

Success Rate of Difficult Biliary Cannulation and Rescue Techniques During Endoscopic Retrograde Cholangiopancreatography at a Tertiary Level Referral Center

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ABSTRACT

Successful deep cannulation of the common bile duct is the indispensable first step in endoscopic retrograde cholangiopancreatography (ERCP), a procedure used to manage biliary disorders. The European Society of Gastrointestinal Endoscopy defines difficult biliary cannulation by prolonged or repeated attempts (>5 contacts or >5 minutes) or inadvertent pancreatic duct cannulation, and reports a deep biliary cannulation success rate of approximately 80%. Advanced cannulation techniques have substantially improved access while reducing the risk of adverse events such as bleeding, intestinal perforation, infection, and particularly post-ERCP pancreatitis. At this tertiary referral unit, the leading preprocedural diagnosis was choledocholithiasis (45.9%), followed by biliary stricture (39.3%). The most frequently used rescue technique was precut sphincterotomy in 98 patients (72.6%), followed by precut sphincterotomy plus interval ERCP (12.6%). Anatomical variations were present in 71.9% of cases. Biliary cannulation was successful in 105 cases (77.78%). The most frequent postprocedural diagnosis was choledocholithiasis (28.1%), followed by biliary stricture (27.4%). Bleeding occurred in 16 cases (12%), and papillary edema occurred in 1 case (1%). Among successfully cannulated patients, the most commonly used rescue technique was precut sphincterotomy (86.7%); among failed cannulations, precut sphincterotomy plus interval ERCP was the most frequent strategy (17 cases; 56.7%). Age and complication rates did not differ significantly between successful and failed cannulation groups (complications, $p=0.1488$).

KEYWORDS: sphincterotomy; biliary tract; precut; pancreatitis; cannulation; ERCP.

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INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) is an essential tool for the diagnosis and treatment of biliary and pancreatic disorders. The first successful biliary cannulation was performed by obstetrician William McCune and the surgical team at George Washington University. They used an Eder fiberoptic duodenoscope equipped with forward- and side-viewing lenses and achieved a 50% success rate. One year later, investigators in Japan reported a 77% success rate without significant morbidity after development of a side-

viewing fiberoptic duodenoscope that allowed more precise cannula manipulation (1).

Biliary cannulation is fundamental to ERCP because it provides access to the biliary and pancreatic ductal systems. Nevertheless, access to the common bile duct can be technically challenging even for expert endoscopists. Recent studies report difficult biliary cannulation in 5%–18% of ERCP procedures, with higher initial failure rates in low-volume centers and among less-experienced endoscopists (2).

Success Rate of Difficult Biliary Cannulation and Rescue Techniques During Endoscopic Retrograde Cholangiopancreatography at a Tertiary Level Referral Center

In some patients, biliary anatomy, strictures, calculi, or postsurgical changes make cannulation more difficult and increase the risk of adverse events, including bleeding, perforation, and post-ERCP pancreatitis (3,10).

The European Society of Gastrointestinal Endoscopy (ESGE) defines difficult biliary cannulation as the presence of one or more of the following criteria (2,4,5):

- More than five contacts with the papilla while attempting cannulation.
- More than five minutes of cannulation attempts after visualization of the papilla.
- More than one unintended pancreatic duct cannulation or opacification.

Multiple advanced techniques have been developed for these situations, including needle-knife precut sphincterotomy, the double-guidewire technique, transpancreatic sphincterotomy, pancreatography-guided or pancreatic-stent-assisted cannulation, endoscopic ultrasound (EUS)-guided access, and endoscopic-radiologic rendezvous (9,10,12–14,27).

CANNULATION AND RESCUE TECHNIQUES

Conventional technique

The conventional technique uses a sphincterotome and guidewire to access the common bile duct (16). A sphincterotome or cannula—often preloaded with a hydrophilic guidewire—is oriented toward the 11- or 12-o'clock position of the papilla, following the expected axis of the bile duct. Under fluoroscopic guidance, the guidewire is advanced until entry into the common bile duct is confirmed. A small amount of contrast medium may then be injected to verify intraductal position fluoroscopically (15–17).

If guidewire-assisted cannulation fails, contrast injection can be used to delineate the anatomy, after which contrast-assisted cannulation without a guidewire may be attempted. A cannula or sphincterotome is placed at the papillary orifice and contrast is injected; if the common bile duct is visualized, the sphincterotome is advanced and its position is reconfirmed. Reported cannulation success is 60%–70% with a contrast-injection cannula and as high as 97% when contrast is injected through a sphincterotome (18).

Precut sphincterotomy (needle-knife papillotomy)

Precut sphincterotomy entails making a biliary sphincterotomy without prior common bile duct cannulation. A needle-knife sphincterotome is used to incise the papilla of Vater and expose the biliary orifice. It is one of the oldest and best-known rescue techniques; biliary access is achieved in up to 80% of cases after papillary incision (6). Two principal forms of precut are used:

Conventional precut (papillotomy directed from the papillary orifice): the endoscopist places the needle-knife at or just within the papillary orifice and makes a vertical cephalad incision—toward the 11-o'clock position—of approximately 5–8 mm. The incision is made through the

papillary mucosa to expose the underlying bile duct, after which cannulation is attempted with a standard sphincterotome or, when appropriate, the needle-knife already in position.

Suprapapillary fistulotomy (infundibulotomy): rather than cutting through the papillary orifice, the endoscopist incises the roof of the papillary mound several millimeters above the orifice, directly over the intraduodenal segment of the common bile duct. This creates a fistulous tract into the bile duct while avoiding the pancreatic duct. The technique is useful when a prominent oral protrusion covers the papillary opening; incision of this fold permits access to the bile duct from above. Patients with a protruding papilla and a long oral protrusion often require precut or fistulotomy to achieve cannulation (8).

Precut techniques achieve high rates of biliary cannulation (19). Several studies report access to the common bile duct in approximately 90%–95% of difficult cases when repeat attempts or staged precut procedures are included (20). A Japanese retrospective study reported a 98.6% success rate with early precut compared with 94.1% when precut was delayed ($p=0.03$) (20). The principal risks are papillary bleeding and duodenal perforation from an overly deep or lateral incision. Pancreatitis also remains a risk, although its incidence is not necessarily higher than with continued conventional attempts. Recent series report precut-associated bleeding in approximately 2%–5% of cases, most of which is controlled endoscopically with electrocautery or injection therapy. Perforation is uncommon (<1%) (2).

Double-guidewire technique

The double-guidewire technique is an early rescue option when selective common bile duct cannulation fails and the hydrophilic guidewire repeatedly enters the pancreatic duct. One guidewire is intentionally left in the pancreatic duct, and a second guidewire or catheter is advanced alongside it to attempt biliary cannulation. The pancreatic guidewire is thought to modify the papillary angle, straighten the trajectory toward the bile duct, and mildly tamponade the pancreatic orifice, thereby directing the second guidewire toward the biliary system (21).

The technique is generally considered after at least one unintended pancreatic duct cannulation. In practice, when the guidewire enters the duct of Wirsung after several failed attempts, many endoscopists use that position to perform double-guidewire cannulation before proceeding to precut. This approach was consistent with earlier ESGE guidance recommending the double-guidewire technique as an initial rescue method after inadvertent pancreatic duct access (23). ESGE also recommends prophylactic pancreatic stenting in appropriate high-risk situations to reduce post-ERCP pancreatitis (24). More recent evidence, however, questions whether double-guidewire cannulation should be the first

Success Rate of Difficult Biliary Cannulation and Rescue Techniques During Endoscopic Retrograde Cholangiopancreatography at a Tertiary Level Referral Center

rescue strategy or whether early precut or transpancreatic sphincterotomy should be preferred (5,7).

Reported efficacy is mixed. Earlier studies described success rates of 70%–80%. A 2012 controlled trial reported 80% success with the double-guidewire technique versus 67% with continued standard attempts, although post-ERCP pancreatitis occurred more often in the double-guidewire group without reaching statistical significance (21). A 2024 meta-analysis of 20 studies found significantly greater cannulation success with double-guidewire cannulation than with persistent standard cannulation (risk ratio, 1.37) (21). The main concern is pancreatic injury: a retained guidewire can traumatize the pancreatic duct, particularly when manipulation is prolonged. Nevertheless, some studies suggest that the double-guidewire technique itself does not significantly increase post-ERCP pancreatitis compared with precut techniques (21).

Pancreatography-guided cannulation: transpancreatic sphincterotomy and pancreatic-stent-assisted cannulation

These techniques use pancreatic duct cannulation and instrumentation to facilitate biliary access. The two principal interventions are transpancreatic sphincterotomy of the biliopancreatic septum and pancreatic stent placement to aid biliary cannulation at a second attempt. In malignant distal biliary obstruction, stent placement across the stricture and papilla during ERCP remains a standard palliative option (26).

Transpancreatic sphincterotomy (transpancreatic septotomy): after inadvertent pancreatic duct cannulation, the endoscopist advances a sphincterotome over the pancreatic guidewire and cuts from within the pancreatic duct toward the bile duct. The pancreatic guidewire serves as a rail, making the direction of the incision more controlled than a conventional freehand precut. The incision divides the septum between the pancreatic duct and common bile duct, enlarging the biliary opening and usually permitting immediate cannulation. The technique is also called transpancreatic precut or pancreatotomy-assisted cannulation (23,27).

A theoretical advantage of transpancreatic sphincterotomy is controlled opening of the biliopancreatic septum; in contrast with a freehand needle-knife precut, the endoscopist knows the precise location and direction of the cut. Historically, the technique was reserved for very difficult, small, hypoplastic, or fibrotic papillae after the duct of Wirsung had been cannulated (23). Recent evidence indicates high efficacy: a Scandinavian randomized trial reported 85% success with transpancreatic sphincterotomy versus 70% with double-guidewire cannulation (25). A network meta-analysis ranked transpancreatic sphincterotomy as the method with the highest probability of successful difficult biliary cannulation, followed by early precut (11,12). Papillary bleeding has been

reported in approximately 5%–10% of cases and is generally mild and endoscopically manageable (2).

A second pancreatography-based strategy is to place a temporary pancreatic stent after unsuccessful biliary cannulation and defer the next attempt for 24–48 hours—or, in selected cases, for a shorter interval. The stent maintains patency of the pancreatic orifice, limits edema, provides a visual and mechanical landmark for cannulation alongside the stent, and preserves pancreatic drainage. This approach is sometimes termed two-step cannulation or interval ERCP with pancreatic stenting (28). A review reported an overall success rate of 76.3% for interval ERCP with a 7.5% complication rate (28). Temporary pancreatic stenting may be considered after 15–20 minutes of failed precut or double-guidewire attempts, when continued manipulation would expose the patient to greater risk (20).

Endoscopic-radiologic rendezvous (percutaneous approach)

The classic rendezvous technique combines ERCP with percutaneous transhepatic cholangiography. Through a percutaneous transhepatic access, a guidewire is advanced through the biliary tree and across the papilla into the duodenal lumen. The endoscopist captures the guidewire with a snare or forceps and uses it to guide retrograde insertion of a sphincterotome or dilator, thereby completing assisted biliary cannulation (28). A review reported an overall success rate of 88.7% (range, 80.4%–100%) and a 13.2% overall complication rate for percutaneous transhepatic–endoscopic rendezvous (28).

With the expansion of EUS-guided interventions, percutaneous rendezvous is increasingly reserved for selected patients, such as those requiring urgent biliary drainage for cholangitis or those treated in centers without EUS expertise. Other patients may undergo interval ERCP or EUS-guided rendezvous (EUS-RV). Reported success rates are approximately 89% for the percutaneous approach and 82%–86% for EUS-RV, with complication rates of 13% and 14%, respectively (28).

EUS-guided biliary access and EUS-guided rendezvous

EUS-guided biliary access uses an echoendoscope to puncture a dilated bile duct from the gastrointestinal tract and establish a temporary or permanent communication for drainage or cannulation. Two principal modalities are used in difficult biliary access (9,29).

EUS-guided rendezvous (EUS-RV): the bile duct is accessed by EUS-guided transhepatic or extrahepatic puncture, and a guidewire is advanced across the papilla into the duodenum. Retrograde cannulation is then completed over or alongside the guidewire, avoiding percutaneous access.

EUS-guided biliary drainage (EUS-BD): if rendezvous fails, an internal bypass can be created by placing a stent from the biliary system to the gastrointestinal tract via EUS-guided

Success Rate of Difficult Biliary Cannulation and Rescue Techniques During Endoscopic Retrograde Cholangiopancreatography at a Tertiary Level Referral Center

choledochoduodenostomy or hepaticogastrostomy. This does not require retrograde cannulation and provides an alternative after failed ERCP. Technical success varies with center expertise; a review of 15 studies through 2016 reported mean EUS-RV success of 84% (range, 72%–96%) (29).

A 2024 meta-analysis comparing EUS-RV with precut found equivalent technical success of approximately 90%, without a significant difference between techniques (30). Potential adverse events include perforation, guidewire extravasation, bile leakage, bleeding from vascular puncture, and pancreatitis. Across published series, EUS-RV adverse-event rates are generally 10%–20%; a 2024 multicenter study of 69 procedures reported a 24% adverse-event rate and better outcomes in benign than malignant disease (29,31).

Statistical Analysis

A total of 135 medical records from 2023–2024 were reviewed. Adult patients with difficult biliary cannulation who underwent one of the following rescue strategies were included: interval ERCP, double-guidewire cannulation, double-guidewire cannulation plus precut sphincterotomy plus interval ERCP, precut sphincterotomy, precut sphincterotomy plus interval ERCP, precut sphincterotomy plus double-guidewire cannulation, or classic rendezvous. Patients were excluded if the medical record was incomplete or if follow-up for interval ERCP was not completed. Demographic characteristics were summarized as the median and interquartile range. Associations between demographic variables and cannulation success were evaluated using the chi-square test, multilevel chi-square analysis, and the Mann–Whitney U test, as appropriate.

RESULTS

The study included 135 patients who underwent ERCP with difficult biliary cannulation at a tertiary referral center during 2023–2024.

Eighty-five patients (63%) were women and 50 (37%) were men. The median age was 53 years (interquartile range, 39–66 years).

The leading preprocedural diagnosis was choledocholithiasis in 62 patients (45.9%), followed by biliary stricture in 53 (39.3%) (Table 1).

The most frequently used rescue technique was precut sphincterotomy in 98 patients (72.6%), followed by precut sphincterotomy plus interval ERCP in 17 (12.6%) (Figure 1). Cannulation difficulty was classified as easy in 86 cases (63.7%), moderate in 12 (8.9%), and high in 37 (27.4%). Anatomical variations were present in 97 of 135 patients (71.9%).

Biliary cannulation was successful in 105 cases (77.78%) (Table 2). The most frequent postprocedural diagnosis was choledocholithiasis in 38 patients (28.1%), followed by biliary stricture in 37 (27.4%) (Table 3).

Bleeding occurred in 16 patients (12%), and papillary edema occurred in 1 (0.7%) (Figure 2).

Among men, cannulation failed in 16 of 50 cases (32.0%), compared with 14 of 85 women (16.47%) (p=0.0361; odds ratio [OR], 2.38; 95% confidence interval [CI], 1.045–5.449). Anatomical variation was present in 29 of 30 patients with failed cannulation (96.7%) and in 68 of 105 patients with successful cannulation (64.8%) (p=0.0013; OR, 16.014; 95% CI, 2.095–122.37).

The most frequent rescue technique among patients with successful cannulation was precut sphincterotomy (91/105; 86.7%). Among patients with failed cannulation, the most frequent strategy was precut sphincterotomy plus interval ERCP (17/30; 56.7%) (p<0.00001). No statistically significant differences were observed in age or complications between groups (complications, p=0.1488) (Table 4).

Table 1. Demographic characteristics and preprocedural diagnoses (n=135)

Characteristic	n (%)
Sex	
Female	85 (63.0)
Male	50 (37.0)
Age, median (IQR), years	53 (39–66)
Preprocedural diagnosis	
Ampullary tumor + biliary stricture	1 (0.7)
Cholangitis	1 (0.7)
Cholangitis + choledocholithiasis	5 (3.7)
Choledocholithiasis	62 (45.9)
Cholelithiasis	5 (3.7)
Bile duct disruption	1 (0.7)
Biliary stricture	53 (39.3)
Biliary fistula	3 (2.2)
Bile leak*	4 (3.0)

Success Rate of Difficult Biliary Cannulation and Rescue Techniques During Endoscopic Retrograde Cholangiopancreatography at a Tertiary Level Referral Center

IQR, interquartile range. *The count for bile leak was omitted from the source table and was inferred from the stated total (n=135).

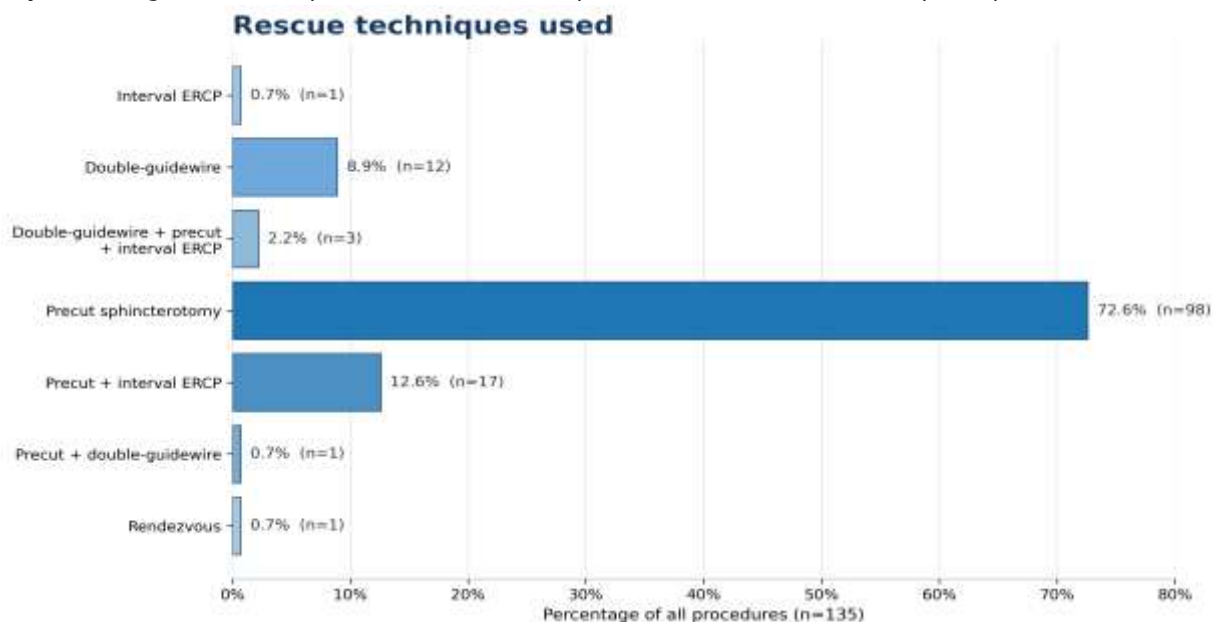


Figure 1. Rescue techniques used

Percentages use n=135. The seven categories shown in the source figure account for 133 cases; two cases were not assigned to a rescue-technique category in the original chart.

Table 2. Cannulation difficulty, anatomical variation, and cannulation success

Variable	n (%)
Cannulation difficulty	
Easy	86 (63.7)
Moderate	12 (8.9)
High	37 (27.4)
Anatomical variation	97 (71.9)
Successful biliary cannulation	105 (77.78)

Table 3. Postprocedural diagnoses (n=135)

Postprocedural diagnosis	n (%)
Ampullary tumor + biliary stricture	1 (0.7)
Cholangitis + choledocholithiasis	4 (3.0)
Cholangitis + biliary stricture	1 (0.7)
Cholangitis + biliary stricture + choledocholithiasis	1 (0.7)
Choledocholithiasis	38 (28.1)
Choledocholithiasis + biliary stricture	1 (0.7)
Cholelithiasis	6 (4.4)
Failed ERCP	28 (20.7)
Bile duct dilation with filling defects	1 (0.7)
Bile duct dilation without filling defects	9 (6.7)
Bile duct disruption	1 (0.7)
Biliary stricture	37 (27.4)
Biliary fistula	2 (1.5)
Bile leak	4 (3.0)
Suspected ampullary tumor	1 (0.7)

Frequency of complications

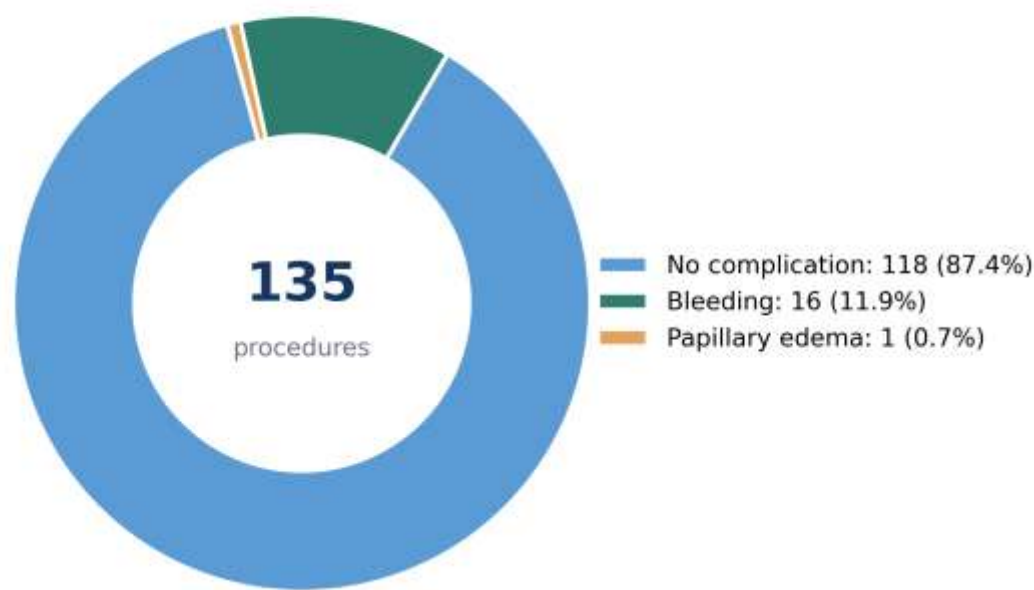


Figure 2. Frequency of complications

Table 4. Comparison of successful and failed biliary cannulation

Variable	Successful (n=105)	Failed (n=30)	p	OR (95% CI)
Sex			0.0361	2.38 (1.045–5.449)
Female	71 (67.6)	14 (46.7)		
Male	34 (32.4)	16 (53.33)		
Anatomical variation	68 (64.8)	29 (96.7)	0.0013	16.014 (2.095–122.37)
Rescue technique			<0.00001	
Interval ERCP	0	1 (3.3)		
Double-guidewire	11 (10.5)	1 (3.3)		
Double-guidewire + precut + interval ERCP	0	3 (10.0)		
Precut sphincterotomy	91 (86.7)	7 (23.3)		
Precut + interval ERCP	0	17 (56.7)		
Precut + double-guidewire	1 (0.95)	0		
Rendezvous	1 (0.95)	0		
Complications			0.1488	
None	94 (89.5)	24 (80.0)		
Papillary edema	0	1 (3.3)		
Bleeding	11 (10.5)	5 (16.67)		

Data are n (%) unless otherwise indicated. CI, confidence interval; OR, odds ratio. Statistical tests: chi-square, multilevel chi-square, and Mann–Whitney U, as appropriate. Rescue-technique rows total 104 successful and 29 failed cannulations as reported in the source table; one case in each outcome group was unclassified.

DISCUSSION

This study analyzed the characteristics and outcomes of patients undergoing ERCP for difficult biliary cannulation at

a tertiary referral center during 2023–2024. The predominance of procedures in women (63%) is consistent with previous studies reporting a higher incidence of biliary

Success Rate of Difficult Biliary Cannulation and Rescue Techniques During Endoscopic Retrograde Cholangiopancreatography at a Tertiary Level Referral Center

disease in women, attributable to multiple biological and epidemiological factors (32). The median age of 53 years also agrees with the epidemiology of biliary disorders, which commonly affect middle-aged adults (4).

A notable finding was the association between male sex and a higher probability of failed difficult biliary cannulation during ERCP (OR, 2.38; 95% CI, 1.045–5.449). Because the confidence interval excludes 1.0, the association is statistically significant and suggests that male sex may be related to greater technical difficulty or a higher risk of cannulation failure in this cohort.

Choledocholithiasis was the most frequent diagnosis (45.9%), consistent with its role as a leading indication for ERCP (13). Cannulation difficulty, based on the number of attempts, was classified as easy in most cases (63.7%); however, more than one quarter (27.4%) were classified as highly difficult, reflecting the technical complexity of ERCP in selected scenarios, particularly when anatomical variations are present (27).

Overall cannulation success was 77.78% and was substantially greater in patients without anatomical variation. Anatomical variation was strongly associated with failed cannulation ($p=0.0013$; OR, 16.014), underscoring the challenge created by altered anatomy and the need for specialized rescue methods or alternative access strategies (1). Precut sphincterotomy was the predominant technique in both successful and failed procedures, emphasizing its central role in the management of difficult biliary access (22).

Bleeding (12%) and papillary edema (0.7%) were the most frequently reported adverse events. These findings are consistent with previous reports describing procedural risk in patients with anatomical variation or those requiring rescue techniques (24). The higher failure rate among men may be related to anatomical differences and technical factors; however, these observations should be interpreted in the context of the retrospective design and the wide confidence intervals (32).

CONCLUSIONS

Difficult biliary cannulation during ERCP remains a substantial clinical challenge. Advanced techniques have improved success rates and can limit adverse events when the strategy is selected according to the patient's clinical context and the endoscopist's expertise. Early recognition of difficult cannulation and timely transition to an advanced technique are essential. Standardized ESGE criteria provide an objective basis for discontinuing conventional attempts and proceeding to rescue cannulation, thereby reducing injury associated with prolonged papillary manipulation. In this cohort, the overall difficult biliary cannulation success rate was slightly lower than expected; however, precut sphincterotomy alone achieved a higher success rate than the overall cohort (86.7% vs 77.78%) with a low incidence of major complications. Early precut therefore appears to be an

effective and safe strategy for difficult biliary cannulation. Continued optimization of rescue techniques is fundamental to improving clinical outcomes and minimizing procedure-related risk.

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Success Rate of Difficult Biliary Cannulation and Rescue Techniques During Endoscopic Retrograde Cholangiopancreatography at a Tertiary Level Referral Center

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