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Current state of biliary cannulation techniques during endoscopic retrograde cholangiopancreatography (ERCP): International survey study

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ABSTRACT

Background and study aims Endoscopist techniques affect biliary cannulation success and the risk of adverse events during endoscopic retrograde cholangiopancreatography (ERCP). This survey study aims to understand the current practice of biliary cannulation techniques among endoscopists.

Methods Practicing endoscopists were sent an anonymous 28-question electronic survey on biliary cannulation techniques and intraprocedural pancreatitis prophylactic strategies.

Results The survey was completed by 692 endoscopists (6.2% females). A wire-guided cannulation technique (WGT) was the preferred initial biliary cannulation approach (95%). The preferred secondary approaches were a double-wire (DWT) (65.8%), precut needle-knife technique (NKT) (25.7%), transpancreatic sphincterotomy (5.9%) or other (2.6%). Overall, 18.1% of respondents were not comfortable with NKTs. In the setting of pancreatic duct (PD) access, 81.9% and 97% reported a threshold of three or more wire passes or contrast injections into the PD, respectively, before changing strategy, 34% reported placement of a prophylactic PD stent <50% of the time and 12.1% reported removal of the PD stent at the end of the procedure. Advanced endoscopy fellowship (AEF) training and high volume (>200 ERCPs per year) were associated with comfort with precut NKTs and likelihood of prophylactic PD stent (P<0.001 for both).

Conclusions A WGT technique followed by the DWT and NKT were the preferred biliary cannulation techniques; however, almost one-fifth of respondents were not comfortable with the NKT. There was considerable variability in secondary cannulation approaches, time spent attempting biliary cannulation and prophylactic PD stent placement, factors known to be associated with cannulation success and adverse outcomes.

Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) is the primary therapeutic option for the management of patients with multiple pancreaticobiliary diseases. The success of biliary cannulation is dependent on a combination of factors which include the underlying disease process, patient anatomy, and the endoscopist performing the procedure. Endoscopist-related factors include knowledge of and proficiency with various cannulation techniques and adverse event (AE) risk mitigation strategies, annual procedural volume, and overall experience with ERCP. Endoscopist-related factors are modifiable and can have a major impact on both the successful completion of the procedure and procedure-related AEs. In patients with normal anatomy, failed procedures are usually due to the inability to achieve selective biliary cannulation and may occur in up to 11% of procedures when using conventional techniques [1, 2, 3, 4, 5]. However, advanced cannulation techniques result in higher rates of success, and a biliary cannulation rate greater than 90% is considered to be the community standard with expert centers reporting cannulation rates exceeding 95% [6, 7].

Standard techniques consist of using an ERCP cannulation catheter or sphincterotome preloaded with a wire and/or contrast for injection to localize the biliary duct [8]. In Western countries, sphincterotomes are preferred over ERCP cannulation catheters [9]. Multiple studies and meta-analyses have demonstrated that compared to contrast injection, a wire-guided cannulation technique (WGT) is associated with shorter cannulation and fluoroscopy times, a reduced rate of post-ERCP pancreatitis (PEP), and decreased need for precut sphincterotomy [10, 11, 12]. When encountering difficult cannulation, advanced techniques for biliary cannulation include the double-wire technique (DWT) and precut access techniques, including precut needle-knife techniques (NKT) and transpancreatic sphincterotomy (TPS) [3, 8, 13, 14]. In addition, there have been considerable advances in endoscopic ultrasound (EUS)-assisted biliary drainage (EUS-BD) approaches, which include EUS-guided biliary wire access to facilitate ERCP (EUS rendezvous) and EUS-guided direct transluminal biliary drainage [15].

The European Society of Gastrointestinal Endoscopy (ESGE) and American Society of Gastrointestinal Endoscopy (ASGE) guidelines on AEs of ERCP and the ESGE guidelines on biliary cannulation recommend the use of a WGT technique as the primary approach to native papilla biliary cannulation due to its association with a reduced risk of PEP [11, 16, 17]. In a national survey of practicing endoscopists in the United States, 76% of respondents reported wire-guided technique cannulation as the preferred initial approach for biliary cannulation [18]. There are, however, limited data on the preferred approaches to difficult biliary cannulation among practicing endoscopists and the influence of advanced endoscopy training on these practices. We performed an international survey study of the practicing endoscopists with the aim of determining the current state of biliary cannulation approaches among endoscopists who perform ERCP.

Methods

Survey design and administration

An online survey was designed to assess biliary cannulation approaches and was administered using the Survey Monkey platform (San Mateo, California, United States). The survey consisted of 28 questions that covered demographics, scope of practice, biliary cannulation approaches (both initial and advanced), and PEP prophylaxis practices pertaining to pancreatic stent placement during cannulation (**Supplementary Table 1**).

The survey questions were designed by two authors (MAA and AK), and the survey was constructed by two authors (AK and PA) initially using the Qualtrics platform (Provo, Utah, United States), and later transferred to Survey Monkey (San Mateo, California, United States) by ASGE personnel. The final survey took about 3 minutes to complete. There were no mandatory questions in the survey and participants were able to skip some questions and complete the survey. The number of answered and skipped questions was recorded for each survey question.

The survey was administered by the ASGE to national and international members through email in November 2021. Trainee members were not surveyed. A reminder email with a link to the survey was sent 2 and 4 weeks after the initial email. The total duration for eligibility to participate in the survey was 6 weeks.

The University of California, San Francisco (UCSF) Institutional Review Board (IRB) determined that this research was exempt from review. In accordance with IRB guidelines for anonymous surveys, the need for documentation of informed consent among participants was waived. Completion of the survey was voluntary, there were no incentives to participate, and consent to participate was inferred from completion of the survey.

Statistical analysis

All completed responses were used in the analysis. Descriptive statistical analysis was performed with values reported as frequency (%) or mean ± standard deviation (SD). All quantitative variables were measured in terms of mean ± SD and biliary cannulation rate was compared between different study groups [advanced endoscopy fellowship (AEF) vs no AEF training status; endoscopist annual ERCP volume; <50 per year defined as low-volume endoscopists (LVE), 51 to 200 per year defined as medium-volume endoscopists MVE and >200 per year defined as high-volume endoscopists (HVE)] by using the standard *t*-test or Analysis of Variance (ANOVA) test. Categorical data are expressed as frequency (%) and were compared using the Chi-square test and/or Fisher exact test. All *P* values were two-sided, and $P<0.05$ was considered statistically significant. All analyses were performed with SPSS statistical software (version 25; IBM-Corp, SPSS Inc., Armonk, New York, United States).

Results

The survey was sent to 7,785 national and international members of the ASGE of whom a total of 711 different providers submitted responses to the questionnaire resulting in a response rate of 9.1%. Among them, five responses were excluded because they did not perform ERCP, while 14 responses were excluded from the final analysis because of incomplete responses to either one or more questions of the survey resulting in a total of 692 respondents who were included in the final analysis.

Demographic and baseline ERCP experience and volume data for respondents are shown in ▶**Table 1** and ▶**Fig. 1a**, ▶**Fig. 1b**, and ▶**Fig. 1c**. There were 646 (93.4%) male respondents and 43 (6.2%) female respondents. Forty-eight percent (n = 332) of endoscopists reported having completed an advanced endoscopy fellowship (AEF) and 46.5% (n = 322) reported working with gastroenterology fellows.

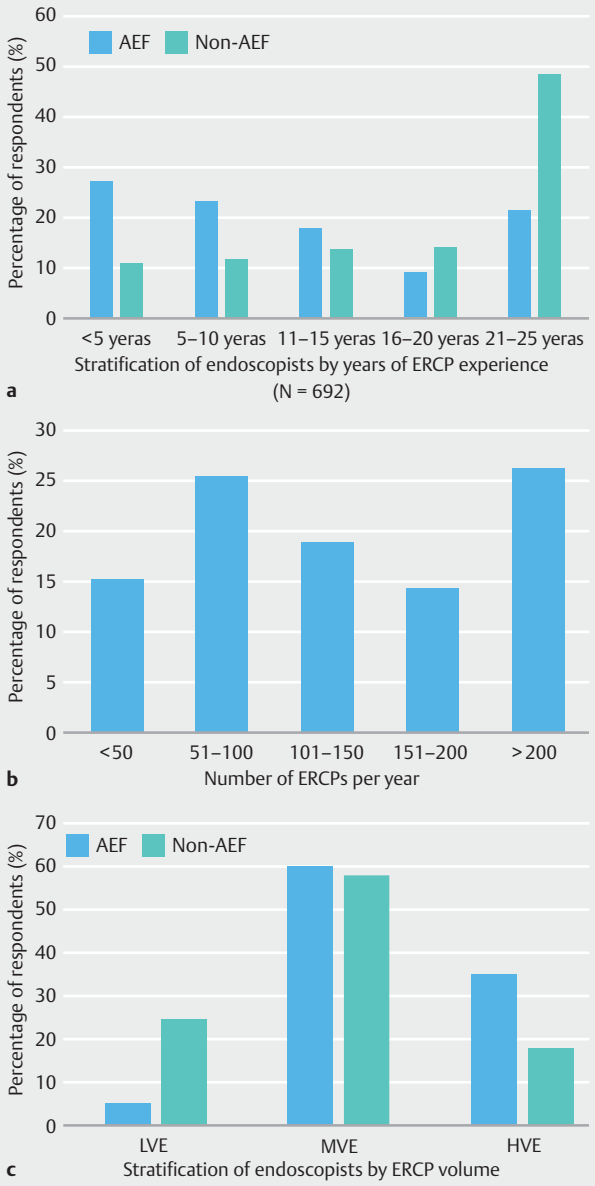
Biliary cannulation approaches

Approaches to biliary cannulation are shown in ▶**Table 2** and ▶**Table 3**. The vast majority of physicians (n = 657, n = 95%) reported using a WGT as their standard (i. e. primary) biliary cannulation approach using either a sphincterotome wire-guided technique (n = 552, 79.8%) or a cannula wire-guided technique

▶**Table 1** Baseline characteristics and procedural volume.

	AEF = n (%)	No AEF = n (%)	Total = n (%)	*P* value
Age (years)				<0.001
▪ ≤50	232 (70.1)	133 (36.9)	332 (52.0)	
▪ > 50	100 (29.9)	227 (63.1)	360 (48.0)	
Gender				0.68
▪ Male	307 (92.5)	339 (52.2)	646 (93.4)	
▪ Female	23 (6.9)	20 (5.6)	43 (6.2)	
▪ Others	2 (0.6)	01 (0.3)	03 (0.4)	
Country				0.13
▪ USA	204 (61.4)	241 (66.9)	445 (64.3)	
▪ Others	128 (38.6)	119 (33.1)	247 (35.7)	
Setting of practice				<0.0
▪ University-based	124 (37.3)	42 (11.7)	166 (24.0)	
▪ Hospital-employed	108 (32.5)	123 (34.2)	231 (33.4)	
▪ Group practice	69 (20.8)	154 (42.8)	223 (32.2)	
▪ Solo private practice	31 (9.3)	41 (11.4)	72 (10.4)	
Work with gastroenterology fellows				< 0.001
▪ Yes	203 (61.1)	119 (33.1)	322 (46.5)	
▪ No	129 (38.9)	241 (66.9)	370 (53.5)	
Duration of work experience				<0.001
▪ <5 years	91 (27.4)	40 (11.1)	131 (18.9)	
▪ 5–10 years	78 (23.5)	43 (11.9)	121 (17.5)	
▪ 11–15 years	60 (18.1)	50 (13.9)	110 (15.9)	
▪ 16–20 years	31 (9.3)	52 (14.4)	83 (12.0)	
▪ 21–25 years	72 (21.7)	175 (48.6)	247 (35.7)	
ERCP volume/year				< 0.001
▪ LVE	17 (5.1)	88 (24.4)	105 (15.2)	
▪ MVE	198 (59.6)	208 (57.8)	406 (58.7)	
▪ HVE	117 (35.2)	64 (17.8)	181 (26.2)	

AEF, Advanced endoscopy fellowship; ERCP, endoscopic retrograde cholangiopancreatography; LVE, low-volume endoscopist (< 50 ERCPs per year); MVE, moderate-volume endoscopists (50–200 ERCPs per year); HVE, high-volume endoscopist (> 200 ERCPs per year).



▶ **Fig. 1** **a** Stratification of endoscopists by years of ERCP experience (AEF vs non-AEF, *P*<0.001). **b** Number of ERCPs performed by endoscopist per year. **c** Stratification of endoscopists by annual ERCP volume (AEF vs non-AEF, *P*<0.001).

(n = 105, 15.2%). The preferred secondary biliary cannulation approaches were a DWT (n = 455, 65.8%) followed by a NKT (n = 178, 25.7%) and TPS (n = 41, 5.9%). The most practiced tertiary approach was a NKT (n = 299, 43.3%) followed by TPS (n = 93, 13.5%). As a fourth line, the most common approaches were to stop and try another day (n = 159, 23.0%) and referral to another colleague/center (n = 136, 19.7%). A referral to interventional radiology or performance of EUS-BD as a tertiary- and quaternary approach were reported by 22 (3.2%) and 26 (3.8%), and 119 (17.2%) and 116 (16.8%) respondents respectively.

Overall, 27.9% (n = 193) of respondents reported spending up to 5 minutes and 48% (n = 332) 6 to 10 minutes, on attempting biliary cannulation before changing strategy (▶ **Fig. 2a** and ▶ **Table 2**). Sixty-nine percent of respondents reported spending greater than 30 minutes on attempted biliary cannulation before stopping the procedure (▶ **Fig. 2b**). Physician-controlled cannulation (also known as the short-wire technique) was preferred by more respondents (n = 439, 63.4%) than an assistant-controlled technique (also known as the long-wire technique) (n = 253, 36.6%).

Pancreatic duct access and pancreatic stent placement

Cumulatively, 567 (81.9%) of respondents reported a threshold of up to three wire passes and 383 (96.96%) respondents reported a threshold of up to three contrast injections into the PD before changing cannulation strategy while attempting biliary cannulation (▶ **Fig. 3a** and ▶ **Fig. 3b**). In the setting of inadvertent pancreatic duct access during attempted biliary cannulation, 41.9% of respondents (n = 290) reported always placing a PD stent while 24% (n = 166) reported placing a PD stent >50% of the time. Conversely, 34.1% (n = 236) of respondents reported placing a PD stent <50% (12.7%, n = 88) or <25% (21.4%, n = 148) (▶ **Table 2**, ▶ **Fig. 3c**). In the setting where a PD stent has been placed to facilitate biliary cannulation, 87.9% (n = 608) of respondents reported that they would leave the PD stent in place after a successful biliary cannulation whereas 12.1% (n = 84) reported that they would remove the PD stent at the end of the case.

Advanced Endoscopy Fellowship (AEF) training

When stratified by AEF training status, respondents who had completed AEF training were younger in age (*P*<0.001) and more likely to be in an academic practice setting (*P*<0.001) (▶ **Table 1** and ▶ **Table 2**). There was no significant difference between the two groups with respect to the primary and secondary cannulation approaches (*p*>0.05) however AEF trained endoscopists were more likely to use an alternative biliary cannulation technique or EUS-BD technique (*P*<0.001) (▶ **Table 2**). Conversely, non-AEF-trained endoscopists were more likely to refer patients to another institution or for IR-guided biliary access after two or three attempted alternative approaches for biliary cannulation (*P*<0.001). Advanced endoscopy-trained providers reported a higher comfort level with the NKT (88.6% *vs* 75.8%; *P*<0.001) and EUS-BD (56.9% *vs* 15.3%; *P*< 0.001). There was no difference between the two groups in the time spent attempting biliary cannulation (*P* = 0.54). Non-AEF-trained providers were more likely to remove the PD stent during biliary cannulation at the end of the procedure (14.7% vs 9.3%; *P* = 0.02).

ERCP volume and practice patterns

When stratified by annual endoscopist ERCP volume, there was a statistically significant difference among respondents for advanced biliary cannulation approaches (*P*<0.05) (▶ **Table 3**). HVEs were more likely to place a PD stent and were more com-

▶ **Table 2** Biliary cannulation approaches and pancreatic duct access practices.

	AEF = n (%)	No AEF = n (%)	Total = n (%)	P value
Standard biliary cannulation approach				0.20
▪ Sphincterotome (wire-guided)	272 (81.9)	280 (77.8)	552 (79.8)	
▪ Sphincterotome (contrast-guided)	12 (3.6)	23 (6.4)	35 (5.1)	
▪ Cannula (contrast-guided)	48 (14.5)	57 (15.8)	105 (15.2)	
Time to change strategy while attempting biliary cannulation				0.54
▪ ≤ 5 minutes	85 (25.6)	108 (30.0)	193 (27.9)	
▪ 6–10 minutes	168 (50.6)	164 (45.6)	332 (48.0)	
▪ 11–15 minutes	53 (16.0)	64 (17.8)	117 (16.9)	
▪ 16–20 minutes	12 (3.6)	13 (4.1)	25 (7.2)	
▪ > 20 minutes	14 (4.2)	11 (3.1)	25 (3.6)	
Preferred secondary advanced biliary cannulation approach				0.23
▪ Precut needle-knife (including fistulotomy)	87 (26.2)	91 (26.3)	178 (25.7)	
▪ Double-wire technique	222 (66.9)	233 (64.7)	455 (65.8)	
▪ Transpancreatic sphincterotomy/septotomy	18 (5.4)	23 (6.4)	41 (5.9)	
▪ Refer to another colleague/center	1 (0.3)	8 (2.2)	9 (1.3)	
▪ Try another day	3 (0.9)	5 (1.4)	8 (1.2)	
▪ Endoscopic ultrasound (EUS) biliary drainage (EUS-BD)	1 (0.3)	0 (0)	1 (0.1)	
Preferred tertiary advanced biliary cannulation approach				< 0.001
▪ Precut needle-knife (including fistulotomy)	166 (50.2)	133 (37.0)	299 (43.3)	
▪ Double-wire technique	47 (14.2)	35 (9.7)	82 (11.9)	
▪ Transpancreatic sphincterotomy/septotomy	55 (16.6)	38 (10.6)	93 (13.5)	
▪ Refer to another colleague/center	7 (2.1)	88 (24.5)	95 (13.8)	
▪ Try another day	31 (9.4)	42 (11.7)	73 (10.6)	
▪ Endoscopic ultrasound (EUS) biliary drainage (EUS-BD)	20 (6.0)	06 (1.7)	26 (3.8)	
▪ Consult IR	5 (1.5)	17 (4.7)	22 (3.2)	
Preferred quaternary advanced biliary cannulation approach				<0.001
▪ Precut needle-knife (including fistulotomy)	49 (14.8)	38 (10.6)	87 (12.6)	
▪ Double-wire technique	10 (3.0)	15 (4.2)	25 (3.6)	
▪ Transpancreatic sphincterotomy/septotomy	37 (11.1)	13 (3.6)	50 (7.2)	
▪ Refer to another colleague/center	27 (8.1)	109 (30.3)	136 (19.7)	
▪ Try another day	77 (23.2)	82 (22.8)	159 (23.0)	
▪ Endoscopic ultrasound (EUS) biliary drainage (EUS-BD)	79 (23.8)	37 (10.3)	116 (16.8)	
▪ Consult IR	53 (16.0)	66 (18.3)	119 (17.2)	
Total time spent on attempting biliary cannulation before stopping the procedure				<0.001
▪ <30 minutes	90 (27.1)	122 (33.9)	212 (30.6)	
▪ 30–45 minutes	111 (33.4)	160 (44.4)	271 (39.2)	
▪ 46–60 minutes	83 (25.0)	62 (17.2)	145 (21.0)	
▪ >60 minutes	48 (14.5)	16 (4.4)	64 (9.2)	

▶ **Table 2** (Continuation)

	AEF = n (%)	No AEF = n (%)	Total = n (%)	P value
PD stent after PD access				<0.001
▪ Always	151 (45.5)	139 (38.6)	290 (41.9)	
▪ >50% of the time	92 (27.7)	74 (20.6)	166 (24.0)	
▪ 25%-50% of the time	38 (11.4)	50 (13.9)	88 (12.7)	
▪ <25% of the time	51 (15.4)	97 (26.9)	148 (21.4)	
Fate of PD stent at procedure completion				0.02
▪ Leave the PD stent	301 (90.7)	307 (85.3)	608 (87.9)	
▪ Remove PD stent at case end	31 (9.3)	53 (14.7)	84 (12.1)	
Guidewire preference				0.46
▪ Physician-controlled (short wire)	206 (62.0)	233 (64.7)	439 (63.4)	
▪ Assistant-controlled (long wire)	126 (38.0)	127 (35.3)	253 (36.6)	
Comfortable with precut using needle-knife				<0.001
▪ Yes	294 (88.6)	273 (75.8)	567 (81.9)	
▪ No	38 (11.4)	87 (24.2)	125 (18.1)	
Comfort with EUS-BD				<0.001
▪ Yes	189 (56.9)	55 (15.3)	244 (35.3)	
▪ No	143 (43.1)	305 (84.7)	448 (64.7)	
>200 ERCPs a year	117 (35.2)	64 (17.8)	181 (26.2)	<0.001
Proactive monitoring biliary cannulation rate				0.75
▪ Yes	191 (57.5)	202 (56.1)	393 (56.8)	
▪ No	141 (42.5)	158 (43.9)	299 (43.2)	
Self-reported mean biliary cannulation rate (± SD)	93.5 ± 10.6	92.2 ± 9.3	–	0.178
Self-reported estimated mean biliary cannulation rate (± SD)	91.7 ± 12.6	90.21 ± 11.09	–	0.20

AEF, advanced endoscopy fellowship; ERCP, endoscopic cholangiopancreatography; EUS, endoscopic ultrasound; EUS-BD, endoscopic ultrasound biliary drainage; IR, interventional radiology; PD, pancreatic duct; SD, standard deviation.

fortable with NK and EUS-BD than lower volume endoscopists (P<0.001).

US and non-US practice patterns

There were 445 responses to the survey from endoscopists practicing in the United States and 247 responses from non-US countries (**Supplementary Table 2**). There was significant difference between the two groups with respect to secondary, tertiary and quaternary techniques. Non-US endoscopists were more likely to use a NKT (51%) and US respondents were more likely to use a trans pancreatic DWT (80%) as their preferred secondary biliary cannulation technique. Non-US respondents reported a high comfort level with the NKT (92.3% vs 76.3%, P<0.001). The two groups did not differ with respect to placement of a PD stent after pancreatic duct access.

Discussion

In this survey of practicing endoscopists, a WGC technique was by far the preferred strategy for biliary cannulation among respondents (95%) and more than that reported by three prior national surveys (76%–84%) suggesting continued adoption of this technique over time [18, 19, 20]. Our findings are in line with current guidelines based on prospective studies and meta-analyses that have shown the WGC technique to be associated with a higher cannulation success rate and decreased risk of PEP as compared to contrast-guided cannulation [10, 11, 12, 17, 21, 22]. Current guidelines and consensus statements recognize the number of biliary cannulation attempts and overall expertise to be more important factors in accomplishing biliary cannulation and to reduce the risk of PEP regardless of the choice of WGC or contrast-guided cannulation [11, 14, 16, 17]. Within the category of WGC, there are variations which include pure WGC, a hybrid approach (wire plus contrast injection as

▶ **Table 3** Biliary cannulation approaches and cannulation practices, by annual ERCP volume.

	LVE = n (%)	MVE = n (%)	HVE = n (%)	P value
Standard biliary cannulation approach				0.05
▪ Sphincterotome (wire-guided)	73 (69.5)	332 (81.8)	147 (79.8)	
▪ Sphincterotome (contrast-guided)	7 (6.7)	17 (4.2)	11 (5.1)	
▪ Cannula (wire-guided)	25 (23.8)	57 (14.0)	23 (15.2)	
Preferred secondary advanced biliary cannulation approach				0.002
▪ Precut needle-knife (including fistulotomy)	23 (21.9)	101 (24.9)	54 (29.8)	
▪ Double-wire technique	66 (62.9)	274 (67.5)	115 (63.5)	
▪ Transpancreatic sphincterotomy/septotomy	9 (8.6)	22 (5.4)	10 (5.5)	
▪ Refer to another colleague/center	6 (5.7)	2 (0.5)	1 (0.6)	
▪ Try another day	1 (1.0)	7 (1.7)	0 (0)	
▪ Endoscopic ultrasound (EUS) biliary drainage (EUS-BD)	0 (0)	0 (0)	1 (0.6)	
Preferred tertiary advanced biliary cannulation approach				< 0.001
▪ Precut needle-knife (including fistulotomy)	23 (21.9)	178 (44.0)	98 (54.4)	
▪ Double-wire technique	14 (13.3)	47 (11.6)	21 (11.7)	
▪ Transpancreatic sphincterotomy/septotomy	10 (9.56)	54 (13.3)	29 (16.1)	
▪ Refer to another colleague/center	43 (41.0)	51 (12.6)	01 (0.6)	
▪ Try another day	7 (6.7)	47 (11.6)	19 (10.6)	
▪ Endoscopic ultrasound (EUS) biliary drainage (EUS-BD)	1 (1.0)	17 (4.7)	22 (3.2)	
▪ Consult IR	7 (6.7)	11 (2.7)	4 (2.2)	
Preferred quaternary advanced biliary cannulation approach				< 0.001
▪ Precut needle-knife (including fistulotomy)	11 (10.5)	51 (12.6)	25 (13.8)	
▪ Double-wire technique	06 (5.7)	12 (3.0)	7 (3.9)	
▪ Transpancreatic sphincterotomy/septotomy	02 (1.9)	32 (7.9)	16 (8.8)	
▪ Refer to another colleague/center	45 (42.9)	77 (19.0)	14 (7.7)	
▪ Try another day	23 (21.9)	90 (22.2)	46 (25.4)	
▪ Endoscopic ultrasound (EUS) biliary drainage (EUS-BD)	6 (5.7)	60 (14.8)	50 (27.6)	
▪ Consult IR	12 (11.4)	84 (20.7)	23 (12.7)	
PD stent after PD access				0.002
▪ Always	28 (26.7)	174 (42.9)	88 (48.6)	
▪ > 50% of the time	25 (23.8)	98 (24.1)	43 (23.8)	
▪ 25%-50% of the times	16 (15.2)	56 (13.8)	16 (8.8)	
▪ < 25% of the times	36 (34.3)	78 (19.2)	34 (18.8)	
Fate of PD stent at procedure completion				0.16
▪ Leave the PD stent	92 (87.6)	350 (86.2)	166 (91.7)	
▪ Remove PD stent at case end	13 (12.4)	56 (13.8)	15 (8.3)	
Guidewire preference				0.02
▪ Physician-controlled (short wire)	69 (65.7)	270 (66.5)	100 (55.2)	
▪ Assistant-controlled (long wire)	36 (34.3)	136 (33.5)	81 (44.8)	

▶ **Table 3** (Continuation)

	LVE = n (%)	MVE = n (%)	HVE = n (%)	P value
Comfortable with precut using needle-knife				< 0.001
▪ Yes	64 (61.0)	333 (82.0)	170 (93.9)	
▪ No	41 (39.0)	73 (18.0)	11 (6.1)	
Comfort with EUS-BD				< 0.001
▪ Yes	7 (4.8)	127 (31.3)	112 (61.9)	
▪ No	100 (95.2)	279 (68.7)	69 (38.1)	
Proactively monitoring biliary cannulation rate				0.19
▪ Yes	54 (51.4)	227 (55.9)	112 (61.9)	
▪ No	51 (48.6)	179 (44.1)	69 (38.1)	
Mean biliary cannulation rate (± SD)	89.52 ± 9.7	92.32 ± 5.7	95.23 ± 5.7	0.67
Estimated mean biliary cannulation rate (± SD)	88.05 ± 8.6	89.34 ± 5.9	94.64 ± 4.2	0.74

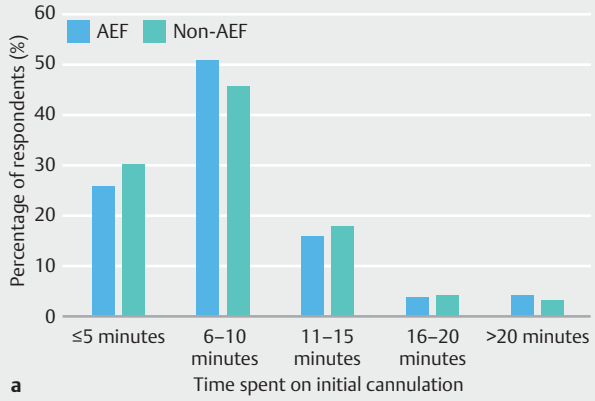
AEF, advanced endoscopy fellowship; ERCP, endoscopic cholangiopancreatography; LVE, low-volume endoscopist (< 50 ERCPs per year); MVE, moderate-volume endoscopist (50–200 ERCPs per year); HVE, high-volume endoscopist (> 200 ERCPs per year); EUS, endoscopic ultrasound; EUS-BD, endoscopic ultrasound biliary drainage; IR, interventional radiology; PD, pancreatic duct; SD, standard deviation.

needed), or a cannulation first approach (biliary access via a sphincterotome or cannula prior to wire advancement) [23]. Although this survey did not distinguish between these approaches, in a recent randomized trial, a hybrid WGC technique (wire plus contrast injection as needed) resulted in a shorter cannulation time, and less need for precut techniques and procedure time compared to an 'exclusive' WGC approach. There was no difference in PEP rates between the two groups [24].

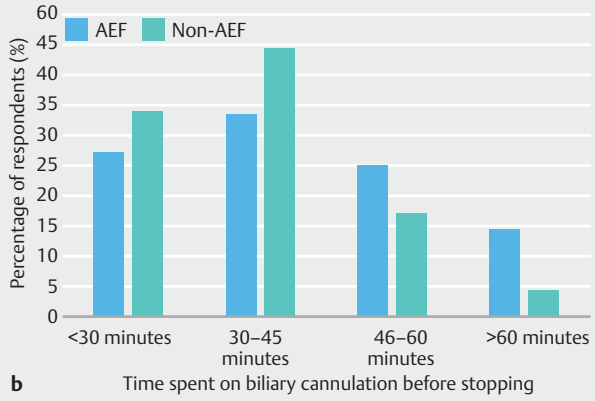
The most frequently reported secondary biliary cannulation technique was the DWT (65.8%). In this technique, the pancreatic wire can help separate the biliary and pancreatic orifices and enable the realignment and orientation of the biliary cannulation wire toward the biliary orifice. Additional advantages are that it can facilitate contrast drainage from the PD and be used to place a PD stent. A NKT was reported by 25.7% of respondents as the preferred secondary approach and 42.5% as the preferred tertiary approach. In our study, US respondents were more likely to use a DWT (80%) and non-US endoscopists more likely to use a NKT (51%) as their preferred secondary biliary cannulation technique with only 11.7% of US respondents reporting NKT as the preferred secondary technique. In a survey of biliary cannulation practices from Portugal, NK precut was reported as the first choice for unsuccessful biliary cannulation by 70% of respondents [20]. The much lower number in our survey may be due to variations in training and practice patterns over time. While a comprehensive review of precut techniques is beyond the scope of this discussion, an early NKT is associated with increased biliary cannulation success and reduced risk of complications when performed by endoscopists with expertise with this technique [25, 26]. Transpancreatic sphincterotomy was reported by 5.9% and 13.5% of respondents as their preferred secondary and tertiary biliary cannulation approach. This is a useful technique for biliary access utilizing access to the pancreatic orifice followed by a sphincterotome-assisted traction sphincterotomy in the orientation of the bile duct. In a recent randomized trial transpancreatic sphincterotomy was associated with a higher rate of successful biliary cannulation (84.6%) compared to DWT (69.7%) and both were associated with similar PEP rates (13.5% and 16.2% respectively) [27].

Overall, 18% of respondents (23.1% US and 7.7% non-US) in the survey reported not being comfortable with a NKT for biliary cannulation. A possible explanation for this finding and the overall low NKT rate in our study especially among US endoscopists is the wider adoption of the DWT as a preferred alternative cannulation approach. Inadvertent passage of the cannulation wire into the PD during WGC lends itself to proceeding to a DWT, potentially resulting in fewer opportunities during training and clinical practice to perform a NKT and over time, less familiarity with this technique. Simultaneously, given the advances in EUS-BD techniques, there may be a preference to proceed with EUS-BD rather than attempting precut access techniques. In our study, AEF trained endoscopists were more likely to use a NKT compared to those without AEF training who were more likely to refer a patient to another provider or interventional radiology. Although AEF trained endoscopists were more comfortable with a NKT, 12.4% reported not being comfortable using a NKT. Endoscopists with AEF training also reported a higher annual volume of ERCP procedures, comfort level with EUS-BD and were more likely to place a pancreatic duct (PD) stent. These findings highlight the important role of AEF training for endoscopists to achieve competency in advanced cannulation techniques.

Difficult biliary cannulation is often defined as more than five cannulation attempts, a duration of more than 5 minutes, and/or inadvertent cannulation of the PD [11, 14]. In this study only 27.9% of respondents changed cannulation strategy after 5 minutes with the vast majority trying for longer, highlighting

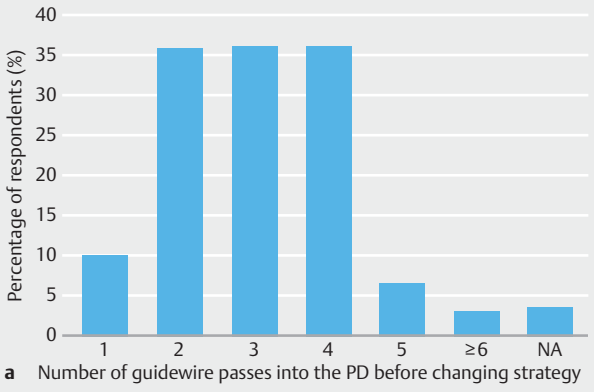


a



b

▶ **Fig. 2** **a** Time spent on initial cannulation approach before changing strategy (AEF vs non-AEF, $P = 0.54$). **b** Total amount of time spent on attempted biliary cannulation before stopping the procedure (AEF vs non-AEF, $P<0.001$).



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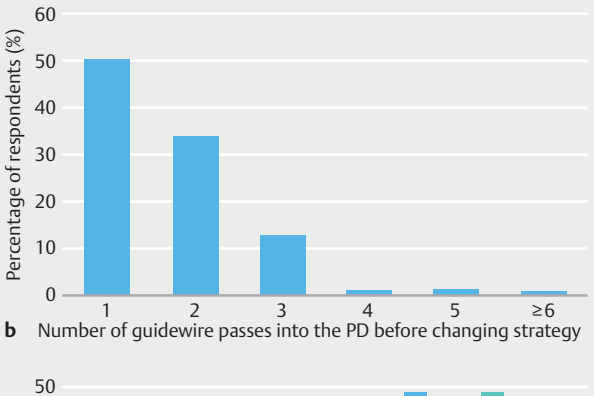

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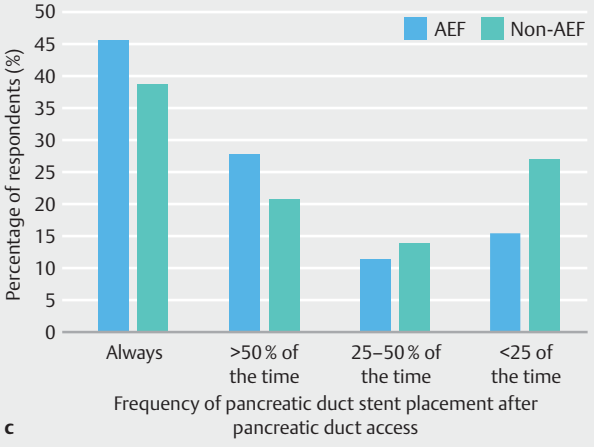

c

▶ **Fig. 3** **a** Number of guide wire passes into the pancreatic duct (PD) prior to changing strategy while attempting biliary cannulation. **b** Number of contrast injections into the pancreatic duct (PD) prior to changing strategy while attempting biliary cannulation. **c** Frequency of prophylactic pancreatic duct stent placement into pancreatic duct (PD) after PD access while attempting biliary cannulation (AEF vs non-AEF, $P<0.001$).

the discordance between the definition used in clinical trials and guidelines, and real-world clinical practice. Furthermore, 69.8% of respondents reported attempting biliary cannulation for more than 30 minutes before stopping the procedure. As stated earlier, prolonged attempts at biliary cannulation are associated with an increased risk of PEP. An early precut approach has been associated with a decreased rate of PEP however this approach has not been shown to definitively improve biliary cannulation [11, 14, 17].

In our study, 81.9% and 97% of respondents reported changing their cannulation strategy after three or more wire passes or contrast injections into the PD. Only 41.9% of respondents reported always placing a pancreatic stent if the PD was accessed, and 21.4% reported placing a stent <25% of the time or never. Furthermore, 12.1% of respondents would remove a PD stent after having placed it initially to facilitate biliary cannulation. A previous survey of 121 endoscopists revealed that 21.3% did not perform prophylactic stenting at all, a practice that was attributed to a lack of experience [28]. Prophylactic pancreatic stent placement is associated with a decreased risk of PEP and is currently strongly recommended in high-risk settings including repeated inadvertent wire cannulation or contrast injection of the PD and the DWT by both the ASGE and ESGE [11, 16, 17].

We did not explore the reasons for endoscopists not placing a pancreatic stent or for the removal of a pancreatic stent immediately after cannulation. A potentially important explanation for not placing PD stents may be the use of pharmacologic prophylaxis, e. g. rectal indomethacin and intravenous fluid hydration, instead of PD stents as highlighted in two survey studies on pancreatitis prophylaxis strategies, one from our group and

another published recently [29, 30]. The adoption of rectal indomethacin administration in patients at high risk of developing PEP was evaluated in a recent database-based study. The rate of rectal indomethacin administration increased every year after its introduction in 2012 to under 50% by 2018 while the rate of PD stent placement decreased from 40.7% in 2013 to 3% in 2018, and the incidence of PEP did not change over this period [31]. In another study, the need for hospitalization for PEP increased by 15% and PEP related mortality increased from 2.2% to 4.4% between 2011 and 2017 [32]. Thus, although the incidence of PEP may not have changed over time, the severity and mortality associated with PEP appear to be increasing in the setting of increased rectal indomethacin utilization and decreased pancreatic stent placement for PEP prophylaxis. In this context, it should be noted that, as highlighted in the recently published ASGE guidelines on PEP prevention strategies, prophylactic pancreatic stent placement is the only method proven to significantly reduce the risk of moderate to severe PEP [33].

In this study 63.4% reported using a physician-controlled cannulation technique. In a randomized trial comparing the two techniques, there was no difference in the rate of successful biliary cannulation [34]. This study was, however, stopped early due to an increased incidence of PEP in the assistant-controlled vs. physician-controlled group (9.3 vs 2.8%, $P=0.049$). Interestingly, HVEs and non-US endoscopists were more likely to use an assistant-controlled approach than MVEs and LVEs.

An important finding in our study is the low number of female respondents (6.2%). This may potentially highlight gender inequity among providers performing ERCP. In a survey of the ASGE match for advanced endoscopy fellowship (AEF) training programs in the US, only 19% of advanced endoscopy fellows for the year 2020 were female [35]. Similarly, a survey of advanced endoscopy program directors showed that women represented 14.8% of advanced endoscopy faculty and 12% of advanced endoscopy fellows, and that the percentage of female advanced endoscopy fellows was strongly associated with the number of female advanced endoscopy faculty [36]. Reported barriers to recruiting included inflexible hours and calls, exposure to fluoroscopy, and lack of female mentorship and women endoscopists at national meetings. Further studies are needed to identify and address the reasons for female underrepresentation in the field of advanced endoscopy and to ensure that female practitioners are not experiencing disparities when it comes to quality of training due to issues such as implicit bias, which has been shown in other specialties [37, 38].

There are some limitations to our study. First is the relatively low response rate which as stated earlier, is because it was not possible for the survey exclude those members of the ASGE email listserv who do not perform ERCP. In addition, other survey studies have reported total number of responses and not response rates [18, 30]. Second, although this is an international survey since it only captures ASGE members, most of whom are likely in North America, the findings are likely biased toward North American practice patterns. Third, our survey did not address biliary access in different clinical scenarios which may influence the preferred cannulation approach e. g. a NKT may be preferred in a bulging papilla due to an impacted bile duct stone but not in a small papilla adjacent to a diverticulum. Fourth, there is a risk of response bias due to the lack of formal validation of the survey.

Conclusions

In conclusion, in this international survey of biliary cannulation practice patterns, we found that a wire-guided cannulation technique is used as the initial cannulation approach almost universally. There are, however, differences in approaches with respect to advanced cannulation techniques with most respondents reporting a preference for a DWT followed by needle-knife techniques (NKTs). Almost one-fifth of practicing endoscopists are not comfortable with NKTs. Based on current guideline definitions and reported practice patterns in this survey, a considerable number of patients would be considered to be at high risk of developing PEP. Despite this, almost one-third of endoscopists do not routinely place pancreatic stents and a small proportion remove stents after achieving biliary cannulation. Further research is needed to understand the implications of practice patterns outside of clinical trial settings including the development of PEP and to determine the need for competency assessment and skills training of endoscopists performing ERCP to ensure that providers performing ERCP are proficient in biliary cannulation and risk reduction techniques.

Conflict of Interest

Mustafa A. Arain: Consultant for Olympus and Boston Scientific. Muhammad K. Hasan: Consultant for Olympus and Boston Scientific. All other authors have no conflicts of interest to declare.

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