, A.K. Burroughs, J.S. Dooley, Endoscopic extraction of bile duct stones: management related to stone size, *Gut* 34 (12) (1993) 1718–1721.
- [3] K.F. Binmoeller, M. Brückner, F. Thonke, N. Soehendra, Treatment of difficult bile duct stones using mechanical, electrohydraulic and extracorporeal shock wave lithotripsy, *Endoscopy* 25 (3) (1993) 201–206.
- [4] D. Vaira, L. D'Anna, C. Ainley, J. Dowsett, S. Williams, J. Baillie, et al., Endoscopic sphincterotomy in 1000 consecutive patients, *Lancet* 2 (8660) (1989) 431–434.
- [5] B. Ödemis, U.B. Kuzu, E. Öztaş, F. Saygılı, N. Suna, O. Coskun, et al., Endoscopic management of the difficult bile duct stones: a single tertiary center experience, *Gastroent. Res. Pract.* 2016 (2016) 1–7.
- [6] G. Manes, G. Paspatis, L. Aabakken, A. Anderloni, M. Arvanitakis, P. Ah-Soune, et al., Endoscopic management of common bile duct stones: European Society of Gastrointestinal Endoscopy (ESGE) guideline, *Endoscopy* 51 (05) (2019) 472–491.
- [7] J.M. Dumonceau, A. Andriulli, B. Elmunzer, A. Mariani, T. Meister, J. Deviere, et al., Prophylaxis of post-ERCP pancreatitis: European society of gastrointestinal endoscopy (ESGE) guideline – updated June 2014, *Endoscopy* 46 (09) (2014) 799–815.
- [8] V. Chandrasekhara, M.A. Khashab, V.R. Muthusamy, R.D. Acosta, D. Agrawal, D.H. Bruining, et al., Adverse events associated with ERCP, *Gastrointest. Endosc.* 85 (1) (2017) 32–47.
- [9] R. Costi, Diagnosis and management of choledocholithiasis in the golden age of imaging, endoscopy and laparoscopy, *WJG* 20 (37) (2014) 13382.
- [10] S. Tazuma, Epidemiology, pathogenesis, and classification of biliary stones (common bile duct and intrahepatic), *Best Pract. Res. Clin. Gastroenterol.* 20 (6) (2006) 1075–1083.
- [11] W.S.L. De Silva, A.A. Pathirana, T.K. Wijerathne, B.D. Gamage, B.K. Dassanayake, M.M. De Silva, Epidemiology and disease characteristics of symptomatic choledocholithiasis in Sri Lanka, *Ann. Hepatobiliar. Pancreat. Surg.* 23 (1) (2019) 41.
- [12] R. Aerts, F. Penninckx, The burden of gallstone disease in Europe, *Aliment. Pharmacol. Ther.* 18 (3) (2003) 49–53.
- [13] Y.G. Bakman, M.L. Freeman, Difficult biliary access at ERCP, *Gastrointest. Endosc. Clin. N Am.* 23 (2) (2013) 219–236.
- [14] A. Rajnakova, P.M. Goh, S.S. Ngoi, S.G. Lim, ERCP in patients with periampullary diverticulum, *Hepato-Gastroenterology* 50 (51) (2003) 625–628.
- [15] J. Baillie, Difficult biliary access for ERCP, *Curr. Gastroenterol. Rep.* 14 (6) (2012) 542–547.
- [16] E. Haraldsson, L. Lundell, F. Swahn, L. Enochsson, J. Löhr, U. Arnelo, et al., Endoscopic classification of the papilla of Vater. Results of an inter- and intraobserver agreement study, *Unit. Eur. Gastroenterol. J.* 5 (4) (2017) 504–510.
- [17] E. Haraldsson, L. Kylänpää, J.M. Grönroos, A. Saarela, E. Toth, G. Qvigstad, et al., The macroscopic appearance of the major duodenal papilla influences bile duct cannulation: a prospective multicenter study by the Scandinavian Association for Digestive Endoscopy study group for ERCP, *Gastrointest. Endosc.* 90 (6) (2019) 957–963.
- [18] E. Christoforidis, K. Vasiliadis, K. Tsalis, D. Patradas, K. Blouhos, M.G. Pramateftakis, et al., Factors significantly contributing to a failed conventional endoscopic stone clearance in patients with “Difficult” choledocholithiasis: a single-center experience, *Diagn. Ther. Endosc.* 2014 (2014) 1–7.
- [19] H.J. Kim, H.S. Choi, J.H. Park, D.I. Park, Y.K. Cho, C.I. Sohn, et al., Factors influencing the technical difficulty of endoscopic clearance of bile duct stones, *Gastrointest. Endosc.* 66 (6) (2007) 1154–1160.
- [20] M. Almadi, M. Eltayeb, S. Thaniyah, F. Alrashed, M. Aljebreen, O. Alharbi, et al., Predictors of failure of endoscopic retrograde cholangiography in clearing bile duct stone on the initial procedure, *Saudi J. Gastroenterol.* 25 (2) (2019) 132.
- [21] E. Williams, R. Ogollah, P. Thomas, R. Logan, D. Martin, M. Wilkinson, et al., What predicts failed cannulation and therapy at ERCP? Results of a large-scale multicenter analysis, *Endoscopy* 44 (07) (2012) 674–683.
- [22] G. Stefanidis, Endoscopic extraction of large common bile duct stones: a review article, *WJGE* 4 (5) (2012) 167.
- [23] J. Ramírez García, Factors related to therapeutic failure in the extraction of bile duct stones for endoscopic retrograde colangiopancreatography ERCP, *Rev. Gastroenterol. Peru.* 31 (4) (2011) 330–334.
- [24] S.S. Sharma, P. Jain, Should we redefine large common bile duct stone? *World J. Gastroenterol.* 14 (4) (2008) 651–652.
- [25] B. Doshi, I. Yasuda, S. Ryozaawa, G.H. Lee, Current endoscopic strategies for managing large bile duct stones, *Dig. Endosc.* 30 (2018) 59–66.
- [26] G. Trikudanathan, U. Navaneethan, M.A. Parsi, Endoscopic management of difficult common bile duct stones, *World J. Gastroenterol.* 19 (2) (2013) 165–173.
- [27] L. McHenry, G. Lehman, Difficult bile duct stones, *Curr. Treat. Options Gastroenterol.* 9 (2) (2006) 123–132.