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TOPICS

Advances in therapeutic ultrasound and endoscopy in hepato-biliary-pancreatic diseases

Spiral enteroscopy for therapeutic ERCP in patients with surgically altered anatomy: actual technique and review of the literature

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Abstract
Background Endoscopic retrograde cholangiopancreatography (ERCP) and associated procedures are difficult to perform in patients with surgically altered anatomy. Recently, balloon enteroscopy (BE) has made it easier to perform ERCP in these patients. However, BE-assisted ERCP is often technically demanding and time consuming.
Methods Spiral enteroscopy (SE), which has recently been developed, is a novel method of using a rotating overtube to pleat small bowel onto the enteroscope, thus advancing it through the lumen. We review the mechanism and efficacy of SE, especially in ERCP of patients with surgically altered anatomy, and report on the first patient to undergo ERCP using SE in Japan.
Results Spiral enteroscopy-assisted ERCP seems to be feasible and safe in patients with surgically altered anatomy. Additionally, SE-assisted ERCP appears to be easier to perform than other methods previously described and allows stable positioning of the enteroscope in order to perform delicate therapeutic maneuvers.
Conclusions SE for ERCP is expected to be at least as useful as balloon enteroscopy in patients with surgically altered anatomy.

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Keywords Spiral enteroscopy · ERCP · Surgically altered anatomy

Abbreviations

ERCP	Endoscopic retrograde cholangiopancreatography
BE	Balloon enteroscopy
SE	Spiral enteroscopy
DBE	Double-balloon enteroscopy
SBE	Single-balloon enteroscopy

Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) and associated procedures in patients with surgically altered anatomy are often challenging, time consuming and have a low success rate. One of the most common causes of difficulty is the inability of the endoscope to reach the papilla of Vater or the bilio-enteric anastomosis, due to the length of the passage or the angle of the anastomosis. Recently, balloon enteroscopy (BE) techniques such as double-balloon enteroscopy (DBE) or single-balloon enteroscopy (SBE) have made it easier to perform ERCP in these patients [1–11].

Spiral enteroscopy (SE) has recently been developed [12, 13]. SE has two components, an endoscope and a rotating overtube which pleats the small bowel and allows access deeper into the small intestine [12, 13]. The potential advantages of SE include shorter examination time, stability of the endoscope within the small bowel, and controlled examination of the intestinal mucosa upon both insertion and withdrawal of the enteroscope [12–14]. Although data on the use of SE are limited, the usefulness

of SE for ERCP in patients with surgically altered anatomy is expected to be equal to or more than that of balloon enteroscopy.

In the present paper, we review the mechanism and efficacy of SE, especially in the case of ERCP with surgically altered anatomy, and report on the first patient in Japan to undergo ERCP using SE.

Spiral enteroscopy

Spiral enteroscopy is a new technique which uses a rotating overtube [Discovery SB overtube® (DSB); Spirus Medical, Inc., Stoughton, MA, USA] to pleat small bowel onto the enteroscope, advancing it through the lumen [12, 13] (Fig. 1). In order to advance the enteroscope, "engagement" is necessary, such that the spiral part of the rotating overtube grips the small intestine properly. Currently, more than 10000 cases have been performed worldwide. Akerman et al. [15] reported that the overall severe complication rate was 0.3%, including a very low perforation rate (0.27%) and pancreatitis rate (0.03%) in the first 2950 patients. The technique is safe and effective for management and detection of small bowel diseases. SE is technically feasible and safe even in elderly patients with numerous comorbidities. Judah et al. [16] reported that SE was successfully completed in 56 of 61 elderly patients (92%) with four mild complications and no intestinal perforation.

Although only published in abstract form, some studies have compared SE with DBE and shown that SE required significantly shorter time than DBE to insert to similar depths [17, 18]. One prospective randomized study showed that examination of the small intestine is more than three times faster using SE than DBE. Average total examination time was only 27 min when performed with SE, versus 86 min with DBE. Positioning for collecting samples and for therapy was more stable with SE than with DBE [19].

Khashab et al. [20] reported the first study comparing SE and SBE. Although SE yielded greater depth of maximal insertion than SBE, both techniques had similar diagnostic yields and procedure times. As seen above, the strengths of SE are rapid advancement in the small bowel and better control of the endoscope, which makes it easy to conduct endoscopic interventions.

Fig. 1 Discovery SB overtube (DSB) over the enteroscope

Spiral enteroscopy-assisted ERCP

Although only published in abstract form, some studies on SE-assisted ERCP have been reported. Chandrasekhara et al. [21] reported a series of 5 patients undergoing ERCP with SE. Three patients had Roux-en-Y gastric bypass and 2 were status post-pancreaticoduodenectomy. All procedures were performed using the Olympus SIF-Q 180 enteroscope and DSB, and the success rate was 80%. Akerman et al. [22] reported a series of 9 patients undergoing ERCP with SE. 7 patients had Roux-en-Y gastric bypass and 2 had standard Roux-en-Y reconstruction. All patients underwent ERCP with the Olympus SIF-Q180 enteroscope and DSB. The average time to reach the pancreaticobiliary orifice and perform the total procedure was 27 and 65 min, respectively. The ERCP success rate was 89% and there were no complications. Shah [23] reported a series of 13 patients undergoing SE-assisted ERCP. Post-surgical anatomy included Roux-en-Y gastric bypass ($n = 6$), liver transplant ($n = 6$), and hepaticojejunostomy post liver resection ($n = 1$). Access to the papilla or anastomosis was achieved in 11/13 patients (85%) and ERCP was successfully performed in 9/13 (62%). Complications were seen in 2 patients, including mild pancreatitis and self-limiting hypopharyngeal trauma. In a multi-center study, Shah et al. [24] reported 129 patients with surgically altered anatomy undergoing ERCP using SBE ($n = 45$), DBE ($n = 27$), and SE ($n = 57$). ERCP success rates of each method were 60, 63, and 65%, respectively. Complications occurred in 16/129 patients (12.4%), including pancreatitis ($n = 4$), perforation ($n = 2$), bleeding ($n = 1$), and other minor events ($n = 9$). Sanjay et al. [25] reported that SE-assisted ERCP was performed in 3 patients including 2 patients for whom DBE-assisted ERCP had failed once. Successful selective cannulation and therapeutic intervention were achieved in all 3 cases. Mean total procedure time was 117 min. The use of SE may facilitate pancreaticobiliary interventions in patients with difficult ERCP, even using DBE. As reviewed above, SE-assisted ERCP seems to be feasible and safe in patients with surgically altered anatomy.

Case presentation

An 81-year-old man underwent a pancreaticoduodenectomy by modified Child method with a Roux-en-Y

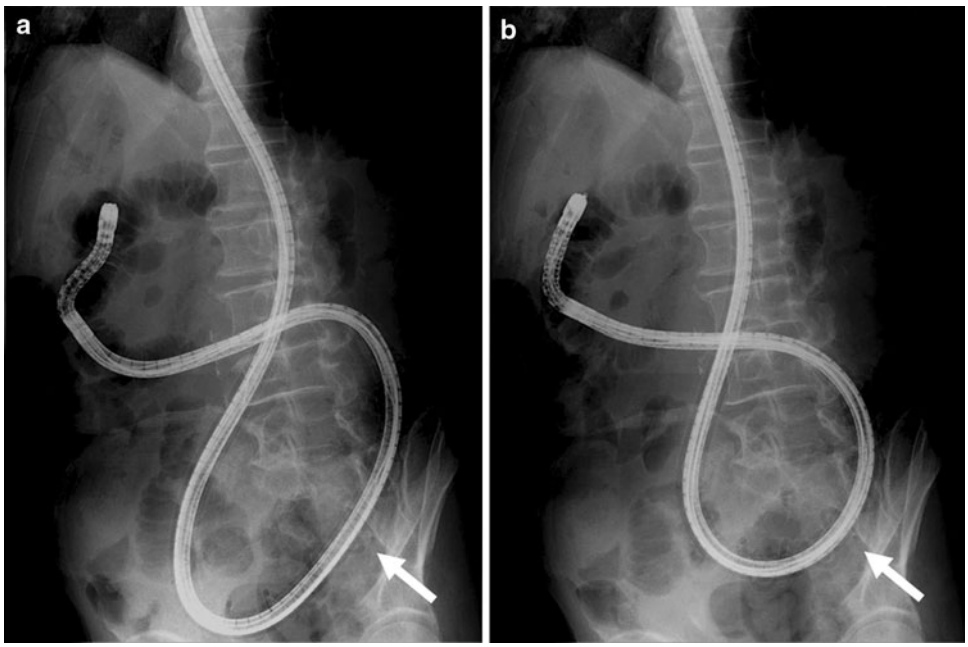

Fig. 2 **a** After the tip of the scope reached the hepaticojejunostomy, the DSB was advanced adequately into the afferent loop (*arrow*). **b** We changed the enteroscope from EN-450T5 to EC-450BI5

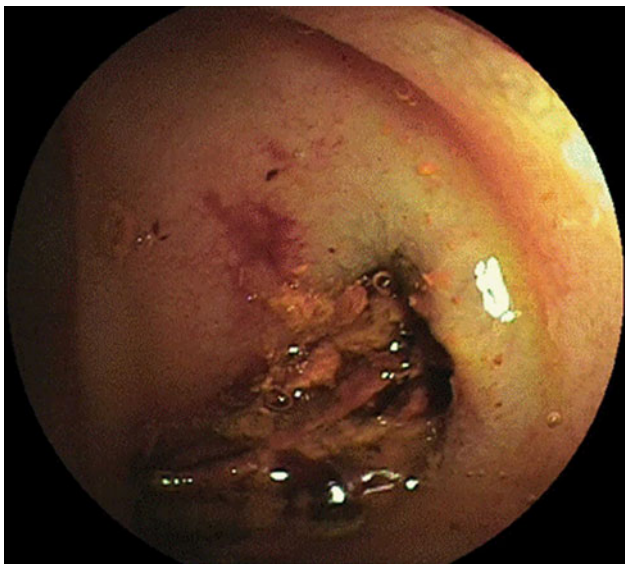

Fig. 3 At the hepaticojejunostomy, stone formation around suture material was seen

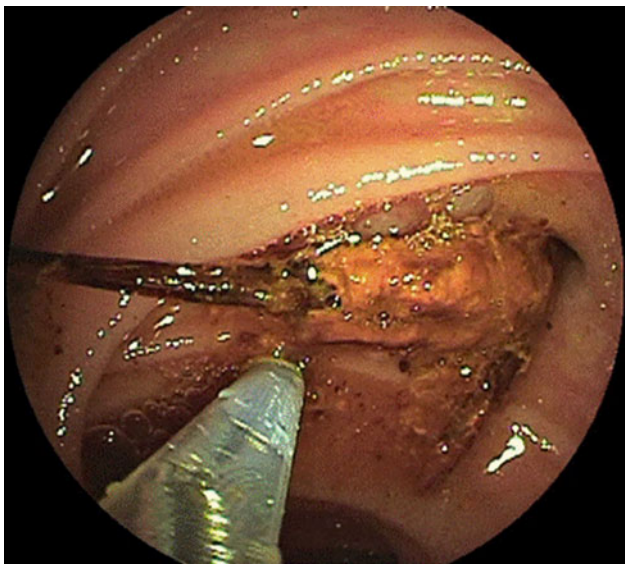

Fig. 4 The bile duct stones and suture materials were removed using a standard four-wire retrieval basket

anastomosis for pancreatic head carcinoma in July 2005. He was treated with adjuvant chemotherapy with gemcitabine for 24 cycles. During follow-up, tumor recurrence was not observed. However, elevation of hepatobiliary enzymes and CA19-9 was found in April 2009. CT scan showed calcified stones in the left hepatic duct and suspected anastomotic stricture of hepaticojejunostomy. We performed ERCP with a "short" double-balloon enteroscope, which has a 152 cm working length and a 2.8 mm working channel (EC-450BI5; Fujifilm Medical Co. Ltd., Tokyo, Japan) and for which conventional accessories are available [11]. The procedure was performed under conscious sedation with pethidine and diazepam. The hepaticojejunostomy was reached by using the push-and-pull method in 30 min. At the hepaticojejunostomy, stone formation around suture material was seen and was removed with a biopsy forceps. The opening of the hepaticojejunostomy did not appear stenotic.

The patient remained asymptomatic during 11 months of follow-up, but developed recurrent episodes of cholangitis in April 2010. CT scan showed the recurrence of calcified stones in the left hepatic duct.We therefore

performed ERCP with SE. DSB was used with a therapeutic enteroscope with a 200 cm working length and a 2.8 mm working channel (EN-450T5; Fujifilm Medical Co.Ltd., Tokyo, Japan). The procedure was performed under conscious sedation as before and used carbon dioxide instead of air for insufflation. The enteroscope and DSB were inserted through the mouth and advanced into the gastrojejunostomy. We succeeded in "engagement" of the overtube after 4 min, and then the engaging unit was advanced by clockwise rotation. Upon reaching the jejunojejunal anastomosis, the DSB was unlocked and the enteroscope was advanced selectively into the afferent loop. The tip of the scope reached the hepaticojejunostomy after 48 min, and the DSB was advanced adequately into the afferent loop using clockwise rotation while pushing forward over the scope (guide-wire maneuver). Then we exchanged the EN-450T5 enteroscope for an EC-450BI5 enteroscope (Fig. 2a, b) because the accessories available for an EN-450T5 are limited. Biliary stone had again developed around the suture material at the hepaticojejunostomy (Fig. 3). The opening of the hepaticojejunostomy did not appear stenotic. Cannulation of the biliary tract was achieved with a tapered-tip biliary catheter (MTW Endoskopie, Wesel, Germany). Contrast injection revealed filling defects in the left hepatic duct. The bile duct stones and suture materials were removed using a standard four-wire retrieval basket (Olympus, Tokyo, Japan) (Fig. 4) and an XEMEX extraction balloon catheter (Zeon Medical, Tokyo, Japan). Finally, a cholangiogram revealed no residual stone. There were no complications associated with the procedure. At follow-up 1 month later, he was asymptomatic and his liver tests had returned to normal.

Discussion

Spiral enteroscopy-assisted ERCP in patients with surgically altered anatomy appears to be safe and effective and can potentially avoid more invasive surgical interventions. Additionally, SE-assisted ERCP appears to be easier to perform than other methods previously described and allows for stable positioning of the enteroscope to perform delicate therapeutic maneuvers. However, we experienced perforation in our second SE-assisted ERCP case with prior subtotal gastrectomy with Billroth II reconstruction. The cause of perforation in the second case is unclear but it could be due to several reasons, including relatively immature endoscopic maneuver technique (we had performed 16 SEs before this case) and Billroth II reconstruction. Intestinal perforation rates during ERCP using a conventional endoscope in patients with Billroth II reconstruction are reported as 5–18% [26]. The number of SE-assisted ERCPs is too small to reach a conclusion regarding its safety. Our first SE-assisted ERCP case encourages us to use the procedure again. Theoretically, SE-assisted ERCP requires a shorter procedure time than BE-assisted ERCP due to quicker insertion and better control of the endoscope. In order to establish a safe and effective procedure of SE-assisted ERCP, more experience is needed. With the advent of spiral and balloon enteroscopy, various pancreaticobiliary interventions for patients with surgically altered anatomy have become possible, but these procedures are still difficult and technically demanding. The development of new endoscopes and accessories which make it easy to perform ERCP in patients with altered anatomy is required.

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