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Introduction

The number of patients with surgically altered anatomy is rising due to the proliferation and success of bariatric surgery and liver transplant, as well as the improved detection of pancreatic and gastric neoplasms and their resultant surgical resection. Despite improved surgical technique, the inherent complication rate of these procedures as well as the baseline prevalence of stricture, stone, and the progression of unresected or metachronous malignancy provide a challenge to the endoscopist when treating patients with surgically altered anatomy [1].

This chapter will review the indications for and technical aspects associated with performing endoscopic retrograde cholangiopancreatography (ERCP) in patients with surgically altered anatomy.

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Surgically Altered Anatomy

There are at least eight commonly performed surgical procedures resulting in altered enteric anatomy that require nonstandard approaches to ERCP [1]. Patients with surgically altered anatomy are susceptible to both normal pancreatobiliary pathology as well as adverse events related to their surgery such as anastomotic strictures, biliary stasis leading to stone formation, and retained stents [2–4]. From the perspective of the endoscopist, the resultant postsurgical anatomy can be categorized according to the length of the afferent limb and pancreatobiliary enteric connection; i.e., “native” papilla or surgically altered biliary or pancreatic-digestive anastomosis. The length of the afferent limb dictates the type of endoscope used and this, in turn, dictates the available tools for performing endoscopic intervention. The presence or absence of a native papilla directly impacts ease of cannulation (Table 15.1). As such, it is imperative that the endoscopist has a keen sense of the patient’s anatomy prior to embarking on endoscopy. Whereas cross-sectional imaging and contrast-enhanced radiography can provide some degree of useful information for preprocedure planning, the original operative report, past endoscopy notes, and a direct discussion with the surgeon are far superior.

Short afferent limbs are most commonly encountered in patients following a Billroth II gastrojejunostomy, as the afferent limb is

Table 15.1 Altered anatomy requiring nonstandard ERCP

| Anatomy | Papilla intact? |
|---|-----------------|
| <i>Short afferent limb</i> | |
| Bilroth II gastrojejunostomy | Yes |
| <i>Long afferent limb</i> | |
| Whipple's procedure | No |
| Gastrojejunostomy | Yes |
| Choledochojejunostomy/ hepaticojejunostomy | No |
| Total gastrectomy with esophagojejunostomy | Yes |
| <i>Very long afferent limb</i> | |
| Gastric bypass | Yes |
| Biliary diversion "duodenal switch" | Yes |

anastomosed directly to the gastric remnant. In patients with retrocolic Billroth II anastomosis, the length of bowel that must be traversed can be as short as 30 cm [5]. These limbs can be traversed with a duodenoscope, though at times the acute angulation at the anastomosis may require a more flexible forward viewing endoscope or balloon-assisted enteroscopy (BAE) [5, 6]. The use of a side viewing duodenoscope has also been reported for patients with a gastrojejunostomy or pylorus-preserving Whipple procedure [6], though this mandates both a short afferent limb and an easy-to-navigate anastomosis.

More commonly, patients with a longer afferent limb such as those patients who have undergone a "standard" Whipple procedure or those with a Roux-en-Y anastomosis require the use of a long forward viewing endoscope or enteroscopy [6, 7]. The lengths of Roux limbs are variable. Short afferent limbs (<50 cm) are commonly encountered in patients with oncologic, transplant, or biliary-diverting procedures such as total gastrectomy with Roux-en-Y esophagojejunostomy, Roux-en-Y choledochojejunostomy, or hepaticojejunostomy [8]. These limbs will have variable papillary anatomy depending on the original indication for surgery (see Table 15.1). Bariatric surgery typically results in a long Roux limb (>100 cm) to promote malabsorption as well as prevent bile reflux [9]. These longer limbs may require the use of overtube-assisted devices for deep enteroscopy, such as BAE or rotational enteroscopy (RE). In addition to particularly long

and tortuous Roux limbs, patients who have undergone a Roux-en-Y gastric bypass have a remnant stomach. This can allow for an additional access point (surgical gastrotomy, endoscopic-assisted gastrotomy) for performing ERCP. For the rare patient who has undergone pancreatico-biliary diversion ("duodenal switch") for obesity, the Roux-en-Y anastomosis can, in some cases, be reached with difficulty using the retrograde approach with BAE [5]. As with Billroth II anatomy, patients with gastric bypass or pancreatico-biliary diversion will generally have native papillary anatomy.

Technical Aspects of ERCP in the Surgically Altered Anatomy

There are three significant challenges to successful ERCP in altered anatomy: reaching the papilla or pancreatico-biliary anastomosis (enteroscopic success), identification and cannulation of the papilla or pancreatico-biliary anastomosis (diagnostic success), and finally, performing therapy if indicated (therapeutic success). A learning curve for successfully performing each of these three maneuvers has been described [10], and, although no single standardized approach exists, there are certain techniques which, when employed, can optimize the chances of overall endoscopic success.

Enteroscopic Success

Preprocedure Planning

With considerable variability in postsurgical anatomy, preprocedure planning is essential. When adequately prepared, the endoscopist can decrease the procedure duration, select the appropriate endoscope, and have the appropriate tools available at the time of endoscopy. Most importantly, the previous operative report should be obtained, recent cross-sectional imaging reviewed, and if possible, a discussion with the surgeon who performed the original operation [11]. Depending on operator expertise and difficulty of the procedure, the range of times reported

for ERCP in altered anatomy can vary from 24 to 150 min [12–14]. The increased complexity and longer procedure duration in patients with post-surgical anatomy may necessitate the use of an anesthesiologist, as adequate (and safe) sedation almost certainly plays a role in affecting the procedure outcome. Several groups have reported improved intubation depth, patient comfort, and decreased overall procedure duration with the use of CO₂ for procedures employing BAE [15, 16].

In patients with short afferent limbs, such as those with Billroth II gastrectomy, a duodenoscope may suffice and provides the benefit of both an elevator and availability of standard ERCP tools. In patients with longer limbs, success has been reported with either the 164 cm long pediatric colonoscope or 240 mm long “standard” enteroscope [7, 17] both with and without the assistance of a gastric overtube. Gastric overtubes may reduce looping in the stomach and duodenum; in patients who have undergone gastrectomy, gastric overtubes are rarely needed. If a colonoscope is used, it is preferable to use one with a variable stiffness setting. Initial insertion is performed on the most flexible setting and the stiffness is increased once the endoscope is passed into the small intestine to reduce loop formation. In patients with longer intestinal limbs, it may be necessary to use the “hook and pull” technique to advance the endoscope deeper into the small intestine. The use of a colonoscope to place a wire into the pancreaticobiliary limb in patients with Roux-en-Y anatomy followed by advancement of a duodenoscope over the wire has been described [17]. More recently the advent of overtube-assisted enteroscopy (both BAE and RE) has allowed the endoscopist a means to navigate tight angulation at the anastomosis and very long Roux limbs to access the pancreaticobiliary tree.

Overtube-Assisted Enteroscopy

Several techniques are now available to perform overtube-assisted deep enteroscopy including the double balloon enteroscopy (DBE), single balloon enteroscopy (SBE), and RE. In general, RE and balloon-assisted enteroscopy (BAE) consist of a forward viewing endoscope that travels

through a flexible overtube. As such, overtube-assisted enteroscopy is a term that can encompass both RE and BAE. RE utilizes a rotating overtube that sequentially reduces and pleats the small bowel over a standard enteroscope. In the case of BAE, there is either a balloon on the distal tip of the overtube (single balloon) or a balloon on both the overtube and the distal tip of the enteroscope (double balloon). The operator is able to inflate or deflate the balloons selectively. Using a push-pull technique, BAE works by pleating the bowel over the endoscope as it is advanced, using balloons to stabilize the device for both forward progress and reduction. With a double balloon, the endoscope is advanced and the balloon at the tip of the endoscope is then inflated, anchoring the scope tip. The overtube is then advanced over the endoscope and, once the overtube has reached the end of the scope, the overtube is inflated and either reduction can be performed or the endoscope balloon can be deflated and advanced further. The single balloon technology works in the same fashion, though without a balloon over the endoscope tip. This sacrifices a degree of stability but provides added flexibility, faster set-up time, and decreased complexity of balloon coordination [18].

Several authors have reported conceptualizing the overtube as a “large working channel” to assist ERCP [19–21]. Once the enteroscope is advanced to the ampulla or the pancreatic or biliary anastomosis, the balloon is inflated on the overtube and reduction is performed. This anchors the overtube and the enteroscope is then removed. In the case of longer overtubes, an incision can be made in the overtube just outside of the patient (taking care not to damage the balloon air channel) and a gastroscope or ultraslim gastroscope can be advanced to the ampulla. This allows passage of standard-biliary tools such as stents [20] that are precluded by the long and narrow working channel of the enteroscope, or direct cholangioscopy [21, 22].

Afferent Limb Intubation

Regardless of anatomy, selecting the appropriate limb to traverse can be the first challenge reached by the endoscopist. Selecting the wrong limb

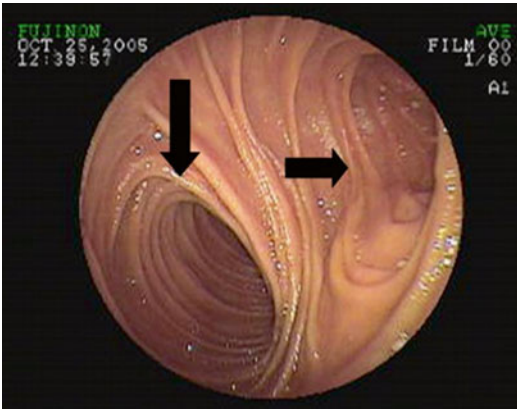


Fig. 15.1 Endoscopic image demonstrating the typical appearance of a jejunojejunostomy in a patient following a Roux-en-Y gastric bypass. The vertical arrow points to the typical location of the efferent limb whereas the horizontal arrow demonstrates the blind limb. The pancreatico-biliary limb cannot be seen in this image

adds time to an already lengthy procedure. In general, the endoscopist will encounter two or three potential lumens (Fig. 15.1) at the surgical anastomosis. If three lumens are visualized, invariably one of the openings is not a true opening, rather a “blind end,” created by the end-to-side creation of the anastomosis. The passage visualized directly adjacent to this lumen is usually the efferent limb. Between these openings one should not see a surgical scar. If the efferent limb is entered and traversed for some distance the endoscopist will generally see multiple loops forming on fluoroscopy. Bile is not a reliable marker to indicate the afferent limb, though generally a greater amount of bile is found in the afferent limb. One group has reported improved identification of the afferent limb in patients with Roux-en-Y anatomy by injecting indigo carmine just beyond the stomach or the esophagojejunostomy. When the anastomosis is then reached, the afferent limb reportedly took up less indigo carmine and thus decreased time of procedure with little added expense or technical challenge [23].

It is not uncommon for endoscopists to become disoriented at the site of the anastomosis and, after accidentally traversing the efferent limb, reintubate the incorrect lumen. Once the appropriate limb has been determined, several groups advocate tattooing the afferent limb for

improving ease of future access [24, 25]. Others recommend tattooing the limb that is initially intubated to prevent reintubation if this becomes the incorrect limb [26]. In either circumstance, clear documentation of which limb was tattooed is essential to expedite future endoscopy.

The second challenge to successful afferent limb intubation is navigating an often acute angulation. The afferent limb is generally located at 5–8 o'clock and should take off at a right angle—essentially an almost 180° turn once the endoscope is inserted into the Roux-en-Y anastomosis. If a variable stiffness colonoscope is used, making this turn should be attempted using the most flexible setting. Occasionally, changing the patient's position to left lateral decubitus or applying abdominal pressure can help navigate the turn. Fluoroscopy often can help confirm passage in the proper direction. If BAE systems are used, it is useful to reduce the scope as much as possible once the jejunojejunal anastomosis is reached (in the case of a Roux-en-Y anastomosis). Following reduction, the tip of the endoscope is advanced as deep as possible into the pancreatico-biliary limb. The balloon at the tip of the endoscope is then inflated and the endoscope tip is “hooked” into the limb using a combination of tip deflection and suction while the overtube is advanced through the anastomosis and into the pancreatico-biliary limb [5]. Despite these maneuvers, further advancement can be impossible. In these instances, a wire can be advanced downstream under fluoroscopy and a large balloon advanced over the wire. Using this balloon as an anchor, the enteroscope can be slowly inched forward [27].

Diagnostic Success

Once the proximal aspect of the pancreatico-biliary limb is reached, the next challenge lies in identifying the papilla, pancreatic, or biliary anastomosis and obtaining deep cannulation with the forward viewing endoscope. It is during cannulation and consideration of therapy that the lack of ERCP-specific tools, lack of an elevator, the altered vector forces, and abnormal anatomy

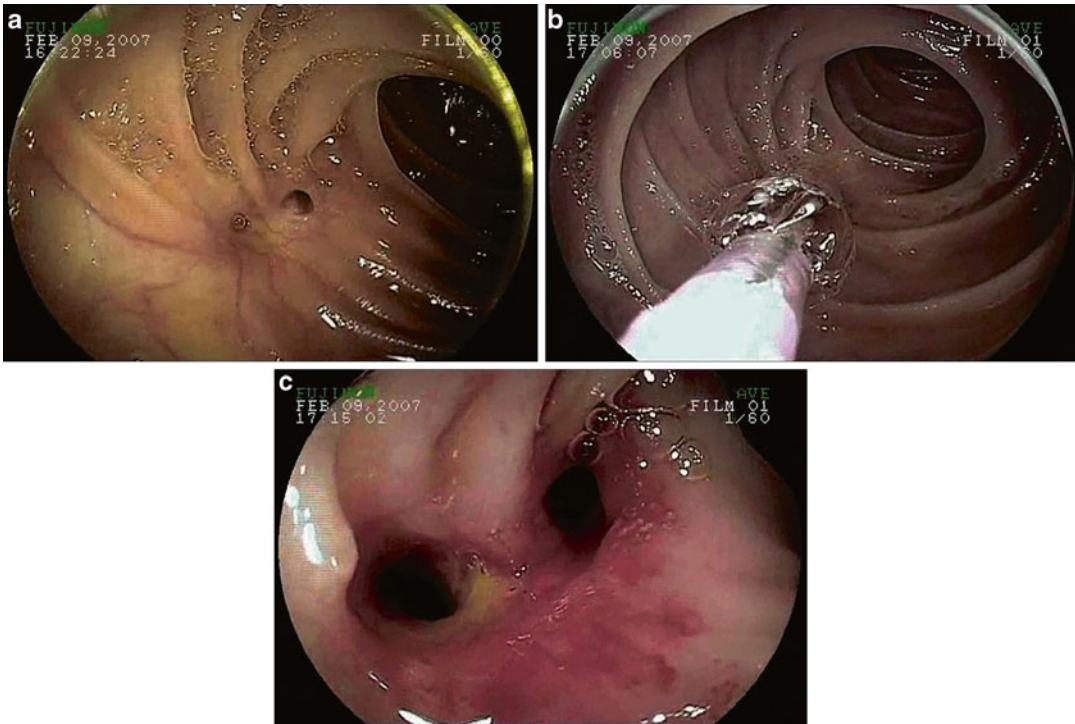


Fig. 15.2 (a) Typical endoscopic appearance of a hepaticojejunostomy. Note that the anastomosis is stenotic. (b) Balloon dilation of the hepaticojejunostomy using a con-

trolled radial expansion balloon. (c) Postdilation appearance of the hepaticojejunostomy

(inverted orientation of the papilla) provide the greatest difficulty to providers accustomed to performing standard ERCP with a duodenoscope.

In patients with a choledochojejunostomy, hepaticojejunostomy, or pancreaticojejunostomy, cannulation is often relatively easy if the anastomosis can be found. Due to their small nature, the anastomosis may be difficult to find, either secondary to near complete stenosis or due to the positioning of intestinal folds or anatomic turns in the bowel (Fig. 15.2a). The hepaticojejunostomy is generally located 10–15 cm downstream from the blind end and is typically found in the lower left field of view. Administration of intravenous sincalide (Kinevac, Bracco Diagnostics, Princeton, New Jersey) at a dose of 0.02 $\mu\text{g}/\text{kg}$ can be performed to stimulate the secretion of bile allowing identification of the biliary anastomosis. In patients with pancreaticojejunostomy, secretin (SecreFlo, Chesapeake Biologic Labs,

Baltimore, Maryland) administered intravenously as a 0.2 $\mu\text{g}/\text{kg}$ bolus can help in a similar fashion. The use of a clear plastic cap (Olympus Co LTD, Japan) affixed to the tip of the endoscope can help improve visualization of biliodigestive anastomoses, as well as aid the visualization and cannulation of native papillae [19, 25]. The cap may also help anchor the endoscope during reduction via mucosal suctioning [12, 28]. Once found, cannulation is often amenable to forward viewing cannulation from the 6 o'clock accessory channel [18].

In patients with an intact “native” major papilla, a forward viewing endoscope will generally find the ampulla located at the 6 o'clock position [18] and “inverted.” Cannulation of both native and anastomotic lumens is typically performed using a straight single or double lumen catheter after achieving wire guided access. The use of a clear plastic hood affixed

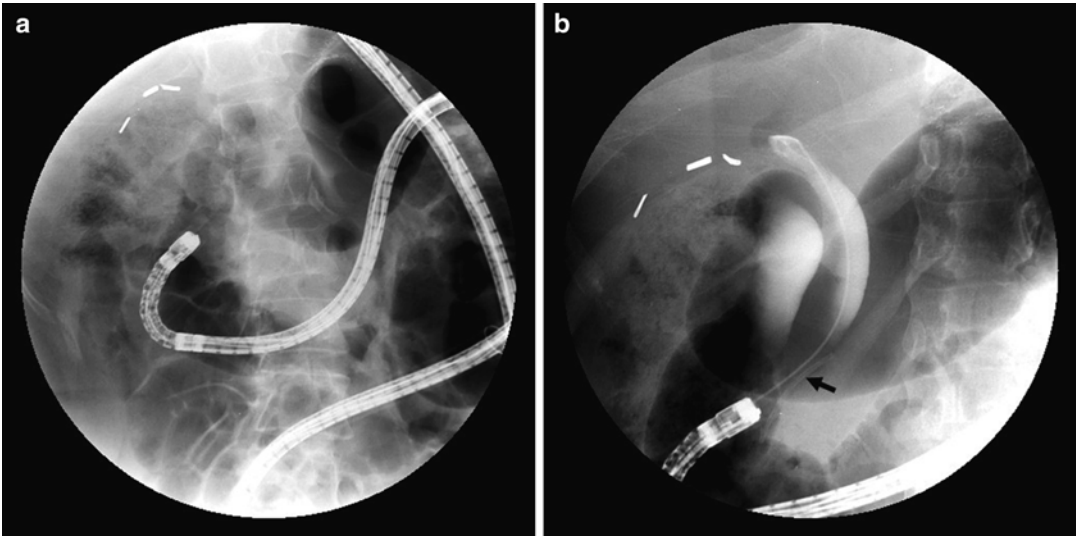


Fig. 15.3 ERCP performed using a double balloon enteroscope in a patient following RYGB. Note that biliary cannulation was achieved over a pancreatic duct stent (*arrow*)

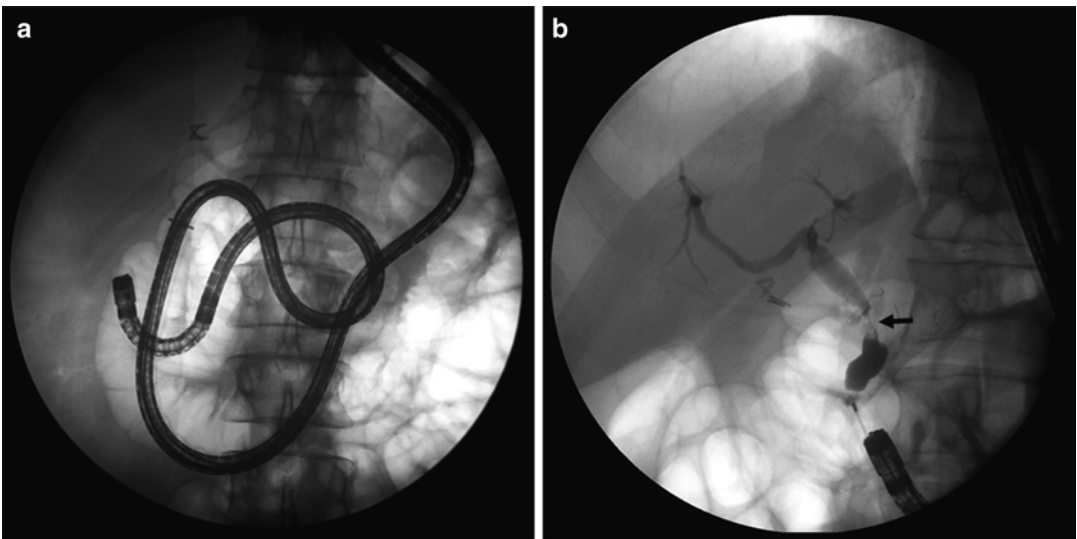


Fig. 15.4 ERCP performed following a Roux-en-Y esophagojejunostomy in a patient status post total gastrectomy for gastric cancer. Note the presence of a high-grade mid-common bile duct stricture (*arrow*)

to the endoscope tip may be useful in identification and cannulation of the native papilla. As with standard ERCP, in some instances where papillary anatomy preferentially results in pancreatic duct cannulation, biliary cannulation can be assisted by pancreatic duct stent placement and wire guided cannulation over the pancreatic duct stent (Fig. 15.3).

Therapeutic Success

After successful cannulation, the final step is delivery of therapy, often dilation of an anastomotic stricture, stone removal, bleeding treatment, or stent placement (demonstrated in Figs. 15.4, 15.5, and 15.6.). Forward viewing equipment provides the following challenges:

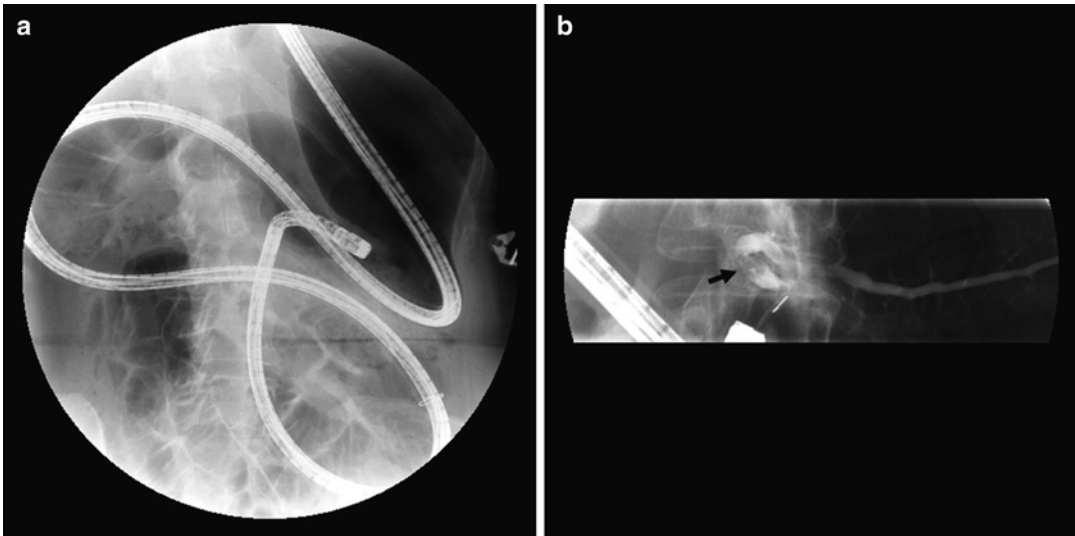


Fig. 15.5 ERCP performed in a patient following a central pancreatectomy with a Roux-en-Y pancreaticojejunostomy. Note the presence of a large pancreatic duct stone (*arrow*).

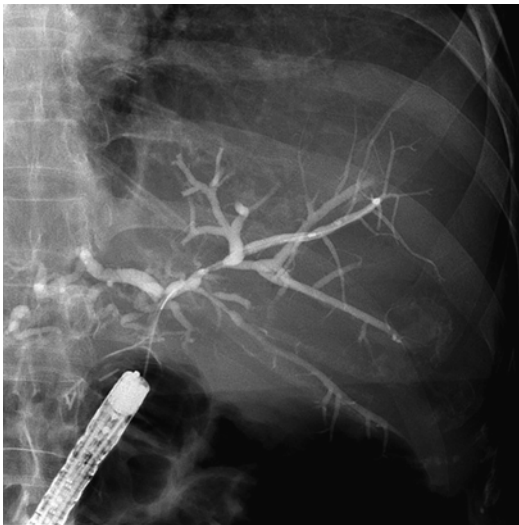


Fig. 15.6 Cholangiogram demonstrating a high-grade stricture of the common hepatic duct in a patient following a Whipple procedure for a cholangiocarcinoma of the distal common bile duct

lack of an elevator making wire exchanges tenuous, small diameter of working channel (generally a 2.8 mm channel compared to 4.2 mm standard duodenoscopes), and an increased length of the working channel precluding many standard ERCP tools. Lastly, due to the length of

the scope, the small diameter of the working channel, and the often multiple loops of the endoscope, there can be considerable resistance to wire and accessory passage. This last point can be improved with the use of a lubricant placed on the tip of the wire before advancement—either silicone or a spray oil such as PAM (ConAgra foods, Omaha, Nebraska). A review of available scope length and working channel diameters is provided in Table 15.2 (tools).

Sphincterotomy is typically performed by placement of a stent into either the pancreatic or bile duct followed by needle knife sphincterotomy over the stent (Fig. 15.7). Rotatable sphincterotomes have been reported [25] and some have reported success with limited sphincterotomy followed by controlled radial expansion (CRE) balloon dilation [19]. In general, the performance of other therapeutic maneuvers is relatively straightforward given the previously listed limitations. It should be noted that due to the long length of accessories, the assistant may “lose” the wire during exchange due to increased length relative to the wire guide being used. Whenever possible, the longest wire guide available should be used. If wire is “lost,” use of a 60 mL syringe filled with water or saline affixed to the accessory in the

Table 15.2 Endoscopes used in altered anatomy

| Endoscopes | Working channel (mm) | Working length (cm) | Distal end diameter (mm) | Overtube | Diameter (mm) | Length (cm) |
|--------------------------------------|----------------------|---------------------|--------------------------|----------|---------------|-------------|
| <i>Balloon-assisted endoscopes</i> | | | | | | |
| EN-450T5, Fujinon | 2.8 | 200 | 9.4 | TS-12140 | 13.2 | 145 |
| EN-450P5, Fujinon | 2.2 | 200 | 8.5 | TS-12140 | 12.2 | 145 |
| EC-450B15, EI-530B, Fujinon | 2.8 | 152 | 9.4 | TS-13101 | 13.2 | 105 |
| SIF Q180, Olympus | 2.8 | 200 | 9.2 | ST-SB-1 | 13.2 | 140 |
| SIF Q160Y, Olympus | 2.8 | 200 | 8.4 | ST-SB-1 | | |
| SIF-Y0004, Olympus | 3.2 | 152 | 9.2 | NR | NR | 88 |
| <i>Spiral endoscopes</i> | | | | | | |
| Endo-Ease Discovery SB (DSB), Spirus | NA ^a | | | | 17.5 | 130 |

^aSpirus is an overtube system compatible with standard enteroscopes

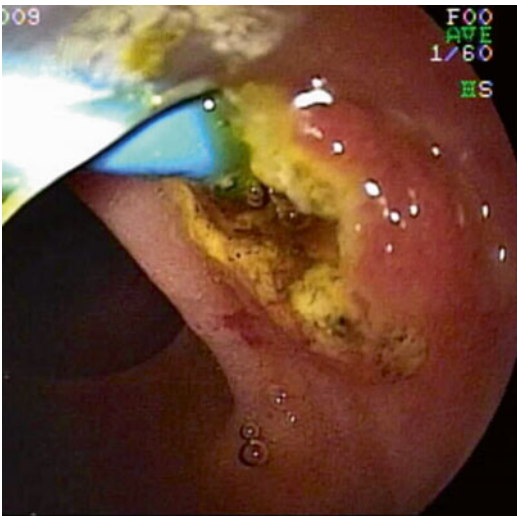


Fig. 15.7 Endoscopic image showing a needle knife biliary sphincterotomy performed over an indwelling pancreatic duct stent. Notice the direction of the cut is toward the 4 o'clock position on the inverted papilla

process of exchanging can be used to create a static column of water. This, along with gentle counter pressure, can help avoid losing duct access.

With the small diameter (2.8 mm) of most enteroscope or colonoscope working channels, a 7 Fr plastic stent is the largest caliber plastic endoprosthesis that can be used. Additional equipment such as enteroscopy-length sphincterotomes, needle knife, and extraction balloons and baskets are available. For balloon dilation, many have reported

success using colonic length-CRE dilation balloons [18, 19] (Fig. 15.2b, c). A shorter double balloon enteroscope with a 2.8 mm working channel and 152 cm working length is available from Fujinon and an Olympus prototype has been reported with a 3.2 mm working channel and 150 cm working length. These endoscopes allow the use of shorter wires and standard ERCP implements, though they are still limited in working channel diameter size. As a workaround, several groups have reported using the overtube as a large working channel. Once the overtube is advanced to the pancreatico-biliary limb, anchored with balloon inflated, and wire guided cannulation is achieved, the endoscope is exchanged out leaving the wire or a long balloon inflated in the bile duct. A hole is cut in the overtube just outside the patient's mouth and shorter instruments such as self-expanding metal stents (SEMS) or ultraslim gastroscopes for direct cholangioscopy can then be utilized [12, 21, 22].

Alternatives to PER OS Endoscopic Access and Failed Altered Anatomy ERCP

The approach to patients with altered anatomy and pancreatico-biliary pathology should be individualized to both the patient and the urgency/emergency of needed intervention as well as local institutional resources and operator experience. With the exception of Billroth II anatomy,

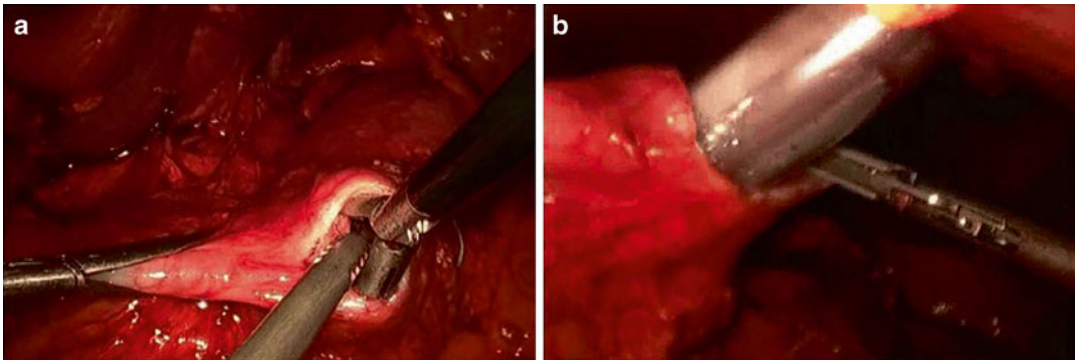


Fig. 15.8 A gastrostomy is made in the excluded stomach (a) in order to perform laparoscopic-assisted ERCP in a patient following Roux-en-Y gastric bypass surgery.

A laparoscopic trocar is placed through the anterior abdominal wall into the excluded stomach (b) to allow for endoscope placement

until the advent of balloon-assisted technology, options for management of surgically altered anatomy were largely limited to surgical or percutaneous access. Percutaneous-biliary access via interventional radiology still remains a viable alternative when local gastrointestinal expertise or equipment is not available, or if endoscopic management is attempted without success. Additionally, percutaneous access may provide temporizing measures, allowing for patient transfer to an expert center with advanced enteroscopic specialty or allowing for decompression and rendezvous attempt with enteroscopy [29]. In some instances, such as nondilated bile ducts or pancreatic duct pathology, percutaneous access is also not a viable option.

Roux-en-Y gastric bypass surgery presents added difficulty for the endoscopist. In general, the afferent limb is very long (>100 cm), native papilla anatomy is expected, and, depending on weight loss, body habitus can provide further challenge. Almost uniformly, studies using balloon technology have lower success rates for both enteroscopic, diagnostic, and technical success (discussed later). Even if the papilla is reached, the procedure can be a failure due to the distance traveled and the lack of instruments adaptable for the 200 cm scope and 2.8 cm channel. As such, endoscopists have explored modified surgical options.

The first described report of surgical gastrostomy creation for ERCP in an excluded stomach was by Baron and Vickers in 1998 [30].

Subsequent reports have shown acceptable diagnostic and therapeutic success using this approach. Briefly, laparoscopic access to the gastric remnant is obtained and the duodenoscope is advanced through a gastrostomy or laparoscopic trocar and advanced to the duodenum in standard fashion [30, 31] (Fig. 15.8, Video 15.1). Following the procedure, if further intervention is thought likely, a gastrostomy tube can be left in place, otherwise the ports and gastrostomy site are closed. Several centers have also reported utilizing endoscopic ultrasound (EUS) for endoscopic transgastric PEG placement [32] or using BAE to reach the gastric remnant and subsequent placement of a self-expanding metal stent through a gastrostomy for same day ERCP [33].

The benefits of utilizing gastrostomy access include the ability to leave a tube for future access, the ability to perform EUS, the opportunity to perform cholecystectomy after ERCP or EUS if indicated, and the availability of standard equipment for diagnostic and therapeutic success. The limitations of this procedure are coordination between surgeon and endoscopist as well as the need and expense for an operating room and operating room staff. The cost effectiveness of laparoscopic access versus attempt at BAE was reviewed in a single center experience [31]. This study found that while ERCP success was much higher in the surgical arm and the time for the endoscopist shorter, the cost associated with surgical approach was considerably higher.

As such, the authors recommended that in patients with a known afferent limb <150 cm, a balloon-assisted enteroscopy be attempted first with surgical gastrostomy access as backup [31].

ERCP Failure

Despite improved equipment, anatomic and technical limitations can still preclude ERCP success. As with standard ERCP, if endoscopic means fail to gain access, interventional radiology can often assist to obtain percutaneous-biliary access, after which point a rendezvous procedure can be attempted. In the event of nondilated bile ducts, gallbladder cannulation followed by a wire placed through the cystic duct has also been reported [34]. More recently several centers have reported utilizing EUS to gain transgastric or transduodenal-biliary or pancreatic duct access for either primary drainage or for endoscopic rendezvous in patients with altered anatomy [35–38].

Systematic Review of Reported Literature

We performed a search of PubMed to identify the published literature of ERCP in altered anatomy with specific focus on ERCP after the advent of overtube-assisted technology. The following search terms were used: double balloon enteroscopy OR single balloon enteroscopy OR spiral enteroscopy AND ERCP. Eighty-one articles were identified with an additional ten articles identified by review of pertinent references. This search found 32 studies reporting retrospectively or prospectively collected data on operator experience with overtube-assisted technology. No randomized controlled trials were found and with few exceptions, these studies were single center, small series, and retrospective reviews.

In all, the case series represent more than 752 patients and 1,068 procedures performed on surgically altered anatomy. Of these, 9 studies reviewed SBE [12, 14, 18, 24, 39–43], 14 studies of DBE [1, 10, 12, 22, 44–53], 3 studies of RE [12, 13, 43], 2 studies of lap assisted [31, 54], 7

studies used “short” double balloon technology [25, 29, 55–59], and 5 studies had mixed modality instruments [19, 31, 60–62]. In general, enteroscopic and ERCP success rates were similar regardless of overtube-assisted technology and varied more by anatomy—enteroscopic and ERCP success decreased as limb length increased and if there was a native papilla. This search identified no head-to-head comparison studies of enteroscopes. However, several studies reported success of BAE after previous failures with forward viewing endoscopes, suggesting that BAE may be the preferable device for initial attempt in patients with long afferent limbs [1, 6, 51, 60].

Conclusion

Future Directions

The advent of overtube-assisted technology has greatly advanced the endoscopist’s ability to perform minimally invasive and effective therapy for patients with surgically altered anatomy. In expert hands, if the papilla can be reached, the chance of diagnostic and therapeutic success is high. Shorter OAE systems and the conceptualization of the overtube as a large working channel have increased the armamentarium available, yet endoscopists are still limited by the lack of an elevator, poor accessory selection, and small diameter working channels within the endoscopes. Despite expert hands, the ability to reach the ampulla can still be a time intensive and difficult challenge, particularly in patients with very long Roux limbs. To work around failed ERCP, novel approaches with endoscopic ultrasound are increasingly described. Also promising are collaborative approaches between surgeons and endoscopists modifying long limb surgery to improve postoperative endoscopic treatment.

In the case of failed ERCP, several centers have reported success with transgastric or transduodenal EUS guided access [35, 38]. This can be for either definitive therapy such as decompression with stent, or can allow for wire placement and BAE rendezvous. The benefit of this approach is twofold: (1) the completion of the procedure can

be accomplished without surgical or percutaneous drainage and (2) the ability to perform the procedure at the time of failed endoscopy. At the present point, techniques to prevent complication are still being worked out [63, 64], but hold promise for patients with surgically altered anatomy who may not be ideal candidates for surgical intervention and require definitive therapy.

In general, prevention is preferable to intervention and it may be possible to maintain the success of anatomic revision or bariatric or malignant intervention and improve the ability to endoscopically manage potential complications. The angulation and long length of Roux anatomy was initially postulated to provide patients with increased protection from bile reflux [9]. However, a recent study described using a short-limb (20 cm) Roux-en-Y reconstruction for gastric bypass. They also performed a submucosal tattoo of the afferent limb at the level of the jejunojejunostomy to help guide future endoscopy. The authors found that short limb Roux-en-Y hepaticojejunostomy (RYHJ) was both safe and associated with a low incidence of postoperative complications. Notably, those who required intervention were managed endoscopically in all cases [9].

ERCP in surgically altered anatomy is now both feasible and, in many cases, successful. Although time consuming and challenging, overtube-assisted technology is associated with fewer complications and decreased cost [31] when compared to surgical management. With the burgeoning population of patients with altered anatomy, particularly as a result of bariatric surgery, there will be further opportunities to determine optimal approaches to altered anatomy and how to manage the invariable failed ERCP.

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Video Legends

Video 15.1 - Transgastric access to biliary tree facilitated by laparoscopy in patient with Roux anatomy. Note contrast injection and unusual scope position.