Techniques in
Gastrointestinal
Endoscopy

Therapeutic Possibilities with DBE: A Focus on Accessories

Christian Schäfer, MD, and Eduard F. Stange, MD

Double balloon enteroscopy (DBE) allows the diagnosis and therapy of small-bowel lesions. Here, we present a spectrum of accessories that are needed to perform various treatment modalities, such as coagulation of angiodysplasias, polypectomy, mucosectomy, and dilation. The placement of metal stents in malignant stenoses has been reported in case reports. In addition, DBE may provide access to the hepatobiliary system in patients with a Roux-en-Y anastomosis. For this situation, specialized equipment has been developed to perform sphincterotomy, stone extraction, dilation of stenoses, and insertion of small-diameter plastic stents.
Tech Gastrointest Endosc 10:70-76 **© 2008 Elsevier Inc. All rights reserved.**

KEYWORDS double-balloon enteroscopy, snare, argon plasma coagulation, polypectomy, mucosectomy, dilation, ERCP, stent

There is an increasing market for accessory diagnostic and therapeutic products that can be used in double balloon enteroscopy (DBE).[1-8] Several factors make it challenging for manufacturers to design appropriate tools and for endoscopists to achieve their diagnostic or therapeutic goal, including (a) length and narrow diameter of the working channel, (b) small bowel anatomy (thin wall, narrow lumen), and (c) difficult access of distant lesions requiring reliable and safe procedures. The following review deals with the most important DBE tools. However, it does not lay claim to provide a complete list of all products available. In addition, it may be expected that several companies develop interchangeable types of accessories in the near future. In case a product is not available, it may be justified to ask local providers to tailor a device for the purpose needed.

Devices for Treating Small Bowel Pathology (Table 1)

Hemostasis

Argon plasma coagulation (APC)

Small bleeding lesions, such as angiodysplasias or minor ulcers, may be treated by local heat application. Both available enteroscopes (Fujinon), the EN-450P5 with a 2.2-mm working channel and the EN-450T5 with a 2.8-mm channel, allow the use of a specially developed argon plasma probe (Fig. 1). To facilitate advancement of this probe, particularly through the diagnostic enteroscope (P5), we use medium chain triglycerides (MCT) as a lubricant.

In our experience, it may be advisable to treat small angiodysplasias during the insertion of the scope in the yet untouched small bowel, since during retraction minor iatrogenic lesions caused by propulsion of the instrument are difficult to differentiate from genuine hemorrhagic lesions.

Because the wall of the small bowel is quite thin and perforations may occur,[1,9] low-level coagulation settings should be chosen to produce coagulation confined to the superficial layers. For the choice of mode and the power settings, it is advisable to adhere to the manufacturer's recommendations. For example, using the ERBE Vio APC 2 generator it is recommended to use either the "Precise" mode (effect "E4" or "E5"), which allows a constant depth of coagulation within a range of 1 to 5 mm distance between the probe and the small bowel wall, or the "Pulsed" mode or "Forced" mode at 20 W to 30 W. The "Pulsed" APC (effect 1 or 2) is particularly useful in patients with multiple angiodysplasias, because it causes reliable ignition at a distance up to 5 mm. As in APC of the right colon, the tip of the APC probe should not touch the bowel wall, because gas blebs or even perforations may occur, and the application duration should be confined to a maximum of 1 to 2 sec.

Injection Therapy

In lesions with ongoing bleeding activity, such as Dieulafoy lesions or bleeding ulcerations, APC is generally insufficient. In this situation, injection therapy may be indicated. Using a single-channel injection needle, either diluted epinephrine (we generally use an amount no higher than 3 mL at a dilution of 1:20,000 to avoid major ischemia) and/or fibrin glue may be applied. Before injecting fibrin glue, the correct in-

Department of Gastroenterology, Robert Bosch Krankenhaus, Stuttgart, Germany.
Address reprint requests to Christian Schäfer, MD, Robert-Bosch-Krankenhaus, Auerbachstr. 110, 70376 Stuttgart, Germany. E-mail: christian.schaefer@rbk.de

 1096-2883/08/$-see front matter © 2008 Elsevier Inc. All rights reserved.
doi:10.1016/j.tgie.2007.12.006

Table 1 Accessories for Treating Small Bowel Pathology

Procedure/Type of Accessory	Company, Article No.	Usable for Channel Size: 2.2 mm EN-450P5	Usable for Channel Size: 2.8 mm EN-450T5
1. Hemostasis			
Argon coagulation probes	eg, ERBE 20132-212	x	x
	eg, ERBE 20132-166		x
	or ERBE 20132-179 (multiple use)		
Lubricant	Fresenius Kabi MCT oil	x	x
Injection needle	Fujinon F2EZTV1805250HP-S		
	Medwork 500753	x	x
Epinephrine	1:20,000 dilution	x	x
Fibrin glue	Various providers	x	x
Metal clip	Boston Scientific Resolution Clip 22612		x
	Olympus Quick Clip HX-201UR-135		
Hot biopsy forceps	Fujinon F6HOPK2304250X		x
2. Polypectomy			
Snares	Recommendation: Ø15 mm, eg:	x	x
	- Fujinon F4E0PK1815250MP-S		
	- MTW S052011212		
	Combined Ø 15 mm/Ø 30 mm:		
	- Medwork 501844		
Retrieval basket	Fujinon ROT-E45-25-350-EIN	x	x
Polyp retriever	Fujinon F7GZEW1835250C-S	x	x
	Medwork 500618		
3. Treatment of stenoses			
Stepwise inflatable balloons	Boston Scientific CRE TTS balloons 6-8 mm (No. 5845), 8-10 mm (No. 5846), 10-12 mm (No. 5847), 12-15 mm (No. 5848)		x
Guidewire	Fujinon F3LQPK 0850650X-S (650 cm)	x	x
4. Retrieval of foreign bodies			
Snares	See polypectomy	x	x
Metal basket	Fujinon F1NSEW1825250Z-S	x	x
5. Tattooing			
Injection needle	Fujinon F2EZTV1805250HP-S		
	Medwork 500753	x	x
Sterile ink	Spot Ink, GI Supply	x	x

tramural position of the needle tip should be confirmed. Injection of fibrin glue may be challenging, since only single-lumen injection needles can be used. In this case, we first flush the needle with saline, followed by the first component, then gently rinse with another portion 2 mL of saline while leaving the needle tip in the wall, and finally apply the second component, followed by a third portion of saline. The different components should be applied steadily and not too fast, because rapid injection may cause interaction of the two components and premature occlusion of the needle.

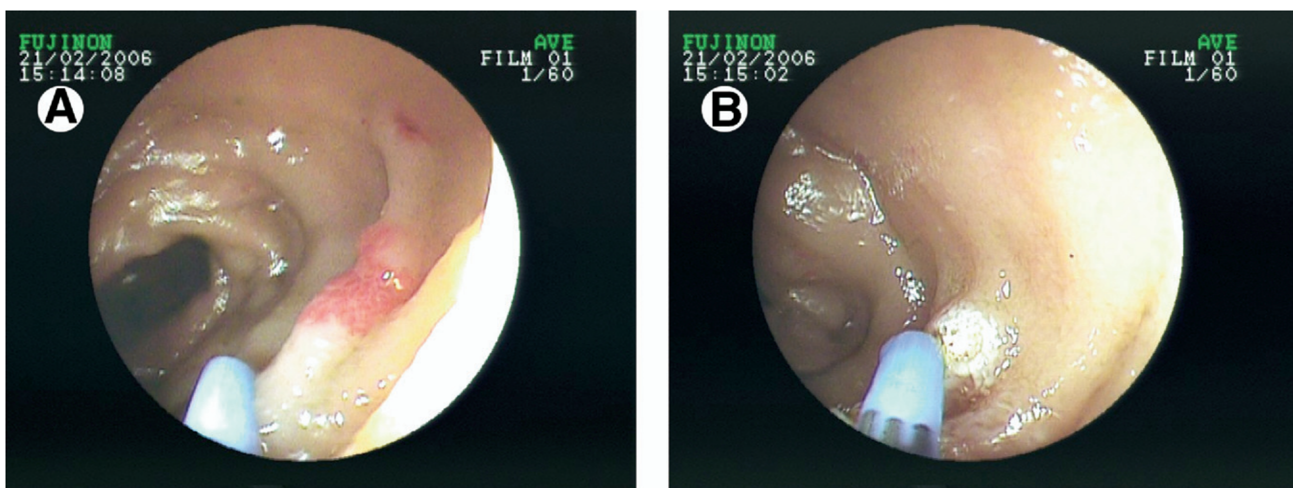

Figure 1 Application of argon plasma coagulation in a patient with multiple angiodysplasias. (A) Before coagulation. (B) After coagulation. (Color version of figure is available at www.techgiendoscopy.com.)

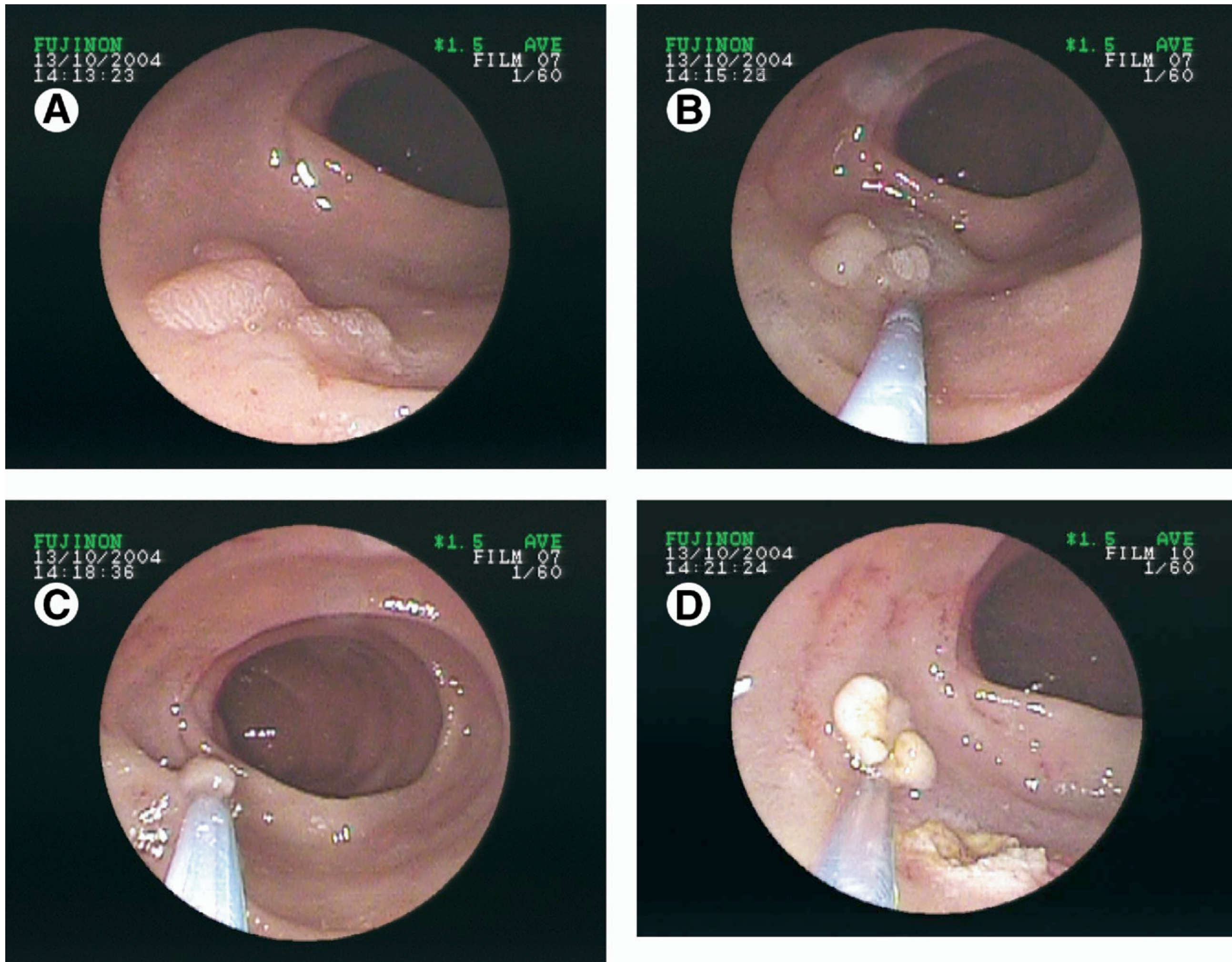

Figure 2 Removal of a flat adenoma in the jejunum. (A) Native polyp. (B) Injection of 3 mL of diluted epinephrine. (C) Snare in position. (D) After diathermic removal.

Endoscopic Clips

So far, there are no endoscopic clips for the diagnostic enteroscope (EN-450P5). However, for the therapeutic instruments, metal clips can be used. The (theoretical) advantage of the Resolution clip system (Boston Scientific, Natick, MA) is the possibility of repositioning and the width of the branches, which even allows the closure of minor perforations.

Heat Coagulation: Hot Biopsy Forceps

Some examiners use hot biopsy forceps to coagulate a bleeding vessel, eg, after polypectomy. Because of the risk of perforation, the duration and the dose of heat application should be kept at a minimum.

Polypectomy and Mucosectomy

Polypectomy in the small bowel is associated with an elevated risk of perforation.[9,10] As in upper GI and colon endoscopy, submucosal injection of a small amount of saline elevates the polyp from the lamina muscularis propria and, thereby, increases the safety margin (Fig. 2). Again, the power settings of the generator should be chosen as low as possible. In particular, the coagulation component should be kept to a minimum. Using the ERBE Vio 2 generator, it is recommended to use "Endo Cut Q" at "Effect 1" (or at most "Effect 2"), because higher "Effects" (≥3) may produce more in-depth coagulation which may result in direct or delayed perforation. If bleeding occurs, one might gently touch the bleeding lesion with the tip of the loop and coagulate (mode: "forced coagulation," Effect 2, 60 W), or use a hot biopsy forceps. Alternatively, diluted epinephrine may be injected.

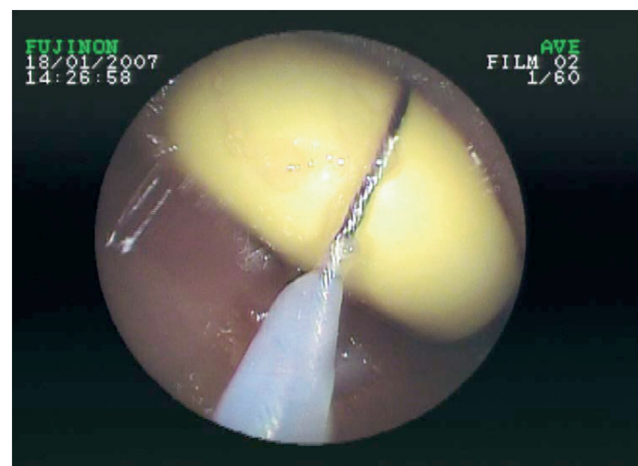

Figure 3 Extraction of a retained video capsule using a polypectomy snare. (Color version of figure is available at www.techgiendoscopy.com.)

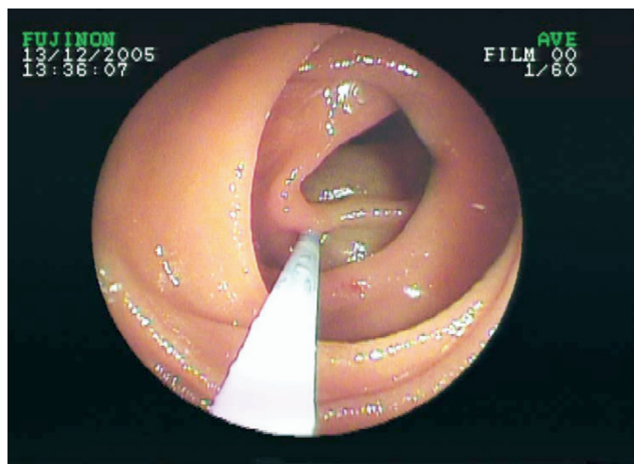

Figure 4 Application of a submucosal tattoo. Before ink injection, the correct position of the needle tip in the submucosa was ascertained. (Color version of figure is available at www.techgiendoscopy.com.)

Companies offer a variety of snares of different sizes (Table 1). Usually, a diameter of 10 to 15 mm is adequate. If polypectomy in a single piece seems too risky, large broad-based polyps or flat lesions can be removed using the piecemeal technique with a smaller snare. One company offers a snare with a special shape which can grasp smaller (15 mm diameter) and larger (30 mm diameter) areas.

The resected specimens may be captured with the snare itself, or, more elegantly, with a net-shaped basket. Resecting multiple polyps, as eg, in Peutz-Jeghers syndrome, is challenging and time-consuming. In this case, one might start with the resection of the most distant polyp, which can be retrieved by catching the polyp in the basket or loop and pulling the scope with its balloon deflated through the fixed overtube. After removing the distal balloon, the enteroscope can be reinserted and the other polyps may be subsequently removed.

Treatment of Enteral Stenoses

DBE, for the first time, provides access to enteral stenoses and the treatment option of balloon dilation. The most favorable indications are short stenoses, eg, in Crohn's disease or NSAID-induced scars. Malignant stenoses which cannot be treated by surgical resection may be dilated as well.[1,11-13]

Dilations with through-the-scope balloons require the therapeutic enteroscope with a 2.8-mm working channel. In difficult anatomical situations, eg, angulated small bowel loops, it may be advisable to delineate the position of the stenosis by fluoroscopy using water-soluble contrast which may be applied via a ERC catheter or, if the channel is occupied by another tool, even via the overtube. The balloon may then be placed into the stenosis, and dilated at least to the diameter of the enteroscope which may be passed beyond the stenosis.[1,11-13] Even three or more stenoses can be successfully dilated, as we could show in a patient with Crohn's disease who had already undergone multiple bowel resections.[2] In this patient, we were able to re-establish the passage to the colon.

Whether wider diameters (>12 mm) should be chosen must be judged individually while keeping in mind the risk of perforation.[1,11-13] With forceful advancement, while slightly going to and fro, one will eventually succeed in pushing the balloon out of the distal tip, even in a curved and unfavorable position of the distal end.[1,11,13]

Using the diagnostic enteroscope with a narrow channel, the dilation may be performed using a different technique, as has already been described in the original DBE paper by Yamamoto and coworkers.[11] A long flexible guidewire (0.035 inches, 650 cm) is introduced through the enteroscope and placed with its tip beyond the stenosis. The enteroscope is removed while leaving the guidewire and the overtube in place, and the balloon system is advanced to the stenosis where the dilation is performed under fluoroscopic observation. Subsequently, the endoscope may be reintroduced to document the success of the procedure.

Table 2 Tools for Double-Balloon ERCP

Procedure/Type of Accessory	Company, Article No.	Usable for Channel Size: 2.2 mm EN-450P5	Usable for Channel Size: 2.8 mm EN-450T5
ERCP catheter	Fujinon F3CTPK1810250M Medwork 501856	x	x
Guidewire	500 cm, Ø 0.021 inch: Medwork 501911	x	x
Guidewire	650 cm, Ø 0.035 inch: Fujinon F3LQPK 0850650X-S	x	x
Sphincterotome	Fujinon F3QTEW1830250-S	x	x
Precut sphincterotome	Fujinon F3QYEW1802250Z-S	x	x
B II sphincterotome	Medwork 501902	x	x
Basket 20 mm	Medwork 500025	x	x
Basket 25 mm	Fujinon F1NSEW1825250Z-S	x	x
Basket 25 mm (may be used for external emergency lithotripsy)	Medwork 501904		x
Inflatable balloons (via guidewire)	See Table 1		
Stent	7-Fr Stents, eg, Geenen (Wilson Cook) Pusher for 7-Fr Stents: Fujinon FPU7270, length 270 cm		x

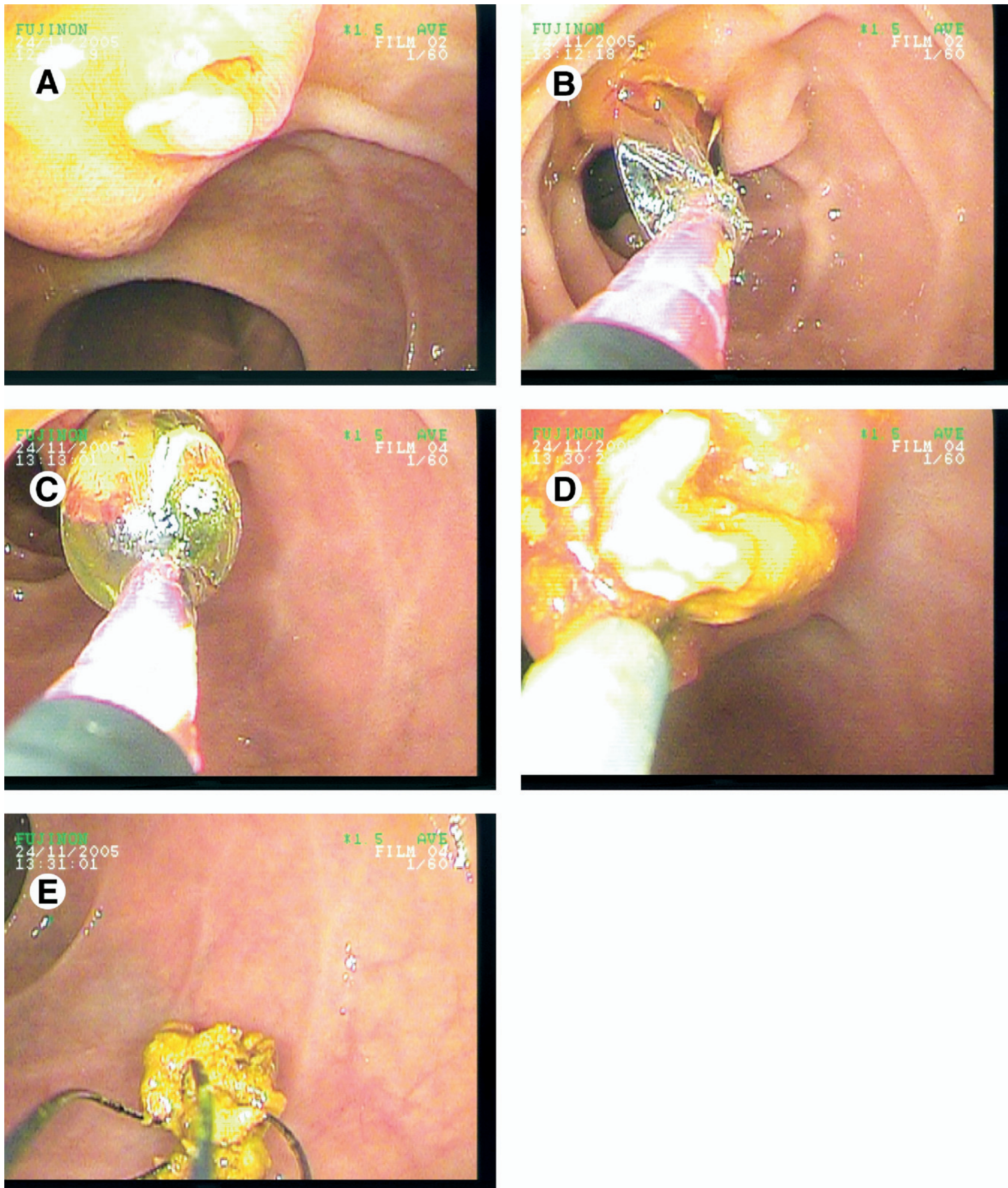

Figure 5 Double-balloon-guided ERC with sphincterotomy in a patient with who had previously undergone gastrectomy with Roux-en-Y anastomosis. (A) Native papilla of Vater. (B, C) Enlargement of the 2-mm cut by balloon dilation. (D, E) Extraction of stones. (Color version of figure is available at www.techgiendoscopy.com.)

The endoscope removal method may also be used to insert a stent introducer through the overtube and, thus, place a self-expandible metal stent (eg, Enteral Wallstent) into an enteral stenosis, as has been performed recently (A. Taylor, personal communication).[13,14] In our view, stenting of enteral stenoses is strictly reserved to inoperable patients with small bowel malignancy. The possibility of treatment failures (eg, stent dislocation) must be kept in mind. Also, despite technical success, more distal stenoses might cause occlusion and should be excluded before considering this procedure.

Retrieval of Foreign Bodies

Foreign bodies, such as video capsules that have been retained because of an unexpected stenosis, can be re-

trieved by DBE (Fig. 3). The foreign body may be grasped by a basket or a snare which can be applied in both types of enteroscopes.[15]

Tattooing

Pathologic findings, such as tumors that cannot be removed by standard polypectomy or endoscopic mucosal resection, may be marked for subsequent operative resection by injecting sterile ink into the submucosal layer (Fig. 4). It is advisable to ascertain that the needle tip is positioned correctly in the submucosa to avoid the peritoneal cavity being contaminated by transmural ink application. To achieve this, a small quantity of saline should be injected submucosally at first. Once lifting of the mucosa indicates the intramural position of the needle tip, the whole volume of ink (we use 5 mL per injection) can be securely applied. If no submucosal cushion appears, the injection should be repeated at another site.

Equipment for Double Balloon ERCP (Table 2)

In patients with a B II stomach or a Roux-en-Y anastomosis, DBE may be performed to gain access to the biliary, and in some instances also the pancreatic duct system.[16-20] Imaging of the duct system can be performed using the DBE-ERC catheter. For sphincterotomy via afferent BII or Roux-en-Y loop, one may use a standard sphincterotome or a precut sphincterotome. An interesting alternative is the B II sphincterotome with an upwardly bulging cutting wire, which enables a straight incision of the roof of the papilla. If possible, the therapeutic tools should be positioned along a guidewire, which needs to be long enough to allow exchange (ie, more than twice the length of the accessory). If the direction of the sphincterotomy does not follow the desired direction, ie, through the roof of the papilla of Vater, the opening may be enlarged using CRE balloons, as shown in Figure 5.

For stone extraction, baskets with a diameter up to 25 mm are available. There is a basket on the market that can also be used for mechanical emergency lithotripsy.

In patients with hepaticojejunostomy, it may be warranted to perform a dilation of the anastomosis.[16] In one patient with a fibrotic stenosis of the anastomosis, we have successfully used 6-mm Ø (maximum 8 mm Ø) balloons. Sphincterotomy, to our knowledge, has also been used to treat stenotic surgical hepatojejunostomies, but in our view, this should be avoided, since it may be associated with an increased risk of perforation.

Through the working channel of the therapeutic scope (EN-450T), it is possible to advance low diameter stents (such as 7-Fr Geenan stents) to overcome bile duct stenoses. Wider plastic or metal stents, however, must be introduced over a guidewire after removing the scope.

Perspective

The rapid development of new devices and technologies has opened a fascinating array of treatment options for small bowel problems. One of the major obstacles in therapeutic DBE—the narrow diameter of the working channel—will be overcome in the near future, since the company will market enteroscopes with a wider working channel (ie, 2.8 mm for the diagnostic and 3.2 mm for the therapeutic instrument). An interesting future adjunct in DBE is the possibility of using CO_2 instead of air for inflating the bowel lumen (eg, CO_2Efficient endoscopic insufflator, E-Z-EM Inc.). Since CO_2 is absorbed more quickly, distension of the small bowel is reduced, which is thought to allow deeper insertion of the enteroscope and to minimize patient discomfort. The clinical efficacy of this device is currently under investigation.

Acknowledgments

We thank Andrea Wurster, RN, for valuable information, and Andrew D. Taylor, MD (Melbourne, Australia), for helpful discussion.

References

1. May A, Nachbar L, Pohl J, et al: Endoscopic interventions in the small bowel using double balloon enteroscopy: feasibility and limitations. Am J Gastroenterol 102:527-533, 2007
2. Schäfer C, Rothfuss K, Kreichgauer HP, et al: Efficacy of double-balloon enteroscopy in the evaluation and treatment of bleeding and non-bleeding small-bowel disease. Z Gastroenterol 45:237-243, 2007
3. Heine GD, Hadithi M, Groenen MJ, et al: Double-balloon enteroscopy: indications, diagnostic yield, and complications in a series of 275 patients with suspected small-bowel disease. Endoscopy 38:42-48, 2006
4. Ell C, May A, Nachbar L, et al: Push-and-pull enteroscopy in the small bowel using the double-balloon technique: results of a prospective European multicenter study. Endoscopy 37:613-616, 2005
5. Mönkemüller K, Weigt J, Treiber G, et al: Diagnostic and therapeutic impact of double-balloon enteroscopy. Endoscopy 38:67-72, 2006
6. Di Caro S, May A, Heine DGN, et al: The European experience with double-balloon enteroscopy: indications, methodology, safety and clinical impact. Gastrointest Endosc 62:545-550, 2006
7. May A, Nachbar L, Ell C: Push-and-pull enteroscopy using a single-balloon technique for difficult colonoscopy. Endoscopy 38:395-398, 2006
8. Zhong J, Ma T, Zhang C, et al: A retrospective study of the application on double-balloon enteroscopy in 378 patients with suspected small-bowel diseases. Endoscopy 39:208-215, 2007
9. Mensink PBF, Haringsma1 J, Kucharzik T, et al: Complications of double balloon enteroscopy: a multicenter survey. Endoscopy 39:613-615, 2007
10. Möschler O, May A, Müller MK, et al: Ergebnisse eines deutschlandweiten Registers für die Doppelballonenteroskopie. Z Gastroenterol 44:849 (abstract P412), 2005
11. Yamamoto H, Kita H, Sunada K, et al: Clinical outcomes of double-balloon endoscopy for the diagnosis and treatment of small-intestinal diseases. Clinical Gastroenterol Hepatol 2:1010-1016, 2004
12. Sun B, Shen R, Cheng S, et al: The role of double-balloon enteroscopy in diagnosis and management of incomplete small-bowel obstruction. Endoscopy 39:511-515, 2007
13. Kita H, Yamamoto H, Yano T, et al: Double-balloon endoscopy in two-hundred fifty cases for the diagnosis and treatment of small intestinal disorders. Inflammopharmacology 15:1-4, 2007
14. Ross AS, Semrad C, Waxman I, et al: Enteral stent placement by double balloon enteroscopy for palliation of malignant small bowel obstruction. Gastrointest Endosc 64:835-837, 2006
15. Miehlke S, Tausche AK, Brückner S, et al: Retrieval of two retained endoscopy capsules with retrograde double-balloon enteroscopy in a patient with a history of complicated small-bowel disease. Endoscopy 39:E157, 2007 (abstract)
16. Haruta H, Yamamoto H, Mizuta K, et al: A case of successful enteroscopic balloon dilation for late anastomotic stricture of choledochojejunostomy after living donor liver transplantation. Liver Transpl 11: 1608-1610, 2005
17. Moreels TG, Roth B, Vandervliet EJ, et al: The use of the double-balloon enteroscope for endoscopic retrograde cholangiopancreatography and

biliary stent placement after Roux-en-Y hepaticojejunostomy. Endoscopy 39:E196-E197, 2007 (abstract)
18. Chu YC, Yeh YH, Yang CC, et al: A new indication for double-balloon enteroscopy: removal of migrated metal stents through a Roux-en-Y anastomosis. Endoscopy 39:E148, 2007 (abstract)
19. Bellutti M, Mönkemüller K, Fry LC, et al: ERCP mit dem Doppelballonenteroskop bei Patienten mit Roux-en-Y Anastomose. Z Gastroenterol 44:651, 2007
20. Spahn TW, Grosse-Thie W, Spies P, et al: Treatment of choledocolithiasis following Roux-en Y hepaticojejunostomy using double-balloon endoscopy. Digestion 75:20-21, 2007