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Antiplatelet or Anticoagulant Therapy for Abdominal Aortic Aneurysms: Growth and Clinical Outcomes

ORIGINAL INVESTIGATION

ABSTRACT

Background: Intraluminal thrombi in the abdominal aortic aneurysms (AAA) were demonstrated to increase aneurysm growth. The effect of treatments on thrombus reduction upon AAA enlargement and clinical endpoints is uncertain Therefore, this study aimed to investigate the effect of antiplatelet and anticoagulant therapy on AAA growth and clinical outcomes.

Method: A total of 357 patients with AAAs were enrolled in this study. They were divided into 2 groups based on their medical therapies. Patients on antiplatelet and anticoagulant therapy were assigned to group 1 (n=234) and group 2 (n=92), respectively.

Results: The greatest reduction in thrombus diameter change was observed in patients with anticoagulant therapy (group 1, −2.26 mm; group 2, −8.16 mm; $P=.001$). The greatest aneurysmal enlargement was found in patients with antiplatelet therapy. There was less AAA progression with anticoagulant therapy than with the other therapy (group 1, 2.08 mm; group 2, 1.31 mm $P=.027$. The more operational need was observed in patients with antiplatelet therapy than in patients with anticoagulant therapy (group 1 67, group 2 16, $P=.036$)

Conclusion: In our study, it was revealed that anticoagulant therapy has been associated with decreased thrombus diameter and less aneurysmal enlargement compared with antiplatelet therapy. Furthermore, this beneficial effect on the thrombus size and aneurysmal diameter decreased the operational need in patients with anticoagulant therapy.

Keywords: Aneurysm, Aorta, Antiplatelet Agents, Anticoagulants

INTRODUCTION

Abdominal aortic aneurysm (AAA) is a degenerative vascular disease resulting from an interaction between genetic and environmental factors, which aggravate normal aging processes.[1] Abdominal aortic aneurysm is defined as an increase of >50% of the expected normal diameter of the aorta. The prevalence in men aged 70-74 is 17%. The prevalence rate in males is 6 times higher than in females. However, women have 4 times more ruptures and a similar number of deaths when compared with men. The main risk factors are age, male sex, smoking history, and family history of AAA in first-degree relatives. The major risk factors for aneurysm rupture include female sex, aneurysm diameter, and rate of growth, low forced expiratory volume in 1 second, current smoking status, and elevated mean arterial pressure.[2,3] The pathology of growing AAA is a localized inflammatory disorder with an accompanying proteolytic imbalance.[4] Human biopsy specimens and studies in rodent models of AAA demonstrate that inflammation, extracellular matrix remodeling, vascular smooth muscle cell dysfunction, angiogenesis, and thrombosis are all important in the pathogenesis of AAA.[5]

Vascular inflammation is the main initial factor. Neutrophils, lymphocytes, mast cells, and natural killer cells gradually infiltrate into the tissue from the adventitia to the intima. Cytokines modulating macrophage infiltration contribute to smooth muscle cell (SMC) apoptosis. Infiltration of inflammatory cells in the aorta produces and stimulates SMCs. Activated SMCs secrete matrix metalloproteinases

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(MMPs). These enzymes destroy the extracellular matrix.[6] The excess collagen degradation is matched by compensatory collagen deposition. However, major qualitative defects exist in the newly deposited collagen. As a result, defective collagen contributes to the weakening of the aortic wall.[4]

In 75% of patients with AAA, the aneurysm wall is covered by an intraluminal thrombus (ILT). The ILT contains inflammatory cells, fibrin, and proinflammatory cytokines. In previous research, the volume of ILT was associated with AAA size and growth in patients. It was demonstrated that cytokines and enzymes in the thrombus had an important role in the development of AAAs.[6] The AAA wall covered by ILT contains more inflammatory cells, fewer smooth muscle cells, and a more degraded extracellular matrix, especially elastin when compared with AAA walls not covered by ILT. It has been demonstrated that ILT formation and growth are active and dynamic processes.[7] Evidence has shown that AAA rupture is a result of mechanical stress on the arterial wall. Some studies suggested that an increase in thrombus diameter might decrease mechanical stress as a mechanical cushion; therefore, preventing the aortic diameter from increasing. However, some studies did not find a beneficial effect of thrombus size on aorta diameter.[8] Accordingly, the effect of ILT on aortic size and clinical endpoints is controversial. For this reason, we aimed to investigate the effect of anticoagulant and antiplatelet therapy on ILT formation, AAA growth, and clinical outcomes in patients with AAAs.

METHODS

Study Population

This retrospective observational study was conducted at the department of cardiology, between January 1, 2011, and June 30, 2019. A total of 357 patients with AAAs were reviewed. Abdominal aortic aneurysm was defined with computed tomography (CT) angiography as infrarenal aorta diameter ≥30 mm at the first visit.[9] All patients in this study underwent follow-up CT angiography. The abdominal aortic diameter and intraluminal thrombus were measured by CT angiography at the beginning and the follow-up duration (Figure 1). The patients were divided into 2 groups based on which therapy they received [antiplatelet, anticoagulant therapy]. The patients were used to these agents prior to the study protocol. Patients who did not receive medical treatment or who changed medical treatment, discontinued medical treatment, or received dual medical therapy were excluded (n=18). Patients on antiplatelet and anticoagulant therapy were assigned to group 1 (n=234), and group 2 (n=92), respectively. The mean follow-up time was 3.05 years in group 1 and 2.72 years in group 2.

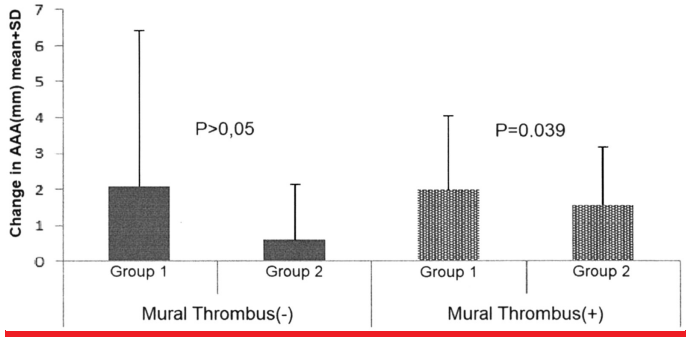

Figure 1. The effect of mural thrombus on abdominal aortic diameter.

Patients with hematologic, liver, and renal disease and connective tissue disorders (13 patients) were excluded from the study. The clinical and laboratory data were collected from hospital admission and outpatient medical records. The clinical endpoints were defined as an operational need, rupture, dissection, peripheral embolism, cerebral embolism, and exitus. Patients's medication was seen in their electronic prescriptions. All patients were contacted by phone.

Computed tomography angiography was obtained using a helical 64-slice multi-scanner (Toshiba Medical Systems, UK). A nonionic iodinated contrast agent (Iohexol 350 mg, Omnipaque) was injected into an antecubital vein. Abdominal aortic aneurysm diameter was measured in different planes (coronal or sagittal) and orientations (orthogonal and axial). Computed tomography angiography was used for screening by an experienced radiologist.

The present study was approved by the Local Ethics Committee (Approval number: 2021/271-3402). Informed consent was submitted by all subjects when they were enrolled.

Data Analysis and Statistical Analysis

The Number Cruncher Statistical System NCSS 2007 (Kaysville, Utah, USA) for Windows program was used for data input and statistical analysis. Mean, median, and standard deviation were used to report the results. To evaluate the conformity of the data to normal distribution, descriptive statistical methods such as mean ± SD, median, IQR, frequency, and percentage were used, along with the Shapiro–Wilk test and box plot graphs. The independent-samples *t*-test was used to evaluate variables with normal distribution in 2 groups, while the paired-samples *t*-test was used for intragroup evaluations. For variables that do not exhibit normal distribution, the Mann–Whitney *U*-test was used for 2-group evaluations, and the Wilcoxon signed-rank test was used for in-group evaluations. Categorical variables were expressed in frequencies and percentages using Pearson's chi-square (χ^2) test and Fisher's exact test. *P*-values < .05 were considered significant.

HIGHLIGHTS

- Abdominal aortic aneurysm is a degenerative disease that results in progressive expansion and rupture.
- Seventy-five percent of AAAs contain intraluminal thrombi. Intraluminal thrombi in AAAs were demonstrated to increase aneurysm growth.
- Antiplatelet or anticoagulant therapy, especially anticoagulant therapy diminished ILT in patients with AAAs.
- Furthermore this beneficial effect on the thrombus in patients with anticoagulant therapy significantly decrease AAA growth and operational need.

RESULTS

A total of 357 patients with infrarenal AAAs were registered in the hospital archive between 2011 and 2019. Patients without medical therapy or dual therapy and patients with history of liver and renal disease were excluded (n = 31). The participants were predominantly male (87.7%) and smokers (54%). The mean patient age was 72.61 ± 7.81 (range, 41-92) years. Among the entire patient group, it was found that 20.2% of patients had diabetes, 67.5% had hypertension, 47.2% had coronary artery disease, and 3.7% of patients had peripheral artery disease. The diameter range of AAAs in tomography was between 30 and 58 mm on the first visit and between 31 and 62 mm on the last visit. The mean follow-up duration was 3 years (group 1; 3.05 years, group 2; 2.72 years, $P = 0.074$). Seventy-two patients with AAAs had no ILT. The diameter range of ILT was between 1 mm and 34 mm at the first visit. Of the 326 patients, 59 (17.9%) patients died during the follow-up period.

Medical therapy: During the follow-up period, salicylate was given to 138 patients (42.3%, group 1), clopidogrel was given to 96 patients (29.4%, group 1), and 50 received NOAC (new oral anticoagulant) therapy (15, 4%, group 2), and 42 received warfarin therapy (12.9%,, group 2). Among 50 patients in the NOAC group treated with 18 apixaban (36%), 9 edoxaban (18%), dabigatran 5 (10%), and rivaroxaban 18 (36%). The reduced doses of NOAC were observed in 14 (28%) patients. In group 2, warfarin therapy was effective (International normalized ratio (INR) > 2) in 37 (88%) patients.

The demographic and descriptive clinical features of the groups are presented in Table 1. The incidence of diabetes and hypertension was similar in the groups. However, the population of patients with coronary artery disease was greater in patients with anticoagulant therapy than in patients with antiplatelet therapy. The use of beta-blockers is similar between groups. However, the use of statin is higher in group 2 than in group 1 (55.6% group 1, 70.7% group 2, $P = .012$).

Table 1. Descriptive Clinical Features of Patients with Antiplatelet and Anticoagulant Therapy

	Groups		
	Group 1 (n = 234)	Group 2 (n = 92)	*P*
Age (years)	72.07 ± 7.75	74.00 ± 7.83	.044[a,*]
Sex (%)			
Female	30 (12.80)	10 (10.90)	.629[b]
Male	204 (87.20)	82 (89.10)	
Current smoker (%)	123 (52.60)	53 (57.60)	.411[b]
Diabetes (%)	45 (19.20)	21 (22.80)	.467[b]
Hypertension (%)	151 (64.50)	69 (75.00)	.069[b]
Coronary artery disease (%)	95 (40.6)	59 (64.10)	.001[b,**]
Peripheric artery disease (%)	9 (3.60)	3 (3.30)	1.000[f]
Bicuspid aortic valve (%)	1 (0.40)	0 (0)	1.000[f]
ACE inh (%)	138 (59.00)	65 (70.70)	.049*
Beta-blocker (%)	136 (58.10)	52 (56.50)	.793
Statins (%)	130 (55.60)	65 (70.70)	.012*
Follow-up (years)	2.70 (3-4)	2.50 (1.3-4)	.074

[a]Independent-samples *t*-tests (mean + SD).
[b]Pearson's chi-square test.
[c]Mann–Whitney *U*-test [median (IQR)].
[f]Fisher's exact test.
*$P < .05$.
**$P < .01$.

Table 2. Comparison of the Laboratory Outcomes Among the Groups

	Groups		
	Group 1 (n = 234)	Group 2 (n = 92)	*P*
FPG (mg/dL)	99 (90-109)	98 (90-106.5)	.802[c]
Cholesterol (mg/dL)	201.45 ± 43.48	200.37 ± 38.36	.834[a]
Triglycerides (mg/dL)	136.96 ± 49.61	132.62 ± 47.47	.473[a]
HDL (mg/dL)	26-180 (40)	24-67 (40)	.686[c]
LDL (mg/dL)	131.73 ± 41.60	132.50 ± 36.97	.876[a]
Leukocyte (× 10³/L)	8.33 ± 2.07	7.99 ± 1.99	.181[a]
Hb (g/dL)	12.96 ± 1.52	12.79 ± 1.50	.373[a]
RDW (%)	15.06 ± 2.16	15.04 ± 1.92	.925[a]
MPV (fL)	8.63 ± 1.15	8.72 ± 1.41	.563[a]
NLR	2 (1,5-3)	1.81 (1.5-2.5)	.237[c]
CRP (mg/dL)	0.70 (0.3-1.5)	0.50 (0.3-1.1)	.402[c]

FPG, fasting plasma glucose; Hb, hemoglobin; HDL, high-density lipoprotein; hsCRP, high-sensitivity C-reactive protein; LDL, low-density lipoprotein; NLR, neutrophil-to-lymphocyte ratio; RDW, red cell distribution width; MPV, mean platelet volume.
[a]Independent samples *t*-test (mean ± SD).
[c]Mann–Whitney *U*-test [median (IQR)].

The laboratory analysis of the groups was similar in all groups (Table 2).

The effect of medical therapy on ILT and aneurysmal expansion is summarized in Tables 3 and 4. The thrombus diameter decreased in both groups. The most decreased thrombus size was observed in patients with anticoagulant therapy. There was less effect on the thrombus size in patients treated with NOAC therapy than in patients treated with warfarin therapy, but this difference was not significant (warfarin vs. NOAC −10.5 mm vs. −6.4 mm, $P > .05$). Clopidogrel therapy

Table 3. Effect of Antiplatelet and Anticoagulant therapy on Change in Intraluminal Thrombus

	Groups		
Mural Thrombus Diameter (mm)	Group 1 (n = 234)	Group 2 (n = 92)	*P*[a]
First measurement (mm)	13 (5-18)	15 (10.5-20)	.045*
Last measurement (mm)	010 (1-15)	5.5 (0-10)	.001**
P	.001[b]	.001[b,**]	
Change in measurement			
First measurement – last measurement, mm	−2 (−5/0)	−8 (−12/−4)	.001**

Data are presented as median with interquartile range (IQR).
[a]Mann Whitney *U*-test
[b]Wilcoxon signed rank test.
*$P < .05$.
**$P < .01$.

Table 4. Effect of Antiplatelet and Anticoagulant Therapy on Change in Abdominal Aortic Diameter

	Groups		
Abdominal aortic diameter (mm)	**Group 1 (n = 234)**	**Group 2 (n = 92)**	***P***
First measurement (mm)	45.24 ± 6.20	45.34 ± 5.97	0.889[a]
Last measurement (mm)	47.32±6.91	46.65±6.36	.792[a]
P	.001[c,**]	.001[c,**]	
Change in measurement			
First measurement – last measurement (mm)	1 (1-3)	1 (0-2)	0.027[b]

[a]Independent-samples *t*-tests (mean + SD).
[b]Mann–Whitney *U*-test [median (IQR)].
[c]Paired-samples *t*-test.
**$P < .01$.

was more effective on ILT than salicylate therapy, but it was not significant (clopidogrel vs salicylate therapy −3.5 mm vs. −1.4 mm, $P > .05$).

The effect of medical therapy on aneurysmal dilatation: The aneurysmal diameter increased in both groups. The most aneurysmal enlargement was observed in patients with antiplatelet therapy during the follow-up. There was less AAA progression in patients treated with warfarin or NOACs than in the other group. When the patients without mural thrombus were compared to the patients with mural thrombus, we found the least aortic aneurysm progression with anticoagulant therapy in patients who had no ILT formation ($P = .039$, Table 5).

The effect of medical therapy on the clinical endpoint: We found a less operational need in patients with anticoagulant therapy. We observed slightly higher cerebrovascular accidents (CVA) and mortality in patients with anticoagulant therapy than in patients with antiplatelet therapy (CVA, 16% vs. 12%, mortality 24% vs. 18%, $P > .05$) (Table 6).

DISCUSSION

Our study presented 3 important results. First, it showed anticoagulant therapy, especially warfarin, decreased intraluminal thrombus size more than antiplatelet therapy. Secondly,

Table 5. Change in Abdominal Aortic Diameter According to Antiplatelet and Anticoagulant Therapy in Patients With and Without ILT Formation

		Change in AAA Diameter (mm)			
	n	**Mean ± SD**	**Median**	**IQR**	***P***
Thrombus (−)					
Group 1	56	2.16 ± 4.31	1	0/2	.317
Group 2	16	0.66 ± 1.42	1	0/1.25	
Total	72	1.82 ± 3.90	1	0/2	
Thrombus (+)					
Group 1	178	2.06 ± 2.09	2	1/3	.039*
Group 2	76	1.45 ± 1.45	1	0/2	
Total	254	1.87 ± 1.94	1	0/3	

Mann–Whitney *U*-test.
*$P < .05$.

Table 6. Clinical Endpoints in Patients with Antiplatelet Therapy and Anticoagulant Therapy

	Groups		
	Group 1	**Group 2**	***P***
Operational need (%)	67 (28.60)	16 (17.40)	.036[a]
Rupture, dissection (%)	8 (3.40)	0 (0)	.111[b]
Peripheral embolism (%)	21 (9)	4 (4.30)	.158[a]
Cerebral embolism (%)	27 (11.50)	15 (16.30)	.248[a]
Ex (%)	37 (15.80)	22 (23.90)–	.087[a]

[a]Pearson's chi-square test.
[b]Fisher's exact test.

it was seen less aneurysmal enlargement in patients with anticoagulant therapy than in patients with antiplatelet therapy. Furthermore, if the patients without mural thrombus were excluded, it was found the least aneurysm expansion with anticoagulant therapy. Thirdly, anticoagulant therapy decreased the operational need.

The influence of medical therapy on AAA progression and clinical outcomes is unclear.[2] Medication of AAA in recent trials focused on its role in modulating the extracellular matrix, altering inflammatory status, and reducing oxidative stress and ILT.[4] Intraluminal thrombus acts as a source of proteases, inflammatory cytokines, free heme, and fibrinolytic products and creates a pro-oxidant environment. Therefore, the thrombus causes a lack of wound healing in the aortic media, leading to increased aortic weakness and dilatation.[7] Whether antiplatelet and anticoagulant therapy affects aneurysmal dilatation and rupture is controversial. Currently, low-dose aspirin is recommended for patients with AAA, but the evidence is controversial.[9] In a meta-analysis of 4137 patients, the use of antiplatelet agents was not associated with AAA growth after multivariable adjustment (−0.123 mm/year, $P = 0.24$) .[10] Preadmission low-dose aspirin was not associated with a risk of AAA rupture, but it increased the 30-day mortality rate after AAA rupture. This study has several limitations. First, the rate of aspirin resistance between the groups (ruptured AAA, unruptured AAA) was not known. Secondly, there was a lack of data on tobacco smoking in patients with ruptured AAA. Tobacco smoking doubled the risk of AAA rupture. Thirdly, there were limited data on AAA size and no data on intraluminal thrombus.[11] In our study tobacco use was similar between the groups. On the other hand, Owens et al. retrospectively analyzed 1578 patients with aortic aneurysms (thoracic, abdominal, or thoracoabdominal) for 2.28 years per individual. P2Y12 inhibitors were less protective in thoracic aneurysms than in abdominal aneurysms, but acetylsalicylic acid (ASA) protected against rupture in both aneurysms. In this trial, antiplatelet therapy slowed the progression of AAA and reduced the number of deaths in patients with AAA compared with patients who did not use antiplatelet therapy. There was no information on the rate of intraluminal thrombus in patients. Therefore we do not understand the effect of intraluminal thrombus on aortic aneurysm in patients with using antiplatelet therapy from Owen's study.[12] In our study, the follow-up duration

is the same as Owen et al (3.05 years in the antiplatelet group, 2.72 years in the anticoagulant group). In addition, cyclooxygenase-2 levels were measured in 117 AAA patients treated with ASA. Acetylsalicylic acid treatment was found to attenuate aortic aneurysm growth via cyclooxygenase 2 inhibition and subsequent anti-inflammatory actions.[13] P selectin is an adhesion molecule on activated platelets. It induces leukocyte rolling, recruitment, and infiltration. Administration of P selectin inhibitors prevented aortic wall thickening in apolipoprotein E- deficient mice. Intraluminal thrombus was not suppressed in the study.[14]

On the other hand, ticagrelor (P2Y12 inhibitor), a potent antiplatelet drug, did not reduce the growth of small AAAs and ILT volumes in the study by Wanhainen et al. This prospective, randomized study had an important limitation. Most patients with AAAs in the control group were on low-dose aspirin therapy (72 patients on ticagrelor, 72 patients on control).[15] In our study, the change in ILT diameter was similar between aspirin therapy and clopidogrel (P2Y12 inhibitor) therapy. We also observed no change in AAA diameter between patients on aspirin and clopidogrel therapy.

Prekallikrein, von Willebrand factor (vWF), ILT, and AAA were measured in 30 patients with asymptomatic infrarenal AAAs. Endothelial injury is responsible for elevated prekallikrein and vWF levels. Also, prekallikrein is a member of the extrinsic coagulation cascade. There was a positive correlation between thrombus volume, vWF activity, and prekallikrein levels. The authors found a weak positive correlation between vWF and AAA volume. There was no correlation between vWF and AAA diameter.[16] In our study, the greatest ILT reduction is observed in patients using warfarin or NOACs, which may possibly suppress the intrinsic and common coagulation pathway. However, we observed a correlation between mural thrombus diameter and AAA diameter in patients with anticoagulant therapy. In a case from an Indian heart journal, dabigatran also provided complete resolution of aortic thrombosis after 6 weeks.[17] In Apo $E^{-/-}$ mice infused with angiotensin II, the administration of a high dose of rivaroxaban (factor Xa inhibitor) for 14 days reduced the maximal diameter of the aorta. Interestingly Immunochemistry showed that high-dose rivaroxaban treatment inhibited aortic remodeling. Furthermore, low-dose rivaroxaban treatment did not display a protective role in the development of aneurysm. High-dose rivaroxaban treatment showed a protective effect by reducing leukocyte infiltration, inflammatory cytokines expression, and matrix metalloproteinases (MMP) expression in the aortic wall.[18] In another study, rivaroxaban treatment improved mitochondrial functionality in human abdominal aortic aneurysms.[19]

Inflammatory mediators activate extracellular matrix degradation enzymes, such as MMP9, and cause vascular smooth muscle cell dysfunction, thereby resulting in excessive loss of elastic fibers and AAA progression. These hypotheses are supported by studies using animal models of AAA progression. Studies using ex vivo cultures of human tissue provided complementary knowledge. Interventions that inhibit inflammatory pathways reduce levels of AAA-related markers.[20] In the Kurosawa et al. review, doxycycline as an inhibitor of MMP inhibited the development of AAA in an experimental elastase-induced rodent model of AAA. In a study of ex vivo cultures of human tissue, doxycycline reduced MMP expression and suppressed the neutrophil content of the aortic wall.[21] Zhou et al.' s study demonstrated a reduction in the incidence of AAA through the suppression of inflammatory mediators in an elastase mouse model and an angiotensin II mouse model.[22]

In a short report, a reduction in MMP activity was shown after 7 days of low-molecular-weight heparin administration in patients with AAA.[23] In Moran et al's study, parenteral use of enoxaparin and fondaparinux reduced aortic aneurysms in apolipoprotein F deficient mice after 14 days. There was a strong correlation between the aortic levels of factor X a and suprarenal aorta diameter. Unfortunately, enteral administration of dabigatran (factor II inhibitor) did not affect aneurysmal dilatation. The study showed monocyte and macrophage accumulation within the adventitia and media of the suprarenal aorta was reduced in mice administered fondaparinux.[24]

Iron oxide taken up by tissue macrophages was used to demonstrate cellular inflammation on magnetic resonance imaging in patients with AAA. The enhancement of iron oxide uptake increases aneurysm expansion, rupture, and the need for surgical repair. Iron oxide uptake was lower in patients using anticoagulant and antiplatelet therapy compared with no antiplatelet or anticoagulant therapy and the lowest uptake was seen in patients using anticoagulant therapy. This result was not significant because the sample size was limited in the anticoagulant group.[25] In our study, the need for surgery was less in the anticoagulant group compared with the antiplatelet group.

In some of the meta-analyses, statins slowed the growth of abdominal aortic aneurysms, while others have reported no significant effect. Similarly, inconsistencies in results have been found in studies involving ACE inhibitors.[2,9] In our study, there were a higher number of patients with coronary artery disease and hypertension among those who received anticoagulant therapy, compared to those who received antiplatelet therapy. As a result, it is possible that more statins and ACE inhibitors were prescribed to patients on anticoagulants. Despite conflicting results in the literature, increased use of statins and ACE inhibitors in patients receiving anticoagulant therapy may have contributed to the slowing of AAA progression.

Apart from this, we observed slightly higher cerebrovascular accidents (CVAs) and mortality in patients administered anticoagulant therapy than in patients with antiplatelet therapy. High mortality in patients receiving anticoagulant therapy may be due to increased CVAs and bleeding risk.

CONCLUSION

According to our study, anticoagulant therapy decreased the rate of expansion of the aneurysm in patients with abdominal aortic aneurysm compared to antiplatelet therapy, while

reducing the intraluminal thrombus on the one hand. The control of anticoagulant therapy on aneurysm enlargement is more pronounced in aneurysms with thrombus. This suggests that shrinking the intraluminal thrombus may have a protective effect on the expansion of the aneurysm. At the same time, the decrease in the operational need for clinical outcomes in the anticoagulant arm may be a clinical result supporting this. Our study needs to be supported by immunohistochemical data, prospective studies with a longer follow-up period, and larger patient groups.

Study Limitations

Our study has some limitations. This study is an observational cross-sectional, retrospective, single-center study, there could be a selection bias based on patient characteristics. Although the extrinsic factors confused the endpoints, we tried to apply strict exclusion criteria to obtain a homogeneous population. However, the population of patients with coronary artery disease and hypertension was greater in patients with antiplatelet therapy than in patients with anticoagulant therapy and the use of statin is higher in group 2 than in group 1. Another limitation of this study is that the follow-up time between patients was variable and the diameter difference in abdominal aortic aneurysm was very small between the groups.

Ethics Committee Approval: The study was conducted with the Declaration of Helsinki and approved by the Institutional Ethics Committee (registration number: HNEAH-KAEK 2021/271-3402).

Informed Consent: All patients signed an informed consent.

Peer-review: Externally peer-reviewed.

Author Contributions: Conceptualization – A.E.Y.; Data Curation – A.E.Y., E.P.; Formal Analysis – A.E.Y., E.P.; Methodology – A.E.Y.; Software – A.E.Y., E.P.; Writing – A.E.Y, E.P.; Editing – A.E.Y., E.P.

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All authors gave final approval on the submitted manuscript and agree to be accountable for all aspects of the work ensuring integrity and accuracy.

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