Review Article

Endoscopic treatment of surgery or procedure-related gastrointestinal bleeding

Ki Bae Bang, Hyun Deok Shin*

A B S T R A C T

Endoscopy is a safe and effective modality for the diagnosis and treatment of lesions in the gastrointestinal (GI) tract. During the last few decades, improvements in image quality and technical advances have led to the widespread use of endoscopy in various medical fields. Because it is relatively noninvasive and generally safe, the role of endoscopy has been emphasized in morbid patients with postoperative GI bleeding. However, there has been concern about the safety and complications of endoscopy. Here, we review endoscopic management of GI bleeding as a complication of surgery and therapeutic endoscopy.

Keywords: Endoscopy; Hemorrhage; Hemostasis; Postoperative complications

Introduction

Endoscopic resection such as endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD) can be used to treat various gastrointestinal (GI) tract neoplasms including premalignant and malignant lesions of the esophagus, stomach, duodenum, and colorectum. However, postprocedural bleeding or perforation are uncommon complications of endoscopic treatment and can be fatal. Fortunately, most iatrogenic complications such as post EMR or ESD bleeding can be controlled by endoscopic interventions. Moreover, endoscopic modalities can be used to treat postoperative complications such as GI bleeding, anastomosis leakage, and perforation and prevent unnecessary reoperations. Endoscopy enables identification of the bleeding focus and management of GI bleeding. Hemostasis of suture-line bleeding can be achieved using various endoscopic modalities (e.g., injection, mechanical, and thermal therapy). In this article, we review the endoscopic management of procedure-related and postoperative hemorrhage.

Procedure Related Bleeding in the GI Tract

Procedural bleeding of the stomach

Endoscopic resection is minimally invasive and as effective as surgery for early gastric cancer. Technical advances have led to the widespread use of ESD as a first-line therapy for early gastric cancer without evidence of metastasis. ESD is associated with higher rates of en bloc and R0 resection than EMR, and a lower rate of local recurrence. Despite the larger areas of resection, the rate of postprocedural bleeding after ESD is comparable to that after EMR according to recent meta-analyses. Post ESD bleeding is the most frequent adverse event associated with ESD. The incidence of bleeding after gastric ESD is 0.6% to 15.6%, and the overall incidence of postprocedural bleeding is 5.1%. The risk of bleeding after ESD is higher in the stomach compared to other sites. Most instances of post ESD bleeding occurred within 24 hours of ESD, but in some cases occurred up to 4 weeks later. Comorbidities, lesion size (≥ 4 cm), antithrombotic therapy, lesion location (lesser curvature, upper stomach), and a prolonged procedure are risk factors of delayed bleeding after gastric ESD.

Intraprocedural bleeding is more frequent in the mid and up-
per stomach due to the greater diameter of submucosal arteries compared to the lower stomach. Delayed bleeding is thought to be more frequent in lesions in the lower stomach, likely due to antral peristalsis, bile reflux, and more careful hemostasis in lesions in the upper or mid-stomach. However, in a recent meta-analysis, the overall bleeding rate did not significantly differ according to lesion location, but delayed bleeding was associated with lesions in the upper stomach. Further studies are required for this issue.

Prophylactic management of postprocedural bleeding

Anti-acid therapy can reduce the rate of postprocedural bleeding after EMR. In a meta-analysis of five studies involving 506 patients, the rate of delayed bleeding was reduced in patients treated with a proton pump inhibitor compared to an H2 receptor antagonist (H2RA) (odds ratio [OR], 0.41; 95% confidence interval [CI], 0.20–0.85). Regarding EMR, there were no significant differences in the rate of delayed bleeding between the two groups. Muco-protective agents may enhance artificial ulcer healing after gastric ESD. However, the rate of delayed bleeding was not reduced by faster ulcer healing in several randomized controlled trials (RCTs) and a meta-analysis. Routine second-look endoscopy after ESD remains controversial. However, in the meta-analysis of three RCTs involving 854 patients, second-look endoscopy had no advantage for the prevention of post ESD bleeding. Moreover, in a recent meta-analysis of 12 non-randomized studies, second-look endoscopy had no effect in reducing delayed post ESD bleeding. However, the role of second-look endoscopy is unclear in high-risk patients according to the Forrest classification.

Endoscopic management of procedural bleeding

Intraprocedural bleeding is a common complication during ESD that necessitates repeated hemostasis. Identification of vessels during submucosal dissection and prophylactic hemostasis is important to prevent intraprocedural bleeding (Fig. 1). Prophylactic coagulation and minor oozing from small vessels can be managed with dissection knives; hemostatic forceps are useful for controlling active arterial bleeding. If coagulation forceps fail to control bleeding before hemoclip application, the bleeding site must be fully exposed. Because their use can hinder further dissection, hemoclips should be reserved for uncontrolled bleeding or after completion of dissection. After dissection, routine coagulation of all visible vessels should be performed to reduce the risk of delayed bleeding. In most cases, delayed bleeding can be managed using standard endoscopic hemostasis methods (Table 1). The degree of ulcer healing might affect the treatment decision. Hemoclips or coagulation forceps are useful in the early phase of ulcer healing (Fig. 2), whereas injection therapy can be useful in the late phase due to hardening of the ulcer floor over time.

Procedural bleeding of the colon

Globally, colorectal cancer is the third most common cancer. Endoscopic treatment of colorectal neoplasm has reduced the in-

Fig. 1. Endoscopic hemostasis for intraprocedural bleeding during endoscopic submucosal dissection (ESD). (A) Submucosal vessel was identified (arrow). (B) Prophylactic hemostasis using Coagrasper (Olympus). (C) Active bleeding during ESD. (D) Bleeding vessel was grasped and coagulated with Coagrasper.
cidence of colorectal cancer and the rate of cancer-related mortality.47–49 Endoscopic treatment is now used widely, although there is some concern over complications, including bleeding (the most frequent complication) and perforation. Postprocedural bleeding is potentially life threatening50 and can require hospitalization, repeated colonoscopy, and blood transfusion.51 The incidence of postprocedural bleeding in the colon is 0.6% to 8.1%.52-63 Postprocedural bleeding can occur immediately or be delayed by up to 2 to 4 weeks.64,65 The risk of bleeding is higher in patients with comorbidities (cardiovascular disease or hypertension), large polyps (> 10 mm), polyps located in the right colon, and polyps with a large stalk (≥ 5 mm).56,67 Antiplatelet or anticoagulant therapy is reportedly associated with delayed bleeding.56,68 The rate of delayed bleeding is estimated to increase by 13% for each 1 mm increase in polyp diameter.69 However, despite the larger polyp size, the bleeding risk for ESD is comparable to EMR according to a recent meta-analysis.70

Table 1  Studies Reporting on the Procedure Related Bleeding in the Stomach

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of lesions</th>
<th>Indication</th>
<th>Treatment</th>
<th>Incidence (%)</th>
<th>Mortality (%)</th>
<th>Risk factors</th>
<th>Bleeding control</th>
<th>Success (%)</th>
<th>Rescue therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yano et al13 (2017)</td>
<td>1,767</td>
<td>EGC</td>
<td>ESD</td>
<td>8.5</td>
<td>0</td>
<td>Specimen ≥ 40 mm, antithrombotic agents</td>
<td>Coagulation forceps and epinephrine injection</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Na et al15 (2015)</td>
<td>706</td>
<td>EGC, adenoma</td>
<td>ESD</td>
<td>13</td>
<td>0</td>
<td>Specimen size</td>
<td>Electrocoagulation injection</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Koh et al14 (2013)</td>
<td>1,166</td>
<td>EGC, adenoma</td>
<td>ESD</td>
<td>5.3</td>
<td>0</td>
<td>Specimen ≥ 40 mm, antithrombotic agent</td>
<td>Coagulation forceps or hemoclipping</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Lim et al16 (2013)</td>
<td>1,461</td>
<td>EGC, adenoma</td>
<td>ESD</td>
<td>4.4</td>
<td>0</td>
<td>Cumulative ESD time</td>
<td>Endoscopy</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Yoshio et al18 (2013)</td>
<td>1,310</td>
<td>EGC</td>
<td>ESD</td>
<td>5.3</td>
<td>0</td>
<td>Heparin replacement</td>
<td>Endoscopy</td>
<td>98.5</td>
<td>Surgery (1)</td>
</tr>
<tr>
<td>Chung et al17 (2009)</td>
<td>1,000</td>
<td>EGC</td>
<td>ESD</td>
<td>16.2</td>
<td>0</td>
<td>Upper stomach, tumor &gt; 40 mm, recurrent lesion, flat lesion</td>
<td>Endoscopy</td>
<td>99</td>
<td>Surgery (1)</td>
</tr>
<tr>
<td>Lim et al16 (2012)</td>
<td>1,591</td>
<td>EGC, adenoma</td>
<td>ESD</td>
<td>5.9</td>
<td>0</td>
<td>EGC, comorbidity, specimen ≥ 40 mm</td>
<td>Endoscopy</td>
<td>96.8</td>
<td>Embolization (3)</td>
</tr>
<tr>
<td>Toyokawa et al17 (2012)</td>
<td>1,123</td>
<td>EGC, adenoma</td>
<td>ESD</td>
<td>5.0</td>
<td>0</td>
<td>Age ≥ 80, long procedure time</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Takizawa et al18 (2008)</td>
<td>1,083</td>
<td>EGC</td>
<td>ESD</td>
<td>5.8</td>
<td>0</td>
<td>Upper stomach, no post-ESD coagulation</td>
<td>Endoscopy</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Miyahara et al17 (2012)</td>
<td>1,190</td>
<td>EGC, adenoma</td>
<td>ESD</td>
<td>6.9</td>
<td>0</td>
<td>Lower stomach, large resection size, scar in the lesion</td>
<td>Hemoclipping, electrocoagulation</td>
<td>98.7</td>
<td>Surgery (1)</td>
</tr>
</tbody>
</table>

EGC, early gastric cancer; ESD, endoscopic submucosal dissection; NA, not applicable.
*Bleeding related mortality.
†Success rate for endoscopic treatment.

![Fig. 2. Endoscopic hemostasis for postprocedural bleeding after endoscopic submucosal dissection (ESD).](image)
(A) Active bleeding from the ESD induced ulcer with visible vessel. (B) Endoscopic hemostasis using hemoclips.)
Postoperative Bleeding Complication

Surgical treatment is an essential part for the management of disease. And increasing demand for digestive surgery is estimated. Because the global incidence of digestive cancer has increased, largely due to the population aging and population growth. Moreover, the number of bariatric operations performed globally is increasing due to the increasing prevalence of obesity. Although postoperative bleeding is an uncommon complication and mostly self-limiting, complications from surgery should not be ignored considering the increasing burden of digestive surgery. Moreover, postoperative bleeding can prolong hospital stay and result in morbidity and mortality, particularly in critically ill patients.

Postoperative bleeding can be intraluminal or extraluminal. Indeed, a significant proportion of hemorrhage is extraluminal and combined intra/extra-luminal bleeding is not uncommon. Intraluminal GI bleeding can be caused by a ruptured pseudoaneurysm secondary to an anastomotic leak after pancreaticoduodenectomy. Endoscopy is a reliable modality for the management of intraluminal GI bleeding. However, in case of bleeding involving extraluminal component, endoscopy can fail to detect the exact site and amount of hemorrhage delaying the appropriate intervention such as angiographic embolization or surgery.

Making decisions regarding treatment for postoperative bleeding is complicated and should take into consideration the type of surgery, accessibility of the bleeding site, time after surgery, and comorbidities. Because postoperative bleeding is associated with significant morbidity and mortality, the risks and benefits of therapeutic interventions, including conservative modalities, should be considered.

Postoperative GI Bleeding after GI Surgery

Postoperative GI bleeding can be caused by surgery itself or a surgery-related condition. Marginal ulcers may develop from mucosal ischemia originating from perfusion defects, anastomosis tension, or sutures material. Although bleeding from suture line is a major source of intraluminal GI bleeding, stress-related mucosal damage can cause upper GI bleeding. Gastritis, duodenitis, gastric ulcer, and duodenal ulcer can be caused by colorectal or non-GI surgery such as cardiothoracic or vascular surgery. Mallory-Weiss tear can be caused by postoperative nausea and vomiting. Importantly, comorbidities are closely related to the risk of postoperative bleeding. The number of postoperative complications is associated with the number of comorbidities in a study of gastric cancer patient.

The incidence of postoperative bleeding varies from 0.22% to 8.4% according to the type of surgery and the definition used. The presentation of postoperative bleeding varies according to its site and extent, from an asymptomatic decrease in hemoglobin level to overt signs of hemorrhage and hemodynamic instability. Hematemesis is a common clinical presentation after GI surgery. Hematemesis was reported in 73% of patients with GI bleeding in a retrospective study involving 933 patients who underwent Roux-en-Y gastric bypass (RYGB) surgery. The frequent hematemesis may be related to the small gastric pouch with a limited gastric reservoir.

In the literature, endoscopic treatment was performed in 4.5% to 100% of patients with intraluminal GI bleeding and has a success rate of 20% to 100% (Table 3). Hemo-clips, epinephrine injection, fibrin glue, argon plasma coagulation,
or a coagulation grasper or heater probe may be used to control GI hemorrhage.\(^{98,102,104,106,107,109,117–122,124–127}\)

The success rate of endoscopic treatment is related to the type of surgery. The different accessibility to the bleeding focus is a main reason for this (Fig. 5). Endoscopic treatment is relatively difficult for RYGB or pancreaticoduodenectomy compared to gastrectomy or colectomy.\(^{106,107,109,118,119}\)

The hemostasis success rate after gastrojejunostomy is favorable.\(^{117,118,126}\) Moreover, a bleeding focus in the anastomotic ring may be associated with the success of hemostasis. In a retrospective study of 16,591 patients who had undergone gastrectomy, the hemostasis success rate was highest on the anterior wall (100%) and lowest on the posterior wall (50%)

From Table 2, Studies Reporting on the Procedure Related Bleeding in the Colorectum

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of patients (no. of lesions)</th>
<th>Indication</th>
<th>Treatment</th>
<th>Incidence (%)</th>
<th>Mortality (%)(^*)</th>
<th>Risk factors</th>
<th>Bleeding control</th>
<th>Success (%)</th>
<th>Rescue therapy (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okamoto et al(^{15})(2017)</td>
<td>451 (509)</td>
<td>Colorectal tumor</td>
<td>ESD</td>
<td>3.1</td>
<td>NA</td>
<td>Antithrombotic therapy, rectal lesion</td>
<td>Endoscopy (100%)</td>
<td>92.9</td>
<td>Surgery (1)</td>
</tr>
<tr>
<td>Ogasawara et al(^{16})(2016)</td>
<td>124 (124)</td>
<td>Large lesion which en bloc resection by EMR would be difficult, cancer</td>
<td>ESD</td>
<td>8.1</td>
<td>0</td>
<td>Rectal lesion, arterial bleeding during ESD (≥ 3)</td>
<td>Endoscopy (60%), hemoclips, APC, coagulation forcep, conservative (40%)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Suzuki et al(^{14})(2014)</td>
<td>317 (327)</td>
<td>Lesion &gt; 20 mm, lesion with fibrosis, residual cancer, tumor with chronic inflammation</td>
<td>ESD</td>
<td>4.4</td>
<td>0</td>
<td>Cecal lesion, intra-procedural bleeding</td>
<td>Hemoclips</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Terasaki et al(^{15})(2014)</td>
<td>363 (377)</td>
<td>Lesion &gt; 20 mm, lesion with fibrosis, residual cancer, tumor with chronic inflammation</td>
<td>ESD</td>
<td>6.6</td>
<td>0</td>
<td>Rectal lesion</td>
<td>Hemoclips, coagulation forcep</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Park et al(^{16})(2018)</td>
<td>3,887 (8,175)</td>
<td>Polys ≥ 5 mm</td>
<td>Polypectomy</td>
<td>3.4</td>
<td>0</td>
<td>Age &lt; 50, immediate bleeding</td>
<td>Hemoclips, APC</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Kwon et al(^{17})(2015)</td>
<td>1,745</td>
<td>Polyps</td>
<td>Polypectomy</td>
<td>1.2</td>
<td>0</td>
<td>Polyps &gt; 10 mm, pedunculated polyp, right side colon, high BMI</td>
<td>Hemoclips, APC</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Choung et al(^{18})(2014)</td>
<td>3,788 (5,981)</td>
<td>Polyps ≥ 5 mm</td>
<td>Polypectomy</td>
<td>1.1</td>
<td>NA</td>
<td>Polyps &gt; 10 mm, right side colon, endoscopist’s experience (&lt; 300 cases)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Consolo et al(^{19})(2008)</td>
<td>1,038 (1,354)</td>
<td>Polyps</td>
<td>Polypectomy</td>
<td>1.3</td>
<td>0</td>
<td>Cardiac disease, tubular adenoma, polyp size</td>
<td>Endoscopy (100%), adrenalin injection, hemoclips, APC</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Kim et al(^{20})(2013)</td>
<td>3,253 (7,447)</td>
<td>Polyps</td>
<td>Polypectomy, EMR, ESD</td>
<td>1.3</td>
<td>0</td>
<td>Polyps &gt; 10 mm, pedunculated polyp, right side colon</td>
<td>Endoscopy (68%), conservative (32%)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Burgess et al(^{21})(2014)</td>
<td>1,172</td>
<td>Polyps ≥ 2 cm</td>
<td>EMR</td>
<td>6.2</td>
<td>0</td>
<td>Proximal colon, IPB</td>
<td>Endoscopy (100%), thermal therapy, hemoclips, epi-nephrine</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Metz et al(^{22})(2011)</td>
<td>288 (302)</td>
<td>LST &gt; 2 cm</td>
<td>EMR</td>
<td>7</td>
<td>0</td>
<td>Right colon, use of aspirin, age</td>
<td>Endoscopy (48%), hemoclips, coagulation forcep, conservative (52%)</td>
<td>80</td>
<td>Embolization (1), surgery (1)</td>
</tr>
</tbody>
</table>

EMR, endoscopic mucosal resection; ESD, endoscopic submucosal dissection; NA, not applicable; APC, argon plasma coagulation; BMI, body mass index; IPB, intraprocedural bleeding; LST, laterally spreading tumor.

* Bleeding related mortality.
† Success rate for endoscopic treatment.

The success rate of endoscopic treatment is related to the type of surgery. The different accessibility to the bleeding focus is a main reason for this (Fig. 5). Endoscopic treatment is relatively difficult for RYGB or pancreaticoduodenectomy compared to gastrectomy or colectomy.\(^{106,107,109,118,119}\) The hemostasis success rate after gastrojejunostomy is favorable.\(^{117,118,126}\) Moreover, a bleeding focus in the anastomotic ring may be associated with the success of hemostasis. In a retrospective study of 16,591 patients who had undergone gastrectomy, the hemostasis success rate was highest on the anterior wall (100%) and lowest on the posterior wall (50%)

Therefore, easy accessibility with a right angle is crucial part for successful hemostasis.

**Endoscopic Treatment of Postoperative GI Bleeding**

Endoscopy for postoperative GI bleeding enables identification of the bleeding site, treatment of the bleeding, and estimation of the risk of rebleeding.\(^{114}\) Although there was concern about a risk of anastomotic disruption and perforation during endoscopic procedures performed immediately after surgery,\(^{129}\) endoscopy was reported to be safe without significant complications even in the early postoperative period in recent studies.\(^{117,118,121,128,130}\)
In a randomized controlled study of patients with recurrent ulcer bleeding, the success rates of endoscopic and surgical treatment were not significantly different, and complications were less common after endoscopic treatment. Endoscopic hemostasis should initially be attempted for postoperative intraluminal hemorrhage. The hemostatic technique for postoperative bleeding does not differ from that of conventional GI bleeding (Fig. 6). Clipping, epinephrine injection, electrocoagulation, and argon plasma coagulation are the available options for hemostasis. Hemoclips are more durable for anastomotic bleeding and do not injure tissue, unlike sclerosant injection or electrocoagulation, and can be used to manage anastomotic leaks or iatrogenic perforations. However, hemoclips application can be technically difficult due to a poor axis caused by anatomical distortion after surgery. No RCT has compared the therapeutic efficacies of the various modalities for postoperative hemorrhage. However, Lee et al reported that the rate of rebleeding was significantly higher after epinephrine and/or heater probe coagulation than after hemoclip application (33% vs 5%). In cases of diffuse bleeding in which hemostasis is not achieved by conventional modalities, hemospray can be used in the early postoperative period. For the refractory bleeding, the OTSC has an acceptable success rate.

**Surgery-Specific Considerations**

**Bariatric surgery**

Sleeve gastrectomy is the most commonly performed procedure worldwide (45.9%), followed by RYGB (39.6%). Bleeding can arise from multiple sites (e.g., anastomoses, staple lines, the pouch, the contiguous small intestine, the excluded stomach, or the bypassed small intestine). Early bleeding usually occurs at the staple lines of the gastrojejunal anastomosis and has an incidence of 1% to 5% after RYGB and 0% to 8% after sleeve gastrectomy. Late bleeding is usually secondary to an anastomotic ulcer. Upper endoscopy can be performed to access the gastrojejunal anastomosis.

However, the diagnosis can be particularly difficult when the source of the bleeding is in the bypassed gastric remnant, proximal duodenum, or biliopancreatic limb. Excluded GI segments after Roux-en-Y reconstruction can be accessed using double-balloon enteroscopy. Alternatively, laparoscopic- or laparotomy-assisted endoscopy can be performed. Bleeding at the gastrojejunal anastomosis can be treated endoscopically in conjunction with standard hemostatic modalities (epinephrine injection, thermal therapy, and hemoclip clipping). Hemoclip clipping is
<table>
<thead>
<tr>
<th>Study</th>
<th>No. of lesions</th>
<th>Indication</th>
<th>Types of surgery</th>
<th>Bleeding site</th>
<th>Incidence (%)</th>
<th>Mortality (%)</th>
<th>Risk factors</th>
<th>Bleeding control</th>
<th>Success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee et al. (2017)</td>
<td>16,591</td>
<td>Gastric cancer</td>
<td>Gastrectomy</td>
<td>Anastomosis</td>
<td>0.22</td>
<td>0.02</td>
<td>Type of gastrectomy (subtotal)</td>
<td>Endoscopy (69%), surgery (17%), conservative (14%)</td>
<td>64</td>
</tr>
<tr>
<td>Kim et al. (2012)</td>
<td>2,031</td>
<td>Gastric cancer</td>
<td>Gastrectomy</td>
<td>Gastrojejunostomy, gastroduodenostomy, esophagojejunostomy</td>
<td>0.3</td>
<td>0</td>
<td>B-II anastomosis, manual anastomosis</td>
<td>Endoscopy (85%), conservative (14%)</td>
<td>100</td>
</tr>
<tr>
<td>Tanizawa et al. (2010)</td>
<td>1,400</td>
<td>Gastric cancer</td>
<td>Gastrectomy</td>
<td>Gastroduodenostomy (50%), gastrojejunostomy, staple line of stomach, esophagojejunostomy</td>
<td>0.43</td>
<td>0</td>
<td>Lymph node dissection (≤ D1)</td>
<td>Endoscopy (83%), surgery (17%)</td>
<td>100</td>
</tr>
<tr>
<td>Lim et al. (2012)</td>
<td>393</td>
<td>Gastric cancer</td>
<td>Gastrectomy</td>
<td>Anastomosis</td>
<td>2.8</td>
<td>0</td>
<td>NA</td>
<td>Endoscopy (82%), conservative (73%)</td>
<td>89</td>
</tr>
<tr>
<td>Jeong et al. (2011)</td>
<td>1,027</td>
<td>Gastric cancer</td>
<td>Gastrectomy</td>
<td>Anastomosis (91%), pseudoaneurysm (19%)</td>
<td>1.6</td>
<td>0</td>
<td>Operating time ≥ 3 hr, BMI ≥ 26 kg/m²</td>
<td>Endoscopy (12.5%), surgery (19%), conservative (69%)</td>
<td>100</td>
</tr>
<tr>
<td>Kim et al. (2008)</td>
<td>1,485</td>
<td>Gastric cancer</td>
<td>Gastrectomy</td>
<td>NA</td>
<td>1.3</td>
<td>0</td>
<td>Comorbidity, surgeon’s experience</td>
<td>Endoscopy (25%), conservative (75%)</td>
<td>100</td>
</tr>
<tr>
<td>Park et al. (2010)</td>
<td>5,739</td>
<td>Gastric cancer</td>
<td>Gastrectomy</td>
<td>Anastomosis</td>
<td>0.8</td>
<td>0</td>
<td>Male, comorbidity, previous abdominal operation, palliative surgery</td>
<td>Endoscopy (28.6%), surgery (18.6%), conservative (42.9%)</td>
<td>50</td>
</tr>
<tr>
<td>Fernández-Esparza et al. (2008)</td>
<td>381</td>
<td>Bariatric</td>
<td>RYGB</td>
<td>Anastomosis</td>
<td>5.8</td>
<td>0</td>
<td>NA</td>
<td>Endoscopy (27%), conservative (73%)</td>
<td>100</td>
</tr>
<tr>
<td>Junil et al. (2008)</td>
<td>933</td>
<td>Bariatric</td>
<td>RYGB</td>
<td>Gastrojejunostomy (100%)</td>
<td>3.2</td>
<td>0.1</td>
<td>NA</td>
<td>Endoscopy (80%), conservative (20%)</td>
<td>100</td>
</tr>
<tr>
<td>Rahl et al. (2011)</td>
<td>742</td>
<td>Bariatric</td>
<td>RYGB</td>
<td>Gastrojejunostomy</td>
<td>0.54</td>
<td>0</td>
<td>NA</td>
<td>Endoscopy (75%)</td>
<td>100</td>
</tr>
<tr>
<td>Fernández de Sevilla Gómez et al. (2014)</td>
<td>2,069</td>
<td>Malignancy, IBD</td>
<td>Colectomy, ileal resection</td>
<td>Anastomosis</td>
<td>3.17</td>
<td>0</td>
<td>NA</td>
<td>Endoscopy (4.5%), surgery (13.6%), angiography (13.6%), conservative (27%)</td>
<td>100</td>
</tr>
<tr>
<td>Lou et al. (2014)</td>
<td>2,181</td>
<td>Rectal cancer</td>
<td>Anterior resection</td>
<td>Anastomosis</td>
<td>0.3</td>
<td>0</td>
<td>NA</td>
<td>Endoscopy (100%)</td>
<td>100</td>
</tr>
<tr>
<td>Besson et al. (2016)</td>
<td>729</td>
<td>Cancer, diverticular disease</td>
<td>Left colectomy</td>
<td>Anastomosis</td>
<td>6.4</td>
<td>0</td>
<td>Stapled anastomosis, diverticular disease</td>
<td>Endoscopy (78.7%), conservative (24.3%)</td>
<td>100</td>
</tr>
<tr>
<td>Linn et al. (2008)</td>
<td>143</td>
<td>Cancer, benign lesion</td>
<td>Left colectomy, anterior resection</td>
<td>Anastomosis</td>
<td>4</td>
<td>0</td>
<td>Surgery for benign lesion</td>
<td>Endoscopy (17%), conservative (83%)</td>
<td>100</td>
</tr>
<tr>
<td>Feng et al. (2014)</td>
<td>840</td>
<td>Malignancy, benign tumor</td>
<td>Pancreaticoduodenectomy</td>
<td>Gastrojejunostomy (29%), marginal ulcer (25%), cholangiojejunostomy, pancreaticojejunostomy</td>
<td>3.3</td>
<td>1.1</td>
<td>Male, end to side pancreaticojejunos- tomy, small pancreatic duct</td>
<td>Endoscopy (60%)</td>
<td>47</td>
</tr>
<tr>
<td>Yekebas et al. (2007)</td>
<td>1,669</td>
<td>Pancreas neoplasm, pancreatitis</td>
<td>Pancreaticoduodenectomy, pancreaticojejunos- tomy</td>
<td>Gastrojejunostomy, enteroc- enteric anastomosis</td>
<td>2.2</td>
<td>0.1</td>
<td>Pancreatic fistula</td>
<td>Endoscopy (42%)</td>
<td>20</td>
</tr>
<tr>
<td>Wei et al. (2009)</td>
<td>628</td>
<td>Periampullary lesion</td>
<td>Pancreaticoduodenectomy</td>
<td>Pancreatico- gastrostomy (33%)</td>
<td>2.2</td>
<td>0.9</td>
<td>Pancreatic leakage intraabdominal-abscence</td>
<td>Endoscopy (38.1%)</td>
<td>NA</td>
</tr>
<tr>
<td>Chen et al. (2015)</td>
<td>703</td>
<td>Periampullary cancer</td>
<td>Pancreaticoduodenectomy</td>
<td>NA</td>
<td>3.8</td>
<td>NA</td>
<td>Pancreatic fistula, abdominal infections</td>
<td>Endoscopy (26%)</td>
<td>57.1</td>
</tr>
</tbody>
</table>

B-II, Billroth-II; NA, not applicable; BMI, body mass index; RYGB, Roux-en-Y gastric bypass; IBD, inflammatory bowel disease.
*Bleeding related mortality.
†Success rate for endoscopic treatment.
the preferred method, and use of thermal therapy at the staple line and anastomosis site requires caution due to the risk of tissue injury.\textsuperscript{106}

\textbf{Pancreaticoduodenectomy}

Pancreaticoduodenectomy is a complex, high-risk surgery for tumors of the pancreatic head and other periampullary structures. The incidence of postpancreaticoduodenectomy hemorrhage is 2.5\% to 20.2\%,\textsuperscript{106} and the incidence of postoperative intraluminal GI bleeding is 2.2\% to 8.4\%.\textsuperscript{105–109} Standard pancreaticoduodenectomy involves distal gastrectomy, duodenectomy, partial pancreatectomy, partial choledochectomy, cholecystectomy, and proximal jejunectomy. Therefore, the procedure involves three anastomoses (gastrojejunostomy, hepaticojejunostomy, and pancreaticojejunostomy). Pylorus-preserving pancreaticoduodenectomy preserves the stomach, pylorus, and the proximal duodenum, which is anastomosed to the jejunum.\textsuperscript{138}

Bleeding can occur at the gastrojejunostomy, hepaticojejunostomy, pancreaticojejunostomy, and/or duodenojejunostomy suture line. In cases of suspected GI bleeding, endoscopy is used to identify the bleeding site and achieve hemostasis. However, the success rate of endoscopic treatment after pancreaticoduodenectomy is less than 60\%,\textsuperscript{106,107,109} possibly due to interference by blood clots in the stomach and because of difficulty accessing the pancreaticojejunostomy suture line if the field of view is obscured by active bleeding.\textsuperscript{139}

\textbf{Conclusion}

Postoperative and procedure-related bleeding are uncommon complications, but can prolong the hospital stay and result in significant morbidity and mortality. Endoscopic modalities are first-line options for surgery- or procedure-related GI bleeding as they enable localization and the control of bleeding. However, data on the efficacy of the available treatment modalities are insufficient. Moreover, the efficacy of these modalities is affected by the postoperative anatomy and bleeding location. Treatment decisions should take into consideration, among other factors, the type of surgery or endoscopic procedure. Hemostasis can be achieved using various endoscopic modalities, which have acceptable success rate and safety profiles.

\textbf{Conflicts of Interest}

No potential conflict of interest relevant to this article was reported.
References


factors for postoperative bleeding in endoscopic submucosal dissection of colorectal tumors. Oncology. 2017;93 Suppl 1:35–42.


Linn TY, Moran BJ, Cecil TD. Staple line haemorrhage following open colorectal resections may be more common when the inferior mesenteric artery is preserved. Tech Coloproctol. 2008;12:289-93.


**Our Goals:**

- **Multi-disciplinary Collaboration to promote world-wide Expertise**
  Establish a comprehensive GI intervention network among endoscopists, interventional radiologists and gastrointestinal surgeons for multidisciplinary collaboration and interaction.

- **Sharing and advancing technological Innovations**
  Inform, promote and globalize the many outstanding technological innovations of each of the specialties.

- **Foster future Specialists**
  Aid young brilliant doctors to make an early debut on the international stage through SGI.

- **Become a Role Model**
  Showcasing the benefits of multi-disciplinary collaboration in science, education and clinical practice.