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Clinical features of postoperative anastomotic bleeding after gastrectomy and efficacy of endoscopic hemostasis: a case–control study

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Abstract
Background Postoperative anastomotic bleeding (PAB) is relatively rare; however, it can be lethal if not treated immediately. The aim of our study was to investigate the clinical features of PAB and the efficacy of endoscopic hemostasis (EH) for PAB.
Methods Between January 2004 and May 2013, 16,591 patients underwent gastrectomy for gastric cancer at Asan Medical Center. Among them, 36 patients who experienced PAB within 2 months after the gastrectomy were enrolled as a case group. Each subject was matched at a ratio of 1:5 with randomly selected patients without bleeding during the same period ($n = 180$, control group). The clinical outcomes and risk factors for patients with PAB were compared with those of the control group, and the results of EH were evaluated retrospectively.
Results The incidence of PAB was 0.22% ($n = 36$), and the median duration from gastrectomy to PAB was 34.5 h (interquartile range, 12.3–132.8 h). EH was attempted in 25 patients (69.4%); surgery was performed in 6 patients (16.7%); and conservative management was applied in 5 patients (13.9%). PAB-related death occurred in three patients (8.3%; one in each treatment modality). Among 25 patients with primary EH, 16 were treated successfully (64%) and hemoclip was the most commonly used endoscopic tool (52%). In the multivariate analysis, the type of gastrectomy was found to be a risk factor for PAB (odds ratio 3.448, 95% confidence interval, 1.138–10.448, $p = .029$).
Conclusions Although PAB is an infrequent and potentially life-threatening complication, endoscopy can be considered as a useful method to avoid additional surgery in properly selected patients.

Keywords Anastomosis · Bleeding · Endoscopy · Gastrectomy

The standard treatment for gastric cancer has been radical gastrectomy with extended lymph node dissection [1, 2]. Improvements in operative techniques and perioperative management have enabled the safe performance of this surgery by well-trained gastrointestinal surgeons [3]. However, the morbidity of gastrectomy with lymphadenectomy has been reported to range from 13 to 24% [4]. The major complications of radical gastrectomy are primarily related to the anastomotic site, including anastomotic leakage, stricture, and bleeding [5]. Compared with leakage and stricture, postoperative anastomotic bleeding (PAB) is relatively rare, with a reported incidence of 0–2% [4, 6, 7]. Usually, PAB is self-limited or can be managed with conservative treatment [6, 8, 9]. However, some cases such as continuous and massive bleeding can result in fatal outcomes in the absence of immediate intervention.

The available options for the management of PAB include reoperation, endoscopic intervention, and radiologic intervention [10]. Recently, owing to consistent advances in endoscopic techniques and instrumentation, endoscopic treatment has been frequently chosen for treatment of PAB [10]. However, there have been only a

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few reports that focused on anastomotic bleeding as a complication of gastrectomy, and the previous reports about endoscopic therapy in PAB were limited to case reports and small case series [5, 7, 11, 12].

Therefore, in the present study, we aimed to investigate the clinical features and outcomes of PAB compared with cases without bleeding. In addition, we also attempted to determine the efficacy of endoscopic treatment for PAB according to the treatment modalities and the location of bleeding in the anastomotic ring.

Patients and methods

Between January 2004 and May 2013, 16,591 patients underwent gastrectomy for gastric cancer at Asan Medical Center, Seoul, Korea. Among them, those patients who experienced PAB within 2 months after gastrectomy were enrolled as a case group. Each subject was matched at the ratio of 1:5 with randomly selected patients without bleeding during the same period (control group). The clinical outcomes and risk factors for patients with PAB were compared with those of the control group by means of a retrospective chart review, including demographic and clinical data such as endoscopic and surgical management techniques. This study was approved by the institutional review board of Asan Medical Center (2015-0517).

Diagnosis of PAB

The diagnosis of PAB was based on a combination of clinical presentation and endoscopic findings that required hemodynamic resuscitation. Clinical diagnosis of PAB was defined as massive bleeding leading to symptoms such as hematemesis, melena, hematochezia and/or dizziness, and/or bloody drainage through a nasogastric tube. Endoscopic findings of PAB were defined as active bleeding or stigmata of recent bleeding at the anastomotic ring.

Management of bleeding

There was no standard protocol for the treatment of PAB; the treatment method was decided at the discretion of the attending surgeon. Some of the options include endoscopic, surgical, and/or conservative management. In this study, the endoscopic procedure was performed without conscious sedation after basic life support, such as intravenous fluid and/or blood transfusion, was provided. A single-channel endoscope (GIF-H260 or GIF-Q260; Olympus Optical Co., Ltd, Tokyo, Japan) was used. To avoid endoscopy-related complications, air inflation and scope control were performed cautiously and impellent exploration to find bleeding focus was discouraged. Single or combination methods with metal hemoclips (HX-600-090L or HX-110LR; Olympus Optical Co., Ltd), epinephrine (1:10,000 solution of epinephrine), and/or fibrin glue (Beriplast P 3 mL Combi-Set; Behring Pharma, Tokyo, Japan) were applied for hemostasis (Fig. 1). Surgery was performed under general anesthesia and through the previous upper midline incision. The major procedure was suture ligation and reinforcement at the anastomotic site after evacuating the intraluminal hematoma; if this was not feasible, revision of the primary bypass was considered. Conservative treatment included transfusion, intravenous proton pump inhibitor, fasting, and full parenteral nutrition.

Definition

Technical success was defined as complete access and successful control of bleeding after the endoscopic, surgical, or conservative management. Technical failure was defined as impossible access due to massive hemorrhage, continuous bleeding despite hemostatic procedure, and rebleeding at the anastomotic site during hospitalization or after discharge. Rebleeding was defined as hemorrhage verified on follow-up endoscopy, or the presence of hematemesis, melena, hematochezia, and/or bloody nasogastric drainage combined with either shock or a decline in hemoglobin levels >2.0 g/dL after the initial bleeding had stopped. Mortality was defined as death directly associated with bleeding. The gastric cancer stage was classified according to the seventh edition of the American Joint Committee on Cancer staging criteria [13].

Statistical analysis

Continuous variables are reported as medians and ranges, and categorical variables as percentages. Differences between categorical variables were tested by using Pearson's Chi-square test or Fisher's exact test, and continuous variables were tested by using Student's two-tailed test (normal distribution) or the Mann–Whitney *U* test (skewed distribution). Univariate and multivariate analyses were conducted by using a logistic regression model to identify the risk factors for PAB. A p value of <0.05 was considered statistically significant, and data were analyzed with the Statistical Package for the Social Sciences software (version 19.0; SPSS Inc., Chicago, IL, USA).

Results

Among 16,591 patients who underwent gastrectomy for gastric cancer, 36 patients (0.22%) experienced PAB (33 during hospitalization and 3 after discharge). The median

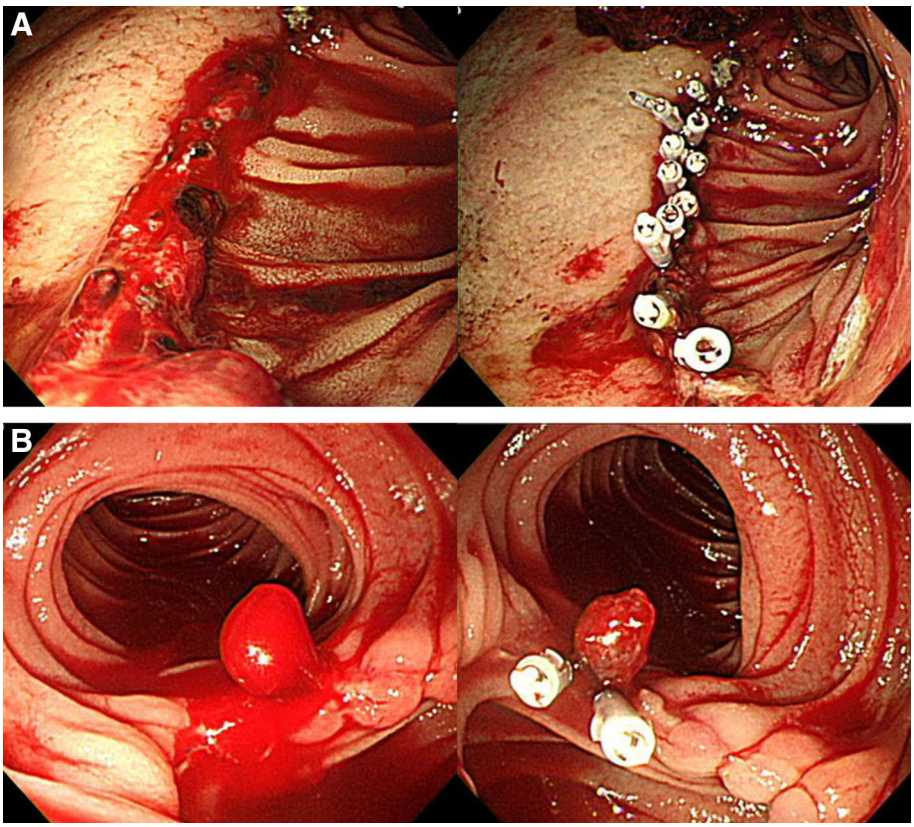

Fig. 1 Endoscopic intervention of postoperative anastomotic bleeding. **A** Endoscopic view of the gastrojejunostomy site with oozing bleeding and after hemostasis with hemoclips, **B** endoscopic view of the jejunojejunostomy site with exposed vessel and oozing bleeding, and after hemostasis with hemoclips

time interval between gastrectomy and bleeding was 34.5 h (range, 1–550 h). Twenty-eight cases of PAB (77.8%) were confirmed on endoscopic examination, and the other eight cases were detected on the basis of clinical presentation, including bloody drainage through a nasogastric tube. Endoscopic and surgical hemostases were applied to 25 patients (69.4%) and 6 patients (16.7%), respectively. Five patients (13.9%) were treated with conservative management (Fig. 2).

Clinical characteristics and outcomes of patients with and without PAB

Table 1 shows the clinical characteristics and comparison of patients with and without PAB. As a prophylaxis for venous thromboembolism during perioperative period, low molecular weight heparin was administered subcutaneously (1 mg/kg once daily) in 50% of the case group and in 39.4% of the control group ($p = 0.240$). In the case group, the median hospitalization duration was longer than that of the control group (12.5 vs. 9 days, $p = 0.001$). Five patients died—three (8.3%) due to PAB-related complications and two due to progression of advanced gastric cancer.

Surgical characteristics of patients with and without PAB

The surgical characteristics of the patients with PAB are shown in Table 2. The rate of subtotal gastrectomy was significantly higher in the case group (88.9%) than in the control group (67.8%) ($p = 0.011$). As an anastomotic instrument, circular staplers, including end-to-end anastomosis stapler and curved detachable head stapler, were the most commonly used (61.1 and 68.3%), followed by linear staplers such as gastrointestinal anastomosis stapler and totally laparoscopic colectomy stapler (25 and 27.2%), and manual suture (13.9 and 4.4%) in both groups. In the comparison of stapler anastomosis and manual anastomosis, the rate of manual anastomosis was significantly higher in the PAB group ($p = .046$). On pathology, the rate of early gastric cancer was higher than that of advanced gastric cancer in both groups (72.2% in the case group and 60.6% in the control group). In the histological results, the undifferentiated type accounted for 50% in the case group and 60% in the control group.

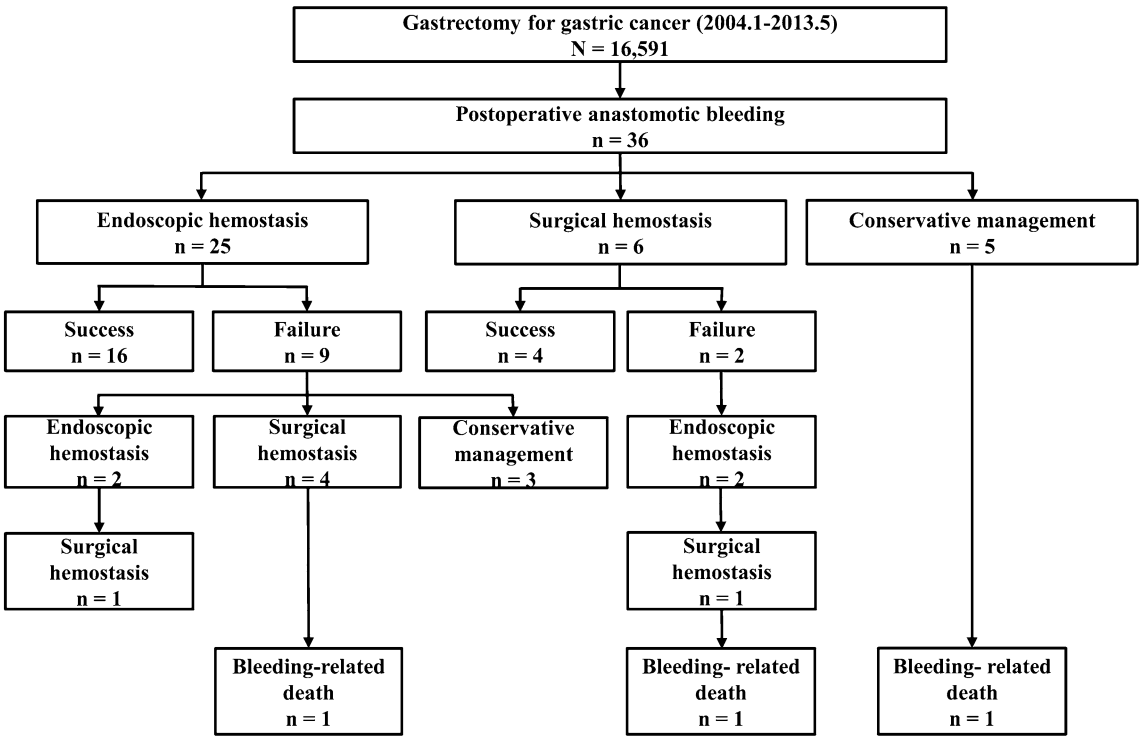

Fig. 2 Flowchart of treatment results in postoperative anastomotic bleeding

Table 1 Clinical characteristics and outcomes of patients with and without postoperative anastomotic bleeding

	Case group ($n = 36$)	Control group ($n = 180$)	p value
Age, median (IQR), years	60 (48–66)	56.5 (48.3–66)	.575
Sex, male/female, *n* (%)	28 (77.8)/8 (22.2)	121 (67.2)/59 (32.8)	.211
Underlying diseases, *n* (%)	14 (38.9)	72 (40)	.901
Hypertension	8 (22.2)	47 (26.1)	.625
Diabetes mellitus	7 (19.4)	21 (11.7)	.273
Liver cirrhosis	1 (2.8)	2 (1.1)	.423
BMI, median (IQR), kg/m^2	22.9 (21.4–24.3)	24.0 (21.7–26.4)	.174
Preoperative hemoglobin, median (IQR), mg/dL	14 (12.8–15.0)	13.6 (12.2–14.7)	.295
Postoperative anticoagulant, *n* (%)	18 (50)	71 (39.4)	.240
Hospital days, median (IQR)	12.5 (10–18.8)	9 (8–10.8)	.001
Death/bleeding-related death, *n* (%)	5 (13.9)/3 (8.3)	35 (19.4)/0 (0)	.433/.004

n number, *IQR* interquartile range, *BMI* body mass index

Risk factors for PAB

Univariate logistic regression analysis showed that the type of gastrectomy and type of anastomotic instrument were significant risk factors for PAB (odds ratio 3.803, 95% confidence interval [CI] 1.285–11.260 [$p = .016$] and odds ratio 2.468, 95% CI 1.065–11.296 [$p = .039$], respectively). In multivariate analysis, subtotal gastrectomy in the type of gastrectomy was identified as a risk factor for PAB with significance (odds ratio 3.448, CI 1.138–10.448, $p = .029$) (Table 3).

Clinical characteristics and treatment outcomes of PAB according to treatment methods

Table 4 shows the clinical characteristics and treatment outcomes of PAB according to three treatment approaches. More than 80% of PAB patients in each treatment group underwent subtotal gastrectomy; in the conservative treatment group, all patients underwent open subtotal gastrectomy. The median time intervals from gastrectomy to PAB were 45 h (interquartile range [IQR], 21.5–126 h) in the endoscopy group, 7.5 h (IQR, 1.0–73.5 h) in the surgery

Table 2 Surgical characteristics of patients with and without PAB

	Case group ($n = 36$)	Control group ($n = 180$)	p value
Mode of operation			.400
Open, *n* (%)	22 (61.1)	123 (68.1)	
Laparoscopic, *n* (%)	14 (38.9)	57 (31.7)	
Type of gastrectomy			.011
Total, *n* (%)	4 (11.1)	58 (32.2)	
Subtotal, *n* (%)	32 (88.9)	127 (67.8)	
Reconstruction method			.591
Billroth-I, *n* (%)	15 (41.7)	71 (39.4)	
Billroth- II, *n* (%)	5 (13.9)	14 (7.8)	
R-en-Y, *n* (%)	10 (27.8)	65 (36.1)	
Delta, *n* (%)	6 (16.7)	30 (16.7)	
Anastomotic instrument			.094
Circular stapler, *n* (%)	22 (61.1)	123 (68.3)	
Linear stapler, *n* (%)	9 (25.0)	49 (27.2)	
Hand sewn, *n* (%)	5 (13.9)	8 (4.4)	
Specimen size, median (IQR), mm	190 (147.8–237.5)	191.5 (150–238.8)	.467
Tumor size, median (IQR), mm	29.5 (20–40)	35 (24–59)	<.005
Dissected LN, median (IQR)	28 (19.8–36.5)	28 (20–37)	.617
Stage (I/II/III/IV), *n* (%)[a]	26 (72.2)/8 (22.2)/2 (5.6)/0 (0)	109 (60.6)/31 (17.2)/39 (21.7)/1 (0.6)	.147
Histology, differentiated/undifferentiated, *n* (%)[b]	18 (50)/18 (50)	71 (39.4)/109 (58.8)	.240
Operation time, median (IQR), min	138.5 (114–159.8)	135 (113–168.25)	.447

LN lymph node, *n* number, *IQR* interquartile range

[a] Based on the seventh tumor–node–metastasis classification of the American joint committee on cancer

[b] Differentiated histology includes the well- and moderate-differentiated types, and undifferentiated histology includes the poorly differentiated type and signet ring cell

Table 3 Logistic regression analysis for risk factors for postoperative anastomotic bleeding

	Univariate analysis		Multivariate analysis	
	Odds ratio (95% CI)	p value	Odds ratio (95% CI)	p value
Age	1.009 (0.978–1.042)	.574		
Sex	1.707 (0.733–3.973)	.215	1.474 (0.611–3.552)	.388
Hypertension	0.809 (0.344–7.898)	.625		
Diabetes mellitus	1.828 (0.712–4.69)	.210	1.776 (0.645–4.888)	.266
Operation time	1.003 (0.996–1.009)	.449		
Preoperative anticoagulant	1.535 (0.748–3.149)	.242	1.658 (0.751–3.662)	.211
Specimen size	0.998 (0.991–1.004)	.466		
Dissected lymph nodes	0.992 (0.963–1.023)	.616		
Mode of operation				
Open vs. laparoscopy	1.373 (0.655–2.878)	.401		
Type of gastrectomy				
Subtotal vs. total	3.803 (1.285–11.260)	.016	3.448 (1.138–10.448)	.029
Anastomotic instrument				
Manual vs. stapler	2.468 (1.065–11.296)	.039	3.116 (0.881–11.015)	.078

CI confidence interval

Table 4 Clinical characteristics and treatment outcomes of patients with postoperative anastomotic bleeding according to the treatment methods

	Endoscopic treatment ($n = 25$)	Surgery ($n = 6$)	Conservative treatment ($n = 5$)
Mode of operation			
Open, *n* (%)	14 (56.0)	3 (50.0)	5 (100)
Laparoscopic, *n* (%)	11 (44)	3 (50.0)	0 (0)
Type of gastrectomy			
Total, *n* (%)	3 (12.0)	1 (16.7)	0 (0)
Subtotal, *n* (%)	22 (88.0)	5 (83.3)	5 (100)
Reconstruction methods			
Billroth-I, *n* (%)	12 (48.0)	1 (16.7)	2 (40)
Billroth- II, *n* (%)	1 (4.0)	2 (33.3)	2 (40)
R-en-Y, *n* (%)	7 (28.0)	2 (33.3)	1 (20)
Delta, *n* (%)	5 (20.0)	1 (16.7)	0 (0)
Dissected LN, median (IQR), *n*	27 (22–37)	30 (20–43.75)	13 (5.5–31)
Operation time, median (IQR), min	130 (111–151)	140 (121–170.5)	178 (145–232.5)
Time interval to PAB, median (IQR), h	45 (21.5–126)	7.5 (1.0–73.5)	36 (7.5–199.5)
Symptom and sign			
Hematemesis, *n* (%)	9 (36)	3 (50)	2 (40)
Melena, *n* (%)	5 (20)	0 (0)	2 (40)
Hematochezia, *n* (%)	9 (36)	1 (16.7)	0 (0)
BP drop, *n* (%)	11 (44.0)	2 (33.3)	1 (20)
Postoperative anticoagulation, *n* (%)	14 (56.0)	4 (66.7)	0 (0)
Transfusion, median (IQR), *n*	6 (3–13.5)	10 (7.5–18)	7 (2.5–7.5)
Hospital days, median (IQR)	13 (10–19.5)	12.5 (7–19.25)	12 (9.5–19)
Treatment failure, *n* (%)	9 (36)	2 (33.3)	0 (0)
Mortality (overall/PAB-related), *n* (%)	1 (4)/1(4)	2 (33.3)/1 (16.7)	2 (40)/1 (20)

n number, *IQR* interquartile range, *LN* lymph node, *PAB* postoperative anastomotic bleeding, *BP* blood pressure

group, and 36 h (IQR, 7.5–199.5 h) in the conservative treatment group, without statistical significance. The median hospitalization duration was similar among the three groups (12–13 days).

Sixteen cases of PAB (64%) were controlled successfully with primary endoscopic treatment. However, nine patients with hemostasis failure of endoscopy received secondary treatment: endoscopic hemostasis in two, surgical hemostasis in four, and conservative management in three patients. One patient experienced bleeding control failure after secondary endoscopic treatment and underwent surgery as a tertiary treatment, with a favorable result. One patient who had undergone total gastrectomy as a secondary treatment died of bleeding-related complication (consecutive anastomotic leakage with septic shock). In the endoscopic hemostasis group, the rate of bleeding-related mortality was 4%. Among six patients who underwent primary surgical therapy, four achieved successful hemostasis and two received secondary endoscopic therapy. On the 18th day after primary hemostasis, recurrent bleeding occurred in one patient, who, despite tertiary treatment with surgery, died of uncontrolled bleeding. In the surgical hemostasis group, the bleeding-related mortality rate was 16.1%. Among five patients managed with conservative treatment, one patient who had underlying alcoholic liver cirrhosis died of disseminated intravascular coagulopathy after massive transfusion of fresh frozen plasma and red blood cells. At the time of endoscopic examination, he had only bleeding stigma of recent bleeding with old blood clot at the anastomotic ring and, thus, was not provided endoscopic hemostasis (Fig. 2).

Endoscopic characteristics of patients who underwent endoscopic hemostasis

Among 25 patients who underwent endoscopic therapy, 16 achieved successful hemostasis and 9 experienced hemostasis failure. In the group with failed hemostasis, the endoscopists failed to detect the bleeding focus in six patients owing to massive hemorrhage occupying the

whole space of the remnant lumen, and another procedure was required for bleeding control. Among the endoscopic tools used for hemostasis were hemoclips (52%), epinephrine injection (32%), and fibrin glue injection (24%), alone (76%) or in combination (24%). Hemoclips were the most commonly chosen tool in both the success and failure groups and were the main strategy in the combination approaches. The median number of clips used was 4 (IQR, 1–23), and the median amount of epinephrine and glue used was 13.5 mL (IQR, 5–20 mL) and 3 ampules (IQR, 1–6 ampules). The median and mean procedure time of endoscopic hemostasis was 17.5 min (range, 2–72) and 22.8 ± 19.3 min; 18 min (range, 9–70) and 25.2 ± 5.2 min in the success group, and 12 min (range, 2–72) and 17.8 ± 24.67 min in the failure group (Table 5). In the failure group, the cases with undetectable bleeding focus due to massive bleeding took mean 5.9 ± 6.12 min for endoscopy, whereas the cases with detected bleeding focus took mean 33.7 ± 33.29 min for endoscopic hemostasis. There were no adverse events like anastomotic rupture during endoscopic procedures.

Bleeding sites at the anastomotic ring were clearly identified in 21 patients and divided into four groups according to the wall side: anterior wall, posterior wall, greater curvature, and lesser curvature. The most common PAB sites in the anastomotic ring were the posterior wall side and the greater curvature side (29 and 29%, respectively), followed by the lesser curvature side (23%) and the anterior wall side (19%). The hemostasis success rate was highest in the anterior wall side (100%) and lowest in the posterior wall side (50%) ($p = .20$, Fig. 3).

Discussion

Although PAB occurs rarely, it is a potential adverse effect after any type of radical gastrectomy for gastric cancer. Few reports have focused on PAB, and each of them included only a small number of cases. According to these reports, the incidence of PAB ranges from 0 to 2% [4, 6, 7]. In the present study, PAB occurred in 36 patients (0.22%) after radical gastrectomy for gastric cancer. This is the largest number of reported PAB cases thus far, although not the highest incidence. Generally, PAB is self-limited and can be managed with conservative treatment. However, continuous or massive bleeding requires endoscopic or surgical treatment. Several previous studies reported successful results of endoscopic and surgical hemostasis without PAB-related mortality [4–7, 10]. In this study, 33 patients with PAB (91.7%) were successfully managed with conservative, endoscopic, or surgical treatment, and 3 patients (8.3%) died of PAB-related causes such as recurrent bleeding after repeated endoscopic procedures, anastomotic leakage after reoperation, and disseminated intravascular coagulopathy after massive transfusion. This study, with the largest number of PAB cases, showed both the good treatment outcome and the potential complications of PAB.

There has been a concern about anastomotic rupture during endoscopic procedure, and some studies had recommended surgical exploration as a mandatory approach for PAB. However, many recent studies revealed favorable outcomes of endoscopic therapy for PAB after gastrectomy and bypass surgery, even within 24 h after surgery

Table 5 Clinical courses and outcomes according to the results of endoscopic treatment

	Total ($n = 25$)	Success ($n = 16$)	Failure ($n = 9$)
Type of gastrectomy			
Total, *n* (%)	3 (12)	2 (12.5)	1 (11.1)
Subtotal, *n* (%)	22 (88)	14 (87.5)	8 (88.9)
Endoscopic tools			
Hemoclips	13 (52)	10 (62.5)	3 (33.3)
Epinephrine injection	8 (32)	7 (43.8)	1 (11.1)
Fibrin glue injection	6 (24)	4 (25)	2 (22.2)
Coagrasper	1 (4)	1 (6.3)	0 (0)
Combination, *n* (%)	6 (24)	4(25)	2 (22.2)
Procedure time, median (range), minutes	17.5 (2–72)	18 (9–70)	12 (2–72)
Second-line treatment, *n* (%)	6 (24)	–	6 (66.7)
Endoscopic hemostasis	2 (8)	–	2 (22.2)
Surgical hemostasis	4 (16)	–	4 (44.4)
Hospital days, median (IQR)	13 (10–19.5)	11.5 (9.3–13.8)	18 (12.5–38.5)
Mortality, *n* (%)	1 (4)	0 (0)	1 (11.1)

n number, *IQR* interquartile range

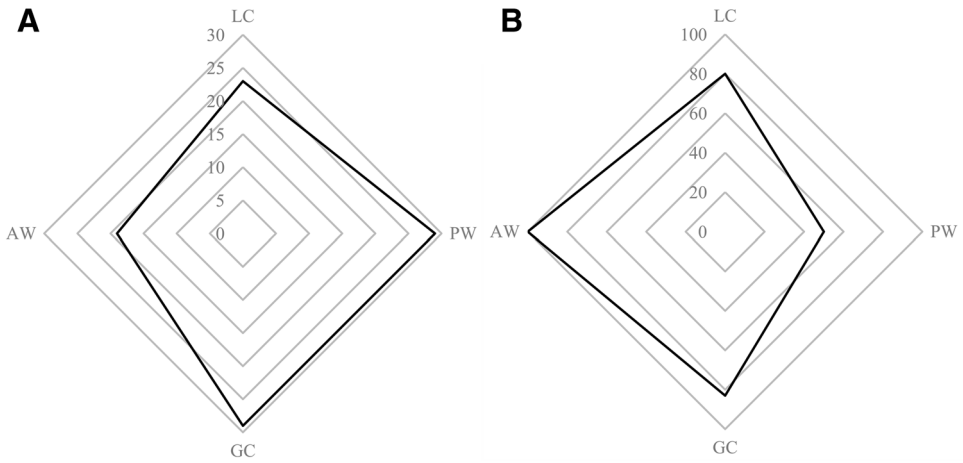

Fig. 3 Hemostasis success rate according to the bleeding site at the anastomotic ring. **A** Incidence of postoperative anastomotic bleeding at the anastomotic site, **B** success rate of endoscopic hemostasis according to the bleeding site at the anastomotic ring. *AW* anterior wall, *GC* greater curvature, *LC* lesser curvature, *PW* posterior wall

[5, 10–12, 14–16]. Endoscopy is a useful method in the exploration of PAB because it allows the identification and localization of the bleeding focus, the treatment of bleeding, and the estimation of the risk of recurrent bleeding [15]. In this study, endoscopic therapy was applied to 25 patients, 16 (64%) of whom achieved successful hemostasis. In the other six patients, therapeutic procedures could not be applied during endoscopy: in five owing to a large amount of blood occupying the remnant stomach and in one because of noncooperation during endoscopy. The endoscopic procedure was actually applied to 19 patients, and 84.2% (16 of 19) achieved successful hemostasis with no adverse events. This result is similar with those of previous studies [5, 10]. The endoscopic approach can be manipulated delicately to prevent complications and, in addition, is noninvasive compared with reoperation. Therefore, for the management of PAB, endoscopic treatment can be an effective option to avoid reoperation.

The hemostatic tools used during endoscopy in PAB are various and similar to those used in peptic ulcer bleeding [15]. In previous studies on PAB, epinephrine injection, hemoclips, and heater probes were used as either single or dual therapy [5, 10, 15, 17]. Kim et al. [10] reported seven cases of PAB in 2031 gastrectomy patients, and six were successfully controlled with endoscopic treatment (five with epinephrine injection and one with hemoclips). Tanizawa et al. [5] also reported six cases of PAB in 1400 gastrectomy patients, of which five patients had successful endoscopic treatment with hemoclips. In the present study, hemoclip was applied to 50% of PAB patients, and epinephrine injection was used in 32%. Each tool achieved a favorable hemostasis rate of >75%. About 25% of patients were treated with dual therapy, with hemoclip with injection being the common strategy. Dual therapy showed a slightly higher success rate than single therapy in the control of PAB (66.7 vs. 63.2%). The treatment outcome of endoscopic therapy can be affected by the location of bleeding [18]. The posterior wall of the duodenal bulb and lesser curvature and high body of the stomach are difficult areas to reach during endoscopic therapy in cases of nonvariceal upper gastrointestinal bleeding. In this study, the hemostasis rate of each quadrant at the anastomotic ring was analyzed to investigate the effect of the location in PAB. PAB in the posterior wall side showed the lowest hemostasis rate and that in the anterior wall side showed the highest hemostasis rate (50 and 100%, respectively). This result may be related to the accessibility to those areas. The application of endoscopic tools was difficult in the posterior wall side of the anastomotic ring owing to the tangential position of bleeding area; however, the anterior wall side was relatively easy to approach, as we expected. Moreover, the location of the working channel of the endoscope in the 7-o'clock side causes difficulty in approaching the posterior wall side. For this reason, the location of PAB can be a useful factor in predicting the prognosis of endoscopic hemostasis.

The current study has several limitations due to its retrospective design. Although this study presented the largest number of PAB cases, the incidence rate was low. This might be because self-limited minor bleedings were not detected and recorded in the medical charts. In addition, the comparison between the case group and the control group is limited by the differences in the medical conditions of patients. Nevertheless, our findings provide a basis for future prospective randomized studies with proper methodological design for the use of endoscopic treatment in the management of PAB.

PAB is an infrequent and potentially life-threatening complication after gastrectomy for gastric cancer. Endoscopy is a useful method to confirm and localize PAB. Furthermore, the endoscopic procedure can be a feasible option to avoid additional surgery for properly selected patients and to improve the mortality and morbidity profiles.

Compliance with ethical standards

Disclosures Sunpyo Lee, Ji Yong Ahn, Shin Na, Hee Kyong Na, Kee Wook Jung, Do Hoon Kim, Jeong Hoon Lee, Kee Don Choi, Ho June Song, Gin Hyug Lee, Hwoon-Yong Jung, Seon-Ok Kim have no conflicts of interest or financial ties to disclose.

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