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ORIGINAL ARTICLE

Continuation of antithrombotic therapy increases minor bleeding but does not increase the risk other morbidities in open inguinal hernia repair: A propensity score-matched analysis

S. Poudel[1,2] · K. Miyazaki[3] · S. Hirano[1]

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Abstract

Purpose An aging population has led to an increased number of patients with cardiovascular comorbidities requiring antithrombotic therapy. Perioperatively, surgeons should consider the increased risk of bleeding and thrombotic events in patients continuing or discontinuing these medications. We aimed to analyze the safety of continued antithrombotic therapy during open inguinal hernia repair.

Methods In this single-center, retrospective study, 4870 adult patients who underwent open inguinal hernia repair surgery by the same surgeon from 2008 January to 2019 March were included. Patients who underwent surgery while continuing antithrombotic therapy were included in the antithrombin group ($n=523$) while those who were not under any antithrombotic therapy during the surgery were included in the control group ($n=4333$). Using propensity score-matching, we then selected patients from each group with similar backgrounds. Surgery time, anesthesia time, postoperative bleeding, reoperation, and thrombotic event data were compared between the groups. Subgroup analysis based on the type of medications used was performed within the antithrombin group.

Results Ten patients in the antithrombin group and seven patients in the control group experienced postoperative bleeding ($p<0.001$). The rate of postoperative bleeding was the highest in patients taking multiple medications. However, most were managed conservatively. Three patients from the antithrombin group experienced thrombotic events postoperatively ($p=0.001$).

Conclusions Patients receiving continued antithrombotic therapy had an increased risk of minor postoperative bleeding; however, they are a high-risk group for thrombotic events.

Keywords Open inguinal hernia repair · Antithrombotic therapy · Anticoagulation · Antiplatelets

Introduction

Advances in medical science have allowed people to live longer. Thus, surgeons worldwide now frequently operate on a population with increasingly advanced age. Elderly patients are more likely to have cardiovascular comorbidities and thus receive antiplatelet therapy and/or anticoagulation therapy. Antithrombotic therapy involves both antiplatelet and anticoagulation therapies. Although both antiplatelet and anticoagulation therapies have different mechanisms of action, they are vital to prevent further cardiovascular thrombotic events in high-risk patients; however, they also pose the risk of hemorrhage [1]. In these patients, surgeons should decide whether to continue these medications perioperatively, while considering the increased risk of bleeding and thrombotic events.

Several guidelines have been published in the past decade to aid surgeons in the decision-making process on the perioperative management of antithrombotic medication [2]. Most guidelines recommend assessing the risk of bleeding and thrombotic events associated with the procedure [2]. In most types of general surgery, whenever possible,

✉ K. Miyazaki
kyosukemiyazaki1@me.com

[1] Department of Gastroenterological Surgery II, Hokkaido University Graduate School of Medicine, Sapporo, Japan

[2] Department of Surgery, Steel Memorial Muroran Hospital, Muroran, Japan

[3] Miyazaki Surgery and Hernia Clinic, Kita 5 Nishi 2, Chuo-ku, Sapporo, Japan

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antithrombotic medications are typically discontinued for a fixed period prior to undergoing elective surgery, with heparin bridging in high-risk patients [3]. These antithrombin medications are restarted after hemostasis is achieved. While heparin bridging is indicated in patients receiving anticoagulant therapy, it is also used in patients receiving anti-platelet therapy, despite a lack of evidence for its efficacy [4]. A recent study of patients undergoing gastric endoscopic submucosal dissection showed an increased rate of thrombosis in the group discontinuing antithrombotic therapy compared to that in the group continuing the therapy or using bridging therapy [5]. In recent years, it has been recommended that these therapies be continued in procedures with a low risk of bleeding, such as dermatological procedures, cataract surgery, and polypectomy, especially in patients with a high risk of thrombotic events [6–8, 8].

A study from the Herniamed Registry, a real-world data repository, showed that surgeons regularly perform hernia surgery for patients receiving antithrombic therapy [9]. There is, however, a lack of evidence on the perioperative management of antithrombotic therapy in inguinal hernia surgery. Randomized controlled trials in this field are few and those reported in the literature included a small sample size. These studies have shown that continuation of antiplatelet therapy through common elective general surgical procedures, such as inguinal hernia repair does not lead to increased bleeding [10, 11]. However, studies on anticoagulant therapy have shown conflicting results [12, 13].

The Miyazaki Surgery and Hernia Clinic is a specialized center providing ambulatory surgery for inguinal hernia. We have performed over 7000 inguinal hernia surgeries to date. In our experience, open inguinal hernia repair has a low risk of perioperative bleeding if the appropriate precautions are taken. Since January 2008, our center began performing open inguinal hernia repair for patients while continuing antithrombotic medications. Thus, we aimed to analyze the safety of open inguinal hernia repair in patients continuing antithrombotic medication.

Methods

Ethical issues

This retrospective study was approved by the institutional review board of Hokkaido University (Med 18-037). The notice for this retrospective study was published on the website of the institute and the patients were given the right to opt out. The researcher analyzing the data did not have access to the personal information of the patients. Prior to surgery, the risk of both continuation or cessation of antithrombotic medications was explained to all the patients.

Patients

All adult patients above the age of 20 years who underwent open inguinal hernia repair surgery in our clinic from January 2008 to March 2019 were included in the study. Patients who stopped taking antithrombotic medications before surgery for any reason were excluded from the analysis. Patients who underwent the surgery while continuing the antithrombotic therapy were labeled the antithrombin group, and patients who were not under any antithrombotic medication were deemed the control group. The patients in the antithrombin groups were further divided into four groups for subgroup analysis: patients receiving only a single medication of low-dose aspirin (aspirin group); patients receiving multiple antithrombotic medications (multiple medication group); patients receiving a single medication of antiplatelet medications other than low-dose aspirin (other antiplatelets group); and patients receiving a single medication of anticoagulation therapy (anticoagulation group). Prothrombin time international normalized ratio (PT-INR) was assessed in patients receiving warfarin therapy, and only patients with good warfarin control with PT-INR below three underwent surgery. Postoperative data, including surgery time, anesthesia time, postoperative bleeding, reoperation, and thrombotic events, were compared between groups. Postoperative bleeding was defined as postoperative hematomas or postoperative bleeding detected at follow-up visit or emergency visit. Thrombotic events were defined as events of a thrombotic nature such as myocardial infarction, cerebral infarction, transient ischemic attacks, and deep venous thrombosis occurring within one week of the surgery. All patients underwent surgery on an outpatient surgery basis and followed up on postoperative day 7, and again one month after surgery. All surgical and postoperative data were entered by the surgeon in a database. The groin areas of all the patients with suspected postoperative bleeding events were photographed with their consent during the postoperative visit and stored separately.

Surgical and anesthetic techniques

All surgeries were performed by the same surgeon, who has performed over 7000 open inguinal hernia repair surgeries. The anesthesia method was decided upon based on each patient's age and comorbidities. All patients underwent surgery using a local anesthesia solution composed of 20 mL 1% lidocaine with epinephrine, 20 mL 0.25% bupivacaine, and 80–120 mL normal saline. Epidural anesthesia was selectively added for surgeries on patients under 60 years of age and those not taking antithrombotic

medication. General anesthesia was administered if the epidural or local anesthesia was not adequate.

The surgical technique was also tailored according to patient characteristics. High ligation was used in young patients with small indirect hernias (European Hernia Society classification L1). We selected tension-free mesh repair for other types of hernia. Primary hernias (L2, L3, M1–3) were repaired using mainly preperitoneal mesh repair or bilayer mesh repair. If difficulty in dissection was expected due to possible adhesions in the preperitoneal space from prior surgery, onlay mesh repair or plug repair were selected. Femoral hernia (F1–3) was repaired using plug repair by femoral approach. The appropriate mesh was selected in recurrent hernias based on the extent of dissection of the preperitoneal space in the primary hernia repair.

To minimize the risk of bleeding, care was taken to minimize blunt dissections in all surgeries. During dissection, a local anesthesia solution was used to separate the plane of dissection and cautery was used for dissection. Superficial epigastric vessels were ligated in all cases.

Statistical analysis

Data are presented as mean (standard deviation). The Student's *t* test was used to compare the data between the two groups. Analysis of variance (ANOVA) test was used to compare data between multiple groups. The χ^2 test and Fisher's exact test were used to compare categorical data.

Propensity score-matching was used to match the background characteristics to reduce selection bias between two groups. For this analysis, variables such as age, sex, body mass index, hernia classification, surgical method used, anesthesia method used, primary or recurrent hernia, unilateral or bilateral, and complicated or simple case, were chosen. Complicated cases were defined as the presence of either cord lipoma, Nuck canal cyst, scrotal hernia, or strangulated hernia. The cases from the antithrombin group were matched with cases in the control group using the nearest-neighbor algorithm without replacement at the ratio of 1:1 with a matching tolerance of 0.05 to create a matched control group.

A two-tailed p value of < 0.05 was considered statistically significant in all analyses. Propensity score-matching was done using MatchIt package (Version: 2.4-21) for R (R for Windows version 3.1.0; The R Foundation for Statistical Computing, Vienna, Austria). The rest of the statistical analyses were performed using SPSS version 17 (IBM, New York, USA).

Results

During the study period, inguinal hernia repair was performed in 4870 adult patients. Of these, 537 patients were receiving some type of antithrombotic therapy. A total of 523 patients underwent open inguinal hernia repair while continuing their antithrombotic medications. Most patients (83%) were using a single antithrombotic medication, and 75.8% of the medications used were antiplatelet therapies with aspirin being the most common medication, followed by warfarin and clopidogrel (Table 1). Cerebral infraction, atrial fibrillation, and coronary artery disease were the most common medical conditions for which antithrombotic therapy was prescribed (Table 1).

Compared to patients in the control group, the patients in the antithrombin group were older and had higher body mass index. The group also had a higher proportion of men, bilateral cases, and complicated cases, as well as more direct hernias repaired using the preperitoneal mesh repair technique. No patients in the antithrombin group were given epidural anesthesia (Table 2). For the patients in the antithrombin group, except for age, no significant difference was found in the background characteristics of the patients in the subgroups (Table 3).

Both surgery time and anesthesia time were comparable in the antithrombin group and control group (Table 4).

Table 1 Medications and medical conditions of the patients in antithrombin group

Medications	($n = 612$[a])	Medical Conditions	($n = 544$ [a])
Antiplatelet therapy	464 (75.8%)	Cerebral infraction	169 (31.1%)
Aspirin	301 (49.2%)	Atrial fibrillation	140 (25.7%)
Clopidogrel	86 (13.8%)	Coronary artery disease	135 (24.8%)
Ticlopidine	36 (5.9%)	Other heart condition	42 (7.7%)
Cilostazol	30 (4.9%)	Arterial stenosis	12 (2.2%)
Other antiplatelets	11 (1.8%)	Others	29 (5.3%)
Anticoagulation therapy	146 (24.2%)	Unknown	17 (3.1%)
Warfarin	92 (15.0%)		
Direct oral anti coagulants	56 (9.2%)		

Data presented as number of patients (%)

[a]Some patients had multiple conditions and were under multiple medications

Table 2 Background of the patients in both the groups

	All data			Matched data		
	CG ($n=4333$)	ATG ($n=523$)	p	mCG ($n=523$)	ATG ($n=523$)	p
Age	57.4 (15.8)	72.9 (9.8)	**< 0.001***	72.5 (9.7)	72.9 (9.8)	0.54
Sex male	3553 (82.0%)	484 (92.5%)	**< 0.001***	488 (93.3%)	484 (92.5%)	0.63
Height (cms)	165.6 (7.9)	163.9 (7.1)	**< 0.001***	163.5 (7.4)	163.9 (7.1)	0.35
Weight (kg)	62.3 (10.4)	62.0 (9.0)	0.48	61.9 (9.0)	62.0 (9.0)	0.98
Unilateral cases	4281 (98.8%)	522 (99.8%)	**0.04***	523 (100%)	522 (99.8%)	1.00
Complicated cases	1184 (27.3)	102 (19.5%)	**< 0.001***	93 (17.8%)	102 (19.5%)	0.53
Nuck canal cyst	205 (4.7%)	0		0	0	
Cord lipoma	509 (11.7%)	66 (12.6%)		51 (9.8%)	66 (12.6%)	
Scrotal hernia	395 (9.1%)	29 (5.5%)		33 (6.3%)	29 (5.5%)	
Irreducible hernia	56 (1.6%)	4 (0.8%)		7 (1.3%)	4 (0.8%)	
Other	19 (0.4%)	3 (0.6%)		2 (0.4%)	3 (0.6%)	
Primary hernia	4307 (95.0%)	490 (93.7%)	0.2	493 (94.3%)	490 (93.7%)	0.80
Hernia type			**< 0.001***			0.60
Lateral	3264 (75.3%)	356 (68.1%)		353 (67.5%)	356 (68.1%)	
Medial	851 (19.6%)	127 (24.3%)		140 (26.8%)	127 (24.3%)	
Femoral	101 (2.3%)	13 (2.5%)		11 (2.1%)	13 (2.5%)	
Combined	117 (2.7%)	27 (5.2%)		19 (3.6%)	27 (5.2%)	
Surgery type			**< 0.001***			0.86
Tissue repair	76 (1.8%)	1 (0.2%)		1 (0.2%)	1 (0.2%)	
Onlay	63 (1.5%)	25 (4.8%)		18 (3.4%)	25 (4.8%)	
Preperitoneal repair	2375 (54.8%)	296 (56.6%)		305 (58.3%)	296 (56.6%)	
Plug and patch	935 (21.6%)	91 (17.4%)		92 (17.6%)	91 (17.4%)	
Bilayer	884 (20.4%)	110 (21.0%)		107 (20.5%)	110 (21.0%)	
Anesthesia type			**< 0.001***			0.51
Local	3167 (73.1%)	521 (99.6%)		521 (99.6%)	521 (99.6%)	
Epidural	1084 (25.0%)	0		1 (0.2%)	0	
General	82 (1.9%)	2 (0.4%)		1 (0.2%)	2 (0.4%)	

Data of presented as mean (standard deviation). Categorical data presented as number of patients (%)

CG Control Group (Patients not under any antithrombotic therapy), *ATG* Antithrombin group (Patient undergoing surgery while continuing antithrombotic therapy), *mCG* matched Control Group (Patients from control group matched with the patients from Antithrombin group)

*Statistically significant difference with the p value of < 0.05

Additionally, no difference was seen in the surgery time or anesthesia time between the subgroups of the antithrombin group (Table 5). Drains were placed due to intraoperative bleeding in two patients in the antithrombin group and four patients in the control group (Table 6). Of all patients undergoing surgery during the study period, there were 17 patients (0.35%) with postoperative bleeding. The rate of postoperative hemorrhage was statistically higher in the antithrombin group compared to the control group ($p<0.001$) (Table 6). Among patients in the antithrombin group, postoperative bleeding was highest in the multiple medication group (4.7%) followed by the anticoagulation group (3.6%); this difference was statistically significant ($p=0.04$) (Table 7). However, most of these patients presented with wound hematoma, and only three patients presented with scrotal hematomas (1 in the control group; 1 in other antiplatelets group; and 1 in anticoagulant group). Most of the bleeding was managed conservatively. Two patients each in the antithrombin group (1 in multiple medications and 1 in anticoagulation group) and control groups required surgical intervention to drain hematomas. Three patients had cardiovascular thrombotic events within 1 week of surgery in the antithrombin group ($p=0.001$) (Table 6). These three patients were receiving single medication of low-dose aspirin (Table 7). There was no difference between other postoperative events between groups (Table 6).

After propensity score-matching, there were 523 cases each in the matched control group and antithrombin groups (Fig. 1). No significant differences were observed between the backgrounds of both groups after propensity score-matching (Table 2). Both surgery time and anesthesia time were similar in the groups (Table 4). The prevalence

Table 3 Background of the patients under different types of antithrombotic therapy

	Asprin only ($n=230$)	Multiple medications ($n=85$)	Other antiplatelets ($n=98$)	Anticoagulants ($n=110$)	p
Age	71.8 (10.1)	75.0 (9.2)	72.0 (9.4)	74.2 (9.8)	**0.02***
Sex male	208 (90.4%)	81 (95.3%)	95 (96.9%)	100 (90.9%)	0.13
Height (cms)	163.8 (7.4)	164.5 (6.7)	163.6 (6.3)	164.3 (7.6)	0.78
Weight (kg)	61.6 (9.8)	62.7 (8.3)	61.6 (6.9)	62.4 (9.8)	0.74
Unilateral cases	229 (99.6%)	85 (100%)	98 (100%)	110 (100%)	0.74
Complicated cases	102 (19.5%)	102 (19.5%)	102 (19.5%)	102 (19.5%)	0.17
Nuck canal cyst	0	0	0	0	
Cord lipoma	33 (14.3%)	11 (12.9%)	10 (10.2%)	12 (10.9%)	
Scrotal hernia	12 (5.2%)	9 (10.6%)	6 (6.1%)	2 (1.8%)	
Irreducible hernia	2 (0.9%)	0 (0.0%)	1 (1.0%)	1 (0.9%)	
Primary hernia	215 (93.5%)	81 (95.3%)	92 (93.9%)	102 (92.7%)	0.90
Hernia type					0.14
Lateral	159 (69.1%)	56 (65.9%)	69 (70.4%)	72 (65.5%)	
Medial	59 (25.7%)	21 (24.7%)	24 (24.5%)	23 (20.9%)	
Femoral	4 (1.7%)	1 (1.2%)	1 (1.0%)	7 (6.4%)	
Combined	8 (3.5%)	7 (8.2%)	4 (4.1%)	8 (7.3%)	
Surgery type					0.29
Tissue repair	0 (0%)	1 (1.2%)	0 (0.0%)	0 (0.0%)	
Onlay	12 (5.2%)	3 (3.5%)	4 (4.1%)	6 (5.5%)	
Preperitoneal repair	129 (56.1%)	55 (64.7%)	48 (49.0%)	64 (58.2%)	
Plug and patch	39 (17.0%)	10 (11.8%)	19 (19.4%)	23 (20.9%)	
Bilayer	50 (21.7%)	16 (18.8%)	27 (27.6%)	17 (15.5%)	
Anesthesia type					0.53
Local	229 (99.6%)	84 (98.8%)	98 (100%)	110 (100%)	
Epidural	0	0	0	0	
General	1 (0.4%)	1 (1.2%)	0 (0.0%)	0 (0.0%)	

Data of presented as mean (standard deviation). Categorical data presented as number of patients (%)

*Statistically significant difference with the p value of < 0.05

Table 4 Surgical data of the patients in both the groups in unilateral cases

	All data			Matched data		
	CG ($n=4281$)	ATG ($n=522$)	P	mCG ($n=523$)	ATG ($n=522$)	p
Surgery time (mins)	53.7 (12.3)	54.7 (12.2)	0.10	54.4 (13.2)	54.7 (12.2)	0.74
Anesthesia time (mins)	69.6 (13.1)	68.5 (12.4)	0.07	68.3 (11.3)	68.5 (12.4)	0.79

Data presented as mean (standard deviation)

CG Control Group (Patients not under any antithrombotic therapy), *ATG* Antithrombin group (Patient undergoing surgery while continuing antithrombotic therapy), *mCG* matched Control Group (Patients from CG matched with the patients from ATG)

Table 5 Surgical data of the patients only under aspirin and other antithrombotic therapy in Unilateral cases

	Asprin only ($n=230$)	Multiple medications ($n=85$)	Other antiplatelets ($n=98$)	Anticoagulants ($n=110$)	p
Surgery time (mins)	54.8 (11.4)	55.4 (14.6)	54.4 (12.2)	54.8 (12.5)	0.96
Anesthesia time (mins)	68.8 (11.3)	68.9 (14.2)	68.4 (12.7)	67.9 (13.1)	0.92

Data presented as mean (standard deviation)

Table 6 Postoperative data of the patients in both the groups. Data presented as number of cases (%)

	All data			Matched data		
	CG ($n=4333$)	ATG ($n=523$)	p	mCG ($n=523$)	ATG ($n=523$)	p
Intraoperative drain placement	4 (0.09%)	2 (0.38%)	0.13	0 (0%)	2 (0.38%)	0.25
Bleeding	7 (0.16%)	10 (1.9%)	**< 0.001***	0 (0%)	10 (1. 9%)	**0.002***
Scrotal hematoma	1 (0.02%)	2 (0.38%)		0 (0%)	2 (0.38%)	
Wound hematoma	6 (0.12%)	8 (1.53%)		0 (0%)	8 (1.53%)	
Reoperations	2 (0.05%)	2 (0.38%)	0.06	0 (0%)	2 (0.38%)	0.25
Postoperative thrombosis events	0 (0%)	3 (0.58%)	**0.001***	0 (0%)	3 (0.58%)	0.25
Postoperative other events	6 (0.12%)	1 (0.19%)	0.55	0 (0%)	1 (0.19%)	1
Drainage of lymphatic fluids	2 (0.02%)	0 (0%)		0 (0%)	0 (0%)	
Re-suturing	1 (0.05%)	0 (0%)		0 (0%)	0 (0%)	
Admission due to pain	1 (0.02%)	0 (0%)		0 (0%)	0 (0%)	
Colon cancer	0 (0%)	1 (0.19%)		0 (0%)	1	
Asthma attack	1 (0.02%)	0 (0%)		0 (0%)	0 (0%)	
Syncope	1 (0.02%)	0 (0%)		0 (0%)	0 (0%)	

CG Control Group (Patients not under any antithrombotic therapy), *ATG* Antithrombin group (Patient undergoing surgery while continuing antithrombotic therapy), *mCG* matched Control Group (Patients from CG matched with the patients from ATG)

*Statistically significant difference with p value of < 0.05

Table 7 Postoperative data of the patients only under aspirin and other antithrombotic therapy

	Asprin only ($n=230$)	Multiple medications ($n=85$)	Other antiplatelets ($n=98$)	Anticoagulants ($n=110$)	p
Intraoperative drain placement	0 (0%)	1 (1.2%)	1 (1.0%)	0 (0%)	0.29
Postoperative bleeding	1 (0.4%)	4 (4.7%)	1 (1.0%)	4 (3.6%)	**0.04***
Scrotal hematoma	0 (0%)	0 (0%)	1 (1.0%)	1 (0.9%)	
Wound hematoma	1 (0.4%)	4 (4.7%)	0 (0%)	3 (2.7%)	
Reoperations	0 (0%)	1 (1.2%)	0 (0%)	1 (0.9%)	0.36
Postoperative thrombosis events	3 (1.3%)	0 (0%)	0 (0%)	0 (0%)	0.28
Postoperative other events	0 (0%)	0 (0%)	0 (0%)	1 (0.9%)	0.29
Colon cancer	0 (0%)	1 (0.34%)	0 (0%)	1 (0.9%)	

Data presented as number of cases (%)

*Statistically significant difference with p value of < 0.05

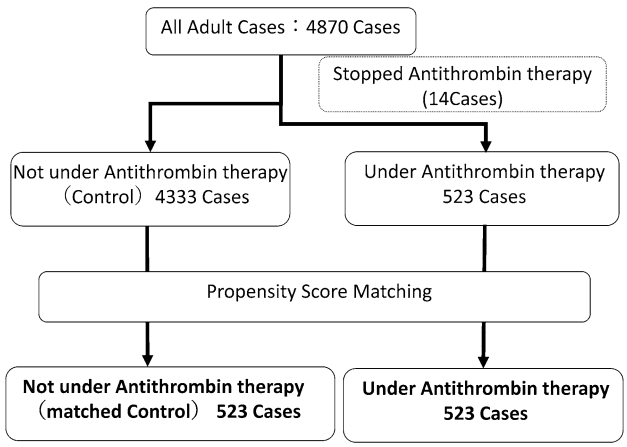

Fig. 1 Study protocol

of postoperative bleeding was statistically higher in the antithrombin group ($p=0.002$); however, other complications did not differ significantly in the matched data (Table 6).

Discussion

In this retrospective study, we demonstrated that while the continuation of antithrombotic therapy increased the rate of minor postoperative bleeding, it did not increase the reoperation rate or mortality. Patients taking antithrombotic medications, especially aspirin, had a higher risk of cardiovascular thrombotic events than those who were not prescribed such medications. To further validate the results,

we performed propensity score-matching to match the background characteristics of patients receiving antithrombotic medications and those not receiving these medications.

Our data shows that open inguinal hernia repair performed by an experienced surgeon has a low risk for bleeding with an overall hemorrhage rate of 0.35%. The rate of postoperative hemorrhage was highest (4.7%) in patients taking multiple antithrombotic medications. The rate of hemorrhage was statistically higher in patients in the antithrombin group compared to those in the control group. Among the patients receiving antithrombotic therapy, patients in the multiple medication group and anticoagulation group had a higher rate of postoperative hemorrhage compared to that in the aspirin group and that in the other antiplatelets group. However, most of these hemorrhages were minor wound hematomas and were managed conservatively. It should be noted that only two patients in this series required surgical intervention to remove hematomas. Even in the group with the highest rate of reoperation (multiple medication group), only 1.2% of the patient required reoperation. These findings are similar to those of previously reported studies. However, most of these studies had a small sample size [10, 11, 14, 15]. Few studies have shown increased risk of postoperative bleeding and hematomas in patients receiving antithrombotic medication [9, 12, 16]. Among these studies, the study from the Herniamed Registry reported postoperative bleeding rate and reoperation rate of 3.91% and 2.26%, respectively, in patients receiving antithrombotic therapy or with coagulopathy, compared with 1.12% and 1.01% in controls [9]. A study from the Mayo Clinic with a large sample size reported a hematoma rate of 1.4% and a reoperation rate of 0.54% [12]. While these studies showed increased bleeding with antithrombotic therapy, it should be noted that no studies, including our study have shown life-threatening complications due to postoperative hemorrhage.

Patients are prescribed antithrombotic medication primarily for prophylactic reasons to prevent thrombotic events. In our study, despite patients continuing their medications through surgery, three patients (0.6%) developed thromboembolic events. This number was significantly higher than that in patients not on the medication, making them a high-risk group. However, studies on hernia repair have rarely reported postoperative cardiovascular events. In the report by Ong et al. [15], two patients (2.4%) who discontinued aspirin perioperatively and one patient (1.7%) who continued aspirin developed cardiovascular thrombotic events. However, the study was not adequately powered due to the small sample size and thus could not determine a statistical significance between the occurrence of thrombotic events in these patients. Data from other procedures have shown an increase in thrombotic events in patients discontinuing antithrombotic medications [5]. A recent national level population-based cohort study from Sweden found that discontinuing aspirin, the most common drug in our study, increased the risk of cardiovascular events by 37%, and most events occurred within 2 weeks of ceasing the medication use [17]. Data from other studies show similar results with short-term discontinuation of antiplatelet therapy and anticoagulant medications, including direct oral anticoagulants [18–20].

In summary, our data and evidence suggest that, while continuing antithrombotic therapy, especially in those receiving multiple medications and anticoagulation therapy, there is an increased risk of bleeding or hematoma after hernia surgery. However, the bleeding or hematoma is usually minor and can be managed conservatively. Conversely, the risk of thromboembolic events increased with temporary cessation. Our data also indicated that patients receiving antithrombotic therapy had a higher risk of thromboembolic events. We also need to consider that while postoperative hematomas and bleeding in open inguinal hernia repair is rarely life threatening, thromboembolic events can be fatal or result in severe disability [21]. Thus, despite the increased incidence of postoperative bleeding, we consider that it is justified to continue antithrombotic medication perioperatively in open hernia repair surgery as this decreases the risk of thromboembolic events.

This study has several limitations. First, it is a single-center study, and all surgeries were performed by one highly experienced surgeon. The results might not be applicable to all surgeons and centers. However, meticulous dissection using local anesthesia solution, and electrocautery, which are the basic principles of surgery, were used to achieve our results. With attention to dissection in the correct plane and by minimizing bleeding in all surgeries, we feel that similar results can be achieved in any setting. The study is also limited by its retrospective nature; it remains possible that unknown confounding factors exist. Although we tried to minimize this using propensity score-matching to match the background characteristics of the two groups, all the confounding factors may not have been addressed. To truly test this hypothesis, a properly powered randomized controlled trial between the group continuing antithrombotic medications and the group ceasing the medications prior to surgery is needed. However, a randomized controlled trial may be unethical if we consider our data. Even while continuing the medications, the patients receiving antithrombotic medication had a higher risk of thromboembolic events, through there was no increase in the risk of severe complications. Although a single center study, this study boasts of a large sample size and included almost all cases of patients receiving antithrombotic medications over a period of 11 years. We feel justified to continue offering this therapy to our patients even without the evidence from a randomized controlled trial.

Conclusion

Patients receiving antithrombotic therapy have a high risk of thrombotic events. Our study showed that, while the risk of postoperative bleeding increased with antithrombotic therapy except aspirin, all types of open inguinal hernia repair surgeries can be safely performed continuing this therapy.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval This retrospective study was approved by the institutional review board of Hokkaido University (Med 18-037). The notice for this retrospective study was published on the website of the institute and the patients were given the right to opt out.

Human and animal rights Animals were not used in this study.

Informed consent Prior to surgery, the risk of both continuation or cessation of antithrombotic medications was explained to all the patients.

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