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COMMENTARY

Advances and applications of enteroscopy for small bowel

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INTRODUCTION

Visual inspection of the entire small intestine is difficult and time-consuming, due to its anatomical location. While the usual techniques of endoscopy facilitate visualization of the most proximal and distal ends of the gut, only limited views of the terminal ileum (only about 5 cm to 25 cm) can be obtained by intubation of the ileocecal valve after total colonoscopy. The proximal jejunal mucosa (20 cm to 50 cm) can be inspected by standard colonoscopy or use of related modified instrumentation. Therefore, investigation of this region is dependent upon enteroclysis and angiography. The diagnostic efficacy of these procedures, however, is relatively low, and confirmative diagnosis has frequently been made only after laparotomy. Achievement of successful endoscopy for other parts of the gastrointestinal tract has allowed for further improvements to the enteroscopy technique. Since the 1970s, vigorous efforts have been made to produce three types of enteroscopes, namely the push type, sonde type, and ropeway type. The recent development of video endoscopes, including a new prototype video enteroscope for small bowel, has benefited clinical practice. In this paper, we describe the recent advances in enteroscopy, including its devices and applications.

ENTEROSCOPE INSERTION TECHNIQUE FOR THE DIFFERENT DEVICE TYPES

Push type enteroscope[1-4]

Push type enteroscopes, such as the SIF-RP, SIF-B and SIF-10, are long forward-viewing fiberscope devices. At present, SIF-10 is the most widely used for examination of the upper small intestine[1-5]. The insertion technique for the push type enteroscopes can be described as follows: The patient should fast for at least for 12 h prior to the procedure. On the procedure day, a local anesthesia (such as lidocaine) is sprayed over the patient's pharynx. The patient is placed on the fluoroscopic table in the left lateral decubitus position. The enteroscope is swiftly introduced into the duodenum, with minimal distention of the stomach. As the instrument is advanced, the patient is moved into various positions to assist in endoscope passage; meanwhile, abdominal pressure helps to minimize or prevent loop formation in the stomach and, simultaneously, withdrawal of the enteroscope can also straighten the formed loop and allow for paradoxical advancement of the instrument tip. When the entire length of the insertion tube is passed, glucagon (1.0 mg) should be administered to inhibit peristalsis. Full insufflation of the bowel with air reduces the height of the intestinal folds. The endoscope may be withdrawn slowly as the bowel is carefully inspected. Usually, endoscopists are able to advance the instrument to an average depth of 35 cm to 60 cm beyond the ligament of Treitz with a mean 50 min procedure time; biopsy is also possible at this step. However, the extent of insertion is limited to the proximal jejunum at 20 cm to 60 cm due to the crooked nature of the duodenum, which is embedded in the retroperitoneum and which makes the transmission of propelling force difficult. As a result, a large loop tends to form in the stomach, consuming the effective length of the scope. In order to overcome this problem, the new push type enteroscope SIF-10L was developed. This type of scope is equipped with a stiffening tube that is specially made as an auxiliary device. Shimizu *et al*[6] described the insertion technique for the SIF-10L. When the scope is advanced to the duodenojejunal junction and its position has been confirmed by fluoroscopy, the distal tip is maximally flexed for fixation at the duodenojejunal junction and the scope can be pulled until it is straight from the descending portion of the duodenum. After that, the stiffening tube, which was lubricated prior to the procedure, is gently advanced over the shaft into the descending portion of the duodenum. When the insertion of the sliding tube is completed, it is fixed on the mouthpiece by the stopper to protect against its being pulled out. The scope is then pushed into the deeper part of the jejunum with concurrent observation of the intestinal lumen. When the maximal working length is achieved, the distal tip is again fixed and the sliding tube is gently advanced beyond the duodenojejunal junction to prevent loop formation in the horizontal portion of the duodenum. The passage of the stiffening tube is observed by fluoroscopy. At this point, the scope is again advanced to its full working length. Insertion extent is determined by measuring the length of the scope from the distal end of the sliding tube, with measurements made on an X-ray film. It has been reported that the time for insertion can range from 7 min to 30 min, with a mean of 11.7 min and the range of observable length being 60 cm to 120 cm from the distal end of the stiffening tube which could be inserted beyond the duodenojejunal junction, at a mean insertion length of 105.8 ± 17.5 cm. By introducing the stiffening tube as an auxiliary device, the insertion extent can be increased remarkably.

Sonde type enteroscope

Several types of sonde scopes are currently available and in clinical use[7-11]. The sonde type small intestinal fiberscope (SSIF-VII) is one among the series of prototype fiberscopes; its features include a 5 mm diameter, 2790 mm length, forward-viewing capacity and 90-degree angle view. It can be passed transnasally and migrates distally, responding to peristaltic activity. The essential step of the procedure is a technique called "piggy backing" in which a long endoscope is introduced into the stomach carrying the enteroscope through the pylorus and beyond the ligament of Treitz, which is facilitated by grasping with forceps and pulling into place. The balloon at the tip of the instrument advances the enteroscope in the small bowel when the endoscope is removed. Metoclopramide is then administered to stimulate small bowel motility. Mucosal inspection is performed when the scope has reached the distal ileum. Glucagon is administered to arrest small bowel activity. The whole procedure lasts 3-8 h, with an average duration of 4.3-6 h[7-9]. However, it is estimated that only approximately 50% of the lumen view is visible during the controlled withdrawal due to the absence of tip deflection, the relatively small angle of view, and occasional rapid withdrawal of the instrument through loops of small intestine or migration to the colon. The another disadvantage of this scope and its application technique is that biopsy is impossible. The newest sonde type enteroscope (SSIF-type 10) that has been developed features a 2 mm biopsy channel, which makes target biopsy possible even in distal parts of the small intestine[9-10]. Finally, a new prototype video enteroscope (ESI-2000, Pentax) has been developed and successfully applied in clinic[11-13].

Ropeway type enteroscope[15-19]

Several types of ropeway enteroscopes, such as FIS-II, SIE-RP and SIE-2C, are currently available. The key step for application of the ropeway enteroscopes, during the examination, is insertion of a long intestinal teflon string that is advanced perorally and discharged from the anus. Completion of this step, however, may require at least 24 h. Once this step is finished, the ropeway enteroscope can be pulled through the gastrointestinal tract with the aid of the Teflon string relatively quickly (within 10 min). Observation and biopsy throughout the entire intestine are possible. Use of this method causes the intestine to shorten, like an accordion, which precludes complete observation; moreover, stenotic and diffuse lesions in the small bowel disallow free passage of the string and limit the effectiveness of this device. Finally, excessive traction on the string augments the risk of instrument-induced perforation. From a physical standpoint, this procedure may cause discomfort to the patient and requires general anesthesia. Thus, application of ropeway enteroscope is limited in clinical practice.

APPLICATIONS IN SMALL BOWEL DISEASES

Obscure gastrointestinal bleeding

Obscure gastrointestinal bleeding is a troublesome medical problem. Although a wide range of investigational tools are available to aid clinicians in localizing sites of gastrointestinal blood loss, approximately 5% of the patients with GI bleeding continue to bleed from an unidentified source. In recent years, some authors have reported their experiences in use of small bowel enteroscope for detecting the source and cause of obscure bleeding. For nearly 26%-77% of those patients, correct diagnosis or identification of the site of occult bleeding was achieved[2,20-22]. Moreover, these results indicated that the following specific lesions could cause obscure bleeding: arteriovenous malformations (AVMs), hemangiomas, Meckel's diverticulum, jejunal diverticulum, jejunal leiomyoma, leiomyosarcoma, ulcerative jejunitis, Peutz-Jeghers syndrome, and Crohn's disease. Of the known causes of obscure gastrointestinal bleeding, AVMs appear to be the most common source. Lewis and Waye[7] employed the SSIF-VII sonde type enteroscope to investigate the cause of chronic gastrointestinal obscure bleeding in 60 patients and found that 33% (n = 20) had blood loss within the small bowel, with 80% (n = 16) of those being caused by AVMs and 15% (n = 3) by ulcers; for only 1 of the 20 patients with small bowel blood loss was the bleeding foci not found, despite the presence of fresh blood. AVMs were limited to the proximal jejunum in 7 patients, distal small intestine in 3 patients, and diffuse small bowel in 6 patients. Foutch *et al*[2] described a group of patients with gastrointestinal bleeding of obscure origin and reported finding a definite cause of bleeding for 15 cases by using the push type enteroscope, 12 of which were diagnosed as AVMs. Similar results reported by another group support the general finding that AVMs are the main cause of obscure gastrointestinal bleeding[20].

Detection of small bowel tumor

Small bowel tumors are difficult to detect using conventional diagnostic techniques. Imaging examinations, such as barium X-ray, ultrasonography and angiography, often produce false negative test results, which can reportedly delay diagnosis for 12 mo or more in nearly one-quarter of patients with primary small bowel neoplasms[23]. At present, enteroscopy is considered to play a precise role in the diagnosis of small bowel disease. Kawai and colleagues published their 11-year experience of detecting and identifying lesions using three types of enteroscope[16], in which a total of 19 lesions were detected and identified as cancer (n = 3), malignant lymphoma (n = 5), leiomyosarcoma (n = 1), leiomyoma (n = 5), hemangiopericytoma (n = 1) and Peutz-Jeghers polyp (n = 5). The authors described the endoscopic appearances of the tumors, which were classified among three types: type Ⅰ, sessile tumor; type Ⅱ, semipedunculated or pedunculated tumor; type Ⅲ, large tumor with central depression. Type Ⅲ was further classified into two subgroups: type Ⅲa, tumors partially encirculating the bowel; type Ⅲb, tumors completely encirculating the bowel. Malignant tumors showed various appearance ranging from type Ⅱ to type Ⅲb, but benign tumors never showed type Ⅲb. Shinya and Mc Sherry[19] also presented their experience with push type and sonde type enteroscopes, and reported that among the 3 cases total 2 were diagnosed as duodenal adenocarcinoma and one as a jejunal hemangiolymphangioma.

Application in familial adenomatosis coli (FAC)

Upper gastrointestinal lesions have been considered rare in patients with FAC or Gardner's syndrome, although recent studies have indicated that FAC and Gardner's syndrome are the same disease and affect the upper as well as the lower gastrointestinal tract[24-26]. Iida *et al*[25] used the push type enteroscope and found that jejunal polypoid lesions were detected in 9 of 10 patients (90%) with FAC or Gardner's syndrome. The lesions were located in the upper jejunum, particularly within about 20 cm below the duodenojejunal junction. The number of polyps varied from 1 to 20, and their sizes were 3 mm or less in diameter. Endoscopically, the polypoid lesions appeared sessile and whitish. Histologic findings of the lesion biopsy specimens revealed a tubular adenoma with mild to moderate epithelial atypia in all 9 cases. Other authors reported 3 cases of jejunal carcinoma in patients with FAC/Gardner's syndrome[28,29]. However, such a situation is quite rare, since the jejunal lesions are usually very small, asymptomatic, and adenomatous in histology. Therefore, as treating physicians we should pay attention to related changes and careful follow-up of patients is needed with endoscopic removal of larger polyps, whenever feasible.

Application in other small bowel diseases

Correct diagnosis of small intestine diseases requires not only intestinal visualization but also biopsy of lesions. Barkin *et al*[4] examined 31 patients with clinically suspected small bowel disease using a PCF-135 flexible pediatric colonoscope perorally and 14 patients were confirmed by biopsy, including celiac disease (n = 5), Whipple's disease (n = 2), lymphoma (n = 1), adenocarcinoma (n

= 1), Crohn's disease (*n* = 1), tropical sprue (*n* = 1), amyloidosis (*n* = 1), enteritis (*n* = 1) and cytomegalovirus infiltration (*n* = 1). Such diseases as Whipple's disease, tropical sprue and amyloidosis could not be diagnosed if biopsies were not available. Tada *et al* examined 15 cases of Crohn's disease using the sonde type enteroscope, and the presence of small intestinal lesions was confirmed in 13 cases, while the small intestine was not involved in the remaining 2. The characteristic findings of Crohn's disease were observed, including longitudinal ulcers, circular ulcers, irregular ulcers, aphthoid ulcers, cobble-stone appearance, inflammatory polyps, pseudo-diverticular formation, and stenosis. The author considered that the enteroscope device was superior to X-ray instrumentation for detecting tiny lesions, and that enteroscopy plays an important role in diagnosis of small bowel disease; further developments and improvements in enteroscopy will support its more widespread use clinically. Different types of enteroscopes have different characteristics, for instance, the push type enteroscope is suitable to detect a lesion on the upper jejunum or obtain a biopsy in the case of a diffusely spreading lesion. The ropeway type enteroscope is helpful for observation of the entire intestine, whereas the sonde type is useful for the examination of emergency cases of gastrointestinal bleeding, in cases of poor general condition, or when a stenosing lesion is located at the distal parts of the small intestine where neither the push type scope nor the ropeway type scope can be introduced. Thus, we can observe small intestinal diseases sufficiently when the suitable enteroscope is employed. However, the questions remain as to how to best utilize the various enteroscopes for pathophysiological research of the small intestine and how to improve the insertion techniques so as to make it easier in technical operation and for patient tolerance.

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