

# New classifications of intraoperative bleeding and muscularis propria injury in endoscopic resection

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With the development of endoscopic techniques and equipment, endoscopic surgery has been widely performed to treat many diseases, such as early gastrointestinal cancer, submucosal tumors, and achalasia. Endoscopic surgery can be classified as digestive endoscopic tunnel technique (DETT) and non-tunnel technique. The non-tunnel technique includes endoscopic mucosal resection, endoscopic piecemeal mucosal resection, endoscopic submucosal dissection (ESD), multi-band mucosectomy, endoscopic submucosal excavation, and endoscopic full-thickness resection.<sup>[1]</sup> Endoscopic submucosal tunnel dissection (ESTD), peroral endoscopic myotomy (POEM), and submucosal tunneling endoscopic resection (STER) are considered types of DETT. Endoscopic resection is safer and more minimally invasive than open surgery and video-assisted surgery.<sup>[2,3]</sup> The complication rate of resection is regarded as the main standard to evaluate the safety of endoscopic surgery, while bleeding and “perforation” are reported to be the most common intraoperative complications.<sup>[4,5]</sup>

A new classification of intraoperative bleeding: The incidence of immediate bleeding related to endoscopic procedures has been reported to be 22.6% to 90.6%.<sup>[6,7]</sup> However, it is difficult to accurately evaluate the amount of bleeding during endoscopic resection. The unified definition of intraoperative bleeding related to endoscopic resection remains unknown. Only one study has revealed a kind of classification method to define the degree of bleeding.<sup>[6]</sup> That study graded immediate bleeding as follows: Grade 0 (no visible bleeding); Grade 1 (trivial bleeding that stops spontaneously or is easily controlled by a single session of hemocoagulation); Grade 2 (minor bleeding that is controlled by multiple sessions of hemocoagulation or is easily controlled by hemoclips); and Grade 3 (major bleeding that needs multiple hemoclips and sessions of hemocoagulation). This classification is not

perfect due to its insufficient accuracy. The standards to evaluate the immediate bleeding rate vary in different studies, causing their figures to be incomparable. Immediate bleeding is believed to be closely related to not only the characteristics of lesions but also the experience of operators. It is much more difficult to evaluate the amount of bleeding during endoscopic operations than during surgical operation, and the operators’ experience makes a difference in hemostatic time. Therefore, it seems inappropriate to grade intraoperative bleeding based on the amount of bleeding and hemostatic time.

I suggest a new classification of intraoperative bleeding, named endoscopic resection bleeding (ERB) classification, on the basis of 30 years of endoscopic experience. ERB classification is suitable for evaluation of the bleeding amount during both DETT and non-tunneling resection. ERB classification can be divided into three grades, including five sub-grades and is shown as follows: ERB-0 means no bleeding because the exposed vessel was immediately treated by electrocoagulation. ERB-controlled (ERB-c) means bleeding that can be controlled by endoscopy. ERB-c can be divided into three sub-grades: ERB-c1 (minor bleeding that can be easily controlled by endoscopy without affecting postoperative vital signs and with no need of blood transfusion), ERB-c2 (a bleeding amount between c1 and c3); and ERB-c3 (major bleeding that can be controlled under endoscopy with the need of a blood transfusion intra- or post-operatively) [Figure 1A–1C]. ERB-uncontrolled (ERB-unc) means uncontrollable bleeding under endoscopy that must be treated by surgery or vessel embolotherapy.

A new classification of muscularis propria (MP) injury (MPI): The incidence of “perforation” related to endoscopic procedures has been reported to be 1.2% to 4.1%.<sup>[8,9]</sup> “Perforation” means full perforation of the MP. Mucosal injury is indispensable during non-tunneling

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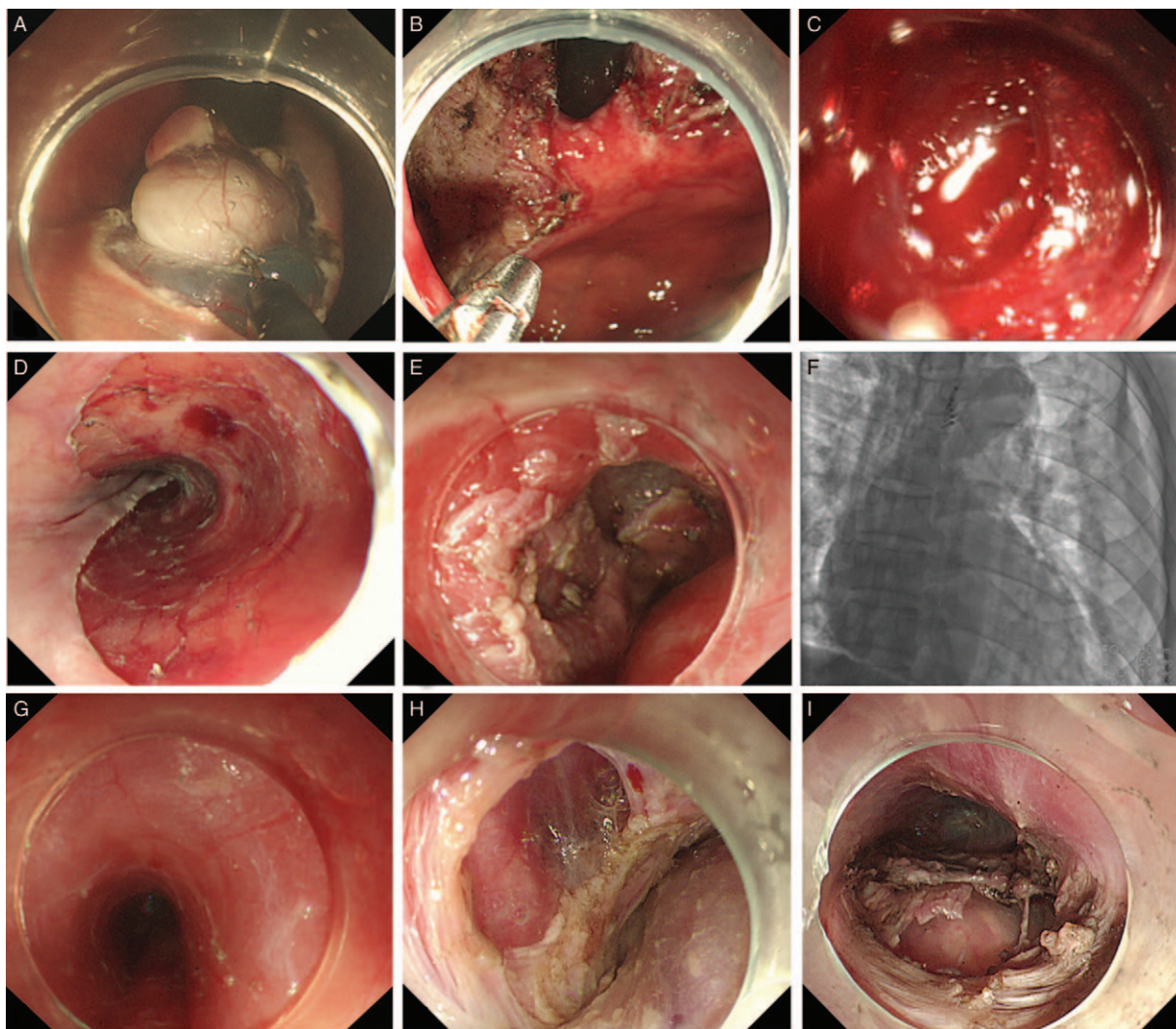
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**Figure 1:** Classifications of intraoperative bleeding and muscularis propria injury in endoscopic resection. (A) ERB-0 classification. No bleeding occurred during ESE when treating a cardiac lesion originating from MP. (B) ERB-c1 classification. Minor bleeding that was successfully stopped by electrocoagulation during ESD when treating early gastric cancer. (C) ERB-c3 classification. Major bleeding that could be stopped under endoscopy during EPMR when treating a large early esophageal cancer; however, the patient needed a blood transfusion postoperatively due to great blood loss. (D) MPI-0 classification. No injury to the MP during ESD when treating esophageal cancer. (E) MPI-i<sub>b</sub> classification. Major injury to the MP during ESE when treating esophageal submucosal tumor originating from the MP. (F) MPI-i<sub>b</sub> classification. Left pneumothorax shown on X-ray after resection. (G) MPD-0 classification. No defect of the MP occurred during STER when treating a tumor located in the submucosal layer. (H) MPD-f classification. Full perforation of the MP occurred during STER when treating a submucosal tumor located in the esophagus. The classification is LeMPD-f (q). (I) MPD-f classification. The classification is LeMPD-f (tq). ERB: Endoscopic resection bleeding; ESE: Endoscopic submucosal excavation; ESD: Endoscopic submucosal dissection; EPMR: Endoscopic piecemeal mucosal resection; Le: Location and esophagus; MPI: Muscularis propria injury; MPD: Muscularis propria defect; q: quarter; STER: Submucosal tunneling endoscopic resection; tq: three-quarter.

resection; therefore, “perforation” seems to indicate injury of the MP layer. “Perforation” adds great psychological stress to patients and fails to evaluate the severity of MPI. Therefore, I proposed a new MPI classification to obtain a better quantification of the severity of lesion adhesion, the proficiency of operation and the condition of the postoperative wound. MPI classification can be divided into three grades, including five sub-grades, and is shown as follows: MPI-0 means no injury of the MP. MPI-injury (MPI-i) means partial injury of the MP without full perforation. MPI-i can be divided into two sub-grades: MPI-i<sub>a</sub> (partial injury of MP where the gas inside the cavity does not penetrate out of the cavity after pressurization) and MPI-i<sub>b</sub> (partial injury of the MP where the gas inside the cavity penetrates out of the cavity after pressurization) [Figure 1D–F]. MPI-perforation (MPI-p) means full-

thickness injury. MPI-p can be divided into two sub-grades: MPI-p<sub>a</sub> (perforation that can be closed under endoscopy) and MPI-p<sub>b</sub> (perforation that cannot be closed under endoscopy and must be treated by surgery). MPI classification is suitable for the evaluation of the MPI during non-tunneling resection.

A new classification of MP defect (MPD) during DETT: Compared with non-tunneling resection, DETT has advantages of maintaining the integrity of the mucosa. However, incision and resection of the MP layer during DETT result in the possibility of the defect of the MP layer. The classification of MPI during DETT is different from that of non-tunneling resection. The MPD classification is suggested to classify the defect grade of the MP layer [Table 1]. It includes three grades: MPD-0 (no defect of the

**Table 1: MPD classification to classify intraoperative defect of MP during DETT.**

Grades	Characteristics
MPD-0	No defect of MP
MPD-p	Partial defect of MP without full perforation
MPD-f	Full defect of MP with perforation
Location (L)	e: esophagus, c: cardia, s: stomach, d: duodenum, i: small intestine, co: colon, r: rectum
Circumference (C)*	≤Quarter (q) 1/4, 1/4 < C ≤half (h) 1/2, 1/2 < C ≤three-quarter (tq) ≤3/4, >3/4
Size (S)†	Longitudinal diameter × transverse diameter

\* Circumference degree evaluation is suitable for the lesion located on digestive tract except for gastric fundus and body. † Size of the lesion should be mentioned when it located on gastric fundus and body. MPD: Muscularis propria defect; DETT: Digestive endoscopic tunnel technique.

MP), MP with a partial-thickness defect (MPD-p: partial defect of the MP without full perforation), and MP with a full-thickness defect (MPD-f: full defect of the MP with perforation) [Figure 1G–1I]. When MPD-f is diagnosed, the location and the circumferential degree extent of the lesion should be mentioned. MPD classification is indicated to evaluate the defect grade of the MP layer during ESTD, POEM, and STER.

These three classifications are based on my 30 years of clinical experience. ERB classification has an advantage due to its relatively accurate evaluation of the severity of intraoperative bleeding; however, it is affected by the experience of the operators and the equipment used to achieve hemostasis in addition to the lesion itself. MPI and MPD classification is related to the experiences of operators and the equipment as well. MPD classification can also act as a predictor for diverticulum and postoperative scarring that may cause stricture. Therefore, these three classifications can be used to estimate the level of different centers and the ability of different doctors. Immediate hemostasis is essential to provide a satisfactory endoscopic view, which can decrease the incidence of MPI and defect. Lesions in the upper stomach, lesions larger than 20 mm, and excessive coagulation and hemostasis have been shown to be risk factors for perforation during ESD.<sup>[10]</sup> Good fluid cushion and repeated injection during

resection are essential to ensure the integrity of the MP. These three classifications are aimed at standardizing complications during endoscopic procedures. I hope they can increase the knowledge of both physicians and patients regarding complications related to endoscopic resection.

### Conflicts of interest

None.

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