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Basics of Therapeutic ERCP in Patients with Surgically Altered Anatomy

Techniques using the short single-balloon enteroscope

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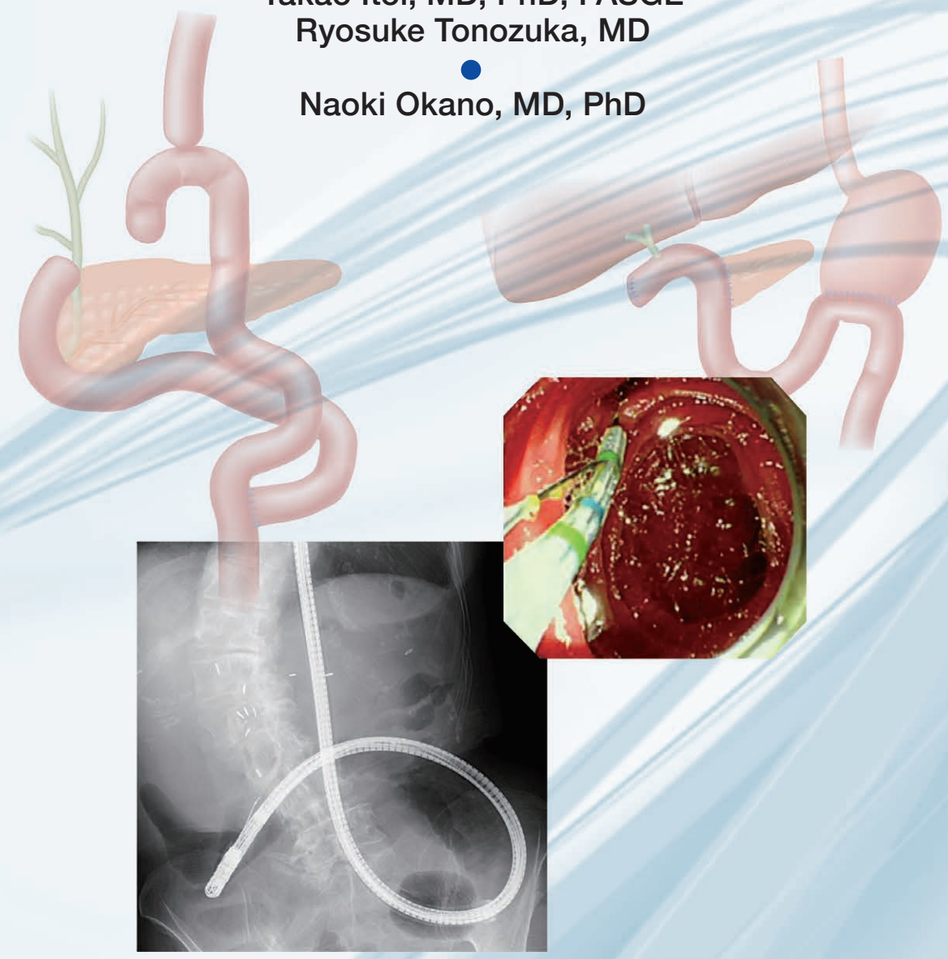

Intact Papilla : Post-gastrectomy Roux-en-Y, Post-choledochectomy Roux-en-Y, and Billroth-II

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I Preparation

Before beginning the procedure, use fluoroscopy to clarify number/size of stones or location of stricture for preparing the appropriate endotherapeutic devices.
Regardless dealing with a Roux-en-Y (R-Y) anastomosis case or a Billroth-II (B-II) reconstruction case, it is important to collect as much pertinent information as possible beforehand. In the former case, you will need to know the length to Y-limb or anastomosis method performed on Y-limb (end-to-side or side-to-side), while in the latter case, you need to know performed gastrojejunostomy method (anterograde or retrograde) or the presence of Braun anastomosis.

Confirmation with fluoroscopy (for preparation of endotherapeutic devices)
• Size and number of stones • Location of stricture

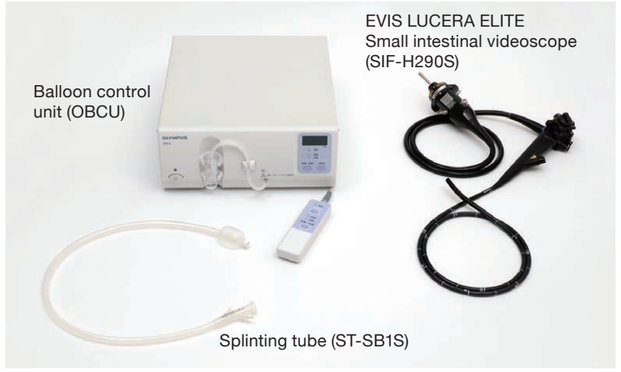
Confirmation with surgical method	
R-Y case	• Length to Y-limb • Y-limb anastomosis method (end-to-side or side-to-side)
B-II case	• Gastrojejunostomy method (anterograde or retrograde) • Presence/absence of Braun anastomosis

II Operation environment

• Equipment required (Fig. 1)
Whenever you perform short-type single balloon enteroscopy (sSBE), you will need SIF-H290S small intestinal videoscope, EVIS LUCERA ELITE video processor and light source compatible with the endoscope, ST-SB1S splinting tube for sSBE, and the OBCU balloon control unit.
Ideally, you should use CO_2 gas for endoscopic insufflation whenever possible. Before starting the procedure, you can mount a distal attachment on the tip of the endoscope beforehand.

• Sedation method and patient position
For sedation, we use pentazocine (Sosegon®) as an analgesic and flunitrazepam (Silece®) as a sedative.
As for patient position, we place patient in left lateral position for endoscope insertion and keep them in that position until endoscope reaching to gastrojejunal/esophagojejunal anastomosis or pylorus. Once past through those regions, we shift patient to prone position as this makes it easier to grasp endoscope position in fluoroscopy.

Fig. 1 Equipment required



EVIS LUCERA ELITE video system center (CV-290) and
EVIS LUCERA ELITE xenon light source (CLV-290SL, CLV-290) are also required.

III Insertion technique (anatomy, workflow and tips of insertion, selection of afferent limb, and tips on passing through bends)

1) Post-gastrectomy Roux-en-Y (RY) cases

In terms of anatomy, the length from esophagojejunal anastomosis to Y-limb is about 30 cm when an operation is performed. However, frequent pushing of endoscope during insertion can stretch the tract as much 60 cm or more. Alternatively, another Y-limb may be formed with a loop. You must repeatedly use tract shortening procedure to keep any extension of the tract to a minimum for finding a so-called “joint” where there are no jejunal folds or a large space (Fig. 2a) with fluoroscopic images (left lateral cranial direction).
Generally, afferent limb is located in the tract (Fig. 2b) where endoscope tip is observed in the left lateral cranial direction under fluoroscopy. Insertion is usually more difficult at this point. This leaves you with no option but to sharply bend endoscope tip to advance the endoscope. However, bends endoscope tip results in a shape that resembles a walking stick handle. If you keep pushing conventional endoscope in that condition, the endoscope axis will move toward efferent limb. Thus, even if the endoscope tip enters afferent limb, it will end up heading in the direction of efferent limb easily. However, SIF-H290S applied a couple of remarkable functions — Passive Bending and High Force Transmission — that makes it much easier to advance the endoscope to afferent limb with combination of simple pushing and downward angulation, compared to conventional endoscope (Figs. 2c, 2d).
If you still find it difficult to advance to afferent limb, you will find it helpful to: 1) apply manual compression from caudal side under fluoroscopic guidance; and 2) hit the endoscope tip against the opposite side to Y-limb by taking advantage of twisting of the endoscope when the angle is not so sharp. In a method like sSBE — in which splinting tube is advanced by taking advantage of hook formed at the endoscope tip — it is effective to advance the endoscope tip after advancing it as close to the blind end as possible.

Illustration of post-gastrectomy R-Y reconstruction

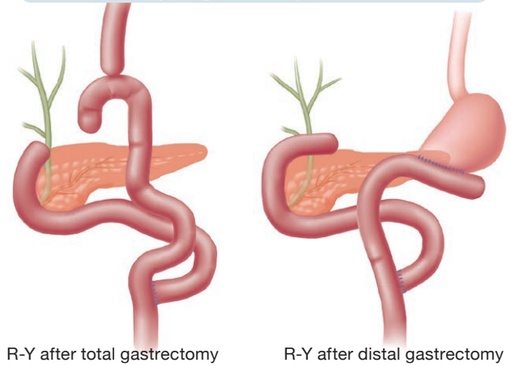
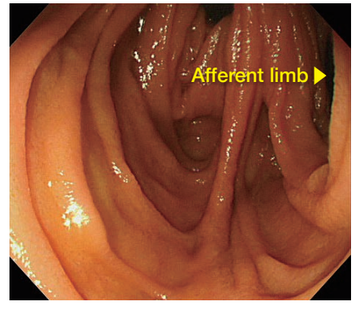
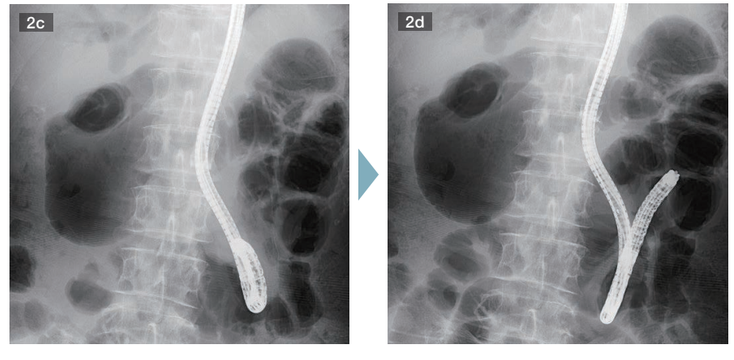


Fig. 2a R-Y anastomosis (fluoroscopic image)

Fig. 2b R-Y anastomosis (endoscopic image)



Figs. 2c, 2d Endoscope insertion method into afferent limb (fluoroscopic image)

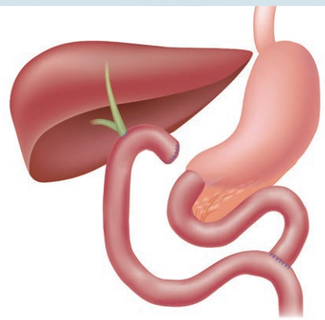


2) Post-choledochectomy R-Y cases

When performing a hepaticojejunostomy plus R-Y anastomosis after a choledochectomy, it is slightly more difficult to reach to the blind end of afferent limb than with a subtotal gastrectomy, a total gastrectomy plus R-Y anastomosis, or a post-pancreaticoduodenectomy. This is true even if a balloon enteroscope is used because of the length of endoscope that has to pass through stomach and duodenum. However, unlike anastomosis with total or subtotal gastrectomy, R-Y anastomosis performed in conjunction with a hepaticojejunostomy forms so-called "T-junction, which means that the angle of end-to-side anastomosis is not as sharp as anastomosis with total or subtotal gastrectomy. Consequently, afferent and efferent limbs are more often observed as two openings (Fig. 3a).

When advancing the endoscope to the afferent limb after the two openings have been observed, success rate is relatively higher when the endoscope is directed to luminal wall, which makes the endoscope tip point to the right and cranial side in fluoroscopy (Fig. 3b). However, this is not necessarily correct approach. Presence of bile also provides a useful guide as to which direction to choose in order to successfully advance the endoscope to afferent limb. Again, we must point out that this method, like the previous method, is not always correct.

Illustration of R-Y reconstruction after bile duct resection



Moreover, even if you succeed in advancing the endoscope to the afferent limb, you may find it difficult to advance it on the proximal side in the vicinity of hepaticojejunal anastomosis due to the presence of sutures or adhesion of elevated jejunum and colon (Fig. 3c). Should this be the case, insert splinting tube to as full extent as possible and change the patient position and/or apply hand pressure to advance the endoscope tip.

Fig. 3a R-Y anastomotic site (endoscopic image)

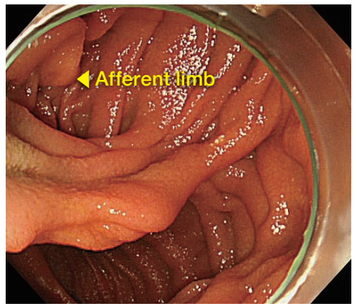
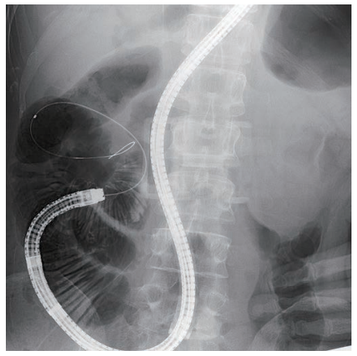


Fig. 3b R-Y anastomotic site (fluoroscopic image)

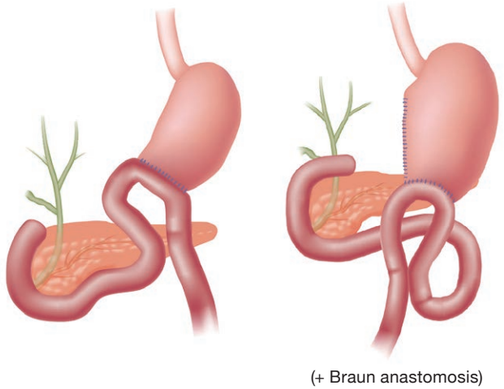
Fig. 3c Adhesion on proximal side of choledochojejunal anastomosis (fluoroscopic image)



3) Billroth II (B-II) reconstruction case

Size of anastomosis depends on surgeon and varies greatly from case to case — such as when afferent and efferent limbs can clearly be recognized as two openings or when only one opening can be recognized. In many cases, afferent limb can be observed all the way from anastomotic opening. However, entrance to the efferent limb tends to form a sharp angle, often making it impossible to observe. Should that be the case, use the area around anastomotic site on the opposite side to folds on greater curvature of stomach as a reference point to look for slit-shaped entrance to efferent limb. When doing this, insert the endoscope tip into the slit while angulating the scope up towards lesser curvature, taking into account any subsequent maneuvering of endoscope. At this time, the distal end of the endoscope usually points to the right side of patient body (Fig. 4a). In addition, there are cases in which it may be useful to perform insufflation to create gaseous images in small bowel in order to confirm whether or not the site in question is afferent limb, as well as to measure the distance to remaining distance to the blind end.

Illustration of B-II



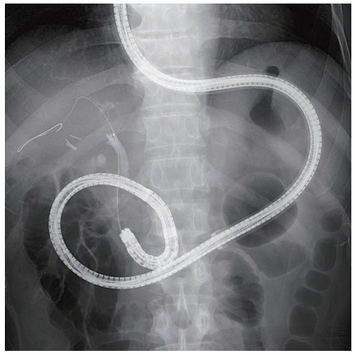
(+ Braun anastomosis)

If the endoscope is angulated sharply upward even if distal end has already entered entrance to afferent limb, simply pushing the endoscope will not make it advance any further. Instead, you should pull the endoscope slightly to straighten shaft so that it is aligned with afferent limb while releasing upward angulation a little at a time. Now you can advance the endoscope by pushing it in (Fig. 4b).

In cases where Braun anastomosis is present, insertion may be difficult because the entrance to afferent limb at gastrojejunal anastomotic site is too steep. If so, you can also approach duodenal papilla via the Braun anastomosis after the endoscope is once inserted into efferent limb.

Fig. 4a Gastrojejunal anastomotic site (fluoroscopic image)

Fig. 4b J-turn to obtain frontal view of papilla (fluoroscopic image)



Ⅳ Tips on how to approach papilla

As opposed to ordinary ERCP, the endoscope is inserted from the anus, so that long axis of papilla is upside down. With a forward-viewing endoscope, it is basically impossible to get a frontal view of papilla in ordinary ERCP. As a result, in most cases — whether R-Y case or B-II case — observation in a tangential direction cannot be avoided. Nevertheless, so-called "J-turn" is often possible in B-II case (Fig. 4b). This allows a frontal view of papilla (although it is upside down). One of methods for obtaining a frontal view of papilla in R-Y cases is a technique called "retroflex position". This involves performing cannulation with an endoscope position similar to J-turn while you push the endoscope slightly by intentionally retroflexing the endoscope tip near inferior duodenal flexure (Figs. 5a, 5b).[1), 4)]

In some cases, it is not possible to adjust endoscope to retroflex position, which means that it may not be possible to obtain a frontal view of papilla depending on location of papilla, presence/absence of diverticula, and size of lumen. It is also important to keep in mind that while a mounted distal attachment can sometimes be useful during insertion as well as for fixing papilla and intubating into bile duct, it can also interfere with maneuvering of the endoscope.

Fig. 5a Illustration of retroflex position

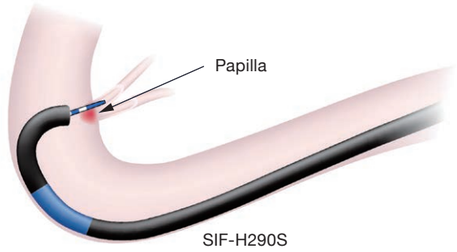
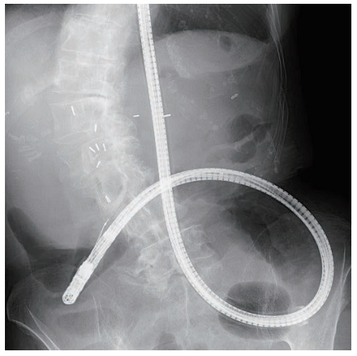


Fig. 5b Retroflex position (fluoroscopic image)



Intubation into bile duct using a forward-viewing endoscope is one of the most difficult techniques to perform. In a non-trivial number of cases, it is only possible to perform cholangiography by using an exquisite combination of a catheter and endoscope. Whatever the case may be conducted with sSBE, it should be kept in mind that catheter enters endoscopic field of view from 7 to 8 o'clock direction (Fig. 5c). Intubation should be performed while aligning papilla and bile duct axis. In cases where you have to insert endoscope blindly, you will have to estimate the alignment.

During intubation, maneuver catheter according to bile duct axis of each papilla (for example, parallel to duodenal wall with a septum type and perpendicular to it with an onion-like type) in the same way as with ordinary ERCP. Generally, we use wire-guided cannulation using VisiGlide2. When and as required, deeper intubation is sometimes performed in combination with trial fluoroscopy. In actual bile duct intubation, manipulation is not limited to catheter manipulation; instead, intubation is often performed in alignment with bile duct axis by adjusting the angulation of the endoscope while minimizing the extruded length of the catheter tip. If fluoroscopy can be performed but the axes of bile duct and catheter cannot be aligned, do not hesitate to use the Radifocus® Guidewire (Terumo). If necessary, a small-diameter catheter (PR-110Q-1, Olympus) or a bendable catheter (SwingTip, PR-233Q, Olympus) can of course also be used. However, the latter model has a large bending radius, making angulation impossible unless part of the catheter tip is extruded from the endoscope tip to a certain degree. Moreover, because the bile duct is positioned in the same direction as the downward angulation direction of the endoscope, it may not be possible to angulate the scope downwards as far as you need to, making this model even less effective in this case.

The biggest advantage of SIF-H290S is that it has an instrument channel diameter of 3.2 mm. This makes it possible to perform a pancreatic duct guidewire technique (or double-guidewire technique) (Fig. 5d), which can be expected to help improve successful bile duct intubation rates. If bile duct intubation is still difficult using the techniques described above, you can try over-the-pancreatic stent pre-cutting after pancreatic stent has been indwelled. If it is difficult even to approach pancreatic duct, you may want to consider free-hand pre-cutting. However, these techniques have a high degree of difficulty and should only be performed by highly experienced endoscopists.

Fig. 5c Instrument entrance/exit direction in SIF-H290S's view field (endoscopic image)

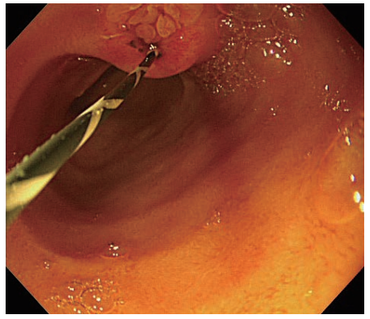
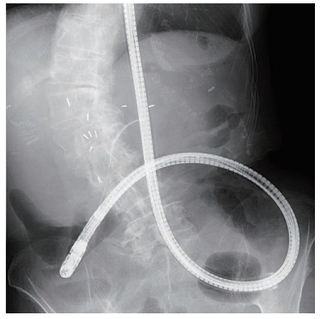
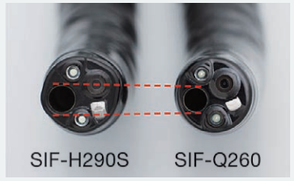


Fig. 5d Pancreatic duct guidewire technique (fluoroscopic image)



V Therapeutic techniques (how to select treatment devices, precautions, etc.)

Thanks to the fact that SIF-H290S incorporates an instrument channel diameter of 3.2 mm and also features a working length of 1,520 mm, almost all currently available treatment devices for bile and pancreatic ducts — including wire-guided devices — can be used. Two of the most commonly performed procedures in clinical cases are choledocholithotomy and biliary stenting, which we will describe below.



Model	SIF-H290S	SIF-Q260
Distal end outer diameter	9.2 mm	9.2 mm
Instrument channel diameter	3.2 mm	2.8 mm
Working length	1,520 mm	2,000 mm

1) Choledocholithotomy

When you need to remove a stone, it is necessary to treat papilla with endoscopic sphincterotomy (EST), endoscopic papillary balloon dilation (EPBD), or endoscopic papillary large balloon dilation (EPLBD) (Fig. 6a). Since the image of papilla displayed by SIF-H290S's is upside down, it is difficult to perform safe, secure EST with endoscope maneuvering alone. Thus, EPBD and EPLBD are more commonly performed to treat papilla.

When we perform EPLBD, we try to perform EST whenever possible in order to lower the risk of onset of postprocedural pancreatitis. For EST, we choose a suitable instrument from Olympus' wire-guided Needle Knife, MTW Endoskopie's wire-guided push-type or rotatable papillotome for B-II (also usable for R-Y cases).

In an actual stone extraction procedure, a wire-guided basket or balloon is inserted into the bile duct via the papilla where EST has been performed. If the stone is large, lithotomy will need to be performed. SIF-H290S's instrument channel can accommodate a wire-guided mechanical lithotripter (BML-V437QR-30, Olympus) (Figs. 6b, 6c), and this is our first choice.

Fig. 6a EPLBD (fluoroscopic image)

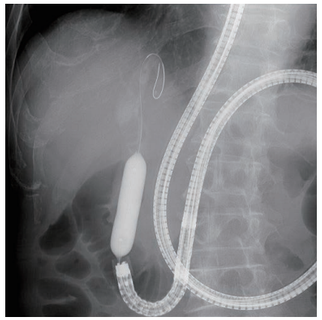


Fig. 6b Stone extraction using mechanical lithotripter (fluoroscopic image)

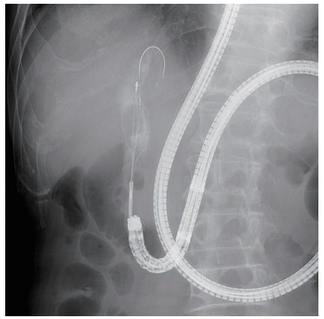
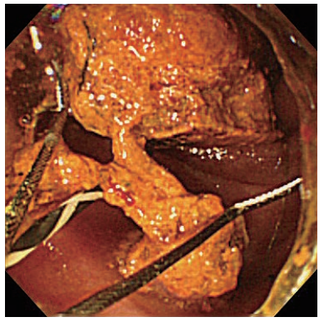


Fig. 6c Stone extraction using mechanical lithotripter (endoscopic image)

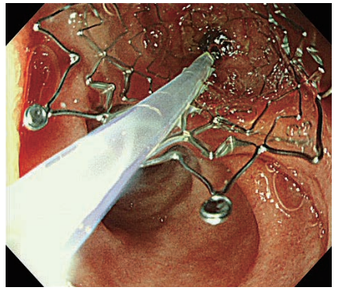


2) Biliary stenting

Since SIF-H290S incorporates a 3.2-mm diameter channel, a plastic stent as large as 8.5 Fr. can be used. If you are going to use a self-expandable metallic stent (SEMS), you will be able to insert a delivery system as wide as 9 Fr. — which means you can use almost all the uncovered SEMSs and most of the covered SEMSs currently available. However, unlike a duodenoscope, SIF-H290S has a forward-viewing direction of view and is not equipped with a forceps elevator. Hence, it is necessary to use a stent insertion technique that takes advantage of pushing-in of endoscope. For example, by pushing in endoscope while part of SEMS tip is extruded from the endoscope tip, you can easily pass through even a rigid stenosis. As a consequence, this procedure is usually repeated until SEMS is in place (Figs. 7a, 7b).

Fig. 7a Endoscopic biliary drainage using SEMS (fluoroscopic image)

Fig. 7b Endoscopic biliary drainage using SEMS (endoscopic image)



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Basic guide to ERCP in patients with reconstruction of the intestine after pancreaticoduodenectomy

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I Operation environment

• Equipment used (Fig. 1 on Page 1)
As it takes longer to administer therapeutic pancreaticobiliary endoscopy to a postoperative intestine than it does to perform ordinary ERCP; carbon dioxide (CO_2) gas is used for insufflation. Because CO_2 gas has excellent bioabsorbability, excessive stretching of intestine can be avoided, and small bowel can be effectively shortened.
The procedure is performed while monitoring patient with electrocardiogram (ECG), pulse oximeter, and continuous sphygmomanometer. This makes it possible to understand the patient's intraprocedural respiratory circulatory kinetics.
Use of a distal attachment helps reduce occurrence of so-called "red ball" phenomenon in which the endoscope tip comes in contact with mucosa. For this reason, use of a distal attachment makes it easier to discern the direction of lumen.

• Sedation method
As in ordinary ERCP, this procedure is performed under conscious sedation. Midazolam, diazepam, flunitrazepam, or propofol is used as a sedative and pethidine or pentazocine as an analgesic. In addition, hyoscine butylbromide or timepidium bromide is used as an anticholinergic in order to suppress intestinal peristalsis. If an anticholinergic cannot be used, glucagon is used as appropriate.

• Patient position
Standard patient position is prone position. This prevents aspiration, as well as allowing you to better assess the shape of the endoscope insertion tube under fluoroscopy. When hand pressure is necessary, switch to the semi-prone position.

II Basic operation of sSBE system

The short-type single balloon enteroscopy (sSBE) system is a combination of SIF-H290S small intestinal videoscope and ST-SB1S splinting tube with a built-in balloon on its tip (Fig. 1a). First of all, insert the endoscope into small bowel. After inflating the balloon of the splinting tube, further advance the endoscope as much as possible (Fig. 1b, ①). Secure intestine using the endoscope tip's up/down and left/right angulation (Fig. 1b, ②). Next, advance the splinting tube with the balloon deflated (Fig. 1b, ③), and when the tip of the splinting tube reaches a point just before the bending section near the distal end of the endoscope, inflate the balloon (Fig. 1b, ④). When advancing the splinting tube, do so while confirming the position of the distal end of the splinting tube with fluoroscopy to ensure it stays in place. Once the balloon has been inflated, release the angulation and then pull back the endoscope and splinting tube to shorten the intestine (Fig. 1b, ⑤). Repeat this maneuver to fold the small bowel toward the proximal side. This will shorten it and allow you to successfully insert the endoscope into the deep small bowel (Fig. 1b, ⑥).
When inserting the splinting tube, pull the endoscope slightly so it will not get pushed in. If you feel any resistance while inserting the splinting tube, take extra care as there is a chance that mucosa could get caught between the splinting tube and endoscope. If this happens, jiggle the endoscope or splinting tube to reduce the chance of catching the mucosa. When shortening intestine, pull the endoscope and splinting tube slowly. If you feel any resistance, do not use force. Instead, attempt shortening in combination with fluoroscopy as appropriate.
If the endoscope is significantly twisted or deep insertion is difficult because the endoscope tip has bent into a shape like a walking stick handle, have an assistant perform hand pressure as appropriate to facilitate insertion.

Fig. 1a Setting sSBE system

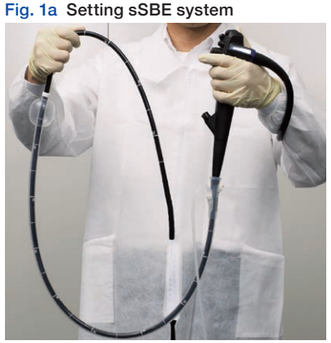
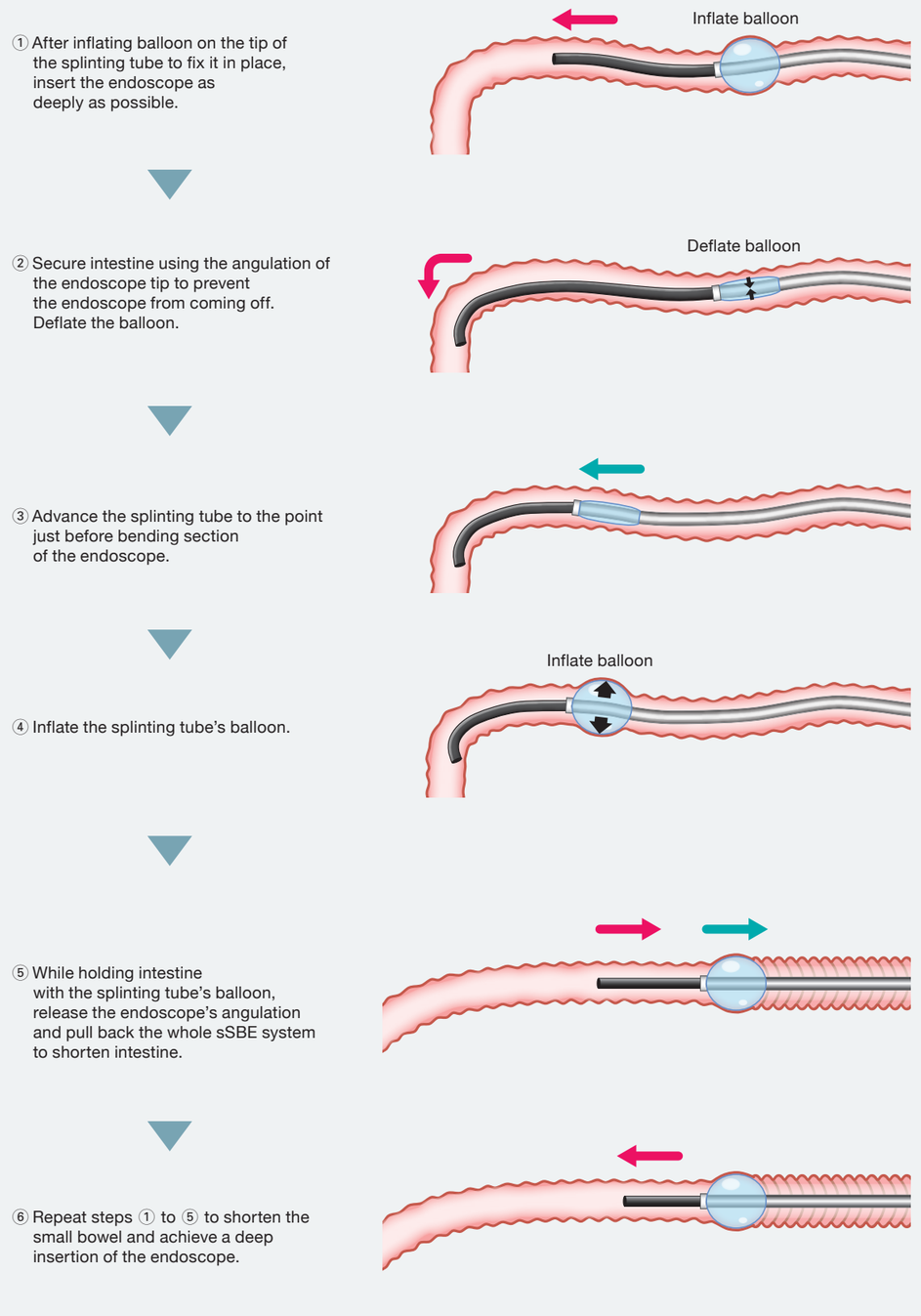


Fig. 1b Inserting sSBE system (Repeat steps ① to ⑤ for insertion in deep small bowel.)

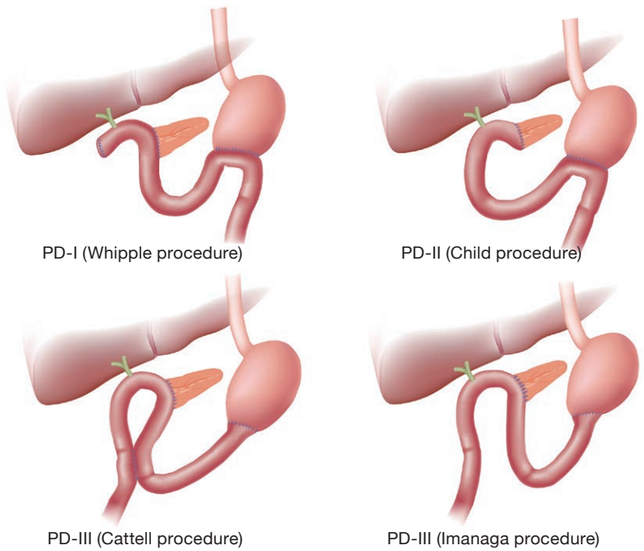


Ⅲ Insertion techniques

• Anatomy

The reconstruction methods used following pancreaticoduodenectomy are classified according to order in which organs are to be reconstructed. From the oral side of the jejunum, the methods to anastomose the jejunum to the pancreas, bile duct, and stomach include PD-I (in the order of the bile duct, pancreas, and stomach) (Whipple procedure), PD-II (in the order of the pancreas, bile duct, and stomach) (Child procedure), and PD-III (in the order of the stomach, pancreas, and bile duct) (Cattell procedure, Imanaga procedure). With PD-III, there are many cases where ERCP using an ordinary side-viewing duodenoscope is possible. With PD-I and PD-II, on the other hand, there are many cases where it is difficult, making forward-viewing sSBE useful.

Illustrations of reconstruction procedures after pancreaticoduodenectomy



• Workflow and insertion tips

The first step in patients with a reconstruction following pancreaticoduodenectomy is to advance the endoscope to gastrojejunal anastomosis so that you can identify afferent limb and efferent limb. In most cases, the tract where it is easy to observe luminal interior and insert the endoscope is efferent limb, while the tract with the sharp angle that makes insertion difficult is afferent limb. Empirically speaking, the lumen visible beyond the anastomosis on left or upper-left side is usually afferent limb (Figs. 2a, 2b). Because the sharp angle can make it difficult to insert the endoscope using push maneuver alone, the endoscope is advanced to afferent limb using a combination of angulation and pull maneuvers. Once the endoscope has been advanced far enough, the splinting tube can be advanced. This makes insertion easier without warping the endoscope's insertion tube. The endoscope is then advanced further while confirming its position with fluoroscopy as required. If the endoscope tip moves in the direction of pelvic cavity side rather than liver side, it is likely that the endoscope is advancing towards efferent limb. In this case, the endoscope should be pulled back to the anastomosis and inserted in the tract on the opposite side. When the endoscope is inserted in afferent limb and moved forward, pneumobilia is often found — which can be used as a reference point. In some cases, afferent limb may be long, so the splinting tube should be advanced in combination with fluoroscopy and small bowel should be shortened as required. If the endoscope becomes overly warped as it is being advanced, the most effective solution is to have an assistant perform hand pressure.

Fig. 2a View of gastrojejunal anastomosis from above (endoscopic image)

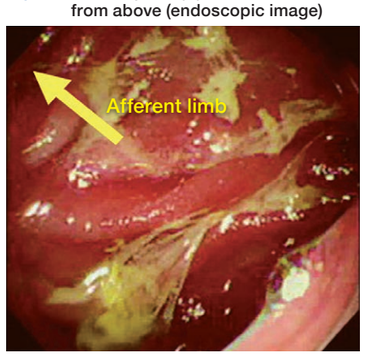
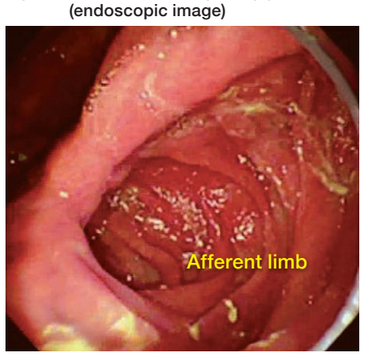


Fig. 2b J-turn view from gastrojejunal anastomosis (endoscopic image)



Ⅳ Tips on biliary cannulation

• Identification of the anastomosis

Since a gastrojejunal anastomosis is usually located in the vicinity of apex of afferent limb, it is relatively easy to identify. Pneumobilia can also help identify the anastomosis.
If it is difficult to identify an anastomosis in cases accompanied by stenosis, it is a good idea to advance the endoscope all the way to blind end and then look for unnatural tightening of folds and scars while pulling the endoscope back gradually.

• Basic approach and troubleshooting

As soon as anastomosis is identified, cannulation is performed with a catheter and guidewire in the same way as in ordinary ERCP. If stenosis is so strong that cannulation is difficult, a small-diameter catheter (PR-110Q-1, Olympus) should be used. If bile duct axis cannot be aligned by angulating the endoscope, a papillotome or a bendable catheter (SwingTip, PR-233Q, Olympus) can be used.

Ⅴ Case Study: Endoscopic therapy after Pancreaticoduodenectomy (Child procedure)

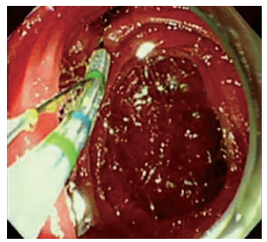
The patient was a 69-year old male. Pancreaticoduodenectomy (Child procedure) was performed for an intraductal papillary mucinous neoplasm at another hospital. He was referred to our hospital because calculi had been found in the intrahepatic bile duct during postoperative follow-up, so we performed endoscopic treatment using SIF-H290S in order to remove the stones. Because SIF-H290S has a short working length of 1,520 mm and a large channel diameter of 3.2 mm, many endoscopic therapeutic devices used for ordinary ERCP can be used. In this case, the afferent limb was long and formed a loop midway, so we released the loop by twisting and pulling the endoscope (Figs. 3a, 3b). In addition, the afferent limb was warped during the endoscope insertion, so we had the assistant apply hand pressure to the lower abdomen to facilitate deeper insertion. Although we had some difficulty operating the endoscope due to strong bending of the small bowel in the vicinity of the choledochojejunal anastomosis, we were still able to reach the anastomosis thanks to the improved operability made possible by SIF-H290S's reduced bending radius and Passive Bending capability (Fig. 3c). Then after having used a papillotome, we angulated the endoscope tip to cannulate the targeted bile duct using a wire-guided cannulation (WGC) technique for injection of a contrast medium for fluoroscopy of the bile duct. Finally, we performed lithotomy using a basket catheter (TetraCatch V, FG-V436P, Olympus) (Figs. 3d, 3e).

Fig. 3a Before releasing afferent limb's loop (fluoroscopic image)

Fig. 3b After releasing afferent limb's loop (fluoroscopic image)

Fig. 3c Choledochojejunal anastomosis (fluoroscopic image)

Fig. 3d Biliary cannulation by WGC technique using papillotome (endoscopic image)



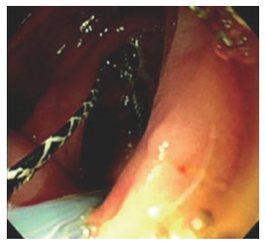


Fig. 3e Stone extraction using basket catheter (endoscopic image)

Preventing accidents

The most significant risk in therapeutic pancreaticobiliary endoscopy using a small balloon enteroscope is accidental damage to lumen and perforation. In consideration of patient comfort and safety, it is important never to perform forcible insertion. Because adhesion is often present in small intestine near pancreaticobiliary anastomosis especially after pancreaticoduodenectomy, neither forcible insertion nor shortening should ever be performed if any resistance is felt while operating the endoscope. It is difficult to precisely predict intestinal adhesions based on preprocedural CT evaluation; therefore, it is critical to pay close attention to what you feel while operating the endoscope, as well as to information obtained from fluoroscopy during insertion. Although this therapeutic technique has proven valuable as a minimally invasive treatment that can replace surgical treatment, it has a high degree of difficulty and should only be performed by endoscopists with extensive experience in endoscope operation who are thoroughly familiar with therapeutic pancreaticobiliary endoscopy and treatment devices.