

# Utility of the Short Double-Balloon Enteroscope to Perform Pancreaticobiliary Interventions in Patients with Surgically Altered Anatomy in a US Multicenter Study

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## Abstract

**Objective** Double-balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography (DBE–ERCP) is an effective method for interventions in the pancreaticobiliary system in the post-surgical patient. However, use of currently available endoscopic accessories during this procedure is limited due to the length of the conventional instrument (200 cm). The aim of this study was to explore the utility of the short DBE (152 cm) for the management of pancreaticobiliary disorders in patients with surgically altered anatomies.

**Methods** Data were collected retrospectively on patients with various anatomic variations in whom ERCP was performed using the short DBE from April 2008 to November 2011. Basic demographic information, clinical presentation, preoperative imaging, and type of surgery, procedural technical success rate, and adverse events were evaluated. Descriptive analysis was used to document the demographic and clinical data of the patients.

**Results** We identified 79 patients in whom DBE–ERCP was attempted (38 % male, mean age 58 years). Indications for the procedure were removal of a previously placed stent ( $n = 5$ ), suspected sphincter of Oddi dysfunction type 1 ( $n = 3$ ), surgical biliary leak ( $n = 3$ ), pancreatic anastomotic stricture ( $n = 2$ ), suspected biliary stones ( $n = 48$ ), and biliary strictures visualized on imaging ( $n = 18$ ). Overall, the success rate of DBE–ERCP in all patients was 81 % (64/79). The scope could not reach the papilla or surgical anastomosis in 8 cases and duct cannulation failed in 7 cases. The following interventions were performed: biliary sphincterotomy ( $n = 39$ ), dilation of CBD stenosis with a balloon ( $n = 30$ ), biliary stent insertion ( $n = 25$ ), stone removal ( $n = 35$ ), brushing cytology of biliary strictures ( $n = 3$ ), and stent retrieval ( $n = 4$ ). Three patients developed post-procedure pancreatitis. There was 1 episode of self-limited bleeding.

**Conclusions** The current study demonstrates that DBE assisted ERCP for pancreaticobiliary interventions using a short enteroscope are feasible in patients with surgically altered anatomy.

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## Introduction

Endoscopic access for endoscopic retrograde cholangiopancreatography (ERCP) in patients with previous intestinal surgery is often challenging and of limited success. The most common reasons for this are either the inability of the endoscope to reach the ampulla, or surgical pancreaticobiliary anastomosis as a consequence of length of the

bowel passage, or severe angulation that cannot be traversed safely as some acute angles of surgical limbs are difficult to navigate. As a result, many of these patients are referred for surgical or percutaneous interventions which have greater complications than endoscopic therapy [1].

The introduction of the double-balloon enteroscope (DBE) in 2001 [2] allowed endoscopists to advance beyond the reach of standard endoscopes and enabled access to the pancreatobiliary limb of small intestine in patients with surgically altered anatomy [3]. DBE has been demonstrated in small case series to be a useful tool in post-surgical patients who require an endoscopic retrograde cholangiopancreatography (ERCP) [1, 4–7]. DBE-assisted ERCP (DB-ERCP) allows the endoscope to reach the papilla or ductal anastomoses in patients with previous small bowel surgery that would otherwise be challenging or impossible with a normal duodenoscope or forward-viewing endoscope (e.g., pediatric colonoscope). Unfortunately, the length of the conventional “long” double-balloon enteroscope (200 cm) precludes the use of many standard ERCP devices. This makes biliary and pancreatic interventions challenging and time-consuming. This was previously the only DBE length available for commercial use. However, a “shorter” DBE, which measures 152 cm in length, subsequently became available, and is short enough to allow use of standard length ERCP accessories.

In this large retrospective case series, we reported our experience with the shorter DBE for various therapeutic pancreatobiliary interventions in patients with challenging postsurgical anatomy.

## Patients and Methods

### Patients

Using our respective endoscopic databases, we analyzed 79 patients with altered postsurgical anatomy and pancreatobiliary problems who underwent an initial DBE-assisted ERCP between April 2008 and November 2011 by 6 experienced endoscopists. The post-surgical anatomy of the patients was as follows: Roux-en-Y gastric bypass ( $n = 39$ ), Billroth II gastrectomy ( $n = 3$ ), pancreaticoduodenectomy ( $n = 20$ ), hepaticojejunostomy ( $n = 3$ ), Roux-en-Y hepaticojejunostomy ( $n = 4$ ), roux-en-Y gastrojejunostomy ( $n = 5$ ), choledochojejunostomy ( $n = 2$ ), and roux-en-Y pancreaticojejunostomy ( $n = 3$ ). All patients with Roux-en-Y gastric bypass or Billroth II gastrectomy had a naive papilla. Patients with a Billroth II gastrectomy or a pancreaticoduodenectomy underwent a DBE-assisted ERCP since they had failed a previous attempt with a standard duodenoscope or a small caliber colonoscope. Informed consent was obtained from each patient prior to the



**Fig. 1** The short double balloon enteroscope (EC-450BI5; Fujinon, Wayne, NJ, USA) with a working channel of 2.8 mm diameter and a working length of 152 cm

procedures. This study was approved by the institutional review boards from each of the respective institutions.

### Procedure Description

Patients were placed in the prone position and endoscopy was performed using general anesthesia or propofol-based monitored anesthesia care as per institutional protocols. Pre-procedure antibiotics were administered at the discretion of the endoscopist. DBE-ERCP was performed under fluoroscopic guidance with the short DBE (EC-450BI5; Fujinon, Wayne, NJ, USA) with a working channel of 2.8 mm diameter and a working length of 152 cm (Fig. 1). The system and the push-and-pull technique of insertion by inflating and deflating the balloons to advance the scope has been described in detail previously [2, 8]. In cases when the DBE was too short to reach the desired location, manual compression and/or the use of a flexible stiffening rod through the endoscope working channel were employed. Once the enteroscope reached the papilla or ductal anastomosis, the position of the endoscope was stabilized by deeply inserting the overtube. The DBE and overtube were then manipulated so as to allow the bile duct to appear in the 11- or 12-o'clock position on the monitor. Selective biliary or pancreatic duct cannulation was achieved with a 0.025- or 0.035-inch guidewire using a sphincterotome (Autotome Rx™; Boston Scientific, Natick, MA, USA) or straight cannula depending upon the appearance of the papilla. The sphincterotome had a rotating handle that allowed the tip orientation to change to facilitate selective cannulation.

## Endoscopic Sphincterotomy

Wire-guided endoscopic sphincterotomy was performed using either a pull-type sphinctertome or needle knife sphinctertome, when required. If cannulation was not possible, a needle knife sphincterotomy of the papilla was performed.

## Endoscopic Biliary Stone Extraction

When bile duct stones were identified, an endoscopic sphincterotomy with or without papillary balloon dilation was performed using a Hurricane dilation catheter (Boston Scientific). A retrieval balloon catheter was then used to sweep the biliary tree and remove the stones.

## Dilation of Hepaticojejunostomy Anastomosis

In patients with a hepaticojejunostomy in whom an anastomotic stenosis was identified, a wire-guided balloon dilatation catheter was used for biliary dilation. In incidences when the balloon catheter could not be inserted, a dilation catheter (Soehendra Biliary Dilation Catheters; Wilson-Cook) was used to serially dilate the stenosis.

## Drainage of the Biliary or Pancreatic Ductal System

In cases of biliary or pancreatic ductal obstruction from a benign or malignant stricture, plastic or metal stents were placed across the stenosis under wire-guidance. In cases where the stricture was suspected to be malignant, brush cytology during ERCP was obtained.

## Statistics

Descriptive analysis was used to evaluate demographic and clinical data of the patients.

## Results

### Demographics and Procedural Indications

ERCP with the short DBE was performed in 79 patients (30 male; mean age 58, range 29–86) years. Fifty-three cases were performed at the Fox Chase Cancer Center and 26 cases were performed at the Thomas Jefferson University Hospital. Indications for the procedure were removal of a previously placed stent ( $n = 5$ ), abdominal pain as a result of suspected sphincter of Oddi dysfunction type 1 ( $n = 3$ ), surgical biliary leak confirmed on a hepatobiliary iminodiacetic acid scan ( $n = 3$ ), pancreatic anastomotic stricture leading to abdominal pain and ductal dilation ( $n = 2$ ), elevated liver function tests and suspected biliary stones

visualized on imaging ( $n = 48$ ), and abnormal liver function tests and biliary strictures visualized on magnetic resonance cholangiography ( $n = 18$ ). Overall, the success rate of DBE-ERCP in all patients was 81 % (64/79).

### Success in Reaching the Major Papilla or Surgical Anastomoses Site

Deep insertion of the short DBE to reach the papilla or surgical anastomoses site was successful in 71/79 (89 %) procedures. The success of deep insertion by the DBE was as follows: Roux-en-Y gastric bypass (32/39), Billroth II gastrectomy (3/3), pancreatoduodenectomy (19/20), hepaticojejunostomy (3/3), Roux-en-Y hepaticojejunostomy (4/4), Roux-en-Y gastrojejunostomy (5/5), choledochojejunostomy (2/2), and Roux-en-Y pancreaticojejunostomy (3/3).

### Success of Biliary or Pancreatic Duct Cannulation

The overall rate of successful biliary or pancreatic duct cannulation and contrast injection of the targeted duct was demonstrated in 64/71 (90 %) procedures in whom the papilla or surgical anastomoses site was reached. Successful cannulation and injection was achieved in: Roux-en-Y gastric bypass (29/32), Billroth II gastrectomy (3/3), pancreatoduodenectomy (16/19), Hepaticojejunostomy (3/3), Roux-en-Y hepaticojejunostomy (4/4), roux-en-Y gastrojejunostomy (4/5), choledochojejunostomy (2/2), and roux-en-Y pancreaticojejunostomy (3/3).

In the 7 cases that the short DBE could not achieve ductal cannulation, 2 were due to the presence of a large periampullary diverticulum, while the other 5 were as a result of being unable to identify the native papilla or ductal anastomosis site. In the latter cases, the percutaneous transhepatic biliary drainage rendezvous technique was used to enable therapeutic ERCP on the second session. The overall success for reaching the papilla or surgical anastomoses AND cannulation is summarized in Table 1 with respect to the surgical anatomy.

### Endoscopic Findings of the Biliary or Pancreatic Ductal System

Findings of the DBE-assisted ERCP are summarized in Table 2. The results are based upon combination of cholangiography and/or pancreatography AND direction visualization of the anastomosis. The majority of patients were found to have stones or sludge in the biliary system. Normal cholangiographic findings were documented in 10 cases performed for abnormal liver function tests; no therapeutic intervention was required in these cases. It was presumed that these patients had spontaneous passage of biliary stones.

**Table 1** Overall procedural success for reaching the papilla or surgical anastomoses AND ductal cannulation

Surgical anatomy	Reaching the papilla or surgical anastomoses		Success of biliary or pancreatic duct cannulation	
	<i>n</i>	%	<i>n</i>	%
Roux-en-Y gastric bypass	32/39	82	29/32	91
Billroth II gastrectomy	3/3	100	3/3	100
Pancreatoduodenectomy	19/20	95	16/19	84
Hepaticojejunostomy	3/3	100	3/3	100
Roux-en-Y hepaticojejunostomy	4/4	100	4/4	100
Roux-en-Y gastrojejunostomy	5/5	100	4/5	80
Choledochojejunostomy	2/2	100	2/2	100
Roux-en-Y pancreaticojejunostomy	3/3	100	3/3	100

**Table 2** Findings of the DBE assisted ERCP

DBE ERCP findings	<i>n</i>
Unsuccessful ERCP cannulation	7
Normal biliary tree	10
Stent retrieval	4
Anastomotic stricture	5
Bile duct stones or sludge	35
Bile duct leak	2
Dilated biliary tract	2
Common bile duct stricture	16
Sphincter of oddi dysfunction	2

### Endoscopic Intervention of the Biliary or Pancreatic Ductal System

Endoscopic therapeutic interventions were successful in all 64 cases in which ductal cannulation were achieved. Therapeutic interventions included biliary sphincterotomy ( $n = 39$ ), dilation of CBD stenosis with a balloon ( $n = 30$ ), biliary stent insertion ( $n = 25$ ), stone removal ( $n = 35$ ), brushing cytology of biliary strictures ( $n = 3$ ) and stent retrieval ( $n = 4$ ). Endoscopic sphincterotomy was performed with a sphincterotome or a needle-knife using wire guidance. Extraction of stones was performed with a biliary sphincterotomy (in patients with a native papilla), with or without a balloon biliary sphincteroplasty followed by the balloon pull-through method. Placement of 22 plastic and 3 metallic stents was performed. These interventions are summarized in greater detail in Table 3.

### Complications

The most common post-procedural complaints were self-limiting abdominal pain (3/79) and abdominal bloating. Three patients developed mild post-ERCP pancreatitis which resolved after a short hospitalization. There was one

**Table 3** Therapeutic interventions performed by the DBE-assisted ERCP

ERCP therapeutic intervention	<i>n</i>
Balloon dilation	2
Balloon dilation + biliary balloon sweep	4
Balloon dilation + biliary balloon sweep + stent	1
Balloon dilation + stent	4
Biliary balloon sweep	3
Brushings + stent	2
Endoscopic sphincterotomy + balloon dilation + stent	5
Endoscopic sphincterotomy + balloon dilation + stone removal by balloon sweep	13
Endoscopic sphincterotomy + brushings + stent	1
Endoscopic sphincterotomy + dilation	1
Endoscopic sphincterotomy + stent	3
Endoscopic sphincterotomy + stone removal by balloon sweep	16
Stent	9
Stent retrieved	4

incidence of post-procedural bleeding that resolved by itself without any intervention. There were no perforations.

### Discussion

Patients with surgically altered anatomy have ERCP success rates that are lower (33–67 %) [9–11] than those encountered in patients with normal gastric and duodenal anatomy (90–95 %) [4, 9–11]. In the past, patients with altered anatomy and a failed conventional ERCP have been referred for surgical or percutaneous interventions which are associated with greater morbidity and cost compared to ERCP [12]. Percutaneous transhepatic cholangiography (PTC) has several technical limitations, including patients with ascites and coagulopathy and those with non-dilated biliary ducts. In addition, interventional radiology procedures on the pancreatic ductal system are typically not feasible.

**Table 4** Review studies evaluating ERCP in patients with altered anatomy

Author	Number of cases	Type of procedure	Number of intact papilla	Reaching the papilla or surgical anastomoses (%)	Success of native duct cannulation or pancreatobiliary anastomosis (%)	Complications (%)
Mehdizadeh [13]	5	DBE-ERCP	2	67	100	0
Aabakken [7]	13	DBE-ERCP	1	94	85	0
Maasser [1]	11	DBE-ERCP	2	63	64	0
Kuga [14]	6	DBE-ERCP	2	100	83	0
Tsujino [6]	12	Short DBE-ERCP	0	100	94	17
Shimatani [15]	103	Short DBE-ERCP	77	97	96	5
Lennon [16]	25	Spiral Assisted ERCP	5	78	40	0

Use of the conventional DBE system, by way of its balloons at the tip of the endoscope and overtube, increases the likelihood that the papilla or pancreatobiliary anastomosis can be reached and that selective pancreatic and/or biliary interventions can be performed [1, 3–5, 7]. However, most standard ERCP accessories measure 200 cm in length, making them too short to be used with this conventional DBE. A review of studies evaluating ERCP in patients with altered anatomy via various techniques is summarized in Table 4.

In the current study, we have demonstrated that the use of the shorter 152-cm DBE in patients with altered bowel anatomy is feasible, and allows localization of the afferent limb, visualization papilla of Vater or surgical anastomoses. The shorter endoscope length also facilitates pancreatobiliary interventions with standard length ERCP tools. Our study cohort consisted of patients with a variety of surgically altered bowel reconstructions. Our overall success in performing ERCP was high (81 %). A wide variety of therapeutic interventions were successfully performed with the short DBE including endoscopic sphincterotomy, stone extraction, balloon dilation of strictures, and stent implantation. The majority of ERCP failures occurred in Roux-en-Y gastric bypass patients. This was probably a result of the length and sharp angulation of the Roux limb, making it difficult to negotiate the passage of the scope to the papilla. Our results are in agreement with previously smaller studies that have also evaluated the role of the short DBE to perform ERCPs in patients with surgically altered anatomy [5, 15]. A strength of the present study is that our cohort was much larger than in most other similar trials. In addition, we demonstrated the effectiveness of the DBE to perform ERCPs in patients with a variety of surgical anatomic variations.

The short DBE is of similar construction and features of the conventional DBE. It consists of a balloon at the tip of the endoscope and one on the overtube; this allows the endoscopist to hold the intestine and to insert the endoscope deeply while shortening the intestine by operating

the two balloons at the same time. By manipulating the endoscope and the overtube, one can align the papilla in an axis where the endoscopists can then achieve pancreatic and/or biliary cannulation.

While there are several studies demonstrating use of the conventional DBE to perform ERCPs, the overall success rate was low with various anatomic variations such as Roux-en-Y gastric bypass or hepaticojejunostomy [1, 3, 4, 7, 17]. There are several advantages of using the short DBE: (1) it may have better maneuverability than the long conventional DBE, which is especially useful in patients with severe surgical adhesions; (2) it enables the endoscopist to apply pressure more effectively to the enteroscope, which may increase the success rate of reaching the papilla or anastomosis [6]; and (3) it allows the use of commercially available ERCP cannulas, performance of wire-guided cannulation, and use of therapeutic instruments to carry out successful therapeutics. The varieties of ERCP devices available for the long conventional DBE are currently insufficient for routine therapeutic work. The advantages highlighted above clearly increase the overall success rate in reaching the papilla or ductal anastomosis, and for performing ERCP-related interventions in the aforementioned patients. In the present study, we also demonstrated that the short DBE could act as a rescue procedure in cases of failed ERCP with a standard duodenoscope in Billroth II gastrectomy or pancreaticoduodenectomy patients. Our study closely mirrors the findings outlined by Cho [18] and Shimatani [15] which also demonstrated that the short DBEs were equally as effective in reaching the target limb as the standard long DBEs. They also showed that the short DBE may overcome some limitations of long DBEs to result in high success rates for endoscopic therapy [15, 18].

The short DBE may be disadvantageous in some patient subsets, such as Roux-en-Y gastric bypass patients with long cumulative distances between the gastric pouch and the jejunojejunostomy and the jejunojejunostomy to the duodenal papilla, because the short enteroscope may not extend far enough. In these cases, the conventional “long” DBE



may be required if the short DBE fails to reach the papilla [19]. Schreiner et al. recently showed that post- Roux-en-Y gastric bypass patients with a Roux + ligament of Treitz to jejunojejunal anastomosis limb length <150 cm should first be offered DBE-assisted ERCP. In patients with Roux + ligament of Treitz to jejunojejunal anastomosis limb length of 150 cm or longer, laparoscopic-assisted ERCP may be a better approach because of the lack of the need for a second procedure, equivalent morbidity and hospital stay, decreased endoscopist time, and decreased cost [20].

Regardless of which is used, all double-balloon endoscopes are forward-viewing and lack an elevator, which makes ductal cannulation and ERCP interventions difficult, especially in patients with a Roux-en-Y reconstruction and an intact papilla.

Patients with bowel reconstruction who undergo an ERCP have a higher incidence of complications than that seen in an ERCP in patients with normal gastrointestinal anatomy [21, 22]. The risk of retroperitoneal perforation in patients with a Billroth II surgery has been reported to be as high as 7–10 % [22]. There is a paucity of data in the literature on the ERCP complications in patients with Roux-en-Y reconstruction, though small case series have reported a rate of 5 % [4, 5, 15]. As such, the actual rates of perforation, bleeding, and pancreatitis associated with DBE-ERCP is unknown. In our case series, we reported no luminal perforations. We had three cases of mild pancreatitis and one self-limited bleeding episode; all cases resolved with conservative therapy. Interesting, all complications occurred in patients with a Roux-en-Y gastric bypass, again reiterating the point that this subset of patients appears to be the most challenging and the highest risk. In conclusion, ERCP using the short DBE is a promising and safe tool to perform diagnostic and therapeutic procedures of the pancreaticobiliary system in patients who have undergone bowel reconstruction. The ability to use conventional ERCP accessories with the short DBE is a significant advantage over the conventional long DBE in this patient population.

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**Conflict of interest** The authors attest that they have no commercial associations (e.g., equity ownership or interest, consultancy, patent and licensing agreement, or institutional and corporate associations) that might be a conflict of interest in relation to the submitted manuscript.

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