

PEDIATRIC ERCP

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- **Introduction**
- **Indications and grading**
- **Anesthesia**
- **Complications**
- **Success**

Introduction

- **ERCP** >>> well established as an endoscopic therapeutic modality for biliary and pancreatic disorders in the adult population
- **Pediatric ERCP** >>> much lower volume compared to the adult population
- **limited pediatric-specific, size-appropriate ERCP device development**
- **The impression that ERCP is technically challenging and risky in children**
- **Lower range of indications for pediatric ERCP(1)**



Indications

Indication	
Biliary	choledocholithiasis/sludge
	postsurgical bile leak
	cystobiliary communication
	traumatic BD injury
	postsurgical BD stricture
	choledochal cyst
	biliary ascariasis
	BRIC
	sclerosing cholangitis
	jaundice – other
Pancreatic	recurrent pancreatitis
	pancreatic duct injury
Total	

Åvitsland TL, Aabakken L. Endoscopic retrograde cholangiopancreatography in infants and children. *Endoscopy International Open*. 2021 Mar;9(03):E292-6.

Indication
Biliary atresia
Biliary stricture
Primary sclerosing cholangitis
Biliary stone
Biliary leakage postoperative
Choledochal cyst
Chronic pancreatitis
Acute pancreatitis
Hyperbilirubinemia
Pancreatic duct stricture
Traumatic liver/pancreatic injury
Pancreatic/biliary tumor
Papillary dysfunction
Cryptosporidiosis

Durakbasa CU, Balik E, Yamaner S, Bulut T, Büyükcüncü Y, Sökücü N, Akyüz A, Bugra D. Diagnostic and therapeutic endoscopic retrograde cholangiopancreatography (ERCP) in children and adolescents: experience in a single institution. *Eur J Pediatr Surg*. 2008 Aug;18(4):241-4. doi: 2):3543-50.

Table 2 ERCP indications stratified by patient's age

Indication for ERCP age 0–12	Number (%)
Biliary obstruction	67 (48.9)
Chronic pancreatitis	36 (25.7)
Acute pancreatitis	14 (10)
Choledochal cyst	5 (3.6)
Trauma	5 (3.6)
Suspected SOD	3 (2.1)
Pancreatic cyst	3 (2.1)
Other	3 (2.1)
Relapsing pancreatitis	2 (1.4)
Bile leak	2 (1.4)
Total	140
Indication for ERCP age 13–19	Number (%)
Biliary obstruction	117 (41.1)
Chronic pancreatitis	78 (27.4)
Suspected SOD	38 (13.3)
Acute pancreatitis	15 (5.3)
Relapsing pancreatitis	8 (2.8)
Other	8 (2.8)
Tumor	6 (2.1)
Trauma	5 (1.8)
Fistula	4 (1.4)
Pancreatic cyst	3 (1.1)
Choledochal cyst	2 (0.7)
Bile leak	1 (0.4)
Total	285

Giefer MJ, Kozarek RA. Technical outcomes and complications of pediatric ERCP. *Surgical endoscopy*. 2015 Dec;29(12):3543-50.

Anesthesia

- Conscious or deep sedation and topical anesthesia has become a safe alternative to general anesthesia in pediatric endoscopy
- But the higher complexity and duration of the procedure in pediatric patients with smaller anatomy sometimes requires general anesthesia.
- Studies report an ignorable rate of serious adverse events such as cardiorespiratory suppression specifically related to deep sedation.
- These findings suggest that the preference between deep sedation and general anesthesia can be determined according to many factors including patient age, weight, and experience



Grading of the complexity of ERCP

Grade 1

- Deep cannulation of duct of interest, main papilla, sampling
- Biliary stent removal/exchange

Grade 2

- Biliary stone extraction <10 mm
- Treat biliary leaks
- Treat extrahepatic benign and malignant strictures
- Place prophylactic pancreatic stents

Grade 3

- Biliary stone extraction <10 mm
- Minor papilla cannulation in divisum, and therapy
- Removal of internally migrated biliary stents
- Intraductal imaging, biopsy, FNA
- Management of acute or recurrent pancreatitis
- Treat pancreatic strictures
- Remove pancreatic stones mobile and <5 mm
- Treat hilar tumors
- Treat benign biliary strictures, hilum, and above
- Manage suspected sphincter of Oddi dysfunction (with or without manometry)

Grade 4

- Remove internally migrated pancreatic stents
- Intraductal image-guided therapy
- Pancreatic stones impacted and/or >5 mm
- Intrahepatic stones
- Pseudocyst drainage, necrosectomy
- Paillectomy
- ERCP after Whipple or Roux-en-Y bariatric surgery



Table reference

1. Cotton PB, Eisen G, Romagnuolo J, et al. Grading the complexity of endoscopic procedures: results of an ASGE working party. *Gastrointest Endosc* 2011;73:868-74.

complications

- Complications associated with pediatric ERCP range widely in severity and are reported inconsistently. A review suggests 6% of pediatric ERCPs have complications(1).
- Procedural complications included post-ERCP pancreatitis (4.7%), bleeding (0.6%) and infections (0.8%). The pooled estimate of post-ERCP pancreatitis was 3% , and other complications were 1% . In neonatal cholestasis subgroup the pooled complication rate was 3%(1) .

Table 4 Complications of pediatric ERCP

Complications	All cases (%)	Patients 0–12 years (%)	Patients 13–19 years (%)
Pancreatitis (any)	26/337 (7.7)	9/108 (8.3)	17/229 (7.4)
Mild	15/337 (4.5)	3/108 (2.8)	12/229 (5.2)
Moderate	9/337 (2.7)	4/108 (3.7)	5/229 (2.2)
Severe	2/337 (0.6)	2/108 (1.9)	0/229 (0)
Pain without pancreatitis	12/337 (3.6)	0/108 (0)	12/229 (5.2)
Sedation/anesthesia difficulties	8/337 (2.4)	0/108 (0)	8 (3.5)
Stent obstruction	4/201 (2)	1/50 (2)	3/151 (2)
Immediate sphincterotomy bleed	2/176 (1.1)	0/63 (0)	2/113 (1.8)
Internal PD stent migration	1/98 (1)	0/27 (0)	1/71 (1.4)
Delayed sphincterotomy bleed	1/176 (0.6)	0/63 (0)	1/113 (0.9)
Intra-hepatic guide wire perforation	1/337 (0.3)	0/108 (0)	1/229 (0.4)
Esophageal mucosal laceration	1/337 (0.3)	1/108 (0.9)	0/229 (0)

Giefer MJ, Kozarek RA. Technical outcomes and complications of pediatric ERCP. *Surgical endoscopy*. 2015 Dec;29(12):3543-50.

Usatin D, Fernandes M, Allen IE, Perito ER, Ostroff J, Heyman MB. Complications of endoscopic retrograde cholangiopancreatography in pediatric patients; a systematic literature review and meta-analysis. *The Journal of pediatrics*. 2016 Dec 1;179:160-5.

Success

- ERCP appears to have similar technical success, clinical success, and safety in children compared to matched adult controls(1,2)
- In a multicenter study, pediatric ERCPs were compared to adult-matched cohorts in two high-volume centers. A total of 93 ERCPs performed in pediatric patients were compared with 145 ERCP in adult controls and demonstrated similar technical and clinical success rates. There was no difference in the complication rate, procedural duration, or the number of procedures performed for each patient. There was increased use of general anesthesia and longer hospital stays in the pediatric cohort(3).
- The most difficult aspect of the ERCP is the first step: selective biliary cannulation (SBC) which may often end in failure. The principles of SBC in children are similar to those used in adult patients. There are some limitations in pediatric patients such as phenotypic characteristics of age range and equipment sizes. Despite all disadvantages, the rate of successful cannulation is as good as comparable to reports in adults



1. Mekaroonkamol P, Shah R, Nietoj, Chawla S, Freeman AJ, Sauer CG, et al. Sa2079 efficacy and safety of rectal indomethacin for prevention of post endoscopic retrograde cholangiopancreatography pancreatitis in a pediatric population. *Gastrointest Endosc* 85(5):AB287-AB8.
2. Rosen JD, Lane RS, Martinez JM, Perez EA, Tashiro J, Wagenaar AE, et al. Success and safety of endoscopic retrograde cholangiopancreatography in children. *J Pediatr Surg*. 2017;52(7):1148-51
3. Shah R, Mekaroonkamol P, Taylor A, Freeman AJ, Fritzen C, Chawla S, et al. Tu1988 safety and efficacy of endoscopic retrograde cholangiopancreatography in pediatric patients: an 8 year experience from a multicenter study. *Gastrointest Endosc* 2018;87(6):AB610AB1.

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ERCP complications identification and management

ERCP is one of the most demanding procedures in gastrointestinal endoscopy.

ERCP is associated with an increased risk of complications including :

Pancreatitis, hemorrhage , perforation , cholangitis and infection.

Post ERCP pancreatitis (PEP) is the most frequent complication of ERCP

Definition

- Pancreatitis
- Mild :Clinical pancreatitis, amylase at least 3x normal >24 hours after procedure, requiring admission or prolongation of planned admission to 2-3 days
- Moderate: Pancreatitis requiring hospitalization of 4-10 days
- Severe:Hospitalization > 10 days, or hemorrhagic pancreatitis phlegmon, pseudocyst, or intervention (percutaneous drainage or surgery)
- Bleeding
- Mild:Clinical (ie, not just endosco- pic) evidence of bleeding Hemoglobin drop < 3 g, and no need for transfusion
- Moderate:Transfusion (< 4 units), no angiographic intervention or surgery
- Severe:Transfusion \geq 5 units, or intervention (angiographic or surgical)
- Perforation

- Mild: Possible, or only very slight leak of fluid or contrast, treatable by fluids and suction for ≤ 3 days
- Moderate: Any definite perforation treated medically 4-10 days
- Severe: Medical treatment > 10 days, or intervention (percutaneous or surgical)
- Infection
- Mild: > 38 °C for 24-48 hours
- Moderate: Febrile or septic illness requiring > 3 days of hospital treatment or endoscopic percutaneous intervention
- Severe: Septic shock or surgery

PEP Definition, incidence, prediction

Incidence

Low-risk patients: 2-3% High-risk patients: 8-26% Effect of risk factors is synergistic.

Mild or moderate severity in approximately 90% of cases.

Prediction

Serum amylase or lipase values <1.5 times the ULN, obtained 2-4 hours post- ERCP have a very high negative predictive value for PEP. Values $>3-5$ times the ULN at 4-6 hours post-ERCP have increasing positive predictive value for PEP.

Prevention – recommendations

- Indication
 - - only therapeutic ERCP indicated
 - - information needed (history, medication, laboratory values)
- Risk stratification
 - - analyzing risk factors (overall, PEP, bleeding)
 - - cost – benefit
- Alternative imaging
 - MRCP
 - - EUS (!!!)
- Appropriate patient selection is instrumental in reducing PEP.
- Trying to avoid unnecessary or marginally indicated ERCP, especially in high-risk patients!

Standard cannulation

- Attempts
 - - try to minimize
 - - procedure-related definite risk factor for PEP (>5-10 min.)
- Contrast injection
 - - only incidentally or if required
 - - keep volume as low as possible
 - - procedure-related definite risk factor for PEP
- Cannulation technique
 - - wire-guided cannulation
 - - wire-assisted cannulation

Conclusion: Compared with the contrast-assisted cannulation technique, the **guide wire-assisted cannulation** technique **increases** the **primary cannulation rate** and **reduces** the **risk of PEP**, and therefore appears to be the most appropriate first-line cannulation technique.

- ESGE recommends keeping the number of cannulation attempts as low as possible (Grade B).
- The number of injections and volume of contrast medium injected into the pancreatic duct should be kept as low as possible (Grade B).
- The wire-guided technique is recommended for deep biliary cannulation (Grade A)

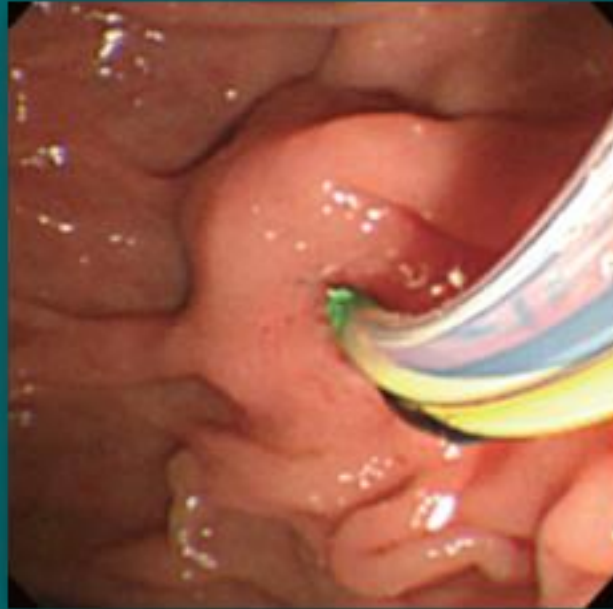
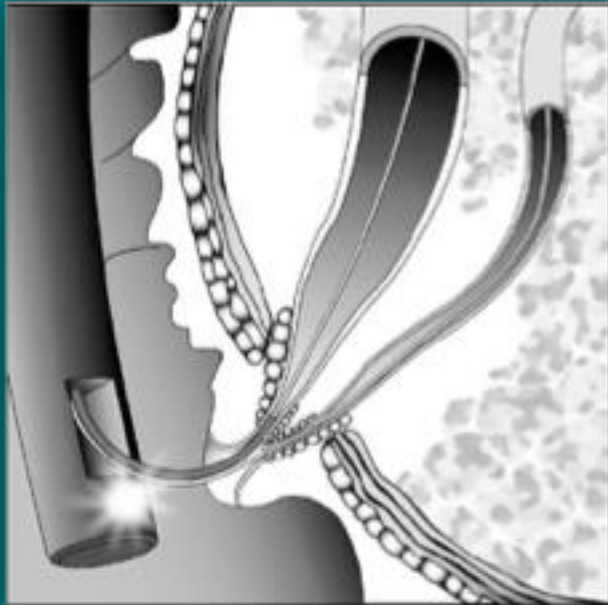
Endoscopic techniques: Difficult cannulation

- Definition (in an intact papilla)
 - - cannulation attempts of duration >5 minutes
 - - >5 attempts
 - - ≥ 2 pancreatic guidewire passages
- Options
 - - persistent attempts at cannulation using standard methods
 - - pancreatic guidewire placement (double wire technique)
 - - precut sphincterotomy
 - - repeat attempts at 24–48 hours later
 - - patient referral to another endoscopist/center

Difficult cannulation – pancreatic wire placement

Hypothesis (double guidewire technique)

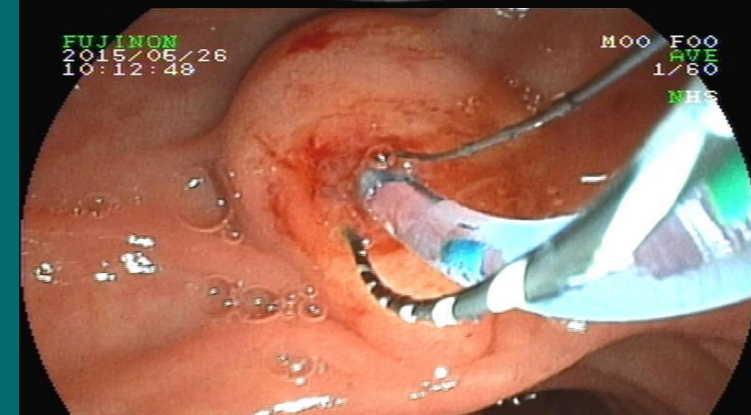
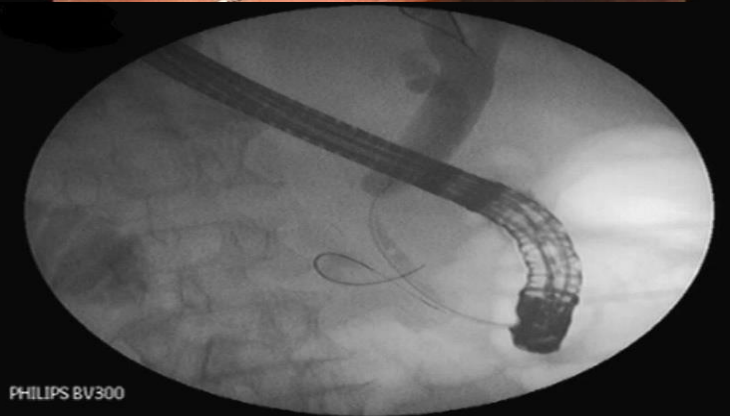
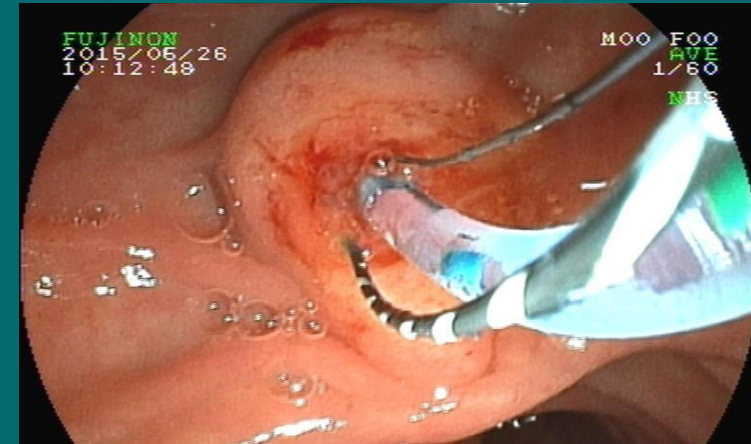
- facilitates deep biliary cannulation
- prevents repeated cannulation of PD



Difficult cannulation – pancreatic wire placement

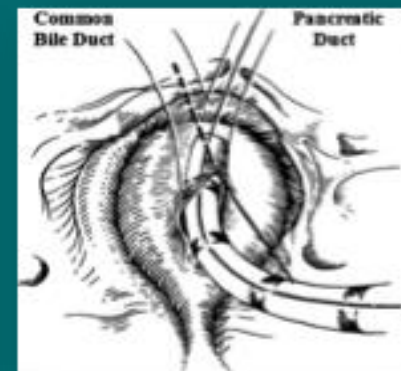
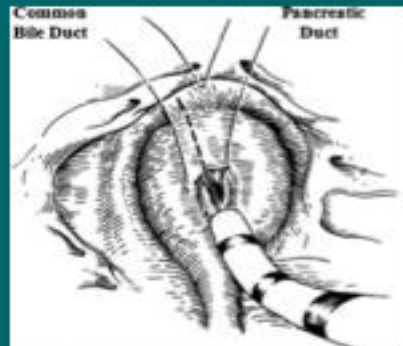
Conclusions: During therapeutic ERC using wire-guided cannulation, converting to a double-guidewire technique **neither facilitated selective bile duct cannulation nor decreased PEP incidence** compared with repeated use of a single-wire technique.

- ESGE suggests restricting the use of a PGW as a backup technique to cases with repeated inadvertent cannulation of the pancreatic duct; if this method is used, deep biliary cannulation should be attempted using a guidewire rather than the contrast-assisted method and a prophylactic pancreatic stent should be placed (Evidence level 1–; Grade B).
- In case of difficult biliary cannulation, when the guidewire is unintentionally inserted repeatedly into the PD, we utilize the double guidewire technique as an option.
- For the prevention of PEP we use 5-Fr prophylactic pancreatic stents.



precut sphincterotomy

- Access sphincterotomy
- Primarily designed for gaining access into the biliary or pancreatic duct when the conventional methods of selective cannulation fail. Basic principle is to unroof the ampulla of Vater for exposing the duct epithelium.
 - Techniques
 - needle-knife (NK) sphincterotomy
- conventional (free hand); over PD stent; suprapapillary fistulotomy - traction sphincterotomy
- traction papillotomy; transpancreatic precut sphincterotomy

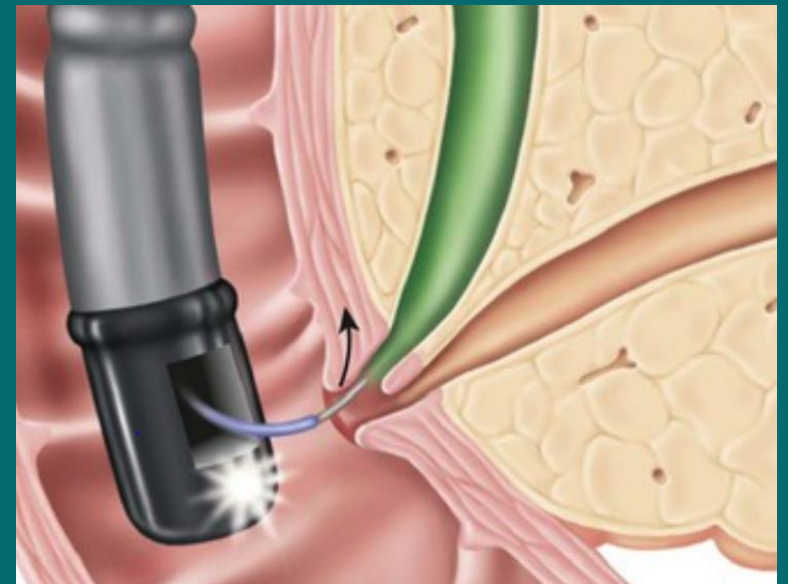
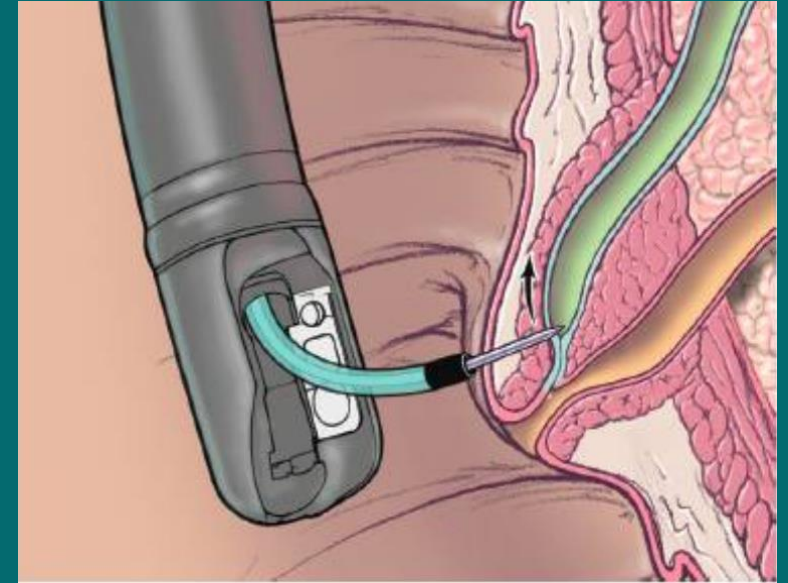


Zhou 2006	1	43	2
Cennamo 2009	1	36	6
Manes 2009	2	77	11
Subtotal (95% CI)		156	
Total events	4		19
Heterogeneity: Tau ² = .00, Chi ² = 1.04, df = 2 (P = .6)			
Test for overall effect Z = 2.24 (P = .03)			
Total (95% CI)		227	
Total events	14		27
Heterogeneity: Tau ² = .15, Chi ² = 4.91, df = 4 (P = .30), I ² = 72.4%			
Test for overall effect Z = 1.19 (P = .23)			
Test for subgroup differences: Chi ² = 3.62, df = 1 (P = .06); I ² = 72.4%			

In conclusion, our study shows that although there is no difference in overall cannulation rate, the institution of **early precut sphincterotomy significantly improves primary cannulation rates** compared with persistent standard therapy in patients with difficult biliary access. The early use of precut sphincterotomy **does not increase the risk of post-ERCP pancreatitis** and in experienced hands **may actually reduce this risk.**



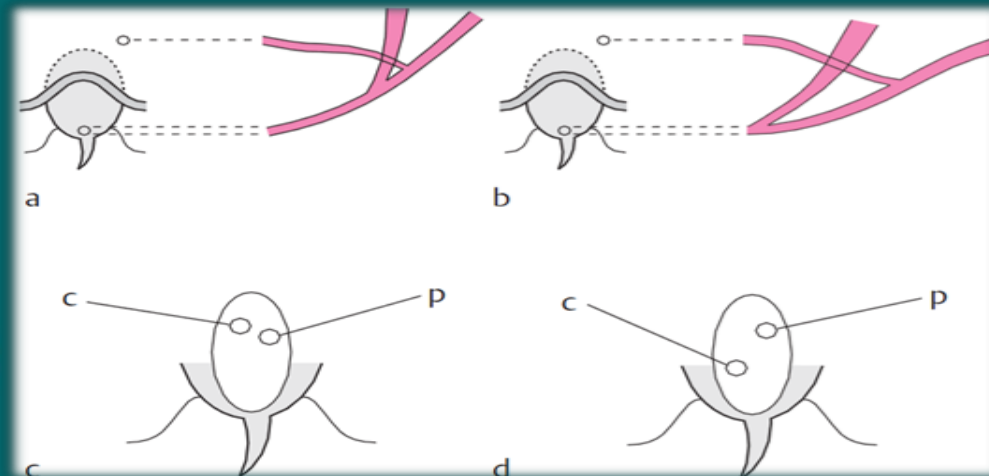
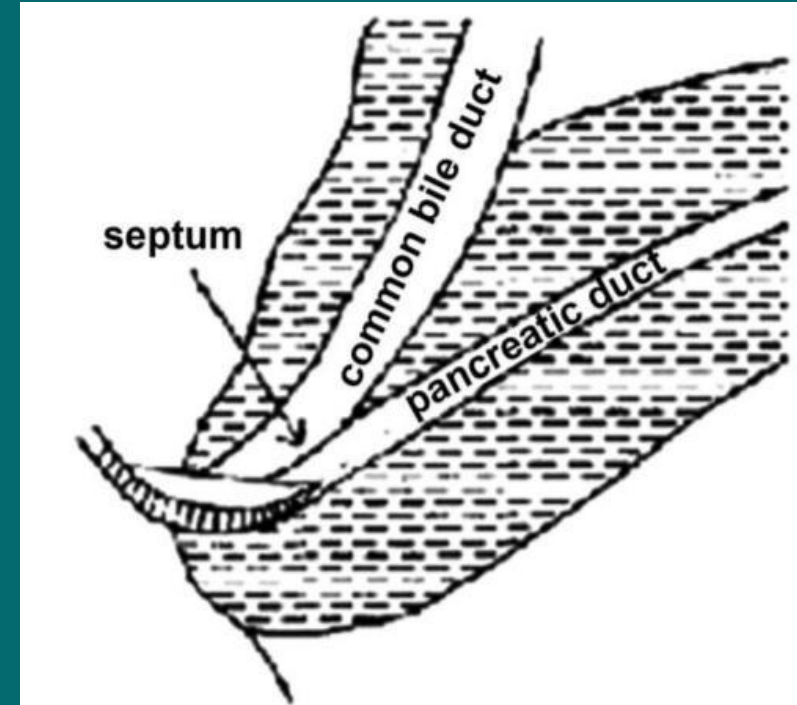
- In cases of difficult cannulation, early precut is associated with lower PEP incidence (Grade B).
- Needle-knife fistulotomy should be the preferred precut technique (Grade B).
- If conventional precut is elected and pancreatic cannulation is easily obtained, ESGE suggests attempting to place a small diameter pancreatic stent to guide the cut and leaving it in place for a minimum of 12-24 hours (Grade B).



- prefer early NK precut sphincterotomy in case of difficult biliary cannulation.
- For the prevention of PEP routinely use 5-Fr prophylactic pancreatic stents.
- A well-positioned guidewire in the MPD is a real blessing.
- This can occur only once during an ERCP, and during the next attempt neither the CBD nor the MPD can be cannulated.
- Therefore, even during the first guidewire passage into the MPD, the endoscopist must seriously consider performing some pancreatic technique for CBD cannulation instead of removing the guidewire from the pancreas and trying again with the standard technique.”

Transpancreatic sphincterotomy

- Synonymous with:
 - Transpancreatic precut papillotomy
 - Precut transpancreatic sphincterotomy
 - Transpancreatic septotomy
 -
 - Upward pancreatic sphincter precutting



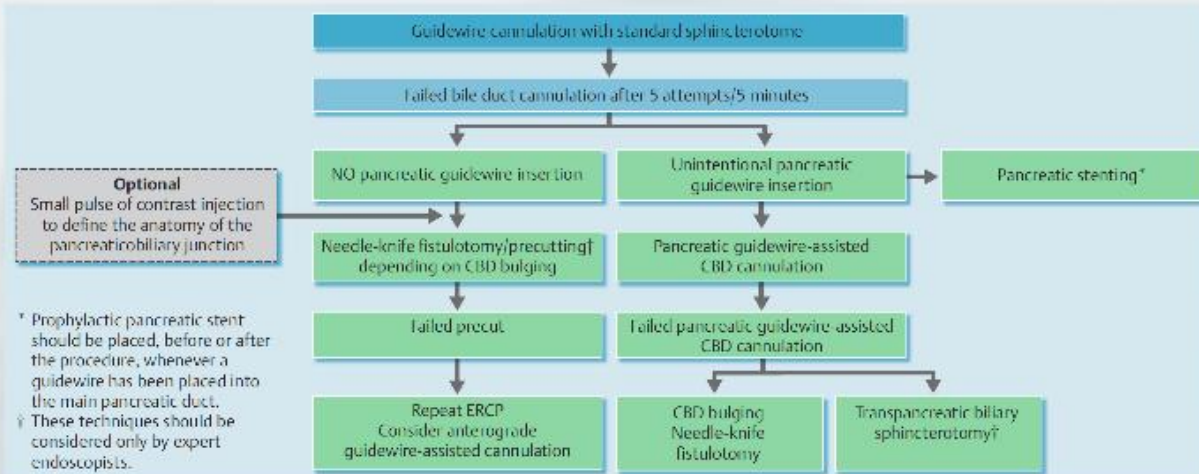


Fig. 1 Evidence-based algorithm for biliary cannulation in endoscopic retrograde cholangiopancreatography (ERCP). CBD, common bile duct.

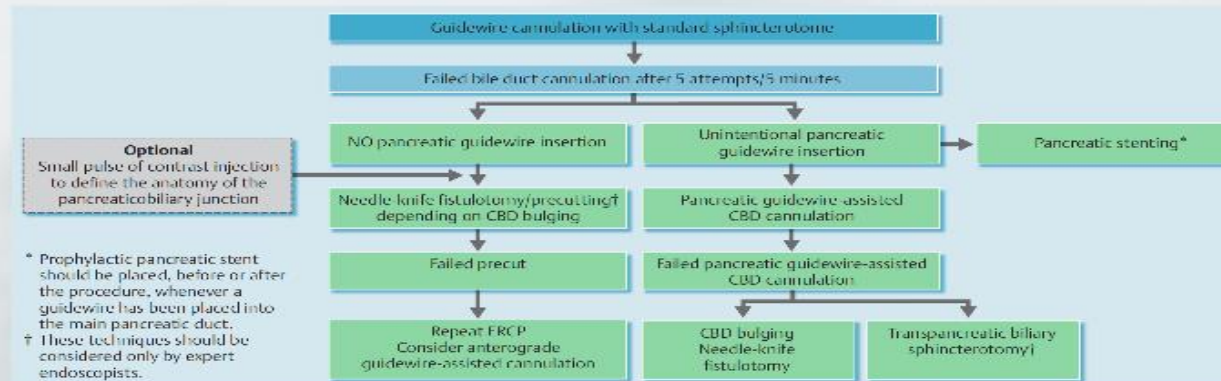


Fig. 1 Evidence-based algorithm for biliary cannulation in endoscopic retrograde cholangiopancreatography (ERCP). CBD, common bile duct.

Prophylactic pancreatic stent (PPS) placement

- Theory
- Mechanical or thermal injury during ERCP may cause papillary edema obstructing the PD; that could lead to increase in intraductal pressure and early intrapancreatic enzyme activation resulting in PEP. PPS can prevent PEP by maintaining the outflow of the pancreatic juice.

Conclusions This meta-analysis showed that **PS placement prevented PEP** after ERCP as compared with no PS placement. We therefore recommend PS placement after ERCP for the prevention of PEP.

Prophylactic pancreatic stent (PPS) placement

What type of stent to choose?

-USRCT(78patients):5-Fr vs.3-Fr

– Networkmeta-analysis(6RCTs):561patients

- Prophylactic pancreatic stent (PPS) placement Complications
- Attempted but unsuccessful PPS placement (high risk for PEP: ~40%)
- Successful placement
 - - Early dislodgement
 - - Proximal migration
 - - Ductal perforations (3/2283 cases = 0.1%)
 - - Prolonged retention in PD
 - ductal and parenchymal changes
 - stent fragmentation
 - pancreatitis caused by removal of retained stents

- Prophylactic pancreatic stenting decreases the risk of PEP in high risk and mixed-case groups; it nearly eliminates the risk of severe PEP.
- ESGE recommends the placement of 5-Fr pancreatic stents in cases at high risk of PEP.
- Passage of the stent from the pancreatic duct should be evaluated within 5 to 10 days of placement and retained stents should be promptly removed endoscopically (Level 1+; Grade A).

Conservative management

- Hydration
- Teory
 - Hypoperfusion of the microvasculature during the early phase of acute pancreatitis.
- Emphasis
 - Early volume resuscitation to prevent or limit pancreatic injury

In conclusion, this prospective randomized trial suggests that aggressive hydration with lactated Ringer's solution reduces the incidence of post-ERCP pancreatitis.

Prophylactic medications - NSAIDs

Conclusions: A single rectal dose of NSAIDs is effective in preventing PEP both in high-risk and in unselected patients, regardless of timing of administration (pre- or post-ERCP) and NSAID type (indomethacin or diclofenac).

- ESGE recommends routine rectal administration of 100 mg of diclofenac or indomethacin immediately before or after ERCP in all patients without contraindication (Grade A).
- Effective PEP prophylaxis has only been demonstrated using diclofenac or indomethacin (Level 1++).

Past ERCP Bleeding

- Mild - Moderate - Severe -
- No transfusion
< 4 units
> 4 units / Intervention

Risk factors Definite

Coagulopathy

Anti Coagulants >3d

Cholangitis

Lower ERCP volume

Pure cutting current Chronic renal failure

Cirrhosis

Dilated CBD

Periampullary diverticulum

Precut

ASA / NSAID Ampullary tumor

Longer ES

Extension of prior ES

Management algorithm

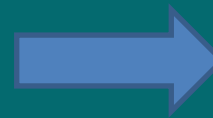
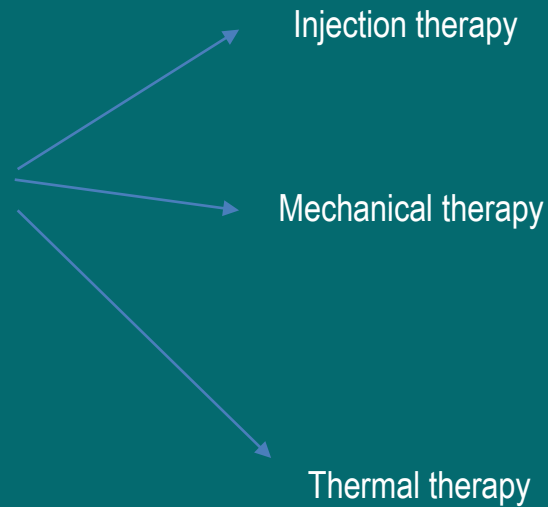
- □ Extend the cut/use coagulation
- □ Spray epinephrine solution
- □ Balloon tamponade



- Not controlled



- Endoscopic treatment



Embolization / Surgery

Perforation

- Mild: Conservative, treated ≤ 3 days
- Moderate: Conservative, treated 4-10 days
- Severe: Intervention, treated > 10 days
- Localization
- Retroperitoneal :
 - pre cut
 - . Guidewire
 - • sphincterotomy
- Intraperitoneal :
 - Billroth II
 - D1 / D2 narrowing

Clinical features

- Ranging between 0.3 % to 1.5 % (mean 0.6%)
- – Poorly defined (low prevalence)
- CT scan required because of air insufflation (use of CO₂!)
- 2/3 retroperitoneal perforation, 1/3 duodenal perforation
- Surgery required in 25% to 50% of the patients

Management

- **Prevention:**CO₂ insufflation, adequate caution
- **Determining the severity:**presence of peritoneal signs, systemic inflammatory response, anatomical location, degree of leakage
- **Conservative treatment:**fasting, fluids iv., antibiotics iv.
- **Surgical treatment:**drainage of collections, repairing defect, diversion

Cholangitis

- **Definition**
- **Mild:** >38 °C for 24 to 48 hrs
- **Moderate:** Fever > 3 days, endoscopic intervention
- **Severe:** Septic shock, surgery

Failed drainage after cholangitis



Incidence, management

- Ranging between 0.9 % to 2.9 % (mean 0.9%)
- Depends on the quality of the biliary drainage
 - – Antibiotic prophylaxis recommended in patients with malignant stenosis, liver transplantation
 - – Proper ERCP technique
 - – Adequate biliary clearance or drainage of the upstream bile duct
- Minimum standards of quality in ERCP
- What is considered successful: – overall complication rates < 10% – overall success rates > 85%

Sum up

- Appropriate indication is indispensable for successful ERCP.
- Appropriate patient selection is instrumental in reducing post-ERCP complications. Always perform with adequate caution.
- For PEP prevention wire-guided cannulation is the preferred standard technique. In assisted cannulation PPS placement is recommended. Precut sphincterotomy is safe and effective alternative to standard cannulation. Rectal NSAID administration is the first line prevention method in PEP prophylaxis in all patients. PPS placement is effective and safe method for PEP prophylaxis, especially in high-risk patients.
- For prevention of post-ERCP bleeding blended current, good ES direction or EPLBD is preferred. Management of post-ERCP bleeding includes injection, mechanical and thermal therapeutic modalities.
- Post-ERCP perforation may be treated conservatively or surgically. Severity can be determined by clinical, laboratory or imaging signs.
- Post-ERCP cholangitis is treated with iv. antibiotics; adequate biliary clearance or drainage of the upstream bile duct is required