Chapter 6
ERCP with Device-Assisted Enteroscopy in Patients with Altered Gastrointestinal Anatomy

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Abstract Diagnosis and treatment using ERCP in patients with altered gastrointestinal anatomy have progressed greatly since the emergence of the double-balloon enteroscope in 2001. The balloon-assisted enteroscope has improved steadily over time, and a short-type balloon-assisted enteroscope with a large working channel became commercially available in 2016. These short-type balloon-assisted enteroscopes accommodate most ERCP accessories, and many kinds of ERCP intervention can be performed, such as conventional ERCP for patients with normal anatomy. Although the success rate of ERCP with balloon-assisted enteroscopy in patients with altered gastrointestinal anatomy has increased to approximately 68–98%, it is still a challenging procedure for many endoscopists. Because ERCP with a balloon-assisted enteroscope is time-consuming, mandates specialized training, and requires special endoscopes and accessories, these factors limit the widespread availability outside tertiary endoscopic referral centers. Other types of device-assisted enteroscopies, including spiral enteroscopy and through-the-scope balloon-assisted enteroscopy, have also been developed to make it easier to perform ERCP in patients with altered gastrointestinal anatomy. These novel device-assisted enteroscopy instruments are still immature compared with balloon-assisted enteroscopy for ERCP in patients with altered gastrointestinal anatomy. Therefore, both device-assisted enteroscopy and ERCP accessories must be improved for this challenging procedure to become a more general procedure.

Keywords ERCP • Altered gastrointestinal anatomy • Enteroscope

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6.1 Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) in patients with altered gastrointestinal (GI) anatomy is still a challenging procedure. Many challenges have been overcome to perform this difficult procedure. Several types of endoscopes (side-viewing duodenoscope, forward-viewing endoscope, pediatric- or adult-use colonoscope, and enteroscope) have been used to perform ERCP. An endoscopic approach in patients with Billroth II anatomy was first reported by Katon et al. in 1975 [1]. The success rates of ERCP in patients with Billroth II anatomy have been reported to be 52–92% [2–5]. Roux-en-Y reconstruction is a more challenging situation in which to perform ERCP. ERCP in patients with Roux-en-Y reconstruction was first reported by Gostout and Bender in 1988 [6]. The success rates of ERCP in patients with Roux-en-Y reconstruction have been reported to range from 33 to 67% [7–9]. Because the success rates of these procedures in patients with altered GI anatomy are extremely low, the endoscopic approach has not become a standard of care. Percutaneous transhepatic cholangiograms or even surgical approaches have been required even for basic diagnostic and therapeutic purposes. Therefore, a new endoscopic approach is required to overcome the low success rate of ERCP in patients with altered GI anatomy.

In 2001, Yamamoto et al. developed a double-balloon enteroscope (DBE) for the diagnosis and treatment of small intestinal disease [10]. The DBE could be inserted into the deep small intestine by anchoring the bowel with an inflated balloon attached to both the tip of enteroscope and the overtube. A Fujinon DBE became commercially available in 2003. The use of a DBE for ERCP in a patient with altered GI anatomy was first reported in 2005 [11]. An Olympus single-balloon enteroscope (SBE) was another type of balloon-assisted enteroscope (BAE); it was developed in 2006 and became commercially available in 2007 [12]. ERCP with SBE has also been attempted in patients with altered GI anatomy [13]. A spiral enteroscope was developed in 2007 to potentially provide a simpler and faster technique than the BAE [14]. The use of a spiral enteroscope was also attempted for ERCP in patients with altered GI anatomy [15–17]. Because the DBE, SBE, and spiral enteroscope are all time-consuming, mandate specialized training, and require special endoscopes and accessories, a new concept of a through-the-scope balloon-assisted enteroscope was developed, and its use was reported in 2008 [18]. Deep enteroscopy with standard endoscopes and a novel through-the-scope balloon system (NaviAid AB) was first reported in 2014 [19, 20]. ERCP with this NaviAid AB system in patients with altered GI anatomy was also reported in 2016 [21]. These device-assisted enteroscopy instruments facilitate ERCP in patients with altered GI anatomy compared with conventional push enteroscopy. In this chapter, we reviewed ERCP with these device-assisted enteroscopes in patients with altered GI anatomy.

6.2 Device-Assisted Enteroscope

6.2.1 Double-Balloon Enteroscope

The double-balloon enteroscope (DBE) was first introduced in 2001 and became commercially available in 2003. The DBE uses a specially coupled enteroscope and overtube apparatus with latex balloons mounted on the distal ends of each component. The balloons are intended to anchor the endoscope in position during insertion to allow the pleating of the bowel over the endoscope shaft, which reduces loop formation and allows a greater insertion depth. Several types of DBEs have been developed for several purposes. The main features that discriminate each enteroscope are the working length of the enteroscope and the size of working channel. The conventional BAE has been designed to have a 200-cm working length (long-type DBE). In the early days, the most commonly used long-type DBE system was EN-450T (Fujinon Co, Saitama, Japan), which has a 2.8-mm working channel and a 200-cm working length. Although it is easier to approach the target lesion by using a long-type DBE, various ERCP accessories cannot be used because the working length of these accessories is approximately 190 cm. Therefore, the need for short-type DBE increased when DBE-assisted ERCP became widely performed. EC-450BI5 (Fujifilm Co, Tokyo, Japan), which has a 2.8-mm working channel and a 152-cm working length, was made for colonoscopy use but was instead used as an enteroscope for balloon-assisted ERCP. EI-530B (Fujifilm Co, Tokyo, Japan) was also developed as a short-type DBE, and it has a 2.8-mm working channel and a 152-cm working length. EI-530B was widely used for balloon-assisted ERCP. To perform more complicated ERCP procedures with BAE, a larger working channel is required. In 2016, EI-580BT (Fujifilm Co, Tokyo, Japan) became commercially available. EI-580BT has a 3.2-mm working channel and a 155-cm working length. This new DBE is equipped with the advanced force transmission function and the adaptive bending system, which allows better scope maneuverability. This DBE is designed so the working channel is in the 5:30 direction of the screen and the catheter can be easily adjusted to the axis of the biliary duct. This new DBE has a large working channel that permits the performance of almost all types of ERCP procedures, including self-expandable metallic stent (SEMS) insertion.

6.2.2 Single-Balloon Enteroscope

A single-balloon enteroscope (SBE) was developed in 2006 and became commercially available in 2007. In contrast to the DBE, only the disposable overtube has a non-latex balloon at its distal end. The SBE can be inserted into the deep small bowel by manipulating the balloon on the distal end of the splinting tube and the angulation mechanism of the scope. Three SBE systems have become available. SIF-Q180 (Olympus Co, Center Valley, PA, USA) and SIF-Q260 (Olympus Medical Systems, Tokyo, Japan) are the conventional SBEs; each has a 2.8-mm working channel and a 200-cm working length. The SIF-Q180 was mainly used in Western countries, whereas the SIF-Q260 was mainly used in Japan. These two SBEs were categorized as long-type SBEs because they have 200-cm working lengths. When a long-type SBE is used for balloon-assisted ERCP, various ERCP accessories cannot be used as they are with a long-type DBE. Therefore, the need for a short-type SBE has also increased. In 2016, the SIF-H290S (Olympus Medical Systems, Tokyo, Japan) became commercially available in Japan. The SIF-H290S has a 3.2-mm working channel and a 155-cm working length. This enteroscope has a passive bending design and a high force transmission design, both of which facilitate a smoother passage through the flexures of altered GI anatomy. Moreover, the large size of the working channel makes it possible to perform almost all types of ERCP procedures, including SEMS insertion.

6.2.3 Spiral Enteroscope

A spiral enteroscope was developed in 2007 to potentially provide a simpler and faster technique compared with BAE. The spiral enteroscope uses a helical overtube that allows deep insertion by pleating the small bowel over the enteroscope as the overtube is rotated clockwise. The overtube is 118-cm long and has a soft raised spiral helix at its distal end that is either 4.5 mm or 5.5 mm in height. The overtube is compatible with enteroscopes that are 200 cm in length and between 9.1 and 9.5 mm in diameter. Two different overtubes are available for antegrade or retrograde examinations. The overtube has a coupling device on its proximal end that affixes itself to the enteroscope. This permits the free rotation of the overtube independent of the enteroscope but prevents independent movement of the enteroscope relative to the overtube. When the overtube is uncoupled, the enteroscope can then be advanced or withdrawn independent of the overtube. A motorized spiral enteroscopy system is in development [22]. When a spiral overtube is used to perform ERCP in patients with altered GI anatomy, a long-type enteroscope is used for the insertion to reach the target sight. A long-type enteroscope is sometimes exchanged for a short-type enteroscope to use most of the ERCP accessories if needed.

6.2.4 Through-the-Scope Balloon-Assisted Enteroscope

The new concept of through-the-scope BAE was reported in 2008. Through-the-scope BAE was marketed as the NaviAid system (SMART Medical Systems Ltd., Ra'anana, Israel). This new device consists of a disposable balloon component that is advanced through the working channel of an endoscope or colonoscope and an air supply unit. The NaviAid AB (Advancing Balloon) has a working length of 350 cm with a balloon diameter of 40 mm. The minimum endoscope working channel diameter needed for passage of the device is 3.7 mm. The deflated balloon was passed through the working channel 20–30 cm ahead of the standard endoscope. It was then inflated to anchor itself to the small bowel. Once it was inflated ahead of the endoscope and anchored in the bowel, the device was used as a rail on which the endoscope was advanced, replacing pushing with guidance. Once the endoscope met the balloon catheter, the balloon was deflated to allow the next cycle of advancement. When the endoscope reached the target sight, the balloon catheter was removed from the working channel to allow the accessories to perform the procedure. Either an adult colonoscope or a therapeutic gastroscope, which has a large working channel, is chosen when this balloon system is used for ERCP.

6.3 ERCP Using Device-Assisted Enteroscopy

6.3.1 Treatment Outcomes

Recently, there have been an increasing number of patients with altered GI anatomy following gastric surgery, pancreatobiliary surgery, liver transplantation, and bariatric surgery. With the increase in altered GI anatomy patients, the frequency at which pancreatobiliary interventions are performed in such patients has increased. The difficulty of performing ERCP is influenced by the type of surgically altered anatomy. Recently, a high success rate of ERCP in patients with Billroth II reconstruction was reported [23]. However, it is still difficult to reach the target site and perform ERCP in patients with Roux-en-Y reconstruction and hepaticojejunostomy [24]. In a questionnaire survey at the Endoscopic Forum Japan 2013, it was reported that the success rates of reaching the target site were 89.6% for Roux-en-Y reconstruction, 94.8% for pancreaticoduodenectomy, 86.4% for hepaticojejunostomy, 90.0% for liver transplantation, and 98.6% for Billroth II reconstruction. In the systematic review of 945 procedures (DBE, SBE, and spiral enteroscopy-assisted ERCP) in 679 patients, an overall success rate was reported to be 70–90%, and the success rates were highest in patients with Billroth II reconstruction and lowest in patients with Roux-en-Y gastric bypass [25]. According to the success rate of reaching the target sight, the length to the target sight and the angulation of the afferent limb are usually the main factors. Roux-en-Y reconstruction with gastric bypass is particularly challenging due to the long limb (often greater than 100 cm) that must be traversed from the gastrojejunal anastomosis to the jejunojejunal orifice. Recently, a short-type DBE and SBE have been introduced and have advantages because most ERCP accessories can be used with these instruments. However, it is sometimes difficult to reach the target sight using these short-type BAEs when the length of target site is long. For the angulation of the afferent limb, the new types of DBE (EI-580BT) and SBE (SIF-H290S) have been introduced to facilitate smoother passage through the flexures of altered GI anatomy.

From the data of the systematic review, which included 945 procedures (DBE, SBE, and spiral enteroscopy-assisted ERCP), the overall ERCP success rate of all procedures was reported to be 74% [25]. When the enteroscopes were compared, the success rates were highest in DBE and lowest in spiral enteroscopy. Regarding the data of DBE, the success rate of reaching the target site was 89% (73–100%), the success rate of cannulation was 93% (85–100%), and the overall success rate was 82% (63–95%). When SBE was used, the success rate of reaching the target site was 82% (75–100%), the success rate of cannulation was 86% (75–100%), and the overall success rate was 68% (60–100%). For the spiral enteroscope, the success rate of reaching the target site was 72%, and the overall success rate was 65%. However, the data for spiral enteroscopy-assisted ERCP were limited. A multicenter experience of through-the-scope BAE showed that the success rate of reaching the target site was 58%, the success rate of cannulation was 94%, and the overall success rate was 55% [21]. Through-the-scope BAE is shown to be an effective modality with which to successfully deliver intervention despite a slightly lower target success rate compared to other device-assisted enteroscopy instruments. Therefore, through-the-scope BAE may not yet be able to replace the current methods because of the lower overall target success rate.

Short-type DBE and SBE are preferred for ERCP in patients with altered GI anatomy. A Japanese multicenter prospective study that included 311 patients and used a short-type DBE with 2.8-mm working channel (EI-530B) showed high success rates that were comparable to the success rates of conventional ERCP in patients with normal anatomy. The success rate of reaching the target site was 97.7%, the success rate of cannulation was 96.4%, and the therapeutic success rate was 97.9% [26]. In this prospective study, only patients with biliary indication were included. The efficacy of a new short-type DBE (EI-580BT) with a 3.2-mm working channel was reported in 2016 [27]. When this new short-type DBE was used to treat 112 procedures, the success rate of reaching the target site was 99.1%, the diagnostic success rate was 98.2%, and the overall success rate was 97.3%. The median time to complete ERCP with DBE was 54 min. Therefore, this new short-type DBE is very useful for ERCP in patients with altered GI anatomy. A large Japanese retrospective observational case series that included 203 procedures with the short-type prototype SBE with a 3.2-mm working channel also showed high success rates [28]. The success rate of reaching the target sight was 92.6%, and the procedural success rate was 81.8%. In this retrospective study, the pancreatic indication was also included. From the multivariate analysis, the pancreatic indication (odds ratio, 4.35), first ERCP (odds ratio, 6.03), and no transparent hood (odds ratio, 4.61) were reported to be potential risk factors for procedural failure.

Biliary cannulation of the intact papilla in patients with altered GI anatomy remains challenging, especially in the case of Roux-en-Y reconstruction. The success rate of the standard cannulation of the intact papilla was reported to be 67.8% [29]. Therefore, several advanced cannulation methods, including the double-guidewire technique, precutting, and percutaneous transhepatic cholangiography-guided rendezvous technique, are required to improve the deep cannulation rate. When these techniques were used, the final cannulation success rate became 95.6%.

Several complications occurred from ERCP with device-assisted enteroscopy. From the data of a systematic review that included 945 procedures, major complications occurred in 3.4% of the procedures. Major adverse events included cholangitis (0.1%), pancreatitis (1.2%), bleeding (0.3%), perforation (1.4%), and death (0.1%), which was attributed to an embolic stroke [25]. From a Japanese multicenter prospective study that used a short-type DBE, adverse events occurred in 10.6% of procedures [26]. The most common adverse event was pancreatitis (3.5%), followed by cholangitis (2.6%). Obvious perforation that required surgical repair occurred in 0.3% of the cases, and microperforations, as identified by escaped air, occurred in 1.9% of the cases. The perforation rate of ERCP with device-assisted enteroscopy is not as high. ERCP in patients with altered GI anatomy could be performed safely, similar to conventional ERCP in patients with normal anatomy.

6.3.2 Therapeutic ERCP

Bilioenteric anastomotic stricture can now be treated with device-assisted enteroscopy [11, 30–32]. A practical classification proposed by Mönkemüller and Jovanovic is used to assess the type of the anastomotic stricture [33]. When the guidewire passes through the stricture, the stricture is usually treated with balloon dilation and/or stent placement (Fig. 6.1). The use of a Soehendra stent retriever and wire-guided diathermic dilator is useful when the balloon cannot pass through the stricture [34, 35]. It is occasionally difficult to determine the orifice of bilioenteric anastomosis. In such cases, a rendezvous technique via percutaneous transhepatic biliary drainage route is usually useful [36, 37].

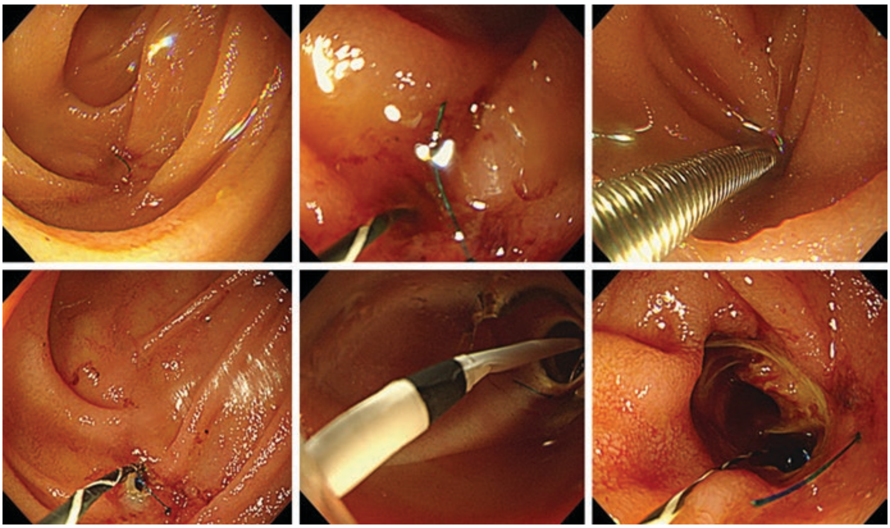

Fig. 6.1 Treatment of bilioenteric anastomotic stricture using short-type single-balloon enteroscope (SIF-H290S)

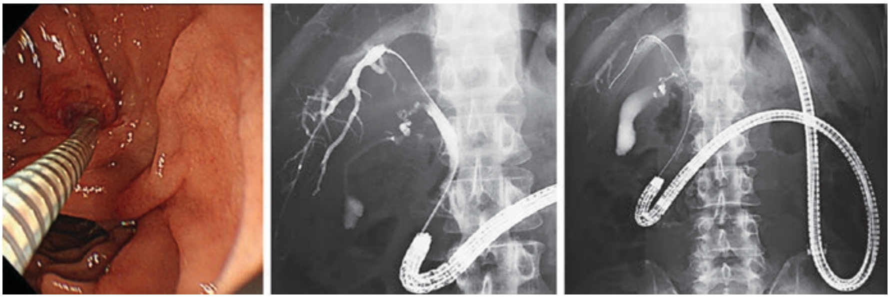

Fig. 6.2 Self-expandable metallic stent placement for malignant biliary obstruction using short-type single-balloon enteroscope (SIF-H290S)

The extraction of a biliary stone is also a major treatment in patients with altered GI anatomy [38]. Endoscopic papillary large-balloon dilation is performed such as a conventional ERCP and shows good efficacy [39, 40]. Direct cholangioscopy with an ultra-slim endoscope or a SpyGlass Direct Visualization System is useful for the detection and treatment of biliary stones and biliary tumors [41–43]. Electrohydraulic lithotripsy could be used to treat a large stone under direct cholangioscopy [44–46].

Biliary drainage via an endoscopic approach is less invasive in patients with altered GI anatomy compared with percutaneous and surgical drainage. Iatrogenic biliary injury and bile leakage from choledochojejunostomy could be treated with biliary drainage with device-assisted enteroscopy [47, 48]. The insertion of SEMS for malignant biliary obstruction was a difficult procedure when a long-type BAE was used [49]. With the introduction of the short-type BAE, it became easier to deploy SEMS, as with conventional ERCP, even in situations of multiple stenting (Fig. 6.2) [50–52].

Pancreatic intervention is more difficult than biliary intervention in cases of altered GI anatomy. Identifying the pancreaticojejunal anastomotic site is difficult because of the location and small size of the anastomosis and interference from the jejunal folds. Therefore, dilation and/or stenting of pancreaticodigestive tract anastomotic stricture showed a relatively low success rate (38%) [53]. The use of the EUS-guided or US-guided rendezvous method may improve the success rate of these difficult cases [53, 54]. Pancreatitis caused by the pancreaticojejunal anastomotic stricture and pancreatic duct stones is a confusing problem in patients with pancreaticoduodenectomy. A short-type BAE with a transparent hood might be useful for the detection of the pancreaticojejunal anastomotic site and the successful removal of the pancreatic duct stone [55].

6.4 Conclusions

The emergence of a BAE has changed the treatment of pancreatobiliary disorders in patients with altered GI anatomy. Due to the improvement of device-assisted enteroscopy, ERCP with device-assisted enteroscopy has become the mainstay of management in patients with altered GI anatomy. However, it is still a challenging procedure for many endoscopists. Therefore, both the device-assisted enteroscopy and ERCP accessories need to be improved for this challenging procedure to become a more general procedure.

Another approach for the treatment of pancreatobiliary disorders in patients with altered GI anatomy is the EUS-guided approach. EUS-guided intervention techniques have also progressed over the past several decades. This novel technique also helps manage pancreatobiliary disorders in patients with altered GI anatomy in combination with a BAE. Because of the improvement of the prognosis of patients with altered GI anatomy, the demand for ERCP for such patients will increase further. The treatment of pancreatobiliary disorders in patients with altered GI anatomy should be improved with the combination of these kinds of novel approach, and each procedure should become more sophisticated.

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