Endoscopic submucosal dissection (ESD) is an excellent procedure for the diagnosis and treatment of superficial mucosal lesions, and has the advantage of en bloc resection which yields a higher complete resection and remission rate compared to endoscopic mucosal resection (EMR). However, the learning process of this advanced endoscopic procedure requires a lengthy training period and considerable experience to be proficient. A well framed training protocol which is safe, effective, easily reproducible and cost-effective is desirable to teach ESD. In Korea, the Korean Society of Gastrointestinal Endoscopy (KSGE) is playing an important role in training many gastroenterologists who have shown an interest in performing ESD by providing an annual live demonstration and a nationwide tutoring program. The purpose of this article is to introduce our ESD tutoring experience, review the published papers related to this topic, and propose several suggestions for future directions in teaching and learning ESD.
expected since the learning process of this advanced endoscopic procedure is long and requires considerable experience. This is one of the reasons why a well-framed training protocol is necessary for this difficult procedure. It is our understanding that the training program should be tailored around needs based on ethnicity, culture, and/or country since the incidence of disease and working environment may be different. However, the training program should focus on safety, effectiveness, easy reproducibility and cost-effectiveness regardless of conditions. In this article, we describe our teaching experience and revisit published papers related to the teaching and learning of ESD.

**ESD TRAINING EXPERIENCE IN KOREA**

ESD was introduced in Korea in the late 1990s and is now widely accepted as one of the standard treatment modalities for early cancers and premalignant lesions of the stomach and colorectum. In 2008, according to the reference of the Korean Health Insurance Review and Assessment Service, ESD was performed in 70 tertiary hospitals, 3 community-based hospitals, and 1 primary physician center in Korea.

Live demonstrations have been held annually by the Korean Society of Gastrointestinal Endoscopy (KSGE) since 2004. It is a good opportunity for beginners to observe procedures performed by experts and to obtain information on ESD. However, we have noticed that simple observation of these procedures does not serve the needs of the endoscopists who are in the fellowship training course. For this reason, the ESD study group of KSGE held a nationwide tutoring program (7 provinces, 8 sessions) from January through October 2007. This program was divided into two sections and included a live demonstration of ESD in an \textit{ex vivo} porcine stomach model and a hands-on training course using the same model. The well-irrigated porcine stomach was used in the experiment 24 h after the animal was slaughtered. The outlet portion of the stomach was closed with Kelly. A schematized frame was used for electrical patch attachment and water immersion was used for detection of air leakage. The inlet portion of the stomach was connected to the overtube and fixed within the frame (Figure 1). Before demonstrating the procedure, a mini lecture on the procedure was given to explain the procedure to the attendees. In the first session, tutors performed ESD with elaboration of the procedure. The endoscope was introduced through the overtube and the stomach was inflated with the endoscope. After selecting a target portion, the imaginary lesion was dissected after marking, injection and circumferential precutting. After completion of ESD, the integrity of the stomach wall was investigated by air insufflations with detection of leakage. In the second session, every participant performed this procedure once or twice under the supervision of the tutors. Although this program was not connected to the next step, such as \textit{in vivo} animal models or human studies, it permitted the trainee endoscopists to gain initial experience in performing this complex procedure and to accumulate knowledge on this therapeutic endoscopic technique. The previously mentioned annual live demonstrations by the KSGE provided valuable information for those who attended the training sessions and for those who led the courses.

**JOURNAL REVIEW ON TEACHING AND LEARNING ESD**

In Korea, a large volume of cases which need endoscopic therapy, especially in the stomach, enables endoscopists to extend their procedure from EMR to ESD step by step. Some early frontiers of ESD in Korea have accumulated their expertise as the EMR technique has evolved. EMR after circumferential precutting (EMR-P), which was first described as endoscopic resection with local injection of hypertonic saline-epinephrine (ERHSE) by Hirao et al\cite{3} for superficial lesions less than 2 cm, was a common challenge towards the next step. With the EMR-P method, lesions are resected by a snare after circumferential precutting and \textit{en bloc} resection of the lesion with low risk of complications is possible. For lesions less than 2 cm in diameter, the rates of \textit{en bloc} resection and complications are comparable for EMR-P and ESD\cite{4}. Choi et al\cite{5} demonstrated a learning curve for the EMR-P technique, reporting an increase in the \textit{en bloc} resection rate from 45% to 85% after 40 cases by summarizing their evolving self-taught experience on the EMR-P technique. There

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**Figure 1 Porcine stomach model for endoscopic submucosal dissection.** The stomach was immersed in water of the frame for detection of air leakage. The duodenum was sealed with Kelly. The electrical plate was attached to the bottom of the stomach. Bluish discoloration with light illumination was seen at the stomach antrum area (A); the endoscope was introduced through the overtube, which was fixed to the frame developed for endoscopic submucosal dissection tutoring (B).
were three perforations in the first 20 procedures (15%) and only one in the remaining 60 procedures (1.7%). They concluded that the trainee would need to perform 20-40 procedures to be able to use the technique safely and effectively. However, in the era of many ESD experts, the self-taught method of learning the EMR/ESD technique described in this study is unlikely to be acceptable as a good model for learning ESD.

In recognition of the complexity of ESD, the National Cancer Center Hospital in Japan, which is one of the highest-volume centers of ESD, has developed a rigorous training program. In this hospital, ESD is performed under the close supervision of an experienced endoscopist who offers advice and can complete the procedure when it is necessary for the benefit of the patient. In that setting, Gotoda et al. reported that experience of at least 30 cases is required for a beginner to gain early proficiency in this technique. In addition, they suggested that a major portion of the ESD training must be devoted to avoiding and managing its potential complications such as bleeding. Recently, Yamamoto et al. reported a study on the assessment of the feasibility and learning curve in ESD performed by supervised residents. Before entry into this study, three supervised residents had experience of at least 1500 regular esophagastroduodenal procedures and more than 10 EMRs. In addition, they had assisted ESD procedures performed by senior doctors for at least 1 year, and then attended a lecture on ESD techniques, using a manual and videos, by an experienced endoscopist. Each of them performed 30 consecutive ESD procedures for differentiated-type mucosal early gastric cancer without ulcers or scars, and smaller than 2 cm. Among the 90 procedures, there was a good overall complete resection rate of 93%, with an acceptable complication rate of 4.4%. The distribution of complete resection and complication rates were similar between operators. The self-completion rate and operation time were significantly worse for submucosal dissection than mucosal incision, which was mostly related to uncontrolled hemorrhage. Median operation time for mucosal incision did not change during the subsequent initial clinical experience would allows endoscopists to obtain knowledge in a relatively short time period, with a tutor on site. Further mentoring during the subsequent initial clinical experience would complement the animal model experience. Nevertheless, it
should be recognized that these simulation workshops are a means of augmenting training in skills in low-volume centers but will not replace patient-based training.\textsuperscript{[11]}

Vázquez-Sequeiros \textit{et al.}\textsuperscript{3} from Spain reported their experience of learning and performing ESD in the absence of experts on ESD in their country. Four endoscopists with no experience in ESD underwent a four-step training program: (1) review of the literature and acquisition of theoretical concepts of ESD; (2) training in an \textit{ex-vivo} animal model; (3) training in an \textit{in-vivo} animal model; and (4) ESD of a gastric tumor in a patient. The four participants performed a total of 6 experiments using 6 porcine stomachs and esophagus for \textit{ex-vivo} training. Six supervised ESDs were performed in a live porcine model under general anesthesia. After that, an ESD procedure in a patient was performed under general anesthesia in the operating room with a surgical team available. The procedure was successful but took quite a long time (210 min) and the resected specimen was 35 mm in size.

**SUGGESTIONS ON TEACHING AND LEARNING ESD**

It has been reported that closely supervised trainees can perform advanced surgery such as esophagogastrectomy, 

hepatectomy\textsuperscript{[1-4]}, or pancreatocystectomy\textsuperscript{[5-7]} with similar outcomes to consultant surgeons. In those studies, surgeons with a large workload encouraged trainees to accept more opportunities to participate in such complex operations, with appropriate supervision, because this improved their learning of the surgical methods and did not jeopardize patient care. Similarly, proficiency in ESD cannot be achieved without the availability of a highly experienced supervisor\textsuperscript{[8]}, because a significant number of cases were not completed by the trainee alone and complications such as perforations were generally managed by the supervisor.

In Asian countries such as Korea and Japan where there is a large volume of early gastric lesions which need endoscopic treatment, endoscopists can learn ESD expanding their skill from EMR to ESD under the supervision of experts. Initial experience in ESD with a simulator model and accumulation of experience during the assisting period and supervised EMR-P and ESD procedures for easier sites such as the gastric antrum would be right step.

On the other hand, it is difficult to overcome a flat learning curve due to a low case volume in Western countries. According to previously published data, Western countries report a lower rate of complete resection and learning curve due to a low case volume in Western countries. According to previously published data, Western countries report a lower rate of complete resection and learning curve due to a low case volume in Western countries. Therefore, learning curve for EMR with circumferential mucosal incision (EMR-P) and \textit{ex-vivo} ESD training for esophageal and/or colonic ESD may be essential for Western trainees since ESD of these lesions is more difficult than gastric ESD.\textsuperscript{[10]}

**CONCLUSION**

ESD is a beneficial procedure which achieves higher rates of \textit{en bloc} resection and complete resection for early cancer. However, training with a high enough volume to become proficient in ESD requires considerable time and patience especially in Western countries. A well structured training program is essential for the trainee, because the outcome of ESD is dependent on the experience of the endoscopist. Novice endoscopists can learn ESD by utilizing a simulation model, observing and/or assisting procedures performed by experts. The training course would be designed differently for Asian and Western countries according to the workload and incidence of disease. Close collaboration between Western and Asian countries will be helpful to improve ESD technique for various sites and to benefit patients who are suffering from early gastric, esophageal or colorectal cancer.

**REFERENCES**


**Endoscopy** is also helpful. In addition, the target lesion for ESD is different in Western countries and ESD could be more frequently used for resection of neoplasia in Barrett’s esophagus or the colon due to their higher incidence compared with early gastric cancer\textsuperscript{[16,17]}. Hence, \textit{ex-vivo} and \textit{in-vivo} training for esophageal and/or colonic ESD may be essential for Western trainees since ESD of these lesions is more difficult than gastric ESD.\textsuperscript{[18]}

**REFERENCES**


gastric cancer performed by supervised residents: assessment of feasibility and learning curve. *Endoscopy* 2009; 41: 923-928


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