The Goals and Pitfalls of Gastric Submucosal Dissection: A Special Focus on Dissection of Lesions with Severe Fibrosis

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Endoscopic submucosal dissection (ESD) has enabled en-bloc resection of superficial gastrointestinal tumors regardless of the size or location of the tumor. However ESD still poses a number of challenges for the experienced endoscopist. These challenges include the adaptation of a demanding technique, the higher incidence of complications, and a longer procedure time compared to standard endoscopic procedures. In this article, we describe the performance of ESD using the Flush Knife technique. We emphasize that the most important factor in the performance of ESD using the Flush Knife technique is maintaining the appropriate depth of dissection. Appropriate dissection of the branched vascular network at the mid-submucosal layer is required to reach the avascular stratum just above the muscle layer. This should be accomplished using the horizontal approach, such that the dissection plane remains as horizontal as possible with respect to the muscle layer. This approach will enable the interventional endoscopist to treat difficult cases with large vessels and severe fibrosis. And at the same time will secure high-quality resected specimens with excellent basal margins so that depth of invasion can be assessed very accurately.

Key Words: Endoscopic submucosal dissection; Quality control dissection; Stomach neoplasms; Gastrointestinal endoscopic resection; Safety procedure

INTRODUCTION

Gastric cancer remains one of the most common cancers worldwide and Helicobacter pylori (Hp) is considered the most important carcinogen in the development of gastric cancer. Recently, Hp eradication has been proposed as a possible primary chemo-preventive strategy to reduce the incidence of gastric cancer. One prospective study showed that the risk of developing gastric cancer remains high, even with successful eradication of Hp.\textsuperscript{1} Therefore patients require endoscopic follow-up even after having undergone Hp eradication. Endoscopy plays an important role in the diagnosis and therapy of gastric cancer. The diagnostic ability of upper endoscopy has been greatly enhanced by technologies such as narrow band imaging (NBI), autofluorescence imaging (AFI) and magnification endoscopy.\textsuperscript{2,3} Advances in therapeutic endoscopy has allowed interventional endoscopist to resect lesions in an en-bloc fashion when endoscopic mucosal resection (EMR) is not desirable or not feasible due to the large size of a lesion or the presence of significant sub-mucosal fibrosis. The en-bloc resection rate using EMR is reported to be successful in only 40-50\% of cases.\textsuperscript{4-7} The requirement to increase the en-bloc resection rate is the main reason that endoscopic submucosal dissection (ESD) was introduced about 15 years ago. ESD is a blend of basic surgical principles and advanced endoscopic techniques utilizing various endo-knives to perform a complete circumferential mucosal incision and submucosal dissection under direct vision. ESD is an innovative method which can enable endoscopic en bloc resection regardless of size, location, and shape of lesion. In addition to this important therapeutic benefit, ESD also provides a diagnostic dimension. The high rate of en-bloc resection provides physicians with precise histopathological information for both lateral and vertical margins, depth of tumor extension, degree of tumor differentiation and the presence of lymphovascular infiltration which is directly related to the risk of lymph node
metastasis. The benefits of ESD must be weighed against the technical difficulties, higher incidence of complications, and longer procedure time. Recently, complications of ESD have been decreasing by use of improved medical devices, high performance electrosurgical units and the increasing experience of experts. As the indications for ESD expand to esophageal and colorectal lesions, greater demand is being placed on interventional endoscopist to perform safe and efficient en-bloc resections. Technical errors while performing ESD procedures can lead to potentially serious complications. It is the purpose of this article to describe how to perform safe ESD and at the same time to obtain high quality en-bloc specimens in a consistent manner.

**ENDO-KNIVES**

There have been a number of recent developments in medical devices that are utilized for ESD. In order to conduct successful ESD it is important to recognize the characteristics of these devices. We have divided the devices into three classes and describe their major characteristics below.

1. **Short needle type**

1) Flush Knife ball tip (BT) (Fig. 1)

The Flush Knife BT (DK-2618JN; FTS, Tokyo, Japan) as its name applies allows for flushing of fluids onto the operative field during ESD as well as providing ongoing sub-mucosal injections to keep the lesion raised off the muscle layer. The Flush Knife is not designed to perform the initial submucosal injection to begin the circumferential incision. That is done with a 25 gauge high-flow injection needle. After making the initial opening in the mucosa with the Flush Knife, the circumferential incision is made in very controlled and staccato fashion. The nature of the catheter and the circular gray shoulder of the tip of the catheter will allow for this. Bleeding can be washed away keeping the field clear and allowing you to coagulate as needed. Once the lesion has been opened somewhat you can use the flush capabilities of the device to perform ongoing sub-mucosal injection. The circumferential incision is usually made using the Endocut Mode and the dissection is usually done with Forced or Swift Coagulation. The Flush Knife has an accompanying foot pedal operated pump for flushing saline or can be used with manual flushing via a syringe.

2. **Insulated Tip (IT) Knife**

The IT Knife (KD-610 L, KD-611 L; Olympus, Tokyo, Japan) allows the operator to apply electrocautery to the target lesion without the risk of the needle tip causing perforation as it is insulated with a ceramic tip.

The IT Knife is very useful in the stomach when making a circumferential incision. Special expertise is required using the long blade of the IT Knife. In experienced hands, the IT Knife will allow for faster dissections in the stomach.

3. **Forceps type**

These devices are rotatable to the desired orientation and they can safely grasp the submucosal tissue under direct vision. These outer sides of the forceps are insulated so that electrosurgical current energy is concentrated at the closed blade to avoid unintentional incision and allow for directed and controlled application of electrocautery.9

![Fig. 1. Flush knife used for endoscopic submucosal dissection. Flush Knife BT (DK-2618JN; FTS, Tokyo, Japan) with 4 different lengths. We usually utilize a 2.5 mm BT Flush Knife for the gastric lesions, a 1.5 mm BT Flush Knife for esophageal lesions and 2.0 or 1.5 mm BT Flush Knife for colorectal lesions.](image-url)
ATTACHMENTS TO THE ENDOSCOPE

1. Endoscope hood

ESD requires that a plastic hood be attached to the distal portion of the scope. The most commonly used hoods are soft tipped hoods. The hood is friction fitted and extends 3 to 4 mm from the scope tip depending on operator preference. The side holes allow for pooled secretions and fluid on the endoscope tip to escape keeping the visual field clean.

1) The ESD procedure using Flush Knife
   (1) Assessment of lesion to ascertain the best resection strategy
      ① The application of ESD: The state of the art at this time is such that ESD is usually undertaken as a separate procedure after the lesion has been identified and an assessment has been made that the lesion may be limited to mucosa, or high sub-mucosa (invasion depth ≤ 500 μm) in which case en-bloc resection is indicated. The first step will then be careful assessment of the lesion, its shape and size, the geometric aspects of the lesion and its relationship to the part of the gastrointestinal (GI) tract it is in. Using the accepted guidelines, the interventional endoscopist can decide whether R0 en-bloc resection is feasible and endoscopic cure can be achieved (Table 1). Experts undertaking ESD will begin to ask themselves a number of important questions so as to formulate a complete strategy as possible before physically beginning the procedure. The endoscopist should begin asking themselves the following questions.
      ② Based on the location, information gleaned from the fluid level and shape of the lesion
   a) Where would be the best location to begin the ESD procedure? The information that the endoscopist needs to answer this question is based on the effect of gravity on the evolving tissue flap being created. It is favorable to utilize gravity to create a retraction type effect during the dissection phase as well to help avoid a situation where the operating field is submerged in fluid that is pooling. When approaching gastric lesions with ESD, the circumferential mucosal incision usually starts from the greater curvature side (Fig. 2A-C).
   b) What is the risk of perforation?: The thinner areas of the GI tract hold more risk for perforation. These areas include the greater curvature of the stomach, duodenum, cecum, right colon and esophagus. Reported risk factors for increased risk of perforation during gastric ESD include greater curvature lesions, increased scarring and sub-mucosal fibrosis of the lesion, long operative time, and performing ESD in the remnant stomach. c) What is the risk of bleeding?: A lesion on the greater curvature of the stomach as well as antrum and cardia has a greater incidence of bleeding than a lesion on the lesser curvature of the stomach. With respect to other sites of GI lesions, the distal rectum and duodenum have an increased risk of bleeding. Other risk factors for post-operative hemorrhage in gastric ESD include oral anticoagulant or antiplatelet drugs and a resected tumor size greater than 5 cm.
   d) Is there a chance that I will be encountering greater submucosal fibrosis during the dissection?: Increased sub-mucosal fibrosis can create great difficulty in the per-

Table 1. Criteria of Endoscopic Submucosal Dissection in Stomach, Esophagus and Colorectum

<table>
<thead>
<tr>
<th>Stomach</th>
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<tbody>
<tr>
<td>1. Guideline criteria</td>
<td></td>
<td></td>
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<tr>
<td>1) m-ca, diff. type, ly(−), v(−), and UI(−) and ≤ 2 cm in size</td>
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<tr>
<td>2. Expanded criteria</td>
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<tr>
<td>1) m-ca, diff. type, ly(−), v(−), UI(−) and &gt; 2 cm in size</td>
<td></td>
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<tr>
<td>2) m-ca, diff. type, ly(−), v(−), UI(+) and ≤ 3 cm in size</td>
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<tr>
<td>3) sm 1-ca (invasion depth &lt; 500 μm), diff. type, ly(−), v(−)</td>
<td></td>
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<tr>
<td>3. Extra criteria</td>
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<tr>
<td>1) Others than guideline criteria or expanded criteria</td>
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Esophagus (squamous lesions only)

1. Guideline criteria
   1) cT1a-EP-ca, 2) cT1a-LPM-ca

2. Expanded criteria
   1) cT1a-MM-ca, ly(−), v(−), infα, diff. type, ly(−), v(−)
   2) cT1b/sm-ca (invasion depth < 200 mm), ly(−), v(−), infiltrative growth pattern, expansive type (infα), diff type, ly(−), v(−)

3. Extra criteria
   1) Others than guideline criteria or expanded criteria

Colorectum

1. Guideline criteria
   1) m-ca
   2) m-ca (< 1.000 mm), diff. type, ly(−), v(−)

2. Extra criteria
   1) Others than guideline criteria

m, mucosal; ca, cancer; diff, differentiated; ly, lymphatic invasion; v, vascular invasion; UI, ulceration; sm, submucosal; EP, epithelium; LPM, lamina propria mucosa; MM, muscularis mucosa.
Fig. 2. The circumferential mucosal incision without bleeding. (A, B) The circumferential mucosal incision started from grater curvature side. It was first incised about one third of the planned circumferential incision. The incision was maintained at a depth so as not to damage the ramified vessel network. (C) The small horizontal vessels running between the muscular layer of the mucosa and submucosal layer were coagulated by soft coagulation with the Flush Knife before dissection.

Fig. 3. Diagnosis using image enhanced endoscopy. (A, B) There is a lesion located at lower body, lesser curvature of stomach, slightly towards anterior wall, near post endoscopic submucosal dissection scar (blue triangular marks). The gross endoscopic classification is IIa+IIc, the size is about 25 mm. (C, D) We use narrow band imaging and magnification imaging to examine the border of the tumor. We determined from this inspection that this was a cancer lesion because there is a definite demarcation line (red triangular marks) as well as irregular surface and vascular patterns.

formance of ESD. The endoscopist can expect to encounter increased sub-mucosal fibrosis if there has been a prior EMR or ESD, in a Barrett’s lesion and some gastric ulcerated lesions. If the target lesion has been biopsied, especially if it is a colonic lesion, significant sub-mucosal fibrosis may be encountered. In these situations, one should be prepared for a prolonged dissection in which vertical fibers between the mucosa and sub-mucosa (termed bridging fibers) will be encountered. This situation requires careful dissection, at times dissecting fiber by fiber.

(2) Marking

Marking of the target lesion is based on the ability of the endoscopist to accurately define the borders of the
lesion. Therefore, we usually use magnification endoscopy together with NBI imaging when placing our white cautery marks, especially in cases where it is hard to determine the tumor border. The marks should be placed about 3 mm from tumor border. This should give adequate borders and minimize the risk of thermal damage to important parts of the pathological specimen (Fig. 3, 4). When you are marking a target lesion with increased sub-mucosal fibrosis or expected fibrosis, be sure to place your marks outside the expected fibrotic zones thereby giving yourself the ability to start the incision in a non-fibrotic region and create an adequate flap before you actually encounter the fibrotic zone.

(3) Injection

Once the initial approach has been decided upon, injection of the lesion is undertaken. The injectate used in the stomach is normal saline without any addition of color. We occasionally use 0.4% hyaluronic acid (MucoUP; Johnson & Johnson, New Brunswick, NJ, USA) in difficult gastric lesions or in segments of a difficult ESD in the stomach. We tend to use more hyaluronic acid in esophageal and colonic lesions. A 25-gauge high-flow injection needle is recommended to manually inject the target lesion. This minimizes the trauma of the puncture and injection and can minimize post injection leak while the ESD is ongoing. One needs to inject the appropriate depth and try to avoid puncturing sub-mucosal vessels to avoid an intra-mucosal hematoma which can then obscure the field of vision. To achieve this, we initially inject a small amount of saline slowly till we see that the sub-mucosal layer is being elevated. Once it is clear that the sub-mucosal layer is being elevated, the speed of the injection can be increased. Injection volumes average about 3–5 mL per puncture (in esophageal and colorectal lesions, we usually use sodium hyaluronate and inject about 2 mL per puncture). About 3 to 4 punctures/injections are usually undertaken before beginning the first partial circumferential incision.

(4) Circumferential incision

In this phase of the ESD a circumferential incision is made either completely circumferential or partially circumferential. Most commonly an initial partial circumferential incision is made encompassing one-third to one-half of the planned circumferential incision. The incision should be maintained at a depth such that one does not damage the vessel network in the submucosal layer. Once the partial circumferential mucosal incision is made, all exposed vessels should be coagulated (Fig. 4). The circumferential incision is then continued in the adjacent mucosa in the usual controlled fashion once again followed by incision of the deeper submucosal tissue. During the incision or dissection, various degrees of bleeding can be encountered. Oozing can be coagulated with the ESD device by using one of the coagulation modes such as forced coagulation (coag). Heavier bleeding will require the use of the Coag Grasper Forceps (FD-410LR; Olympus; soft coag mode) which can actually help you locate the bleeding site by closing it on the suspected bleeding area (the bleeding should stop and not re-accumulate after irrigation if you have closed the grasper on the bleeding vessel in an accurate fashion) and then applying coagulation current while gently lifting the

Fig. 4. Marking. (A, B) We mark by soft coagulation using the Flush Knife at about 3 mm from the tumor border. This patient has two tumors inside the marking with the main lesion at the top of the marked field and the second lesion located at the greater curvature side with a size of about 5 mm (red triangular mark). We usually make a double mark at the anal side for orientation purposes post resection.

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grasped tissue upward. During the ESD procedure you will see intact vessels that are potential bleeding points. For small vessels once again use the ESD device to coagulate them. For larger vessels, use the Coag Grasper to prophylactically coagulate them.

(5) Dissection
   ① Dissection using the Flush Knife: Flush Knife allows for ongoing sub-mucosal injection or irrigation of saline through its tip, allowing the endoscopist to elevate the sub-mucosa when needed throughout the ESD without having to exchange devices for ongoing sub-mucosal injection. The continued injection of saline via the Flush Knife as needed is advantageous as it helps the endoscopist to stay clear of the muscle layer when applying electrocautery.

   Flush Knife Strokes: The movement of the Flush Knife

![Fig. 5.](image)

(A) Hooking or scooping technique. The submucosal tissue being targeted for dissection is hooked or scooped with the knife before applying electrocautery (the ball tip [BT] model of the Flush Knife allows for more efficient hooking or scooping). (B) Sliding technique (toward yellow arrow). In fibrotic cases we sometimes use the 1 mm Flush Knife non-tip [NT] device which has the shortest Flush Knife tip and is needle shaped. By sliding the tip smoothly over the dissection target and applying short bursts of electrocautery, one can avoid causing injury to deeper tissue layers in cases where it is hard to differentiate the muscle layer from the submucosal layer due to severe fibrosis. (C) Tapping technique. In non-contact tapping, the Flush Knife remains a millimeter or less above the target as the cautery is activated by the pedal without actually making contact with the tissue.
and the concomitant use of the accompanying pump is very directed and deliberate during the dissection. There are three basic strokes utilized during dissection and each one is used when the specific situation warrants it based on what the anatomy of the dissection looks like. All the strokes listed below are utilized in the standard context of a) fixing the knife to the specific target area in the sub-mucosa you are planning to dissect, b) adjust the knife so that you are certain it is in perfect position and that any specific movement of the tip you are planning to make will indeed occur when you finally activate your cautery device, c) dissect by activating the cautery pedal which in dissection is most commonly short bursts of forced coagulation but at times can be other settings (swift coag). It is helpful to remember the eponym FAD for Fix-Adjust-Dissect. As with all aspects of ESD, the cautery is always activated in a brief, controlled and staccato fashion. The following are the strokes.

a) Hooking or scooping (Fig. 5A): In this stroke the Flush Knife is placed into the endoscopic field at the specific target and specific depth that the endoscopist wishes to dissect. The submucosal tissue being targeted for dissection is then hooked or scooped with the knife (the BT model of the Flush Knife allows for more efficient hooking or scooping.). After making any needed fine adjustments to insure the muscle layer is safe the cautery pedal is tapped briefly as the visual effect is observed carefully.

b) Sliding (Fig. 5B): At various phases of the ESD dissection process, it may be desirable to use the sliding stroke. In this stroke the Flush Knife is made to slide over the submucosal tissue while activating your electrocautery device. The cautery is activated in a staccato fashion and care should be taken to make sure the Flush Knife is in motion if the sliding stroke is being used. This stroke is helpful in the trimming phase of dissection as well as in situations where there is a continuum of sub-mucosal tissue usually in the higher layers of the sub-mucosal. In fibrotic cases we sometimes use the sliding stroke with the 1 mm Flush Knife not-tip device which is the shortest of Flush Knife. This technique can help you avoid damaging the muscle layer that is bound to the sub-mucosal layer by fibrosis by using short bursts of electrocautery.

c) Tapping (Fig. 5C): Tapping during dissection allows the operator of the Flush Knife to apply a single short burst of electrocautery current at a very specific target during the dissection phase. This allows for dissection of that specific target area and at the same time minimization of electrosurgical current to unwanted areas such as muscle layer, suspected muscle layer or a possible vessel that the endoscopist may not yet wish to focus on. Tapping may be both contact and non-contact. Contact tapping refers to the Flush Knife making contact with the specific target tissue by briefly tapping the tip of the Flush Knife to the target. In non-contact tapping, the Flush Knife remains a millimeter or less above the target as the cautery is activated by the pedal without actually making contact with the tissue. This is desirable when a greater margin of safety is required and is usually used at the more difficult parts of a challenging dissection where submucosal fibrosis may be playing a role and the dissection plane may be difficult to determine. In these challenging parts of the dissection tapping can open a small window thereby allowing the operator to inject saline via the Flush Knife and reestablish the sub-mucosal dissection plane.

Once you are familiar with all the above individual strokes you will be able to use them in a combination fashion on a very fluid basis allowing you perform a safe and efficient sub-mucosal dissection. Think of them as musical notes that can be put together in various ways to create a symphony, depending on the requirements generated by the case you are doing.

Ω Important general principals of dissection: The most important element in performing successful and effective ESD is understanding the anatomy and structure of the blood vessels in the GI luminal wall so that an appropriate depth of dissection can be maintained. These vessels normally penetrate the muscle layer vertically and then turn horizontally at the level of middle submucosal layer forming the ramified vascular network.15

The endoscopist should aim for the goal of safe and reliable dissection while maintaining excellent hemostasis, by maintaining the appropriate depth of dissection and taking care to coagulate the penetrating vessels before dissection, a safe, reliable and high quality dissection is achieved (Fig. 6). The ramified vessel network in the sub-
Fig. 6. The method of cutting vessels penetrating the muscle layer without inducing bleeding. (A∼C) The appropriate depth of dissection was just above the muscle layer. When vessels penetrating the muscle layer appear in the field of dissection, we resect the submucosal tissues surrounding vessels taking care not to induce bleeding. The large vessels are then pre-coagulated by using the hemostatic forceps with soft coagulation mode (Coag Grasper or Hot Biopsy Forceps).

Fig. 7. Endoscopic submucosal dissection technique in fibrotic lesions. (A) After the circumferential mucosal incision, dissection is carried out to the appropriate depth of the submucosal layer. The mucosal flap is then created. (B) Mucosal incisions are carried out incrementally as required. (C) After the incision, dissection is done, continue to resect completely to open the deep submucosal layer. (D) In the fibrotic lesion, the side of the lesion in which the initial circumferential opening is made is more important than in non-fibrotic lesion. (E) The resection line is determined by careful observation of all aspects the visible muscle layer. (F) Carefully resected fibrotic submucosal layer, in a highly fibrotic lesion.

Therefore in the ideal ESD procedure the endoscopist resects the vessel network at the edges of incision, and then gains entrance into the appropriate depth of submucosal layer by broadening the groove from mucosal incision (Fig. 7A∼C). The appropriate depth of submucosal
layer is maintained to dissect and form a complete mucosal flap (Fig. 7D).

When performing ESD in the fibrotic lesion, the endoscopist should take care to broaden the groove at the edge of incision by beginning the circumferential incision with a larger margin. This approach will help overcome the difficulty in the recognition of the dissection plane between muscle layer and the vessel network. In addition, by dissecting from the lateral edge of the target lesion to the center, one can minimize the impact of the fibrotic area (Fig. 7D~F).

Pathological specimens obtained from ESD should be of a quality that precise histo-pathological information be obtainable from both lateral and vertical margins as well as the depth of tumor extension, the degree of tumor differentiation and the presence of vascular and lymphatic infiltration which are key factors in assessing the risk for lymph node metastases. Excessive repeated bleeding and hemostasis will disturb the transparency of the submucosal layer and raise the risk of the damage to the target lesion. Using proper ESD technique will allow you to avoid repeated bleeding and hemostasis and insure a high quality specimen (Fig. 8).

③ The use of ESD traction techniques in lesions with severe fibrosis: The use of traction devices are sometimes useful when doing ESD in the fibrotic lesion. We find the clip and snare method useful to achieve traction. First, the clip is positioned on the resected mucosa. The snare is then carried to the clip outside the scope while it is being grasped with forceps which are in the channel of the scope. The clip is then snared allowing the snare to pull on the clip and create the needed traction. This way gives the endoscopist excellent views to continue the dissection in the correct plane. When dissecting the sub-mucosal layer using this traction technique, one should avoid pulling excessively on the clip so as not to pull up on the muscle layer with the mucosa (Fig. 9).

Experience in our unit with ESD with severe fibrosis in ulcerated and non-ulcerated lesions.

We researched the previous ESD cases which were performed in our unit from July 2010 to January 2013 in lesions up to 3 cm with and without ulcer present. The results indicated that lesions with an ulcer took a significantly longer time to complete ESD than non-ulcer lesions. Only one case had localized mucosal damage to the degree that pathological examination could not ascertain the complete status of the margins. However, there were no significant differences between two types of lesions with respect to other parameters including complications (Table 2). We believe that good ESD treatment outcomes can be achieved in lesions with ulceration if one strives to adhere to the principles that allow for

Fig. 8. The resected tissue. (A) Endoscopic submucosal dissection bed in the stomach after a complete resection. (B) Resected tissue stained with indigo dye. (C) The pathological examination is reported as adenocarcinoma, a mucosal lesion with severe fibrosis without vascular infiltration (yellow box) (H&E; left: ×1, right: ×40).
Fig. 9. The clip and snare traction method for severe fibrotic lesions. (A) This lesion was located at lower body anterior wall and was ulcerated. The marking points surrounding the tumor were marked 1 to 2 cm greater than usual lesions in anticipation of dealing with the fibrosis. It was difficult to maneuver the endoscope close enough to this lesion to perform adequate dissection. (B) This figure depicts the traction method utilizing the clip and snare. (C) In this method the clip is grasped by the snare, and the snare is pulled gently from the outside of the mouth toward the opposite side of the desired dissection area. This figure shows that once this type of traction was achieved it was easier to observe the submucosal layer to insure safer and more efficient dissection.

(6) Final Inspection of the ESD ulcer site

It is recommended that one carry out a final careful inspection of the dissection bed to identify any potential sources that could cause delayed bleeding and coagulate them. Any areas of perforation should obviously be closed with hemoclip.s. In addition, any significant muscle injury that could lead to delayed perforation should be clipped appropriately.

**CONCLUSION**

ESD presently plays an important role in the therapy of superficial GI tumors. The rate of complications has been decreasing due to improved devices and growing expertise with the ESD technique. Nonetheless once an en-
Table 2. Treatment Results of Comparison of with or without Fibrotic Lesions from July 2010 to January 2013

<table>
<thead>
<tr>
<th>Lesions</th>
<th>Ulcer findings (−)</th>
<th>Ulcer findings (+)</th>
<th>P value</th>
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<td>Age (yr)</td>
<td>71 (44~88)</td>
<td>73.5 (52~86)</td>
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<tr>
<td>Men/women</td>
<td>72/21</td>
<td>4/29</td>
<td>NS</td>
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<tr>
<td>Tumor size (mm)</td>
<td>15.5 (2~30)</td>
<td>15.8 (5~30)</td>
<td>NS</td>
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<tr>
<td>Procedure time (min)</td>
<td>82.7 (20~198)</td>
<td>102 (29~180)</td>
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<tr>
<td>En-bloc R0 resection (%)</td>
<td>98.9</td>
<td>97</td>
<td>NS</td>
</tr>
<tr>
<td>Perforation rate (%)</td>
<td>2.1</td>
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<tr>
<td>Post operative bleeding rate (%)</td>
<td>1.05</td>
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<td>NS</td>
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<tr>
<td>Pathological undeterminable rate for tissue damage (%)</td>
<td>0</td>
<td>3.0 (1 case)</td>
<td>NS</td>
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Values are presented as n or median (range). NS, not significant.

doscopist makes a technical error during the ESD procedure, significant complications may ensue. We believe that the key to high quality, safe and effective ESD is focusing your approach on the target lesion such that you create a groove between the submucosal vessel network and the muscle layer, especially in difficult cases. This is the most reliable way to assure you obtain a high quality pathological specimen where pathological analysis can focus on both lateral and vertical margins, lymphovascular invasion and depth of invasion.

REFERENCES