Using balloon-overtube-assisted enteroscopy for postoperative endoscopic retrograde cholangiopancreatography

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Abstract: Endoscopic retrograde cholangiopancreatography (ERCP) is technically more challenging in patients with postsurgical anatomy such as Roux-en-Y anastomosis, frequently mandating an operative intervention. Although limited, there is growing evidence that ERCP can be performed using the balloon-overtube-assisted enteroscopy (BOAE) in patients with complex postoperative anatomy. We present the technical aspects of performing ERCP with the BOAE in patients presenting with complex postsurgical anatomy having biliary problems. ERCP using the BOAE is feasible in patients with complex postsurgical anatomy, permitting diagnostic and therapeutic interventions in 80% of patients.

Keywords: cholangiography, double balloon enteroscopy, hepaticojejunostomy, overtube-assisted enteroscopy, Roux-en-Y anastomosis, single balloon enteroscopy

Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) is requisite in the management of many pancreatobiliary diseases and has a 95% success rate in the general public; however, among patients with altered small bowel anatomy, the success rate has been approximately half of that [Yamamoto *et al.* 2001; May *et al.* 2003; Feitoza and Baron, 2001]. The introduction of the double-balloon enteroscopy (DBE) and single-balloon enteroscopy (SBE) techniques, referred to collectively as balloon-overtube-assisted enteroscopy (BOAE), has greatly improved our ability to perform ERCP in patients with altered upper gastrointestinal (GI) anatomy [Haber, 2007; Mönkemüller *et al.* 2008]. Spiral enteroscopy, a third overtube-assisted enteroscopy technique, initially showed promise, but is no longer commercially available [Lennon *et al.* 2012]. Therefore, this report focuses on the two dominant and still available techniques for BOAE-ERCP: SBE and DBE methods.

The purpose of this review is to educate readers on underlying anatomical variations necessitating BOAE techniques, provide a technical description of the procedure, describe success rates regarding anatomical variations, and describe technical difficulties that the endoscopist may encounter during BOAE-ERCP.

Postsurgical anatomy

It is imperative that the endoscopist has a good understanding of postoperative anatomy (Figures 1–4). From the perspective of the endoscopist, we delineate postsurgical anatomy into two subgroups: those that can be accomplished with a standard duodenoscope with standard ERCP accessories, and those that require longer, forward viewing endoscopes (i.e. colonoscope or enteroscope) to accomplish ERCP.

A standard duodenoscope can be used in patients status post gastric banding, sleeve gastrectomy, or Billroth I. Gastric banding entails the placement of a band circumferentially around the proximal part of the stomach in close proximity to the gastroesophageal junction [Belachew *et al.* 1995]. The band can be periodically adjusted through a subcutaneous port positioned in the rectus abdominis [Belachew *et al.* 1995]. A sleeve gastrectomy [Figure 1(a)] involves the resection of the greater curvature of the stomach, while maintaining unaltered continuity between the esophagus, stomach, pylorus, and duodenum [Moy *et al.* 2008]. The Billroth I procedure involves resection of the distal aspect of the stomach with anastomosis of the proximal stomach to the duodenum [Uyama *et al.* 1995].

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Figure 1. Complex postsurgical upper gastrointestinal anatomy. (a) Gastric sleeve. In these patients endoscopic retrograde cholangiopancreatography can be performed using a standard duodenoscope. (b) Roux-en-Y with hepaticojejunostomy. In this case a double hepaticojejunostomy was performed.

Figures 2. Billroth II operation. (a) The body and antrum are resected. (b) A gastrojejunostomy is created. The entrance to the afferent limb is usually on the 'right'.

A long scope (e.g. colonoscope) or balloon-assisted enteroscopy is required to gain access to the papilla of Vater or hepaticojejunostomy in patients status post Billroth II gastrojejunostomy [Figure 1(b)] and any technique in which a Roux-en-Y is created [Haber, 2007]. The Billroth II gastrojejunostomy (Figure 2) was initially devised to treat gastric outlet obstruction, but can be applied to any distal subtotal gastrectomy [Goh *et al.* 1992]. In this technique the jejunum is attached to the proximal gastric remnant in the creation of a gastrojejunal anastomosis [Goh *et al.* 1992]. The duodenojejunal segment is

Figure 3. Total gastrectomy with Roux-en-Y anastomosis. (a) Resection of the stomach. (b) Esophagojejunal anastomosis. The proximal anastomosis can be straight or J shaped. If J shaped, careful attention must be paid not to confuse the blind pouch with another limb.

approximately 15–30 cm in length, with the papilla of Vater intact to provide the second anchor point of the segment [Goh *et al.* 1992]. Roux-en-Y anastomosis are most commonly performed in conjunction with total gastrectomy with esophagojejunostomy (Figure 3), gastric bypass and pancreaticobiliary procedures, which include pancreaticoduodenectomy (Whipple procedure), pylorus-preserving pancreaticoduodenectomy (modified Whipple procedure) [Figures 1(b) and 4], Frey procedure, and orthotopic liver transplantation with choledochojejunostomy [Feitoza and Baron, 2002; Chahal *et al.* 2006]. The following is a description of the Roux-en-Y technique used during a gastric bypass procedure:

The stomach is first transected with the anterior portion being formed into a small gastric pouch. Next, the jejunum is transected 30–75 cm distal to the ligament of Treitz. The distal jejunal segment is joined to the anterior gastric pouch in a gastrojejunal anastomosis. This becomes the Roux-limb. The excluded biliary limb is then anastomosed to the jejunum 50–150 cm distal to the gastrojejunal anastomosis in the formation of the jejunojunal anastomosis [Higa *et al.* 2000].

Definition of ERCP using the BOAE

BOAE-ERCP is the performance of diagnostic or therapeutic interventions of the biliary or

Figure 4. Classic Kausch-Whipple operation. (a) The schematic shows the lines of resection: antrum, head of pancreas and duodenum. (b) The proximal end of the jejunum is brought to the liver bed and a hepaticojejunostomy is performed. The jejunal limb is used to create a gastrojejunostomy. Notice that the afferent limb can be quite short, and thus accessible with a colonoscope or even a duodenoscope. However, the success rate of using 'shorter' scopes is about 50%.

pancreatic ducts in patients who require the use of enteroscopes and devices such as overtubes or overtubes with balloons to access the papilla of Vater or pancreaticobiliary anastomosis due to a long or tortuous path created by prior GI surgery. Success is defined by the most common pitfalls of the technique, namely enteroscopic success and cannulation success. Enteroscopic success is defined as the ability to identify the pancreaticobiliary anastomosis or papilla of Vater. Cannulation success is the ability to cannulate either the papilla or the anastomosis. Cannulation success is commonly subdivided further into diagnostic success and therapeutic success, with diagnostic success defined as the ability to perform a cholangiogram leading to a diagnosis and therapeutic success defined as the ability to treat the underlying disorder (e.g. stone removal, stent insertion, balloon dilation). Resultant complications of BOAE-ERCP are defined according to standard criteria and experience of large centers performing DBE [Cotton *et al.* 1991; Mensink *et al.* 2007]. However, there are no studies specifically evaluating the complications associated with BOAE-ERCP.

Patient preparation and type sedation/anesthesia

The operative report should be studied in order to understand the patient's anatomy and plan for

the procedure. In addition, all available GI imaging, including computed tomography, magnetic resonance tomography (MRT), and upper GI series should be reviewed. If the operative report is not available, we recommend that a standard esophagogastroduodenoscopy (EGD) be performed prior to BOAE-ERCP to clarify the anatomy of the upper GI tract. Whether performing enterography (e.g. MRT enterography) assists in the planning of BOAE-ERCP is unknown. Often, Billroth I and II anatomies are confused. In a patient with Billroth I anatomy the ERCP can be performed using a standard duodenoscope. Likewise gastric bypass and gastric sleeve operations are commonly confused. Gastric sleeve [Figure 1(a)] is only a 'narrowing' of the stomach, whereas gastric bypass entails a long jejunal interposition, similar to what is performed during a total gastrectomy (Figure 3). In our experience, performing an EGD can be useful to 'map out' and clarify the anatomy, and often ERCP can be performed with a standard duodenoscope.

Because many patients requiring BOAE-ERCP have cholestasis and are more likely to have coagulopathies due to vitamin K malabsorption, particular attention should be paid to the prothrombin time, with efforts made to rectify aberrant values with intravenous vitamin K [Clarke *et al.* 2006]. Both aspirin and P2Y12 platelet inhibitors can be safely continued during ERCP [Boustiere *et al.* 2011].

Perioperative antibiotics such as ciprofloxacin or ceftriaxone should be provided to prevent cholangitis when biliary drainage is incomplete in patients with post-transplant biliary strictures, patients with communicating pancreatic cysts or pseudocysts. In patients with artificial heart valves we follow the guidelines from the American Society for Gastrointestinal Endoscopy [Banerjee *et al.* 2008].

Patients should be fasting for at least 6 h prior to the procedure [American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists, 2002]. Due to the complexity and length of the procedure, BOAE-ERCP should be performed using moderate sedation with propofol or under general anesthesia. Although this decision is typically made based on local expertise and preference, we strongly recommend using general anesthesia as the procedure can be lengthy and the minor movements of the patient may

Table 1. Enteroscopy device specifications.

Enteroscopes	Scope working length (cm)	Scope diameter (mm)	Specifications			
			Channel diameter (mm)	Overtube length (cm)	Overtube diameter (mm)	Potential advantages
SBE (Olympus, Tokyo, Japan, SIF-Q180)	200	9.2	2.8	140	13.2	Ease of use
DBE (Fujinon, Tokyo, Fujifilm, Japan, EN-450PS/20)	200	8.5	2.2	145	12.2	Flexibility
DBE (Fujinon, Tokyo, Fujifilm, Japan, EN-450T5)	200	9.4	2.8	145	13.2	Depth of insertion
DBE (Fujinon, Tokyo, Fujifilm, Japan, EC-450BI5)	152	9.4	2.8	105	13.2	ERCP
Pentax VSB-3430K	220	11.6	3.8			Any instrument
SE Spirus medical (Stoughton, MA, USA), discovery SB	*	*	*	118	16	Shorter examination time

*Either the Fujinon DBE enteroscope or the Olympus SBE enteroscope can be used to perform SE with a SE overtube.

DBE, double-balloon enteroscopy; ERCP, endoscopic retrograde cholangiopancreatography; SB, small bowel; SBE, single balloon enteroscopy; SE, spiral enteroscopy.

result in displacement of stent or loosening cannulation of a tiny hepaticojejunostomy. The use of antispasmodics is not routinely recommended. However, during bile duct cannulation we use intravenous antispasmodics (e.g. hyosciamine) if the motility of the afferent limb is increased.

Technical aspects

Endoscopes

Enteroscopes are divided according to their designed task: diagnostic or therapeutic. They differ in length, scope diameter, working channel diameter, overtube length, overtube diameter. We currently recommend using either a standard 200 cm or 'short' 152 cm therapeutic enteroscope with a 2.8 mm accessory channel. A list of enteroscopes and their specifications is provided in Table 1.

Although we were the first to report on the feasibility and potential utility of SBE-ERCP, we currently recommend DBE-ERCP, as the presence of the balloon on the tip of the scope is particularly useful in the presence of tight angulations, nicked bowel and external adhesions [Mönkemüller *et al.* 2008]. It allows for faster intubation of the afferent limb and intubation of the excluded stomach in patients who have undergone gastric bypass.

Procedure description

Learning curve. Although no formal studies have documented the learning curve associated with BOAE-ERCP, the learning curve associated with DBE has been described. In one trial the mean duration of the first 10 cases was 109 min, while in subsequent cases the mean duration was 92 min. This was associated with a decline in mean fluoroscopy time. There was no change associated with depth of intubation [Mehdizadeh *et al.* 2006].

Technique of advancing the BOAE into the excluded Roux-en-Y limb. The patient should be placed in decubitus supine position on the table, with a C-arm in place so that fluoroscopic guidance can be provided throughout the procedure [Mönkemüller *et al.* 2009] (Figure 5).

The push-then-pull method operant during a standard DBE can be used for advancing the enteroscope. Previous abdominal surgery complicates the procedure, with adhesions limiting the mobility of the intestines and inhibiting further intubation of the lumen. It is critical that the enteroscope is not advanced forcefully. Changing the position of the patient or applying external abdominal pressure may aid in advancement of the enteroscope. Fluoroscopy can help the endoscopist visualize the direction the enteroscope is taking, as well as provide estimates as to the degree of looping [Moreels *et al.* 2009]. The endoscopist must minimize insufflation, as bowel

Figure 5. Fluoroscopy findings of enteroscopes during balloon-overtube-assisted enteroscopy for endoscopic retrograde cholangiopancreatography in patients with gastric bypass and Roux-en-Y anastomosis. (a) The limb leading to the excluded stomach may be quite large. As seen from this image, reaching the excluded stomach using standard scopes is impossible and the use of BOAE is mandatory. (b) The excluded stomach shadow can be easily identified by the presence of air delineating its contour (arrows). The scope has entered the stomach through the pylorus.

distention can drastically limit enteroscope advancement. Due to its increased rate of absorption, insufflation with carbon dioxide rather than standard air improves intubation depth and lessens postprocedural pain [Domagk *et al.* 2007].

Measurement of depth of insertion. There are no data on how to measure the depth of insertion during BOAE-ERCP. Because of the presence of adhesions there is no way to exactly evaluate the depth of insertion. Indeed, measuring the depth of insertion during BOAE-ERCP is not useful, as the key issue is to find the afferent and efferent limbs.

Localization of the anastomosis and afferent limb. Finding the afferent limb in patients with gastrojejunostomy (e.g. Billroth II) should not be very difficult, and in most patients the afferent limb entrance is located on the right side. Juxtaposed to this, in patients with Roux-en-Y surgery, the anastomosis is not recognized in up to half of cases during the initial pass, and fluoroscopy should be utilized to aid in the localization of the jejunojejunal anastomosis [Mönkemüller *et al.* 2009; Moreels *et al.* 2009]. Fluoroscopic visualization of the enteroscope in the mid-abdomen or pelvis, or depth of insertion in excess of 120–140 cm indicates that the enteroscope missed the anastomosis. At this point, the enteroscope should be retracted slowly in careful search of the anastomosis. The presence of bile, luminal dilation, the loss of circular folds or paradoxical peristalsis are all signs of jejunojejunal anastomosis [Moreels *et al.*

2009]. Once the anastomosis is reached, the enteroscope should be guided into the limb with bilious drainage or ‘yellow bubbles’ resultant from bile saponification [Mönkemüller *et al.* 2009]. Because visualization of this is critical, flushing with simethicone should be avoided until the afferent limb has been intubated. Once the anastomosis and afferent limb have been successfully identified, they can be marked with India ink for any future possible procedures [Pohl *et al.* 2009; Shimatani *et al.* 2009; Raithel *et al.* 2011] (Figure 6).

Intubation of the afferent limb. Nonangulated anastomoses typically provide no difficulty for intubation; however, they are frequently not the norm. The jejunojejunal anastomosis leading into the afferent limb typically has slight to marked angulation, which can provide a challenge. When intubating, it is useful to advance the enteroscope 15–20 cm into the afferent limb and then inflate its balloon to secure its position [Mönkemüller *et al.* 2009]. The overtube can then be passed into the afferent limb with its balloon subsequently inflated [Mönkemüller *et al.* 2009]. Pushing in the enteroscope further while advancing the overtube may provide even further stability in the afferent limb [Mönkemüller *et al.* 2009]. After the overtube is secure in the afferent limb, the push-then-pull maneuver can be resumed [Mönkemüller *et al.* 2009]. Frequently it is useful to briefly advance and pull the endoscope in a ‘to and fro’ manner, allowing the intestine to slide over the scope and improving the ability to negotiate through the small bowel

Figure 6. Roux-en-Y jejunojunctional anastomosis. (a) The afferent limb is on the right. (b) The afferent limb is on the left. In both cases there were bile induced bubbles at the entrance of the limb. However, these bubbles are nonspecific. (c) It is recommended to use an India ink tattoo to mark the afferent limb. However, when the scope has advanced deeply into the efferent limb it is fine to mark the proximal end of this limb. The main objective is to have one limb clearly marked, but the report should clearly specify which one is marked. Marking the efferent limb may be easier and more practical, as the entrance to the afferent limb may be 'upward' and angulated. During repeat balloon-overtube-assisted enteroscopy for endoscopic retrograde cholangiopancreatography the upwards going limb with its India ink tattoo may be missed.

turns. Using fluoroscopic control the endoscopist can recognize the enteroscope is moving towards the liver shadow, with the enteroscope assuming either a figure of eight or spiral shape, denoting that the afferent limb has been deeply intubated [Moreels *et al.* 2009]. The balloon on the tip of the catheter can be inflated and contrast injected into the lumen of the afferent limb to confirm under fluoroscopy correct positioning and the trajectory of the afferent limb [Shimatani *et al.* 2009]. The presence of percutaneously placed stents can also serve as a localization method for the afferent limb and either the hepaticojejunostomy or the papilla of Vater [Mönkemüller *et al.* 2009].

Finding the hepaticojejunostomy or papilla during BOAE-ERCP. Successful intubation of the afferent limb, which is typically 50–90 cm long, is defined as localization of the proximal end of the anastomosis (i.e. blind pouch) and ability to identify the opening of the hepaticojejunostomy or papilla of Vater. In all cases, the blind pouch, located under the liver shadow during fluoroscopy, should be carefully identified [Neumann *et al.* 2009]. The localization of the hepaticojejunostomy or papilla can be somewhat variable, but generally is in the lower left field of endoscopic view [Mönkemüller *et al.* 2009]. This has an advantage, as the opening of the accessory channel is at the 6 o'clock position, which allows directing the accessory material easier into the biliary opening [Mönkemüller *et al.* 2009]. Generally, the opening of the hepaticojejunostomy, which sits approximately 10–15 cm distal to the blind end, is very small, making it difficult to

identify [Mönkemüller *et al.* 2009]. Patience and perseverance are often requisite for success. If there is not complete obstruction of the common bile duct, the hepaticojejunostomy may be identified by the exuding of bile from the opening [Moreels *et al.* 2009]. Less frequently, the hepaticojejunostomy opening is very large, permitting the introduction of the tip of the BOAE into the common bile duct and therefore allowing the performance of a direct cholangioscopy [Mou *et al.* 2010]. When there are two small orifices in the blind pouch, injection of contrast under fluoroscopy may help identify the common hepatic duct or pancreatic duct.

In cases of Roux-en-Y gastric bypass, DBE allows for advancement of the scope and overtube into their excluded stomach. The balloon on the tip of the scope serves as an anchor, allowing for the overtube to be slid towards the tip of the scope entering from the duodenum, through the pylorus and into the antrum (Figure 7).

Cannulation of the biliary tree. Cannulation of either the native papilla or biliary anastomosis is a requisite precondition for successful ERCP and may provide some difficulty for the endoscopist. It should be noted that repositioning of either the overtube or the enteroscope can be utilized to change the position of the papilla relative to the working channel [Osoegawa *et al.* 2012]. A soft transparent hood (DH-17EN; Fujifilm, Tokyo, Japan) has successfully been utilized to fix the papilla in place to ease cannulation [Osoegawa *et al.* 2012]. Cannulation of the biliary tract can be achieved with a tapered tip

Figure 7. View of the backside of the pylorus in Roux-en-Y gastric bypass. (a) The pylorus extrudes well inside the duodenal bulb. (b) Multiple small erosions on the backside of the pylorus.

biliary catheter, several types of 650 cm guidewires or BOAE-ERCP designed sphincterotomes. If conventional cannulation proves to be intractably difficult, a needle-knife precut papillotomy can be performed to facilitate cannulation [Fukatsu *et al.* 2008]. When performing BOAE-ERCP in patients with previously placed percutaneous stents, the guidewire should be advanced into the common bile duct before removing the percutaneous stents, particularly in patients with an intact papilla.

Cholangiography. With the advent of BOAE-ERCP, we are now able to characterize hepaticojunostomy strictures, and doing so is helpful in the planning of therapeutic interventions [Mönkemüller and Jovanovic, 2011]. The hepaticojunostomy orifice may be small (type A) or large (type B) [Mönkemüller and Jovanovic, 2011] (Figure 8). The strictures are categorized by length: short (type 1, ≤ 5 mm) or long (type 2, > 5 mm); or whether the strictures are intrahepatic (type 3) [Mönkemüller and Jovanovic, 2011].

Therapeutic interventions. In order to perform BOAE-ERCP related interventions, we recommend using either the standard 200 cm or 'short' 152 cm therapeutic enteroscope. We would caution against a 'short' enteroscope system in patients with long-limb gastric bypass as no prospective or retrospective studies have validated its feasibility in this setting. Importantly, these devices have a 2.8 mm diameter working channel, which allows for a larger variety of therapeutic accessories [Cho *et al.* 2011; Mönkemüller *et al.* 2009]. Because standard length enteroscopes are 200 cm long, they require the use of extra-long accessories, which are currently limited [Cho *et al.* 2011]. Circumventing this limitation, the 152 cm enteroscope can utilize standard length accessories, which may provide some

advantage pertaining to therapeutic interventions [Cho *et al.* 2011; Shimatani *et al.* 2009; Siddiqui *et al.* 2013]. Unfortunately, many ERCP tools, including 10 Fr and self-expanding metal stents, require a 3.2 mm working channel. We and others have utilized a rendezvous technique in which a guidewire is passed through a previously placed percutaneous transhepatic biliary drain, and larger accessories can be placed over that guidewire under both fluoroscopic and enteroscopic visualization [Itoi *et al.* 2009; Mönkemüller *et al.* 2013a, 2013b]. Additionally, we recently employed a technique to utilize accessories that do not fit through current BOAE working channels in which we utilized a DBE-ERCP to advance a guidewire deep in the biliary tree [Skinner *et al.* 2013]. The enteroscope was removed out of the overtube while the guidewire was left in place. Subsequently, utilizing fluoroscopic visualization we were able to advance a self-expanding metal stent over the guidewire, through the overtube, which functionally served as an 'extra-large working channel', into the biliary tree [Skinner *et al.* 2013] (Figure 9).

Occasionally, the accessory equipment will not advance through the tip of the scope due to the curvature at the tip of the scope. This can be visualized and corrected under fluoroscopy to allow the advancement of the accessory materials. Lubrication of the working channel of the scope with mixed chain triglyceride oil (Fresenius Kabi, Bad Homburg, Germany) or silicone (Silikonspray, Asid Bonz, Böblingen, Herrenberg, Germany) can also be useful.

Outcomes

In aggregate, BOAE-ERCP has shown itself to be tremendously successful in the treatment of biliary

Figure 8. Hepaticojunostomies. (a) Occasionally the hepaticojunostomy is very small and can only be recognized by the presence of mucus or bile flow. This is a type A anastomosis based on the Mönkemüller and Jovanovic classification. (b) Cholangiogram reveals a short, tight stricture, type 1. Thus, the hepaticojunostomy is type A1 (small opening, short stricture). (c) Normal or large opening hepaticojunostomy (type B) anastomosis (large opening). (d) There are intrahepatic strictures and dilations (type 3). Thus, this is a type B3 hepaticojunostomy anastomosis. (e) Direct cholangioscopy in a large, type C hepaticojunostomy. Always perform a direct cholangioscopy using water, saline or carbon dioxide to distend the lumen, as direct insufflation of air into the bile duct is associated with air embolism. (f) The process of direct cholangioscopy and cholangiography is called endoscopic retrograde cholangioscopy and cholangiography.

complications in patients with altered GI anatomy. Success rates vary depending on the underlying anatomy of the patient. In patients who have undergone a prior Roux-en-Y gastric bypass, enteroscopic success is 80% and ERCP success 70% [Skinner *et al.* 2014]. In patients who underwent a prior Whipple procedure, enteroscopic success is 85%, while ERCP success is 76%. In patients with underlying Billroth II (BII) anatomy, the success of enteroscopy is 96% and ERCP success is 90% [Skinner *et al.* 2014]. Cannulation rates appear to be comparable between native papilla and pancreaticobiliary anastomoses, with success rates of 90% and 92% respectively [Skinner *et al.* 2014]. Success rates appear to be similar between SBE and DBE, and depend most highly on local expertise [Shah *et al.* 2013]. The complication rate of 3.4% is in fact lower than that of standard ERCP. This is likely due to the fact that a sizeable percentage of patients have pancreaticobiliary anastomoses, which are less susceptible to postprocedure complications such as pancreatitis.

Alternative endoscopic techniques

The two most studied alternative techniques are ERCP through a gastrostomy tract (GERCP) and laparoscopy-assisted ERCP (LA-ERCP). One study demonstrated access to the major papilla was 95% in GERCP procedures *versus* 63% with BOAE-ERCP; however, it was associated with a 14.5% complication rate *versus* 3.1% [Choi *et al.* 2013]. A report comparing LA-ERCP with BOAE-ERCP noted respective success rates of 100% *versus* 56% in a study underpowered to detect for complication rates [Schreiner *et al.* 2012]. The use of endoscopic ultrasound guided biliary drainage is limited to patients with intact stomach, but practically impossible in patients with gastric bypass.

Summary

This report demonstrates the technique and utility of BOAE to perform diagnostic and therapeutic pancreatobiliary interventions in patients with surgically distorted small bowel anatomy, such as

Figure 9. Interventions during balloon-overtube-assisted enteroscopy for endoscopic retrograde cholangiopancreatography. (a) Insertion of a guidewire through a tiny, type A hepaticojejunostomy. (b) Placement of a single 7 Fr plastic stent. (c) Multistenting using several 5 Fr (pancreatic) plastic stents. We found that pushing the smaller diameter pancreatic stents is much easier than the biliary 7 Fr plastic stents and use the 'multi-stenting' concept for bile duct strictures. (d) Balloon dilation of a stenotic hepaticojejunostomy. (e) The scope can be advanced into the biliary tract (i.e. direct cholangioscopy) and then selective cannulation of the branches is performed. Injection of contrast through the scope into the bile ducts. (f) Biliary sphincterotomy using a Billroth II sphincterotome in a patient with Billroth II anatomy. Notice that the direction of the bile duct is at the 5 o'clock position because the papilla is upside down.

Roux-en-Y anastomosis with hepaticojejunostomy. Our experience and that of others demonstrates that ERCP with BOAE is feasible. Using BOAE, it is possible to intubate the afferent limb, visualize the hepaticojejunostomy, and demonstrate anastomotic strictures or bile duct stones of the choledochojejunostomy. Therapeutic procedures have included stone extraction, sphincterotomy, biliary stent placement, biliary balloon dilation, stent extraction and application of argon plasma coagulation at angiodysplasias at the hepaticojejunostomy.

BOAE-ERCP is still in its infancy, and with further refinements to the enteroscope, such as a larger working channel and an increased variety of extra-long biliary accessories for the 200 cm enteroscope, efficacy of BOAE-ERCP should continue to improve.

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Conflict of interest statement

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