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Endoscopic treatment of biliopancreatic pathology in patients with Whipple's pancreaticoduodenectomy surgical variants: Lessons learned from single-balloon enteroscopy-assisted ERCP

Rodrigo Garcés-Durán, Laurent Monino, Pierre H Deprez, Hubert Piessevaux, Tom G Moreels*

Department of Gastroenterology and Hepatology, Université catholique de Louvain, Cliniques Universitaires Saint-Luc, Avenue Hippocrates 10, 1200 Brussels, Belgium

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ABSTRACT

Background: Endoscopic treatment of biliopancreatic pathology is challenging due to surgically altered anatomy after Whipple's pancreaticoduodenectomy. This study aimed to evaluate the feasibility and safety of single-balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography (SBE-ERCP) to treat biliopancreatic pathology in patients with Whipple's pancreaticoduodenectomy surgical variants.

Methods: We retrospectively analyzed 106 SBE-ERCP procedures in 46 patients with Whipple's variants. Technical and clinical success rates and adverse events were evaluated.

Results: Biliary SBE-ERCP was performed in 34 patients and pancreatic SBE-ERCP in 17, including 5 with both indications. From a total of 106 SBE-ERCP procedures, 76 were biliary indication with technical success rate of 68/76 (90%) procedures and clinical success rate of 30/34 (88%) patients. Mild adverse event rate was 8/76 (11%), without serious adverse events. From a total of 106 SBE-ERCP procedures, 30 were pancreatic indication with technical success rate of 24/30 (80%) procedures ($P = 0.194$ vs. biliary SBE-ERCP) and clinical success rate of 11/17 (65%) patients ($P = 0.016$ vs. biliary SBE-ERCP). Mild adverse event rate was 6/30 (20%) ($P = 0.194$ vs. biliary SBE-ERCP), without serious adverse events. After SBE-ERCP failure, endoscopic ultrasound-guided drainage, percutaneous drainage and redo surgery were alternative therapeutic options.

Conclusions: Biliopancreatic pathology after Whipple's pancreaticoduodenectomy variants can be treated using SBE-ERCP without serious adverse events. Technical and clinical success rates are high for biliary indications, whereas clinical success rate of pancreatic indications is significantly lower. SBE-ERCP can be considered as first-line treatment option in this patient group with surgically altered anatomy.

Introduction

Whipple's pancreaticoduodenectomy (PD) is the standard surgical technique to treat benign and malignant pancreatic lesions like adenocarcinoma, neuroendocrine tumors, intraductal pancreatic mucinous neoplasia, cholangiocarcinoma, ampulloma, duodenal tumors and chronic pancreatitis [1,2]. PD requires the surgical creation of several anastomoses, including hepaticojejunostomy, pancreaticojejunostomy, and gastrojejunostomy [3]. Over the years, variants of the surgical procedure have emerged with an additional Roux-en-Y anastomosis, preservation of the pylorus or the creation of a pancreaticogastrostomy [4,5]. Despite the advances in surgical treatment, biliary and pancreatic PD-related complications are still frequent, including anastomotic strictures and intraductal stone formation with subsequent recurrent episodes of acute cholangitis or pancreatitis. The rate of clinically significant anastomotic strictures ranges from 5% to 12% in recent reports [6,7].

The treatment of anastomotic strictures in PD variants is challenging with both surgical, radiological and endoscopic management strategies, often depending on local availability and expertise. Although endoscopic therapy of biliary and pancreatic anastomotic strictures is considered the least invasive approach, the surgically altered anatomy of PD variants does not allow the use of the conventional side-viewing duodenoscope to reach the biliopancreatic system [8]. However, with the advent of device-assisted en-

* Corresponding author.
E-mail address: tom.moreels@saintluc.uclouvain.be (T.G. Moreels).

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teroscopy systems, intubation of the afferent biliopancreatic limb with or without additional Roux-en-Y anastomosis to reach the hepaticojejunostomy and the pancreaticojejunostomy is now feasible. This approach allows endoscopic retrograde cholangiopancreatography (ERCP) in patients with altered anatomy after PD [8]. Although ERCP in patients with surgically altered anatomy has been facilitated by the development of device-assisted enteroscopy, endoscopic access to the biliopancreatic system in PD patients remains challenging due to the long and tortuous aspect of the small bowel. As a result, many of these patients are referred for surgical or percutaneous interventions, procedures that are more invasive and that come with higher adverse event rates compared to endoscopic therapy [9].

Device-assisted enteroscopy groups with different enteroscopy techniques: single- and double-balloon enteroscopy and (motorized) spiral enteroscopy [10]. Although some researchers have indicated that single-balloon enteroscopy (SBE) may be inferior to double-balloon enteroscopy in achieving total enteroscopy, the success rates of balloon enteroscopy-assisted ERCP have been reported to be similar for both techniques [11]. Preliminary results of enteroscopy-assisted biliary ERCP in patients with surgically altered anatomy using the newly developed motorized spiral enteroscope do not seem to outclass the success rates of balloon-assisted enteroscopy [12]. The balloon-loaded overtube helps to grip the intestinal wall to ensure deep small bowel intubation to reach the biliary and pancreatic anastomosis and to stabilize the enteroscope during ERCP manipulations. The therapeutic working channel (3.2 mm in diameter in the latest models) contributes to the expansion of therapeutic options, accommodating the use of most available accessories to perform ERCP-related procedures such as anastomotic balloon dilatation, stone extraction, and deployment of plastic or even metallic stents. Even intraductal electrohydraulic lithotripsy can be a salvage treatment during balloon enteroscopy-assisted ERCP [13]. Use of carbon dioxide insufflation instead of air insufflation reduces the risk of barotrauma [14].

Although balloon enteroscopy-assisted ERCP has improved the outcomes of ERCP in patients with Whipple's PD anatomy, it remains a challenging procedure. The most common cause of failed ERCP is either the inability to reach the biliary or pancreatic anastomosis due to long, tortuous and fixed small bowel limbs, or the difficult catheterization of the bile or the pancreatic duct using a forward viewing enteroscope without elevator. Therefore, alternative approaches have been developed. Endoscopic ultrasound-guided pancreatic duct drainage (EUS-PDD) can be used as a rescue procedure after technical failure of balloon enteroscopy-assisted ERCP [15]. EUS-PDD includes EUS-guided rendez-vous technique and anterograde EUS-PDD. The technique consists of transmural gastric puncture and pancreatography, followed by anterograde transanastomotic guidewire insertion to facilitate rendez-vous pancreatic duct cannulation or direct anterograde passage of a pancreatic stent. EUS-PDD is technically challenging with a higher adverse event risk compared with other endoscopic drainage modalities [16]. According to recent guidelines from the European Society for Gastrointestinal Endoscopy (ESGE), EUS-PDD should be reserved as a salvage procedure when ERCP-guided drainage of the pancreatic duct fails [17]. However, in some expert centers EUS-PDD is also used as a first-line procedure to drain the pancreatic duct in patients with surgically altered anatomy. It also allows the use of 10-Fr plastic and metallic stents attributed to the larger EUS working channel [18].

The current study aimed to evaluate the therapeutic role of SBE-assisted ERCP (SBE-ERCP) to treat biliary and pancreatic pathology in patients with surgically altered anatomy following Whipple's PD and its variants, like pylorus-preserving PD and PD with Roux-en-Y reconstruction.

Patients and methods

Patients

We conducted a retrospective study of 106 SBE-ERCP procedures in 46 consecutive patients with biliary and/or pancreatic pathology after Whipple's PD surgical variants. All procedures were performed between October 2014 and October 2021 in the Cliniques Universitaires Saint-Luc, Brussels, Belgium. All patients provided written informed consent for the procedure. The study was approved by the Ethics Committee of the Cliniques Universitaires Saint-Luc (No. 2021/07AVR/162).

The indications for biliary ductal drainage were recurrent episodes of acute cholangitis, cholestasis with dilated main bile duct or presence of bile duct stones. The indications for pancreatic ductal drainage were symptomatic pancreatic ductal obstruction, suspected because of pancreas-associated pain or recurrent acute pancreatitis in the setting of a dilated main pancreatic duct or occluded surgical pancreatic stent. We collected data of all patients for first or index SBE-ERCP procedure concerning age, sex, time from surgery to endoscopy, type of surgery, primary disease, and radiological diagnostic findings prior to endoscopic drainage.

Technical and clinical success

Overall technical success rate was defined as completion of the intended procedures at the end of the study.

Success of enteroscopy was defined as complete intubation of the afferent/biliopancreatic limb and reaching the biliary and/or pancreatic anastomosis with the SBE.

Success of diagnostic ERCP was defined as selective cannulation of the biliary or pancreatic duct resulting in cholangiogram or pancreatogram and leading to a diagnosis.

Success of therapeutic ERCP was defined as successful intended endoscopic interventions using SBE-ERCP.

Successive ERCP was defined as a technically successful repeat SBE-ERCP procedure because of recurrent symptoms or for stent exchange, or an endoscopic technique that facilitated future definitive therapy.

Overall clinical success was defined as symptomatic relief at the end of the study. The endoscopic endpoint in both biliary and pancreatic indications, was definitive therapy, defined as clinical success by transanastomotic drainage.

Alternative treatments were defined as alternative approaches like radiological percutaneous drainage, surgery or EUS-guided transgastric drainage to help the SBE-ERCP procedure or as final treatment after failed SBE-ERCP.

SBE-ERCP-related complications included abdominal pain, cholangitis, pancreatitis, bleeding, and perforation. The severity of adverse events (AEs) was graded according to the ESGE guideline for endoscopic AEs [19].

Procedures

All patients were in the supine position on the fluoroscopy table, under general anesthesia with endotracheal intubation. SBE-ERCP was performed using carbon dioxide insufflation with different models of the single-balloon enteroscope (SIF-Q180, XSIF-180JY, SIF-Y0011 and the short SIF-H290S, Olympus, Tokyo, Japan) with a working channel of 2.8 mm or 3.2 mm diameter and a working length of 156 cm or 200 cm. Detailed description of the SBE types has been published before [10]. The enteroscope was loaded with a transparent cap on the tip. The push-and-pull technique of insertion was used by inflating and deflating the balloon to advance the enteroscope and to stabilize it by inserting the over-

tube. Fluoroscopy was used to identify the afferent/biliopancreatic limb and to perform the ERCP procedure.

Data were categorized according to the index and repeat SBE-ERCP procedures. Enteroscope progression was rated as "normal, difficult, very difficult (requiring external abdominal compression) or impossible". Procedure time was calculated from the time of enteroscope insertion until the end of the procedure. The biliary and pancreatic anastomoses were described as "normal, substenosis, pinpoint stenosis or complete occlusion". Cannulation was performed using the StarTipV catheter (Olympus) or the MD 1-JECT injection needle (Prince Medical, Ercuis, France) in case of complete closure of the anastomosis. The 500 cm long 0.025 inch Jagwire Revolution guidewire (Boston Scientific, Marlborough, MA, USA) was used to obtain deep cannulation of the bile duct or the pancreatic duct. Intraductal findings were ductal strictures (benign or malignant), intraductal stones or intraductally migrated stent. A variety of endoscopic techniques were used to achieve definitive therapy, including needle access, balloon dilatation, stone removal, stent placement or removal, direct cholangioscopy with the enteroscope and intraductal electrohydraulic lithotripsy.

Intervals to successive SBE-ERCP and from index to final SBE-ERCP were calculated. Procedure-related AE severity during hospitalization was evaluated in all patients.

The primary outcome measurements of the current study were the technical and clinical success rates of SBE-ERCP in patients with Whipple's PD. The secondary outcome measurements were the following: recurrence after initial technical or clinical success, need for other unplanned endoscopic, radiological or surgical procedures, AEs during or after the first 24 h after the SBE-ERCP procedures and the procedure time.

Statistical analysis

Statistical analysis was performed using Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA, USA) for descriptive statistics and SPSS version 26 (SPSS Inc., Chicago, IL, USA) for comparative statistics. Quantitative variables were presented as median (interquartile range) and qualitative variables as proportion. Comparisons were performed using Chi-square test for categorical variables and Mann-Whitney rank sum test for continuous variables. A $P < 0.05$ was considered statistically significant.

Results

Patient baseline characteristics

A total of 106 SBE-ERCP procedures were performed in 46 patients with previous Whipple's PD surgical variants (Fig. 1). There were 29 patients with biliary indications, 12 with pancreatic indications, and 5 with both biliary and pancreatic indications. Biliary SBE-ERCP was performed in 34 (74%) and pancreatic SBE-ERCP in 17 (37%) patients. Patient characteristics are shown in Table 1.

Biliary SBE-ERCP

Indications for biliary SBE-ERCP are shown in Table 2. Five patients had both biliary and pancreatic indications. Stricture of the hepaticojejunal anastomosis followed by intrahepatic bile duct stones was the most common indication. Classical ERCP procedures were performed including balloon dilatation of the hepaticojejunal anastomosis or intrahepatic bile duct strictures, bile duct stone removal, plastic stent placement and removal, uncovered metallic stent placement, direct cholangioscopy and intraductal lithotripsy (Fig. 2).

A total of 76 biliary SBE-ERCP procedures were performed in 34 patients with both a high technical success rate of 90% (68/76) and clinical success rate of 88% (30/34) with a median of 1 (1-3) SBE-ERCP procedures and a median time interval of 3 (2-6) months between the first and the second SBE-ERCP procedures. Indications for second SBE-ERCP were repeated balloon dilatation of the hepaticojejunal anastomosis, stent removal of previously placed plastic biliary stents or redo SBE-ERCP in case of symptom recurrence.

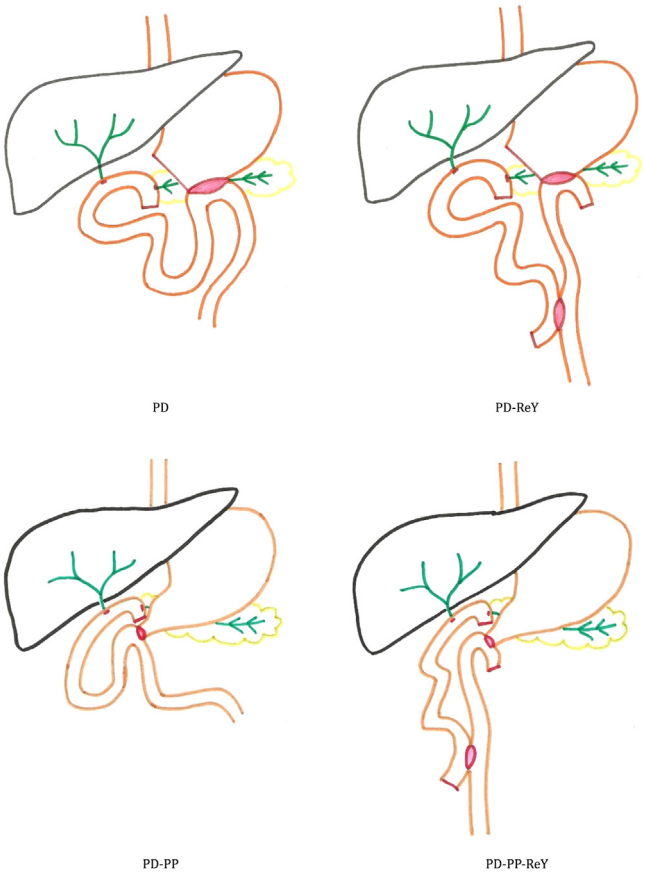

Fig. 1. Whipple's pancreaticoduodenectomy (PD) and surgical variants, PD with preservation of the pylorus (PD-PP), PD with Roux-en-Y reconstruction (PD-ReY), PD with preservation of the pylorus and with Roux-en-Y reconstruction (PD-PP-ReY).

Table 1
Patient characteristics per indication (biliary vs. pancreatic) in patients with (variants of) Whipple's pancreaticoduodenectomy.

Variables	Biliary indication ($n = 34$)	Pancreatic indication ($n = 17$)	*P* value
Male/female	23/11	7/10	0.070
Age (yr)	67 (59-73)	59 (53-68)	0.119
Time since surgery (mon)	36 (22-78)	25 (14-60)	0.516
Type of surgery			0.661
Whipple's PD	24 (70%)	11 (64%)	
PD-PP	3 (9%)	3 (18%)	
PD-ReY	5 (15%)	1 (6%)	
PD-PP-ReY	2 (6%)	2 (12%)	
Indication for surgery			
Pancreatic cancer	11 (32%)	10 (58%)	
Ampulloma	3 (9%)	2 (12%)	
Chronic pancreatitis	1 (3%)	2 (12%)	
IPMN	4 (12%)	2 (12%)	
NET	5 (15%)	1 (6%)	
Cholangiocarcinoma	3 (9%)	0	
Duodenal tumor	7 (20%)	0	

PD: pancreaticoduodenectomy; PD-PP: Whipple's PD with pylorus preservation; PD-ReY: Whipple's PD with Roux-en-Y; PD-PP-Rey: Whipple's PD with pylorus preservation and Roux-en-Y; IPMN: intrapancreatic mucinous neoplasia; NET: neuroendocrine tumor.

Table 2
Technical and clinical results per indication (biliary vs. pancreatic) in patients with (variants of) Whipple's pancreaticoduodenectomy.

Variables	Biliary indication (n = 34)	Pancreatic indication (n = 17)	P value
Indicaton for index SBE-ERCP			0.831
Stricture of HJ anastomosis	11 (32%)	5 (29%)	
Stricture of PJ anastomosis	5 (15%)	9 (53%)	
Biliary stones	9 (26%)	0	
Malignant recurrence	3 (9%)	1 (6%)	
Stent placement/removal	6 (18%)	2 (12%)	
Median procedure time of index SBE-ERCP (min)	57 (49-86)	74 (63-110)	**0.028**
Median number of SBE-ERCP procedures	1 (1-3)	1 (1-2)	0.657
Median time interval to 2nd SBE-ERCP procedure (mon)	3 (2-6)	3 (1.5-4)	0.719
Technical success per procedure	68/76 (90%)	24/30 (80%)	0.194
Clinical success per patient	30/34 (88%)	11/17 (65%)	**0.016**
Adverse events	8/76 (11%)	6/30 (20%)	0.194
Enteroscope progression			0.192
Normal	26 (76%)	10 (59%)	
Difficult	4 (12%)	5 (29%)	
Very difficult	1 (3%)	1 (6%)	
Impossible	3 (9%)	1 (6%)	

SBE-ERCP: single-balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography; HJ: hepaticojejunal; PJ: pancreaticojejunal.

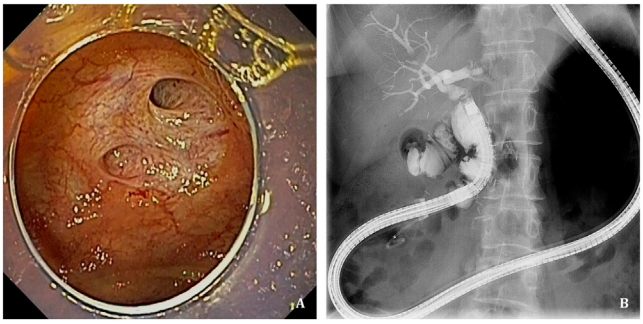

Fig. 2. SBE-ERCP procedure of a 59-year-old female patient who underwent Whipple's PD because of an ampulloma. She presented with both biliary (disturbed liver function tests) and pancreatic indications (chronic pain of pancreatic origin with dilated pancreatic duct and exocrine pancreatic insufficiency). The endoscopic aspect of the hepaticojejunal anastomosis was normal (**A**) as was the retrograde cholangiography (**B**). Notice the position of the SBE to reach the hepaticojejunal anastomosis. SBE-ERCP: single-balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography; PD: pancreaticoduodenectomy.

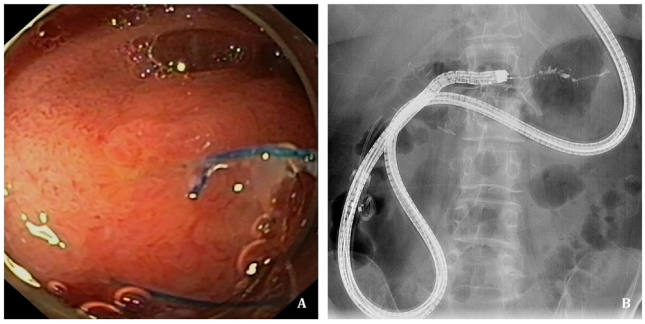

Fig. 3. SBE-ERCP procedure of the same 59-year-old female patient who underwent Whipple's PD because of an ampulloma. The endoscopic image showed a pinpoint stenosis of the pancreaticojejunal anastomosis (**A**) and a dilated pancreatic duct upon retrograde pancreatography (**B**). Notice the position of the SBE to reach the pancreaticojejunal anastomosis. SBE-ERCP: single-balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography; PD: pancreaticoduodenectomy.

SBE-ERCP failed in 4 patients and these patients underwent subsequent alternative final treatments: percutaneous biliary drainage, surgical biliary drainage, palliative care or EUS-guided drainage, one for each. Enteroscope progression to the hepaticojejunal anastomosis during the index SBE-ERCP procedure was considered normal in 76% of the patients, difficult in 12%, very difficult in 3% and impossible in 9% and the median procedure time of the index SBE-ERCP was 57 (49-86) min. Mild AEs were self-limiting cholangitis and abdominal pain in 8/76 (11%) procedures. There were no serious AEs following biliary SBE-ERCP.

Pancreatic SBE-ERCP

Indications for pancreatic SBE-ERCP are shown in Table 2. Five patients had both biliary and pancreatic indications. Stricture of the pancreaticojejunal anastomosis was the most common indication. ERCP procedures included re-opening of the occluded anastomosis using a needle catheter, balloon dilatation of the pancreaticojejunal anastomosis, plastic stent placement and removal (Fig. 3).

A total of 30 pancreatic SBE-ERCP procedures were performed in 17 patients with a technical success rate of 80% (24/30) and a clinical success rate of 65% (11/17) with a median of 1 (1-2) SBE-ERCP procedures and a median time interval of 3 (1.5-4) months between the first and the second SBE-ERCP procedures. Indications for second SBE-ERCP were repeat balloon dilatation of the pancreaticojejunal anastomosis, stent removal of previously placed plastic pancreatic stents or redo SBE-ERCP in case of symptom recurrence. Pancreatic SBE-ERCP failed in 6 patients and they underwent alternative final treatment: EUS-guided transgastric drainage of the main pancreatic duct in 4, EUS-guided coeliac bloc in 1 and clinical follow-up in 1. Enteroscope progression to the pancreaticojejunal anastomosis during the index SBE-ERCP procedure was considered normal in 59% of the patients, difficult in 29%, very difficult in 6% and impossible in 6% and the median procedure time of the index SBE-ERCP procedure was 74 (63-110) min. Mild AEs were self-limiting pancreatitis or abdominal pain in 6/30 (20%) procedures. There were no serious AEs.

Discussion

Late postoperative complications after Whipple's PD and its surgical variants are not rare, and mainly characterized by anastomotic stricture of the hepaticojejunostomy and/or the pancreaticojejunostomy, often in association with intraductal stone formation [6,7]. However, endoscopic access to the biliopancreatic system in patients with surgically altered anatomy is difficult and sometimes impossible. Balloon-assisted enteroscopy enables endoscopic access to the biliary and pancreatic anastomosis and allows enteroscopy-assisted ERCP in patients with surgically altered anatomy [8]. However, because of the challenging and time-consuming aspect of enteroscopy-assisted ERCP in patients with surgically altered anatomy, these procedures are usually performed

in referral centers. The current study shows that SBE-ERCP is effective and safe to treat both biliary and pancreatic pathology in patients with Whipple's PD and its variants and that technical success rates are increasing thanks to the availability of balloon-assisted enteroscopy.

Initial attempts to perform ERCP in patients with (variants of) Whipple's PD using side-viewing duodenoscopes and forward-viewing colonoscopes were disappointing with low technical success rates, especially when trying to reach the pancreaticojejunal anastomosis [20,21]. With the advent of balloon-assisted enteroscopy, the biliary and pancreatic systems of patients with different types of surgically altered anatomy came into reach of the newly developed enteroscope. However, even today, ERCP in patients with surgically altered anatomy remains challenging because of long and tortuous small bowel limbs, sharply angulated enteric anastomoses, postoperative adhesions and difficult cannulation of the bile and/or pancreatic duct with a forward-viewing enteroscope without elevator [14]. SBE has been shown to be an effective endoscopic method to achieve deep intubation of the small bowel, also in patients with surgically altered anatomy [22]. In the present study we show that both the hepaticojejunal and pancreaticojejunal anastomoses after Whipple's PD variants are accessible with a high success rate and that diagnostic and therapeutic SBE-ERCP is feasible, useful and safe. Early reports in patients with Whipple's PD highlighted the difference in technical success rate between biliary and pancreatic ERCP, with pancreatic cannulation rates of less than 10% [21]. Our results show that SBE allows much higher technical success rates of 80% in pancreatic SBE-ERCP and even 90% in biliary SBE-ERCP, illustrating the step forward with the technical evolution of enteroscopy. However, these results also illustrate the remaining complexity of pancreatic ERCP in patients with (variants of) Whipple's PD, even when using the SBE. Several reasons can be put forward to explain these difficulties. Firstly, the pancreaticojejunal anastomosis is located deeper towards the blind end of the biliopancreatic limb as compared to the hepaticojejunal anastomosis. Secondly, although only 10-30 cm apart, this additional jejunal segment is usually very tortuous and fixed in between the two anastomoses, rendering the final progression of the enteroscope problematic. Thirdly, the caliber of the main pancreatic duct is much smaller than that of the common bile duct, resulting in a smaller anastomosis that may be difficult to identify endoscopically. Sometimes, a pale fibrotic scar without ductal orifice is all that is visible. In those cases ($n = 2$), we used an injection needle catheter to puncture the center of the scar, in order to gain access to the main pancreatic duct and to reopen the occluded anastomosis. Finally, the position of the forward-looking enteroscope does not allow an easy access to the pinpoint end-to-side anastomosis of the main pancreatic duct to the side of the blind end of the biliopancreatic limb. These difficulties explain the longer procedure time (57 vs. 74 min) and the still lower technical success rate of pancreatic compared to biliary SBE-ERCP in patients with Whipple's PD, despite the technological revolution of device-assisted enteroscopy.

In addition to the technical success rate, there was an even greater difference in clinical success rate between biliary and pancreatic SBE-ERCP. With only 65% of clinical success (reduction in abdominal pain of pancreatic origin) after pancreatic SBE-ERCP compared to 88% (reduction in symptoms related to cholangitis) after biliary SBE-ERCP, alternative treatment options are sought for in case of failed pancreatic SBE-ERCP treatment. Transgastric EUS-guided drainage of the main pancreatic duct is one option, but it is more invasive with higher AEs, and it does not always lead to sufficient pain reduction [15,23]. EUS-guided coeliac bloc can help to reduce pain of pancreatic origin temporarily, as performed in one patient in the current study. Despite the availability of endoscopic alternative treatments, redo surgery might be the only definite option to deal with chronic pain of pancreatic origin in these patients. Although this study, as well as older ones, showed that endoscopic treatment of pancreaticojejunostomy obstruction after Whipple's PD is still open for improvement, one must take into account that pancreatic ERCP indications are less frequent than biliary ERCP indications in this group of patients, as illustrated by the double number of consecutive patients with a biliary indication compared to patients with a pancreatic indication. The vast majority of ERCP indications, both biliary and pancreatic, are related to stricture formation at the level of one or both anastomoses. These are considered late complications, since they occur only in months or even years after the surgical intervention, ranging between 3 and 336 months after Whipple's PD in the current study. Therefore, SBE-ERCP can be performed safely in these patients with surgically altered anatomy without the risk of traumatizing recent gastrointestinal anastomoses [14].

Biliary SBE-ERCP in patients with (variants of) Whipple's PD was shown to be very effective, both technically and clinically with success rates approaching 90%, and without serious AEs, which is comparable with existing data in the literature [24]. Almost all conventional biliary ERCP interventions are possible using SBE, provided sufficient length of the accessory catheters and guide wires. These have progressively become commercially available over the last few years. However, the 3.2 mm working channel of the available enteroscopes only allows plastic stenting up to 7 Fr, and there are very few compatible metallic stents currently available on the market. In the rare event of biliary SBE-ERCP technical failure, percutaneous and transgastric drainage are available as more invasive options [25].

The current study highlights the difficulties of endoscopic access to the biliary and the pancreatic systems after Whipple's PD and its variants with preservation of the pylorus and with Roux-en-Y reconstruction. Compared to the era from before balloon-assisted enteroscopy, important progress has been made with increasing technical success rates 90% for biliary ERCP and 80% for pancreatic ERCP, with an excellent safety profile in experienced centers. However, as in the early days, both technical and clinical success rates of pancreatic ERCP in patients with (variants of) Whipple's PD are still open to further improvement. Alternatives of more invasive EUS-guided approaches have been developed. Because of the good technical and clinical results, SBE-ERCP can be considered as an effective and safe first-line endoscopic procedure to treat biliary and pancreatic pathology in patients with (variants of) Whipple's PD.

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CRediT authorship contribution statement

Rodrigo Garcés-Durán: Conceptualization, Data curation, Formal analysis, Project administration, Writing – original draft, Writing – review & editing. **Laurent Monino:** Investigation, Methodology, Writing – review & editing. **Pierre H Deprez:** Investigation, Writing – review & editing. **Hubert Piessevaux:** Writing – review & editing. **Tom G Moreels:** Conceptualization, Datacuration, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing.

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Ethical approval

This study was approved by the Ethics Committee of the Cliniques Universitaires Saint-Luc (No. 2021/07AVR/162).

Competing interest

Laurent Monino, Pierre H Deprez, Hubert Piessevaux, and Tom G Moreels have received speaker's fee from Olympus Europe. Rodrigo Garcés-Durán declares no conflict of interest.

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