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OBSERVATION

Supportive techniques and devices for endoscopic submucosal dissection of gastric cancer

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Abstract

The indications for endoscopic treatment have expanded in recent years, and relatively intestinal-type mucosal stomach carcinomas with a low potential for metastasis are now often resected *en bloc* by endoscopic submucosal dissection (ESD), even if they measure over 20 mm in size. However, ESD requires complex maneuvers, which entails a long operation time, and is often accompanied by complications such as bleeding and perforation. Many technical developments have been implemented to overcome these complications. The scope, cutting device, hemostasis device, and other supportive devices have been improved. However, even with these innovations, ESD remains a potentially complex procedure. One of the major difficulties is poor visualization of the submucosal layer resulting from the poor countertraction afforded during submucosal dissection. Recently, countertraction devices have been developed. In this paper, we introduce countertraction techniques and devices mainly for gastric cancer.

Key words: Countertraction; Endoscopic submucosal dissection; Gastric cancer

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INTRODUCTION

The incidence of gastric cancer is high in East Asia, Eastern Europe and South America. In Japan, 50 000 people a year die from gastric cancer, so countering gastric cancer is an important mission. Early detection and early treatment are regarded as the most important factors in the treatment strategy. In patients with early gastric cancer (mucosal stomach cancer), endoscopic submucosal dissection (ESD) enables *en-bloc* dissection of larger lesions than that by endoscopic mucosal resection (EMR)[1-3]. *En-bloc* resection allows more accurate pathological diagnosis and reduces the risk of recurrence[3-6].

However, ESD requires complex technical maneuvers and a long operation time. Moreover, complications such as bleeding and perforation occur more frequently with ESD than with EMR[2,3,7]. To overcome these complications, many supportive techniques and devices have been developed.

We classify supportive techniques and devices under the following 3 categories: (1) improvements to the scope [magnifying endoscopy[8-10], the narrow band imaging system[11-13] and the flexible spectral imaging color (FICE) system[14], scopes with a built-in forced irrigation channel[15], and so on]; (2) cutting and hemostasis devices (high frequency generator[16], various knives[17-19], various hemostasis forceps[20], various hemostasis clips and so on); and (3) other supportive devices (local injection agents[21]) and CO_2 insufflations to the alimentary tract[22]). Even with these innovations in place, ESD is still not easy. One of the major difficulties is poor visualization of the submucosal layer resulting from the poor countertraction afforded during submucosal dissection, therefore countertraction devices have been developed in recent years[23-39]. These countertraction devices could be placed in the 4th category in addition to the three outlined above. The focus of this article will be countertraction devices (Table 1).

Table 1 Classification of countertraction devices and methods

Double endoscope methods	Authors	Year
Double endoscopic intralumenal operation (DEILO)	Kuwano *et al*[23]	2004
Thin endoscope-assisted ESD	Uraoka *et al*[25]	2010
Transnasal endoscope-assisted ESD	Ahn *et al*[24]	2010
Countertraction tool attached to the endoscope		
Small-caliber-tip transparent hood	Yamamoto[26]	2003
Double-channel therapeutic endoscope (the "R-scope")	Yonezawa *et al*[29]	2006
Multipurpose treatment hood (TxHood)	Kawano *et al*[28]	2008
Angler fish-type countertraction system	Sakurazawa *et al*[30]	2009
Sheath-assisted countertraction ESD	Hijikata *et al*[27]	2010
Countertraction tool independent of the endoscope		
Percutaneous traction-assisted EMR	Kondo *et al*[31]	2004
Magnetic anchor system	Kobayashi *et al*[33]	2004
External grasping type of forceps	Imaeda *et al*[34]	2006
Internal traction using a nylon loop	Chen *et al*[36]	2007
Percutaneously-assisted endoscopic surgery using a new PEG-minitrocar	von Delius *et al*[32]	2008
Peroral traction-assisted ESD	Jeon *et al*[39]	2009
Spring-assisted ESD	Sakurazawa *et al*[40]	2009
The pulley method ESD	Li *et al*[38]	2010
Medical ring system	Matsumoto *et al*[35]	2011
Clip-band technique	Parra-Blanco *et al*[36]	2011

ESD: Endoscopic submucosal dissection; EMR: Endoscopic mucosal resection.

SUPPORTIVE TECHNIQUES AND DEVICES FOR ESD

Improvements to the scope

Zoom endoscopy magnifies the surface structure of tumors and allows the operator to detect the precise border of the tumor[8-10]. The narrow band imaging system (NBI) selects a spectrum of the emitted illumination to enhance the structure of the blood vessels and the tumor border. By using these systems, a more accurate diagnosis is obtained to avoid unnecessary resection of the lesion to reduce the risk of bleeding and perforation[11-13]. The FICE system is different from the NBI system in that it allows selection of the limited spectrum of the light being reflected from the lesion to enhance detection of the border between the tumor and normal mucosa[14]. The water-jet scope can immediately wash away bleeding during an ESD procedure. With this facility, bleeding points can be precisely identified, and we can stop bleeding more easily[15].

Cutting and hemostasis devices

The new high frequency generator calculates the electrical resistance of the tissue instantly, and changes the current flowing though the electric knife depending on the electrical resistance of the tissue to enhance coagulation thus decreasing bleeding from the area of incision[16].

Various knives (IT knife, Hook knife, and Flex knife) have been developed[17-19], in addition to various hemostasis forceps and hemostasis clips[20]. These innovations now allow us to use the most appropriate knife, hemostasis forceps and hemostasis clips in each scene of ESD.

Other supportive devices and techniques

As a substitute for saline which is used conventionally, a new local injection agent was developed based on hyaluronic acid. Following the use of hyaluronic acid, the mucosal elevation time improved markedly[21]. Because mucosal elevation was stable for a long time, the risk of perforation was reduced. In recent years, CO_2 insufflation has been used for ESD. Because, CO_2 is more quickly absorbed in water than air, even in the event of a perforation-related pneumoperitoneum occurring, the CO_2 is absorbed immediately[22]. This helps to prevent perforation-related pneumoperitoneum compartment syndrome.

Countertraction devices

Various countertraction devices have been developed. We have classified these devices under the following three types: double endoscope methods, countertraction tool attached to the endoscope, countertraction tool independent of the endoscope.

Double endoscope method: This method involves the use of two scopes as two endoscopists are sometimes required, one scope lifts the lesion and the other resects it. The merit of this technique is that the direction and strength of countertraction can be obtained by manipulating the lifting scope. The demerit is that their movements are slightly affected by friction between the two scopes. Kuwano *et al*[23] reported a double endoscopic intralumenal operation. This novel technique is characterized by the use of two endoscopes. One scope lifts the lesion in any desired direction to give clear visualization of the submucosal layer. Because two scopes were inserted together into the stomach *via* the oral cavity, ESD was undertaken under general anesthesia. Ahn *et al*[24] reported transnasal endoscope-assisted ESD, which is a traction method using two scopes. The nasal scope is used as the traction scope. This method reduces friction between the two scopes in the oral cavity. The disadvantages of the procedure include nasal bleeding due to the transnasal access and the requirement for two endoscopists. Uraoka *et al*[25] reported thin endoscope-assisted ESD. The traction was obtained by using a thin endoscope in the large intestine. This system uses the thin endoscope as lifting forceps to obtain traction in the desired direction. Thin endoscope-assisted ESD has been limited to the rectum and rectosigmoid colon due to difficulty in intubating the second endoscope to the oral side of the distal sigmoid colon. The thin endoscope is not stiff enough for deep intubation. Another limitation is the need for a second endoscopist to operate the traction system.

Countertraction tool attached to the endoscope: An advantage of this method is that it uses a single scope, thus the preparations for the device are comparatively simple. Furthermore, it is not difficult for the operator to achieve countertraction, because the countertraction tool is attached to the endoscope. One disadvantage is that the direction and strength of countertraction is affected by the movement of the scope.

Yamamoto *et al*[26] developed an ST hood which is clear and placed on the tip of the scope. The ST hood prevents tissue from adhering to the scope lens to allow clear observation of the cutting line. At the same time, the ST hood opens the cutting line and exerts countertraction in the local area. However, the field of view is limited to a small area. Endoscopic submucosal dissection with sheath-assisted countertraction was reported by Hijikata *et al*[27]. This method uses 2 channel scopes and a sheath which lifts the lesion and exerts countertraction in the cutting area. The sheath uses one channel and the knife uses the other channel. A TxHood was developed by Kawano *et al*[28]. It can include various therapeutic and treatment tools such as an electric needleknife, a snare wire, an injection needle, and a water jet line, and the lines can be selected freely before insertion of an endoscope covered with the TxHood. Using the grasping forceps from the TxHood, the lesion is lifted to make the cutting line clear.

The therapeutic endoscope we use (the "R-scope") was developed by Yonezawa *et al*[29]. This instrument is equipped with a multibending system and has two movable instrument channels: one moves a grasping forceps vertically for lesion countertraction; the other swings a knife horizontally for dissection. We have also employed the angler fish-type countertraction system[30]. This device has a fine spring grasper which works as the fishing rod to lift up the desired lesion.

Countertraction tool independent of the endoscope: The benefit of this approach is that the direction and strength of countertraction is not affected by the movement of the scope because the countertraction tool is independent of the endoscope. Preparations differ greatly for each method, and are associated with both advantages and disadvantages.

Kondo *et al*[31] reported percutaneous traction-assisted EMR which uses a type of forceps which penetrates the abdominal and gastric walls to provide countertraction. With this method it is easy to coordinate the strength and direction of the countertraction. However, there is a risk of pneumoperitoneum and peritonitis. von Delius *et al*[32] reported percutaneously-assisted endoscopic surgery using a new PEG-minitrocar for advanced endoscopic submucosal dissection. The device is inserted using a PEG technique through the skin and stomach wall, and pulls on the lesion. This system seems similar to the above mentioned percutaneous traction-assisted EMR. The magnetic anchor system was reported by Kobayashi *et al*[33]. It requires the use of a magnetic control system. This uses magnetic force and it is able to change the direction and strength of countertraction. However, this system is large and because it depends on the use of magnetic force, it is not appropriate in patients fitted with a pacemaker. The external grasping-type forceps were reported by Imaeda *et al*[34]. These forceps pull the specimen to obtain countertraction. The direction of countertraction is limited, because the countertraction tool can only be used to pull and push the tissue of interest. This type of forceps is used from the outside so it is unlikely to be affected by the movement of the scope. The medical ring system was reported by Matsumoto *et al*[35]. It uses a ring and makes countertraction. This tool is compact and can pass the forceps channel of the scope, and achieves countertraction during local traction of a tumor. The clip-band technique was reported by Parra-Blanco *et al*[36]. This method uses a rubber band to make countertraction. This rubber band was originally used for orthodontic treatment. The author carefully determined the size of the ring in accordance with ESD. This system is easy to prepare and inexpensive. Chen *et al*[37] reported internal traction using a nylon loop that was attached to the tumor edges with hemoclips. The loop anchored by the 2 hemoclips was tightened by pulling the smaller loop with the hot biopsy forceps, and local countertraction is provided by rolling up the tumor. Li[38] reported the pulley method of ESD which can change the direction of the traction by using a pulley in the stomach. The pulley method with standard clips and dental floss was used to provide traction to improve visualization of the dissection plane during ESD. Jeon[39] reported peroral traction-assisted ESD. A thread is inserted orally to pull a lesion to make countertraction. After circumferential mucosal cutting, one hemostatic clip, tied with a white silk suture, was applied at a site of the lesion suitable for oral traction. During submucosal dissection, the applied suture material was pulled to the oral side.

We have introduced and performed spring-assisted ESD in which countertraction is applied with a spring[40]. A spring is introduced into the stomach through the forceps channel. One end of the spring loop is fixed to the tumor with a clip. The loop at the other end of the spring is fixed with a clip to the intact mucosa on the opposite side. The submucosal layer is dissected under adequate countertraction force. Our newly introduced countertraction device can be easily handled by one endoscopist, and shows sufficient effective traction distance in any desired direction without interference by the gastroscope movements. The device was helpful for dissection of the submucosal layer without complications and hemostatic treatment.

CONCLUSION

ESD is a very effective treatment for early gastric cancer, but there are many complications. It is thought that we can reduce complications and treatment time through the use of various innovative devices. We think that the countertraction device will become an important device in the future.

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