

Emergency Gastrointestinal Surgery in Patients Undergoing Antithrombotic Therapy in a Single General Hospital: A Propensity Score-Matched Analysis

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Abstract

Background: This study aimed to review and evaluate the surgical outcomes, particularly intraoperative severe blood loss and postoperative blood complications, of emergency gastrointestinal surgery in patients undergoing antithrombotic therapy (AT). Emergency surgeries for patients with antithrombotic medication have been increasing in the aging population. However, the effect of AT on intraoperative blood loss and perioperative complications remains unclear.

Methods: We retrospectively reviewed 732 patients who underwent emergency gastrointestinal surgery between April 2014 and March 2019. Patients were classified into AT group and Non-AT group, and propensity score-matched analysis was performed to compare the short surgical outcomes between the groups. Additionally, risk factors in severe estimated blood loss (EBL) were assessed. The optimal value of EBL was determined using the receiver operating characteristic curve.

Results: Altogether, 64 patients received AT; 50 patients and 12, and 2 were given antiplatelet and anticoagulant, and both drugs, respectively. After propensity score matching, EBL (101 vs. 99 ml; $p = 0.466$) and postoperative complications (14 vs. 16 patients; $p = 0.676$) were similar between the groups (63 patients matched paired). Intraoperative severe bleeding ($EBL \geq 113$ ml) occurred in 146 patients. Multivariate analysis using the full cohort revealed that anticoagulant drug use was an independent risk factor for severe bleeding (odds ratio, 6.50; 95% CI 1.4 - 36; $p = 0.015$).

Conclusions: This study demonstrated antithrombotic drugs do not adversely affect the perioperative outcomes of emergency gastrointestinal surgery, although patients taking anticoagulant drugs or multiple antithrombotic drugs should undergo careful surgical performances and postoperative management.

Introduction

Medical science and technology improvements are leading to an increase in aging people patients with more comorbidities. Accordingly, the number of patients taking anticoagulant drugs or antiplatelet drugs to prevent primary and secondary thromboembolism from atrial fibrillation, heart-valve replacement, and coronary-artery stenting (1, 2) is increasing.

In abdominal surgery, perioperative antithrombotic therapy (AT) may increase intraoperative blood loss and postoperative bleeding complications. (3, 4) Therefore, temporary cessation of antiplatelet and anticoagulant drugs is recommended before cardiac or non-cardiac surgery.(5–7) Hence, various perioperative AT management protocols have been developed in elective laparotomy and laparoscopic surgery, such as cholecystectomy, nephrectomy, colon resection, and rectal resection.(8–11)

Emergency general surgery patients are well-known for facing high risks for postoperative complications and death within 30 postoperative days because of an extremely high prevalence of systemic inflammatory response syndrome, sepsis, and septic shock in this subpopulation.(12–14) Although vitamin K antagonizes warfarin, most antithrombotic drugs remain in development.(15) Surgeons, therefore, are faced with difficult choices such as whether to perform emergency surgeries in patients undergoing AT. There is accumulating evidence on emergency surgery for patients undergoing antiplatelet therapy for acute appendicitis and acute

cholecystitis.(16–18) AT may have a greater effect in patients requiring emergency surgery than in those requiring elective surgery. However, peri- and postoperative outcomes in patients receiving AT remain unclear in an emergency gastrointestinal surgery.

This study aimed to review and evaluate the surgical outcomes, particularly intraoperative severe blood loss and postoperative blood complications, of emergency gastrointestinal surgery in patients undergoing antithrombotic therapy.

Materials And Methods

Patient classification

We retrospectively evaluated 732 consecutive critical digestive disorder patients who underwent surgery within 24 h after medical reception between April 2014 and March 2019 at our institution. The operation criteria requiring emergency surgery were determined by the digestive surgeons' opinion based on the laboratory data, computed tomography findings, the abdominal findings, and patients' intention. We excluded patients who underwent surgery over 24 h from the hospital visit.

Patients were classified into the AT (antithrombotic therapy) group or the Non-AT group according to medication history for AT. AT is administering either or both of antiplatelet and anticoagulant drugs.

The study protocol was approved by the Ethics Committee at Kawakita General Hospital.

Treatment and postoperative management of patients undergoing antithrombotic therapy

The surgical procedure for laparotomy or laparoscopy was decided on by an individual surgeon, and we had no strict selection criteria for emergency laparoscopic surgery. During the study period, the percentages of emergency laparoscopic surgery in the fiscal year from 2014 to 2018 constantly increased per year at 29%, 48%, 62%, 63%, and 75%, respectively.

In the patients taking anticoagulants, unfractionated heparin was postoperatively restarted immediately after surgery if there were no postoperative complications. Oral antithrombotic agents were also immediately resumed.

Data collection

Patient data such as age, gender, postoperative diagnosis, Charlson comorbidity index, body mass index (BMI), American Society of Anesthesiologists classification of physical status (ASA-PS), and preoperative laboratory data including white blood cell, platelet counts, serum level of creatine, c-reactive protein (CRP), prothrombin time-international normalized ratio (PT(INR)), and activated partial thromboplastin time (APTT) were retrospectively retrieved from medical records. Postoperative complications were assessed using the Clavien-Dindo classification(19), with grade II or greater defined as significant. Data on surgical procedure, operating time, estimated blood loss, and perioperative blood transfusion were also obtained from the medical

charts and records. Postoperative complications were defined as adverse events occurred in 30 days after surgery.

Statistical analysis

Categorized variables were assessed by using the chi-squared test or Fisher's exact probability test, and continuous variables were assessed by using the Student's test or Wilcoxon test. Propensity score matching was used to minimize the selection bias due to unbalanced baseline characteristics between patients in the AT and Non-AT groups for emergency gastrointestinal surgery.(20) The parameters that were different between both groups and other potential factors that could influence surgical outcomes such as age, gender, type of postoperative diagnosis, Charlson comorbidity index, and ASA-PS were selected to create a propensity score ranging from zero to one using a logistic regression model. Subsequently, we performed a 1:1 match between both groups, using the nearest neighbor matching with a caliper set to 0.2 of the standard deviation of the propensity score logit.(21)

To determine the optimal cut-off value for perioperative severe bleeding, a receiver operating characteristic (ROC) curve was used. Variables with p value < 0.05 on univariate analysis were further evaluated using logistic regression analyses in multivariate analyses. All statistical analyses were performed using JMP software ver. Pro 11.0 (SAS Institute Inc., Cary, NC, USA). P values < 0.05 were considered statistically significant.

Results

Altogether, 732 patients who underwent emergency gastrointestinal surgery for critical digestive disorders were analyzed during the study period (median age: 53 years old, 400 male patients (55%), mostly postoperative diagnosis: appendicitis (60%)). 64 (8.7%) patients were under antithrombotic therapy (AT) in the present study. We classified the patients under AT into 3 groups, such as antiplatelet (50 patients) or anticoagulant (12) or both drugs group (2), respectively. Because the risk of perioperative bleeding complications is probably different in each therapy. The patient profile on chronic antithrombotic medication is shown in Table 1. The most common reason for the antiplatelet use was stroke followed by ischemic heart disease. In contrast, atrial fibrillation was the leading cause for anticoagulant use. The breakdown of the antiplatelets was aspirin (30 patients), clopidogrel (14), cilostazol (5), ticlopidine (2) and dipyridamole (1), whereas that of the anticoagulants was warfarin (11 patients), apixaban (1), edoxaban (1) and dabigatran (1).

The baseline characteristics of the patients in each group are summarized in Table 2. Before propensity score matching, it was observed that the AT group were older, had higher Charlson comorbidity index, poor ASA-PS, and had a higher white blood cell count than the Non-AT group. The predominant kinds of postoperative diagnosis of the AT and the Non-AT group are small bowel obstruction, appendicitis, and upper gastrointestinal (UGI) perforation. Therefore, we should have adjusted a large number of differences of baseline characteristics between the AT and Non-AT groups to compare the short surgical outcomes for emergency gastrointestinal surgery. To minimize the selection bias due to unbalanced baseline characteristics between patients in the AT and Non-AT groups, we used propensity score matching using the parameters such as age, gender, type of postoperative diagnosis, Charlson comorbidity index, and ASA-PS. Sixty-three matched pairs were created from the original cohort (Table 2).

In the present study, median of the estimated blood loss with / without laparoscopic surgery or energy device were 56 ml vs 5 ml ($p < 0.001$) and 24 ml vs 5 ml ($p < 0.001$), respectively. Therefore, these variables also should be adjusting. Perioperative outcomes between both groups after propensity score matching are shown in Table 3. There are no significant differences between the groups in each parameter, such as the number of laparoscopic surgeries, power device using, mean of the operating time, and estimated blood loss. The ratio of the number of blood transfusions during the perioperative period is also similar. There is no significant difference in grade II or greater postoperative morbidity in the AT and the Non-AT groups, respectively (14 [27%] vs. 16 [25%] patients, $p = 0.676$). Bleeding events developed in two (3.2%) and zero patients in the Non-AT and the AT groups, respectively ($p = 0.094$). Regarding other adverse events, neither stroke, embolic, nor thrombotic events occurred in the AT group patients, whereas stroke events occurred in one patient of the Non-AT group. Death within postoperative day 30 occurred in three (4.8%) and four (6.3%) patients in the AT group and the Non-AT group, respectively ($p = 0.6969$). There were also no significant differences between both groups in terms of postoperative stay ($p = 0.409$) and hospital death ($p = 0.752$).

We then assessed the associations between AT and intraoperative estimated blood loss (EBL), or postoperative bleeding complications. The optimal cut off value of intraoperative severe bleeding for blood transfusions was 113 ml, and the area under the curve was 0.90 (Fig. 1). Univariate and multivariate analyses for severe intraoperative bleeding and postoperative bleeding complications were performed and shown in Table 4 and Table 5, respectively. In intraoperative severe bleeding analyses, anticoagulant drug use (odds ratio 6.50, $p = 0.015$) was an independent risk factor together with poor ASA-PS (odds ratio 3.77, $p < 0.001$), gastrectomy (odds ratio 2.87×10^7 , $p = 0.003$), colectomy (odds ratio 10.13, $p < 0.001$), cholecystectomy (odds ratio 10.22, $p < 0.001$), and laparotomy (odds ratio 4.64, $p < 0.001$). Concerning postoperative bleeding complications analyses, antithrombotic drug use (odds ratio 1.08, $p = 0.947$), anticoagulant drug use (odds ratio 2.39, $p = 0.584$), and dual antithrombotic drug use (odds ratio 49.11, $p = 0.058$) were not independent risk factors similar to other variables.

Discussion

Patients undergoing antithrombotic therapy (AT) have high risks of bleeding and thrombosis from their comorbidity.(22, 23) As those risks tend to be high when surgical intervention is required, several perioperative period protocols have been developed to prevent complications based on AT.(5–7) In contrast, the analysis of more than 400,000 surgical cases demonstrated that emergency procedures increase the risk of major postoperative morbidity and mortality.(24) Hence, the perioperative bleeding risk for patients undergoing AT may be expected to increase, making perioperative outcomes in an emergency setting a potential concern. Generally, as older people also have more comorbidities than young people, we hypothesize that perioperative complications will occur in patients with AT than those without AT.

Similar to other studies' findings (8, 10), the patients in this study undergoing AT were older, have higher Charlson comorbidity index, and poor ASA-PS than those who were not undergoing AT (Table 2). Advanced age is a well-known risk factor of cardiovascular disease, such as stroke (25) and coronary artery disease (26).

In using pre-matching data, there were no differences in operation time and estimated blood loss, whereas there were more Clavien-Dindo classifications of grade II or greater, longer postoperative hospital stay, and higher hospital death rate in the AT group than in the Non-AT group (Tables 2 and 3). A higher Carlson-comorbidity index and postoperative diagnosis are negative predictors of mortality, postoperative complications, and postoperative stay in older patients.(27)

After adjusting these biases using the propensity score matching method, the estimated blood loss, perioperative blood transfusion, overall morbidity, and postoperative hospital stay were similar between the patients in both groups. Matsuoka et al. also demonstrated that antithrombotic drugs do not affect short surgical outcomes in their propensity score matching setting.(28) Additionally, Imamura et al. reported that there were no significant differences in blood loss, severe blood loss more than 100 ml, blood transfusion, and postoperative mortality for patients with or without antithrombotic therapy in emergency laparoscopic cholecystectomy.(17) These studies' findings are line with our results, which may help surgeons in deciding the strategy for critical cases with antithrombotic therapy. Therefore, antithrombotic therapy does not affect perioperative short surgical outcomes in the situation of adjusting backgrounds.

We then evaluated the risk factors for the intraoperative severe bleeding needing blood transfusions in the all cohort. Because previous studies evaluating the correlation between blood loss and blood transfusion obtained cut-off values for severe bleeding using ROC curve analysis,(29) the cut-off value in this study was determined similarly, the optimal one and AUCs were 113 ml and 0.90, respectively. Although 113 ml is less than 750 ml (28) or 1000 ml (30) in previous studies, our results may be sustained with the use of new surgical instrumentations and techniques. Energy devices, including vessel-sealing devices and ultrasonically activated devices, have improved surgical outcomes in low anterior resection, liver transection, and hysterectomy. (31–33) These surgical techniques may be more effective in controlling intra- and postoperative bleeding in emergency surgery in patients undergoing antithrombotic therapy. Concerning the need for blood transfusion in cases of severe intraoperative bleeding, antithrombotic and antiplatelet drug use were not related. However, anticoagulant drug use was more controversial in here (Table 5). In the elective setting, two randomized clinical studies recently demonstrated that bleeding and thrombotic events after elective non-cardiac surgery had no significant differences between patients with or without interruption of antiplatelet agents.(34, 35) Concerning abdominal surgery, several studies demonstrated the safety and feasibility of discontinued single aspirin or clopidogrel use in gastrointestinal surgery and colorectal resection. (30, 36, 37) These results including ours suggested that discontinuing single antiplatelet drugs does not increase perioperative bleeding even in emergency surgery. Meanwhile, our results revealed that anticoagulant drug use is one of the risk factors for severe intraoperative bleeding. The previous study reported that bleeding and mortality for emergency surgery were significantly higher than those for elective surgery in general surgical patients receiving warfarin.(38) Therefore, surgeons should pay more attention to manage the risk of intraoperative blood loss and reduce the need for blood transfusion in emergency gastrointestinal surgery in patients taking anticoagulant drugs than those taking antiplatelet drugs.

Finally, we assessed the relationship between AT and postoperative bleeding. Here, there was a higher tendency of postoperative bleeding between patients taking and not taking dual antithrombotic drugs. The overall incidence of postoperative bleeding was low, and there were no statistical differences between the groups. The previous study reported that dual antiplatelet drugs increased postoperative bleeding.(30, 39)

Therefore, as multiple antithrombotic drug use may increase postoperative bleeding complications in an emergency setting, careful postoperative management is necessary.

This retrospective study has several limitations. Several types of diseases were included, and the selection of surgical approach was not randomized. Antithrombotic therapy included many types and different generations of antiplatelet and anticoagulant agents. The total number of patients who underwent abdominal emergency surgery was relatively small in propensity score matching analyses. A comparison of the relationship between the patients with or without anticoagulant therapy in propensity score matched analysis was not performed due to their small number. Although administration of more than two anticoagulant drugs was a negative predictor for bleeding complications (30, 39), the present study included only two patients.

Conclusion

This study indicated that intraoperative blood loss and postoperative complications related to emergency gastrointestinal surgery were not significantly affected by antithrombotic therapy. However, patients taking anticoagulant drugs or multiple antithrombotic drugs should undergo careful surgical performances and postoperative management.

Abbreviations

AT : antithrombotic therapy, EBL : estimated blood loss, ASA-PS : Anesthesiologists classification of physical status, ROC curve : receiver operating characteristic, AUCs : area under curves, UGI : upper gastrointestinal

Declarations

Ethical Approval and Consent to participate

The study protocol was approved by the Ethics Committee at Kawakita General Hospital.

The requirement for obtaining informed consent from patients was waived because of the observational nature.

Consent for publication

Not applicable.

Availability of supporting data

Data of the current study can be available from the corresponding author if requested.

Competing interests

The authors declare that they have no competing interests.

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Not applicable.

Authors' contributions

Author contribution: Shinya Abe conceptualized and designed the study, acquired, analyzed, and interpreted the data, and drafted the article. Katsunori Ami conceptualized and designed the study, interpreted the data, and critically revised the manuscript. Akira Katsuno acquired and interpreted the data, and critically revised the manuscript. Noriyasu Tamura, Tosihko Harada, Shunsuke Hamasaki, Yusuke Kitagawa, and Taku Machida acquired the data. Naoyuki Umetani conceptualized and interpreted the data, and critically revised the manuscript. All authors approved the final submission.

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Conflicts of Interest and Sources of Funding

None declared.

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Tables

Table 1
Patient profile on chronic antithrombotic medication

	Antiplatelets	Anticoagulants	Both
Patient history or current comorbidities	(n=50)	(n=12)	(n=2)
Stroke	23 (46%)	2 (17%)	0
Ischemic heart disease	20 (40%)	0	1 (50%)
Artificial fibrillation	1 (2%)	8 (67%)	1 (50%)
Peripheral artery disease	1 (2%)	1 (8%)	0
Cardiac valve replacement	1 (2%)	0	0
Deep vein thrombosis	0	1 (8%)	0
Central retinal artery occlusion	1 (2%)	0	0
Unknown	3 (6%)	0	0

Table 2
Baseline characteristics of patients in the cohort

Variables		n=732	No-matched cohort			Matched cohort		
			AT (n = 64)	Non-AT (n = 668)	p value	AT (n = 63)	Non-AT (n = 63)	p value
Patient-related factors								
Age [‡]	Years	51 (34 - 74)	83 (76 - 8)	47 (32 - 68)	<0.001	83 (76 - 87)	81 (69 - 87)	0.214
Gender	Male	400 (55%)	39 (61%)	361 (54%)	0.290	39 (62%)	32 (51%)	0.209
Postoperative diagnosis	Appendicitis	441 (60%)	9 (14%)	432 (65%)	<0.001	9 (14%)	10 (16%)	
	Small bowel obstruction	142 (19%)	33 (52%)	109 (16%)		33 (52%)	28 (44%)	
	UGI perforation	47 (6%)	8 (12%)	39 (6%)		8 (13%)	9 (14%)	
	Cholecystitis	34 (5%)	3 (5%)	34 (5%)		3 (5%)	0	
	Large bowel perforation	30 (4%)	4 (6%)	31 (4%)		4 (6%)	7 (11%)	
	Large bowel obstruction	23 (3%)	2 (3%)	21 (3%)		2 (3%)	8 (13%)	
	Bacterial peritonitis	7 (1%)	1 (2%)	6 (1%)		1 (1%)	0	
	Gastrointestinal bleeding	6 (1%)	3 (5%)	3 (0.5%)		3 (5%)	1 (1%)	
	Others	2 (0.2%)	1 (0.2%)	1 (0.2%)				
	Charlson comorbidity index	0	572 (78%)	32 (50%)		540 (81%)	<0.001	
1		95 (13%)	21 (33%)	74 (11%)	21 (33%)	13 (20%)		
2		41 (6%)	9 (14%)	32 (5%)	9 (14%)	8 (13%)		
3		13 (2%)	1 (1%)	12 (2%)	1 (2%)	5 (8%)		
≥ 4		11 (2%)	1 (1%)	10 (1%)	0	0		

BMI [□]	kg/m ²	21.4 (19.0 - 23.8)	21.9 (18.8 - 24.4)	21.4 (19.1 - 23.7)	0.701	21.9 (18.8 - 24.4)	20.2 (18.4 - 22.9)	0.172
ASA [□] PS	1	356 (49%)	0	356 (53%)	<0.001	0	4 (6%)	0.125
	2	306 (42%)	45 (70%)	261 (39%)		45 (71%)	43 (68%)	
	3	64 (8%)	19 (30%)	45 (7%)		18 (29%)	16 (26%)	
	4	5 (1%)	0	5 (1%)		0	0	
Malignancy	yes	29 (4%)	2 (3%)	27 (4%)	0.719	2 (3%)	8 (13%)	0.048
Preoperative laboratory data								
White blood cell [□]	/μL	12300 (9500 - 15400)	10500 (7525 - 13200)	12600 (9600 - 15600)	<0.001	10600 (7600 - 13300)	9900 (6800 - 14500)	0.725
Hemoglobin [□]	g/dL	13.8 (12.5 - 15.0)	12.6 (11.1 - 14.3)	13.9 (12.6 - 15.1)	<0.001	12.6 (11.0 - 14.3)	13.3 (11.8 - 15.0)	0.147
Platelet [□]	×10 ⁴ /μl	23.0 (18.8 - 28.1)	22.0 (13.1 - 36.1)	19.5 (14.0 - 28.9)	0.455	21.7 (13.0 - 36.6)	19.0 (13.3 - 33.2)	0.742
Creatinine [□]	U/l	0.77 (0.64 - 0.94)	1.07 (0.88 - 1.70)	0.75 (0.63 - 0.91)	<0.001	1.06 (0.88 - 1.66)	0.83 (0.68 - 1.10)	0.003
C-reactive protein [□]	mg/dl	1.9 (0.23 - 6.81)	1.99 (0.22 - 9.56)	1.89 (0.23 - 6.65)	0.706	1.90 (0.22 - 8.85)	1.17 (0.13 - 9.31)	0.934
PT(INR) [□]		1.09 (1.02 - 1.19)	1.13 (1.06 - 1.36)	1.09 (1.02 - 1.17)	<0.001	1.13 (1.06 - 1.35)	1.08 (1.01 - 1.16)	0.005
APTT [□]	sec	28.8 (26.6 - 31.6)	29.8 (27.1 - 33.3)	28.7 (26.6 - 31.3)	0.020	29.7 (27.0 - 33.1)	28.0 (25.6 - 29.8)	0.003
AT : antithrombotic therapy, □ : Median (Quartile), BMI : body mass index, ASA [□] PS : American Society of Anesthesiologists classification of physical status								
PT(INR) : prothrombin time-international normalized ratio, APTT : activated partial thromboplastin time								

Table 3
 Perioperative outcomes of patients who underwent emergency gastrointestinal surgery

Variables		No-matched cohort				Matched cohort		
		n = 732	AT (n = 64)	Non-AT (n = 668)	p value	AT (n = 63)	Non-AT (n = 63)	p value
Laparoscopic surgery	Present	402 (55%)	14 (22%)	338 (58%)	<0.001	14 (22%)	17 (27%)	0.501
Energy device	Present	395 (53%)	26 (41%)	369 (55%)	0.025	25 (40%)	25 (40%)	1.000
Operating time*	min	94 (71 - 124)	100 (62 - 128)	93.5 (71 - 124)	0.927	36 (10 - 299)	53 (5 - 251)	0.955
Estimated blood loss*	ml	10 (2 - 70)	40.5 (10 - 307)	8 (2 - 61)	<0.001	101 (62 - 129)	99 (74 - 131)	0.466
Intra- and postoperative blood transfusion	Present	1 (0.2%)	11 (17%)	25 (4%)	<0.001	11 (17%)	7 (11%)	0.309
Overall complications	Present	61 (8.3%)	21 (22%)	40 (6.0%)	<0.001	14 (27%)	16 (25%)	0.676
Bleeding	Present	8 (1.1%)	3 (4.7%)	5 (0.75%)	0.025	0	2 (3.2%)	0.094
Stroke	Present	3 (0.4%)	3 (0.5%)	0	0.458	1 (1.6%)	0	0.238
Pulmonary	Present	12 (1.6%)	4 (6.3%)	8 (1.2%)	0.016	2 (3.2%)	3 (4.8%)	0.647
Renal/urological	Present	7 (1.0%)	1 (1.6%)	6 (0.9%)	0.630	2 (3.2%)	0	0.094
Surgical site infection	Present	29 (3.7%)	5 (7.8%)	24 (3.6%)	0.138	7 (11.1%)	5 (7.9%)	0.543
Anastomotic failure	Present	4 (0.5%)	1 (1.6%)	3 (0.5%)	0.335	2 (3.2%)	1 (1.6%)	0.555
Death within 30 days after surgery	Present	17 (2.3%)	5 (7.8%)	12 (1.8%)	0.013	3 (4.8%)	4 (6.3%)	0.697
Hospital stay after surgery*	Days	5 (4 - 10)	13 (9 - 22)	5 (4 - 9)	<0.001	13 (9 - 22)	10 (7 - 20)	0.409
Hospital death	Present	25 (3.4%)	6 (9.4%)	19 (2.8%)	0.020	5 (8%)	6 (10%)	0.752

Median (Quartile), AT : antithrombotic therapy

Table 4
Univariate analysis for severe intraoperative bleeding (EBL \geq 113 mL) and postoperative bleeding complication

Variables	n=732	Severe intraoperative bleeding (EBL \geq 113 mL)		Postoperative bleeding complication	
		Present	<i>p</i> value	Present	<i>p</i> value
Age (years)					
<65	475	46 (9.7%)	<0.001	1 (0.2%)	0.002
\geq 65	257	100 (38.9%)		7 (2.7%)	
Gender					
Female	332	56 (16.9%)	0.057	5 (1.5%)	0.327
Male	400	90 (22.5%)		3 (0.8%)	
BMI (kg/m ²)					
< 22	333	57 (17.1%)	0.204	4 (1.2%)	0.282
\geq 22	259	55 (21.2%)		1 (0.4%)	
Charlson comorbidity index					
1 - 2	708	131 (18.5%)	<0.001	6 (0.9%)	0.001
3 - 6	24	15 (62.5%)		2 (8.3%)	
ASA-PS					
1 - 2	663	99 (14.9%)	<0.001	4 (0.6%)	<0.001
3 - 5	69	47 (68.1%)		4 (5.8%)	
Antithrombotic drugs					
Absent	668	124 (18.6%)	0.003	5 (0.8%)	0.004
Present	64	22 (34.4%)		3 (4.7%)	
Antiplatelet drugs					
Absent	682	113 (19.6%)	0.344	6 (0.9%)	0.113
Present	50	13 (25.0%)		2 (3.9%)	
Anticoagulant drugs					
Absent	722	136 (18.9%)	<0.001	6 (0.8%)	<0.001
Present	12	10 (76.9%)		2 (15.4%)	
Dual antithrombotic drugs					

Absent	730	145 (19.9%)	0.287	7 (1.0%)	<0.001
Present	2	1 (50.0%)		1 (50.0%)	
Malignancy					
Absent	700	130 (18.6%)	<0.001	7 (1.0%)	0.258
Present	32	16 (50.0%)		1 (3.1%)	
Appendectomy					
Absent	297	116 (39.1%)	<0.001	8 (2.7%)	0.001
Present	435	30 (6.9%)		0	
Gastrectomy					
Absent	728	142 (19.5%)	<0.001	8 (1.1%)	0.833
Present	4	4 (100%)		0	
Patch repair					
Absent	698	141 (20.2%)	0.434	7 (1%)	0.288
Present	34	5 (14.7%)		1 (2.9%)	
Colectomy					
Absent	669	99 (14.8%)	<0.001	6 (0.9%)	0.096
Present	63	47 (74.6%)		2 (3.2%)	
Intestinal surgery					
Absent	584	105 (18.0%)	0.008	5 (0.9%)	0.221
Present	148	41 (27.7%)		3 (2.0%)	
Cholecystectomy					
Absent	697	131 (18.8%)	0.001	7 (1%)	0.304
Present	35	15 (42.9%)		1 (2.9%)	
Drainage operation					
Absent	7719	141 (19.6%)	0.092	7 (1.0%)	0.021
Present	13	5 (38.5%)		1 (7.7%)	
Surgical approach					
Laparoscopic surgery	404	28 (6.9%)	<0.001	1 (0.3%)	0.015
Laparotomy	328	118 (36.0%)		7 (2.1%)	
Energy device					

Present	395	72 (18.2%)	0.209	3 (0.8%)	0.348
Absent	337	74 (22.0%)		5 (1.5%)	
BMI : body mass index, ASA-PS : American Society of Anesthesiologists classification of physical status					

Table 5

Multivariate analysis for severe intraoperative bleeding (EBL \geq 113 mL) and postoperative bleeding complication

Variable		Severe intraoperative bleeding (EBL \geq 113 ml)			Postoperative bleeding complication		
		Odds ratio	95% CI	<i>p</i> value	Odds ratio	95% CI	<i>p</i> value
Age (years)	< 65 vs. \geq 65	1.54	0.88 - 2.69	0.133	2.76	0.34 - 75.61	0.377
Charlson comorbidity index	1 - 2 vs. \geq 3 - 6	2.71	0.90 - 8.26	0.075	5.63	0.69 - 34.42	0.097
ASA-PS	1 - 2 vs. \geq 3 - 5	3.77	1.91 - 7.58	<0.001	2.83	0.49 - 17.34	0.238
Antithrombotic drugs	Absent vs. Present	0.51	0.22 - 1.14	0.102	1.08	0.05 - 7.83	0.947
Anticoagulant drugs	Absent vs. Present	6.50	1.43 - 36.86	0.015	2.39	0.07 - 76.33	0.584
Dual antithrombotic drugs	Absent vs. Present				49.11	0.86 - 4780	0.058
Malignancy	Absent vs. Present	2.18	0.88 - 5.35	0.093			
Appendectomy	Absent vs. Present	0.87	0.34 - 2.47	0.791	2.81×10^{-7}	0 - 1.2×10^{-27}	0.063
Gastrectomy	Absent vs. Present	2.87×10^7	3.71 - NA	0.003			
Patch repair	Absent vs. Present						
Colectomy	Absent vs. Present	10.13	3.66 - 30.59	<0.001			
Intestinal surgery	Absent vs. Present	1.36	0.55 - 3.65	0.517			
Cholecystectomy	Absent vs. Present	10.22	3.17 - 35.47	<0.001			
Drainage operation	Absent vs. Present				3.97	0.18 - 36.17	0.315
Laparotomy	Absent vs. Present	4.64	2.59 - 8.60	<0.001	1.24	0.16 - 25.64	0.850
EBL : estimated blood loss, ASA-PS : American Society of Anesthesiologists classification of physical status, CI : confidence interval							

Figures

Figure 1

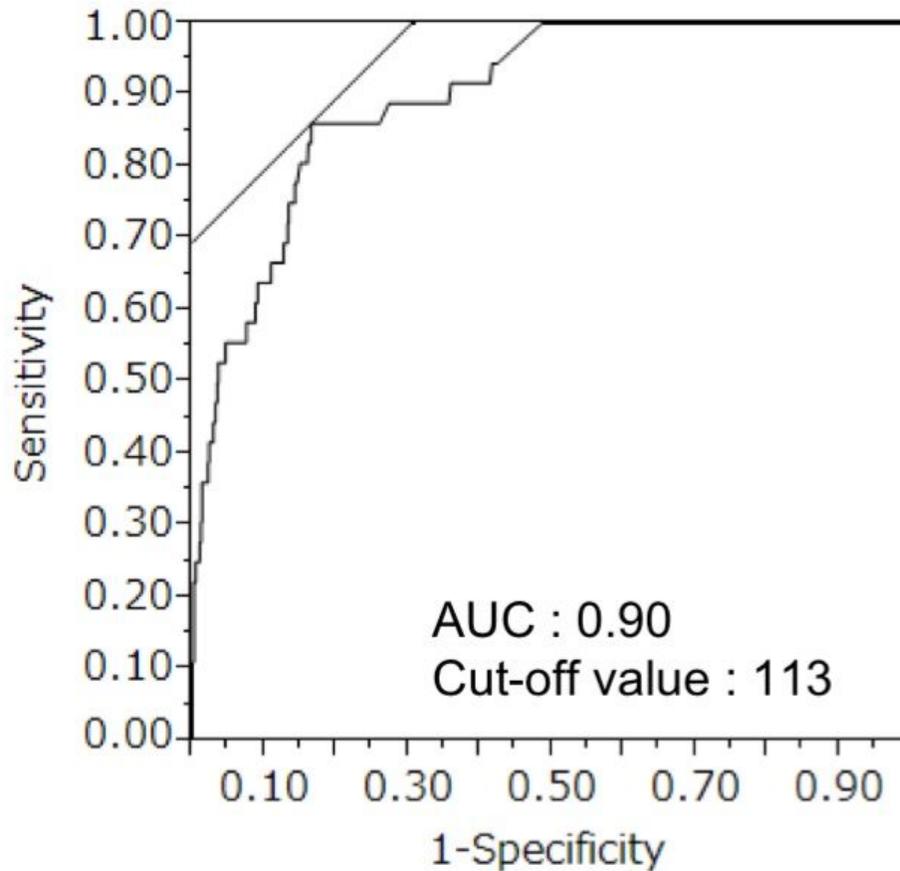


Figure 1

Correlation between intraoperative estimated blood loss and perioperative blood transfusion. Receiver operating characteristic curves predicting perioperative blood transfusion by intraoperative estimated blood loss is represented. The area under the curve is 0.90. The optimal cut-off value determined for intraoperative estimated blood loss is 113 ml.