Safety of Chronic Anticoagulation Therapy After Endovascular Abdominal Aneurysm Repair (EVAR) CME ☆

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WHAT THIS PAPER ADDS

Knowledge of the negative impact (higher risk of loss of stentgraft sealing, reintervention, and conversion) of chronic anticoagulation on early and late outcomes of endovascular aortic repair (EVAR) shown in this study should inform the future decision-making approach for patients with both abdominal aortic aneurysms (AAA) and cardiac disease, who may require prolonged anticoagulation treatment.

Objective: Current data supporting the effect of anticoagulation drug use on aneurysm sealing and the durability of endovascular abdominal aneurysm repair (EVAR) are conflicting. This study assessed the safety of chronic anticoagulation therapy after EVAR.

Methods: Records of 1409 consecutive patients having elective EVAR during 1997—2011 who were prospectively followed were reviewed. Survival, reintervention, conversion, and endoleak rates were analyzed in patients with and without chronic anticoagulants. Cox proportional hazards models were used to estimate the effect of anticoagulation therapy on outcomes.

Results: One-hundred and three (7.3%) patients were on chronic anticoagulation drugs (80 on vitamin K antagonists) at the time of EVAR. An additional 46 patients started on anticoagulants after repair were identified. Patients on chronic anticoagulation therapy at repair (mean age 73.6 years; 91 males) had more frequent cardiac disease (74.8% vs. 44.2%; $p < 00001$), but no other differences in demographic and major baseline comorbidities with respect to the others. At baseline, mean abdominal aortic aneurysm (AAA) diameter was 56.43 mm vs. 54.65 mm ($p = .076$) and aortic neck length 26.54 mm vs. 25.21 mm ($p = .26$) in patients with and without anticoagulants, respectively. At 5 years, freedom from endoleak rates were 55.5% vs. 69.9% ($p < .0001$), and freedom from reintervention/conversion rates were 69.4% vs. 82.4% ($p < .0001$) in patients with (including those with delayed drug use) and without chronic anticoagulants, respectively. Controlling for covariates with the Cox regression method, at a mean follow-up of 64.3 ± 45.2 months after EVAR, use of anticoagulation drugs was independently associated with an increased risk of endoleak (odds ratio, OR 1.6; 95% confidence interval, CI: 1.23—2.07; $p < .0001$) and reintervention or late conversion rates (OR 1.8; 95% CI: 1.31—2.48; $p < .0001$).

Conclusions: The safety of anticoagulation therapy after EVAR is debatable. Chronic anticoagulation drug use risks exposure to a poor long-term outcome. A critical and balanced decision-making approach should be applied to patients with AAA and cardiac disease who may require prolonged anticoagulation treatment.

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Vitamin K antagonists (VKAs) and heparins have been used as an effective therapy to prevent the thromboembolic complications of atrial fibrillation (AF), valvular heart disease (VHD), and venous thromboembolism (VTE). The use of chronic anticoagulation drugs is expected to further increase in the Western world because of the aging population and the introduction of new oral anticoagulants with safer profiles.[1] However, chronic anticoagulant therapy is extremely challenging in clinical practice: the target level of anticoagulation involves a balance between prevention of ischemic events and avoidance of hemorrhagic complications.[2] The risk/benefit ratio should be estimated in each individual patient and is particularly important for elderly patients with AF. Specifically, in old patients with abdominal aortic aneurysms (AAA) and cardiac disease (often requiring

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chronic anticoagulant therapy), endovascular aneurysm repair (EVAR) is usually preferred to open surgery to minimize the operative complications and hemorrhagic risks of open surgery. Therapeutic doses of anticoagulants could theoretically prevent spontaneous aneurysm sac thrombosis and increase the incidence of endoleak and, therefore, of EVAR failure. Nevertheless, the effect of the patient coagulation status on the success of endovascular aneurysm exclusion in the early stages, and particularly in the long term, is a reason for concern. This remains unresolved in the current literature because studies that specifically analyze the effect of chronic anticoagulation on outcomes of EVAR are limited and the results discordant.[3–8]

The aim of this study was to analyze early and late outcomes of EVAR patients on chronic anticoagulation therapy in a large series of patients.

METHODS

From April 1997 to December 2011, all patients with infrarenal AAA who underwent EVAR were prospectively entered into a database. Recorded data included demographics, clinical comorbidities, baseline drug use including anticoagulation methods, aneurysm morphology details, EVAR devices, intraoperative details, and follow-up outcomes. Patients treated as an emergency for AAA rupture and those receiving fenestrated stentgrafts were excluded from the present study that focused on 1409 patients receiving anticoagulant therapy or not. The collected data were reviewed to investigate whether the use of chronic anticoagulation drugs before EVAR affected EVAR outcome. Patients were divided into two groups: those on chronic anticoagulation therapy (VKAs or heparins) and those not, at the time of EVAR. However, the database only included drug data at the time of operation and data were not collected on the use of anticoagulants during follow-up after EVAR. For the purpose of this study, to further investigate the potential effect of chronic anticoagulants on late outcomes of EVAR, patients were contacted by telephone and specifically questioned about the introduction of anticoagulation therapy following EVAR. The overall group of patients with long-standing (on therapy at the time of EVAR) and delayed (started after discharge) anticoagulation treatment was separately assessed.

Patients on anticoagulants and those not, were compared for perioperative variables and outcomes at 60 months. The primary outcomes were survival and the need for reintervention. Secondary outcomes were aneurysm-related survival, need for conversion, and endoleak incidence.

Patients received intraoperative intravenous unfractionated heparin (100 U/kg). EVAR was performed by a dedicated team under general or local anesthesia using different device models depending on the aorto-iliac morphology, stentgraft availability, and operator preferences. There were $n = 610$ (43.3%) Zenith (Cook Inc., Blooomington, IN, USA); $n = 235$ (16.7%) AneuRx (Medtronic Vascular, Santa Rosa, CA, USA); $n = 167$ (11.8%) Talent (Medtronic Vascular, Santa Rosa, CA, USA); $n = 71$ (5.0%) Endurant (Medtronic Vascular, Santa Rosa, CA, USA); $n = 232$ (16.5%) Excluder (Gore & Associates, Inc, Flagstaff, AZ, USA); $n = 35$ (2.5%) Fortron (Johnson & Johnson – Cordis Corporation, Bridgewater, NJ, USA); $n = 53$ (3.8%) Anaconda (Terumo Vascutek, Inchinnan Renfrewshire, UK), and $n = 6$ (0.4%) others.

After EVAR, patients were scheduled for serial follow-up including clinical evaluation and imaging with duplex ultrasound and computed tomography angiography (CTA) scan at 1, 6, and 12 months, and yearly thereafter. Use of CTA was less frequently applied in the most recent years. A vascular dedicated digital workstation (TeraRecon Aquarius Workstation, Terarecon, Foster City, CA, USA) was used for CTA-scan imaging analysis and three-dimensional (3D) reconstructions. Endoleaks and complications were recorded and classified according to Standardized Reporting Practices in Vascular Surgery.[9] Reinterventions were performed at the discretion of the attending surgeon, but, in general, treatment was applied when AAA showed type I/III endoleak or persisting type II endoleak/endotension associated with a diameter increase >5 mm after EVAR or in the presence of major complications (migration, disconnections, limb occlusion, rupture). The type of treatment was individualized to aneurysm anatomy and endoleak source.[10]

Because of the retrospective analysis of prospectively collected data, there was no requirement for local ethical committee approval.

Statistical analysis

Descriptive statistics for categorical variables were presented as relative frequencies (percentages); chi-square test or Fisher exact test, when appropriate, were used to evaluate univariate differences between the chronic anticoagulant (VKAs or heparin) and non-anticoagulant groups. Continuous variables were expressed as mean with standard errors (SE) and ranges. Kaplan–Meier survival estimates were used to determine survival, aneurysm-related survival, and freedom from reintervention, conversion, and endoleak in patients with and without chronic anticoagulation therapy. Log-rank test was used to assess difference between groups.

The odds ratio (OR) and 95% confidence intervals (CIs) for different outcomes were estimated with multivariate analyses using Cox regression models. Backward selection was used to evaluate time-to-event effects of chronic anticoagulation and the development of need for reintervention and endoleak occurrence while controlling for the following confounders: age, gender, diabetes, hypertension, cardiac disease (CAD), peripheral artery disease (PAD), chronic obstructive pulmonary disease (COPD), aneurysm diameter, intraluminal thrombus, and anticoagulation treatment.

Findings were considered statistically significant if the resulting p value was less than .05. SPSS for Mac/OS version 20.0 (SPSS Inc. Chicago, IL, USA) was used for all statistical analyses.

RESULTS

One-hundred and three (7.3%) patients were on chronic anticoagulation drugs at the time of repair. Mean age was 73.57 + 7.2 years and 91 (88.3%) were males. Eighty were on VKAs and the remaining 23 on heparins. No new oral anticoagulants were used. There were no major differences in baseline morphology or clinical characteristics of patients with and without anticoagulants at the time of repair, with the exception of cardiac disease which was more frequent in the group on anticoagulation drugs: 74.8% vs. 44.2%, $p < .0001$ (Table 1). Specifically, mean AAA diameter (56.43 mm vs. 54.65 mm; $p = .076$) and aortic neck length (26.54 mm vs. 25.21 mm; $p = .26$) were comparable in patients with and without chronic anticoagulation therapy.

Distribution of anticoagulation treatment among different device models is shown in Table 2.

Perioperative mortality was 0.9% without significant differences among patients with and without anticoagulants ($p = .62$). Rates of immediate endoleak (at procedure completion angiography or at discharge duplex scan) were detected in 25/103 (24.3%) of the anticoagulated group vs. 203/1306 (15.5%) of the others ($p = .026$). The overall rate of early endoleaks detected at 30 days was significantly higher in the anticoagulated group: 28.2% vs. 17.6%; $p = .012$ (Table 1).

Patients on anticoagulants had lower 5-year late all-cause survival rates compared with those without anticoagulation treatment: 65.5% vs. 70.5%; $p = .045$ (Fig. 1). However, aneurysm-related survival was comparable in the two groups (at 5 years: 98.2% vs. 98.5%; $p = .42$). Five-year freedom from any reintervention (69.3% vs. 84.5%; $p < .0001$) and from any reintervention or late conversion (68.5% vs. 81.9%; $p < .0001$) were significantly lower in patients using anticoagulants. Freedom rates from reintervention specifically focused on type II endoleak were also significantly lower ($p = .048$).

Occurrence of any endoleak was higher in patients on anticoagulation therapy: 5-year freedom rates were 57.5% vs. 69.2% ($p = .005$) in patients with and without anticoagulation treatment, respectively. However, freedom from type II endoleak rates were not significantly lower: 71.6% vs 77.3%; $p = .06$.

An additional 46 patients started on anticoagulant therapy after repair were identified during mean follow-up of 64.3 ± 45.2 months. According to phone interview with patients, the most common indication was AF but full ascertainment of reasons and underlying cardiac or other diseases could not be confirmed. The main characteristics of the whole group of 149 early and delayed anticoagulated patients are shown in Tables 1 and 2. When the overall group of anticoagulated patients was analyzed, 5-year rates

Table 1. Baseline characteristics and demographics of patients with and without anticoagulant therapy.

	Anticoagulant @repair ($n = 103$)		No anticoagulant @repair ($n = 1306$)		p-value[a]	Anticoagulant (repair or after) ($n = 149$)[b]
	N	%	*N*	%		*N* (%)
Age (y), mean ± SD	73.57 ± 7.2		72.86 ± 7.7		.37	73.22 ± 6.7
Males	91	88.3	1196	91.6	.23	133 (89.3)
Hypertension	83	80.6	998	76.4	.39	119 (79.9)
CAD[c]	77	74.8	577	44.2	<.0001	100 (67.1)[c]
Obesity	13	12.6	158	12.1	.87	23 (15.4)
PAD	19	18.4	161	12.3	.09	23 (15.4)
Diabetes	19	18.4	156	11.9	.06	24 (16.1)
COPD	51	49.5	645	49.4	.99	75 (50.3)
Chronic renal failure	17	16.5	184	14.1	.47	21 (14.1)
Cerebrovascular disease	14	13.6	179	13.7	.99	20 (13.4)
Vitamin K antagonists	80		–	–	–	126
Antiplatelets[c]	7	6.8	701	53.7	<.0001	
AAA diameter, mean + SD	56.43 ± 9.8		54.65 ± 9.7		.076	55.20 ± 9.2
Neck length, mean + SD	26.5 ± 12.8		25.2 ± 10.6		.26	26.7 ± 12.0
Neck diameter, mean + SD	24.16 ± 3.1		23.45 ± 3.6		.06	23.8 ± 2.9
Circumferential calcification	2	1.9	18	1.4	.65	2 (1.3)
Intraluminal aortic thrombus	53	51.5	642	49.2	.68	80 (53.7)
Perioperative death	0		13	1.0	.62	
Immediate endoleak[c]	25	24.3	203	15.5	.026	
Immediate type II endoleak	18	17.5	151	11.6	.083	
30-day endoleak[c]	29	28.2	230	17.6	.012	

CAD = cardiac disease; PAD = peripheral artery disease; COPD = chronic obstructive pulmonary disease; AAA = abdominal aortic aneurysm.Antiplatelets including aspirin, ticlopidine, clopidogrel, and others.

[a] p-value displayed for comparison between patients anticoagulated and not at the time of repair.

[b] 149 patients with any anticoagulation (at the time of repair or after) were compared with the remaining 1260 for distribution of characteristics.

[c] Significant differences.

Table 2. Anticoagulant use distribution by device models.

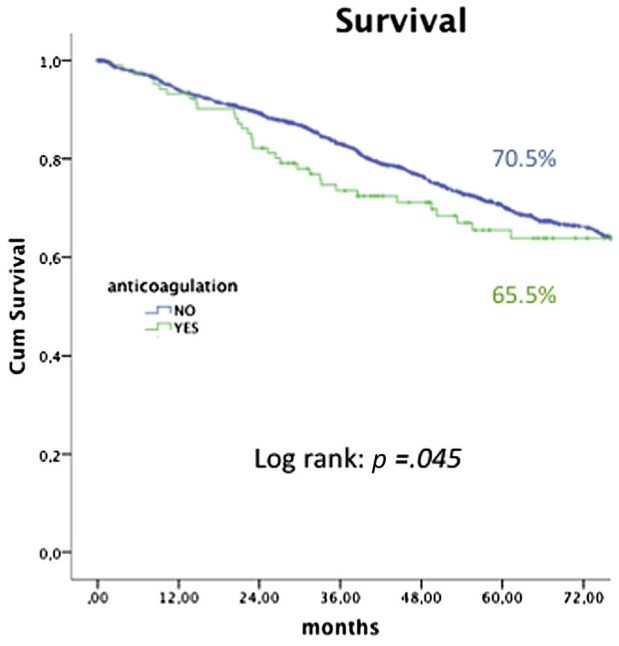
	N	Anticoagulant @repair ($n = 103$) *N* (%)	No anticoagulant @repair ($n = 1306$) *N* (%)	*p*-value	Any anticoagulant (repair or after) ($n = 149$) *N* (%)	*p* Value
Zenith Cook	610	52 (50.7)	558 (42.7)	.15	74 (49.7)	0.12
Excluder Gore	232	14 (13.6)	218 (16.7)	.49	24 (16.1)	0.99
Endurant Medtronic	71	5 (4.9)	66 (5.1)	.99	6 (4.0)	0.69
Talent Medtronic	167	14 (13.6)	153 (11.7)	.53	16 (10.7)	0.79
AneuRx Medtronic	235	14 (13.6)	221 (16.9)	.49	21 (14.1)	0.42
Anaconda Vascutek	53	2 (1.9)	51 (3.9)	.43	3 (2.0)	0.36
Fortron Cordis	35	1 (1.0)	34 (1.0)	.51	4 (2.7)	0.78
Others	6					
New devices[a]	879	68 (66)	811 (62.1)	.46	95 (63.8)	0.79

[a] AneuRx, Fortron, and Excluder and Anaconda 1st generation, were excluded.

of freedom from reinterventions (71.7% vs. 84.9%; $p < .0001$), reintervention or late conversion (69.4% vs. 82.4%; $p < .0001$; Fig. 2), and late conversion (94.1% vs. 96.1%; $p = .036$) were significantly lower in the group of patients on anticoagulants. Freedom rates from reintervention for type II endoleak were 89.5% vs. 95.3% ($p = .008$).

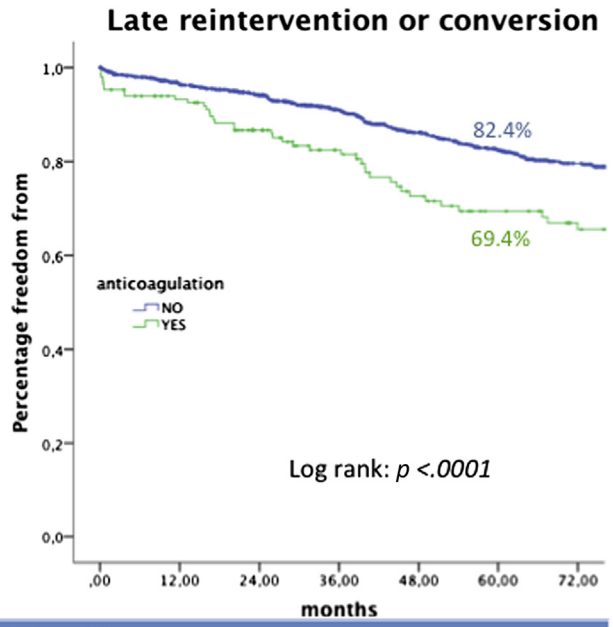
Five-year freedom from endoleak rates (55.5% vs. 69.9%; $p < .0001$) (Fig. 3) or type II endoleak rates (67.6% vs. 78.0%; $p = .002$) were also significantly lower in anticoagulated patients.

Cox regression analysis identified anticoagulation therapy as an independent positive predictor of reintervention or late conversion (OR 1.8; 95% CI: 1.31–2.48; $p < .0001$) together with large AAA diameter and coronary disease. Diabetes was identified as a negative predictor (Table 3). Anticoagulation therapy was also an independent predictor of any endoleak, OR 1.6; 95% CI: 1.23–2.07; $p < .0001$ (Table 3), except type II endoleak alone.



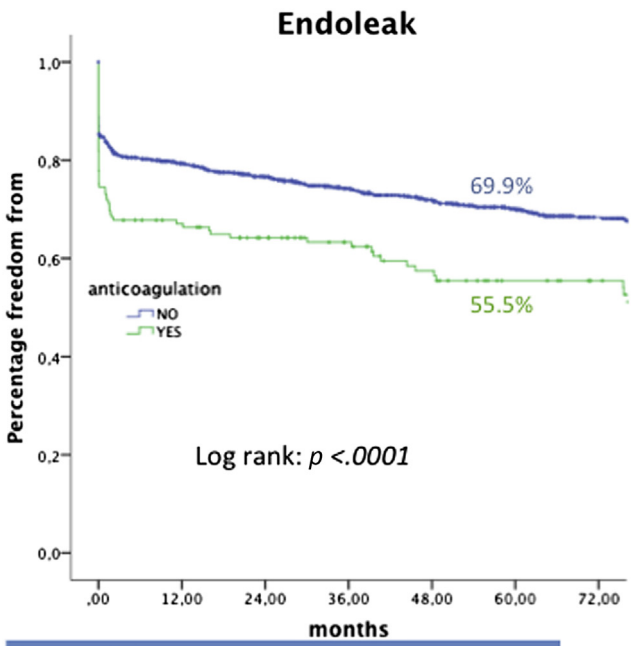
No anticoagulation						
months	6	12	24	36	48	60
N at risk	1236	1170	1050	880	732	600
SE	.004	.007	.009	.011	.013	.014
%	97.4	94.0	89.2	83.0	76.5	70.5
Anticoagulation						
months	6	12	24	36	48	60
N at risk	100	95	82	66	56	41
SE	.017	.025	.038	.045	.046	.051
%	97.1	93.2	82.2	73.5	71.1	65.5

Figure 1. Late all-cause survival in patients on anticoagulants or not at time of endovascular aortic aneurysm repair (EVAR).



No anticoagulation						
months	6	12	24	36	48	60
N at risk	1167	1084	951	761	594	464
SE	.004	.005	.007	.009	.011	.013
%	98.0	96.4	94.1	90.8	86.1	82.4
Anticoagulation						
months	6	12	24	36	48	60
N at risk	137	131	109	88	71	59
SE	.020	.021	.028	.033	.041	.043
%	93.9	93.2	86.7	82.5	72.6	69.4

Figure 2. Freedom from late reintervention or conversion after aortic aneurysm repair (EVAR) in patients on anticoagulants or not.



No anticoagulation						
months	6	12	24	36	48	60
N at risk	958	896	776	625	505	397
SE	.011	.011	.012	.013	.013	.014
%	80.4	79.3	76.6	74.2	71.9	69.9
Antocoagulation						
months	6	12	24	36	48	60
N at risk	99	95	83	69	57	46
SE	.038	.039	.039	.040	.043	.044
%	67.8	67.1	64.2	63.3	57.5	55.5

Figure 3. Freedom from any endoleak after aortic aneurysm repair (EVAR) in patients on anticoagulants or not.

DISCUSSION

Even though the proportion of EVAR patients on anticoagulants represents a minority (<20%) of the overall EVAR population,[3–6] concerns about the use of warfarin in these patients is of relevance because EVAR outcomes can be largely influenced by an individual based decision-making approach. Furthermore, it is expected that the number of patients with AF (requiring chronic anticoagulation) and AAA will increase in the near future because of the aging population.[1] Indeed, anticoagulants are among the few drugs with known effects on outcomes of AAA. In the last few years there has been an increasing interest in the option to pharmacologically change the natural history and outcome of AAA. Although statins, non-steroidal anti-inflammatory drugs (NSAIDs), macrolides, antihypertensive, and beta-blockers have been scrutinized, there is no consistent pattern of their pharmacological influence on aneurysmal expansion rate and rupture prevention.[11,12] However, there are data supporting the concurrent use of chronic anticoagulants negatively influencing durability of EVAR. Anticoagulated patients require almost twice as many reinterventions to maintain aneurysm sac exclusion at a mean follow-up of 64.3 months after endovascular repair, based on the results of this study. Furthermore, despite the higher number of repeated procedures/reinterventions after EVAR (freedom from reintervention rates, 71.7% vs. 84.9% in anticoagulated patients vs. not) repair more often resulted in failure, with a higher risk of late conversion to open surgery ($p = .036$). As in most anticoagulated patients the reason for choosing EVAR is likely to be to avoid open surgery for coexistent cardiac disease, the delayed need for conversion to open surgery after EVAR failure represents a considerable challenge. However, the results of this study should be interpreted with caution because no random assignment was used and the strength of findings was limited by the retrospective analysis with inherent risk of bias.

Table 3. Cox regression analysis.

Dependent variable	Covariate	OR	95% CI	*p*-value
Late reintervention or conversion	Anticoagulant	1.80	1.31—2.48	<.0001
	Cardiac disease	1.30	1.01—1.68	.041
	Aneurysm diameter	1.02	1.01—1.03	.001
	Diabetes	0.44	0.26—0.75	.002
Endoleak	Anticoagulant	1.60	1.23—2.07	<.0001
	Age	1.02	1.01—1.03	.002
	Aneurysm diameter	1.01	1.01—1.02	.019
	Peripheral disease	0.73	0.53—0.99	.048

The negative effect of chronic anticoagulation on the outcome of EVAR is a relevant factor to be considered in the best management of care when counseling patients requiring treatment for both their cardiac disease and AAA. Because of the conflicting effects of anticoagulation drugs and EVAR on AAA repair it may be reasonable to avoid combining the two treatments in the same patient and to select EVAR with drug alternatives to anticoagulants in EVAR candidates or continue to anticoagulate patients while using open surgery for treatment of the aneurysm.

The proportion of patients on anticoagulants (10.6%) at the time of repair or after in this study was limited and inferior to that shown in other series of EVAR patients. In US series, percentages of 15—18% were reported.[3–6] This variability might be a result of underestimation of true rates because of study limitations, but it can reflect different national strategies to application of chronic anticoagulation therapy. Today in Western countries, AF is the most common indication for the use of chronic anticoagulants. Despite current AF guidelines, both European and AHA suggest a rather liberal use of anticoagulant prophylaxis to prevent ischemic stroke and mortality.[13–16] Not all AF patients are on chronic anticoagulation drugs, for a variety of reasons, but mainly the balance and monitoring of hemorrhagic risks. Furthermore, it is known that in many patients on chronic warfarin therapy, the proper therapeutic target range of anticoagulation is not always maintained[17–21] and patients are often over-anticoagulated or under-anticoagulated despite chronic drug administration without intentional therapeutic interruptions ("holds").[2] Reviews of studies reporting warfarin-treated patients

Table 4. Literature studies on anticoagulant and EVAR.

Author year	EVAR *N*	Follow-up, mean	Anticoagulant *N* (%)	No anticoagulant *N* (%)
Fairman 2002[2]	232	18 months	36 (15.5)	196
30-day endoleak			7 (19.4)	36 (18.4)
Delayed endoleak			2 (5.6)	2 (1)
Any endoleak			9 (25)	38 (19.3)
Sac shrinkage		12 months	(17.5%)	(7.6%)
Biebl 2005[5]	182	16.3 months	21 (11.5)	161
30-day endoleak			5 (23.8)	17 (10.6)
Delayed endoleak			0	17 (10.6)
Any endoleak			5 (23.8)	34 (21.1)
Conversion			0	3 (1.9)
Sac shrinkage			8 (38.1)	79 (49.1)
Sac stabilization			13 (61.9)	77 (47.8)
Bobadilla 2010[4]	127	2.14 years	24 (18.9)	103
Any endoleak			13 (54.2)	25 (24.3)
Volume change			(+29.3%)	(−18.9%)
Reintervention			6 (46)	8 (32)
Conversion			3 (12.5)	2 (1.9)
Johnson 2013[3]	363	29 months	68 (18.7)	295
Any endoleak			11 (16.2%)	34 (11.5)
Sac expansion			5 (7.4)	21 (7.1)
Rupture			0	2 (0.7)
Reintervention			10 (14.7)	33 (11.2)
Conversion			3 (4.4)	5 (1.7)
Deaths			7 (10.3)	35 (11.9)
Total	904	64 months	149	755
Present study	1409		103 at repair (7.3)	1306
			149 overall (10.6)	1260

EVAR = endovascular abdominal aneurysm repair.

showed that AF patients spend only about one-half the time within the therapeutic international normalized ratio (INR)[17–19] mainly because of inadequate compliance that the patient does not recall or does not declare.[2,17,18] Also, it has been noted that the occurrence of a low INR often depends on the indication for anticoagulant therapy, with the highest risk in patients who used anticoagulants as prophylaxis and the lowest risk in patients with mechanical heart valves.[19] Even though it is likely that with the newer anticoagulation agents with safer profiles and lower monitoring requirements (e.g. dabigatran, rivaroxaban, apixaban) patients' adherence and stabilization of blood anticoagulation levels can be improved,[16,22] the great amount of time outside the target therapeutic range in many currently anticoagulated patients may question the absolute necessity of anticoagulation drugs in these settings.[21,22] This is specific in those patients with cardiac dysrhythmia and AAA suitable for EVAR, which might be selected as a first therapeutic aneurysm repair choice. In some older patients, especially those at higher risk of cerebral hemorrhage (e.g. severe hypertension) and with lower thromboembolic risk, use of aspirin (ASA) rather than oral anticoagulants might still be a valid option. However, the decision should be cautious and balanced as discontinuation of anticoagulants may not be advisable in many other patients at higher thromboembolic risk given their severe heart disease.

A number of studies have suggested that chronic anticoagulation drugs might contribute to type II endoleak occurrence or persistence because of interference with the clotting of blood flowing into the excluded aneurysm sac from collateral vessels.[4–6] Nevertheless, it is likely that anticoagulation drugs could impact any type of endoleak occurrence because of the negative effect of achieving adequate sealing between the stentgraft and the aneurysmal sac, regardless of the source of intrasac blood flow. In this series there was a significant difference in overall endoleak rates in anticoagulated and non-anticoagulated patients: 55.5% vs. 69.9% freedom rates ($p < .0001$). Similarly, Bobadilla et al. found an any-type endoleak rate of 13/24 in the warfarin group and 25/103 in the antiplatelet group of EVAR patients.[4]

Results of this study suggesting a negative outcome for EVAR in anticoagulated patients do not totally agree with those of other series.[3,6] The most recent publication by Johnson et al. reported on 68 EVAR patients with a 29 month follow-up and showed composite reintervention and death rates similar to those of 295 non-anticoagulated EVAR patients.[3] However, there is only limited and mostly conflicting published literature on the issue.[4,5] It is likely that the variability is related to the small number of the overall population in each study as summarized in Table 4. Although there may be more information available in EVAR registries on this topic, underestimation of true rates and

variability in national strategies are likely to influence the findings. Our large series of 1409 EVAR patients could provide stronger data and improve the knowledge on anticoagulants in EVAR patients.

Although this study provides the largest series on the use of anticoagulants in EVAR patients, limitations include retrospective analysis (with related risk of bias) and the "presumptive" use of chronic anticoagulation because of the lack of ascertainment of therapeutic range (INR between 2.0 and 3.0) for each patient. Patient adherence to therapy is another issue. Furthermore, the accuracy of ascertainment of new introduction of anticoagulation drugs after discharge by telephone interview with patients may be limited. Accordingly, the most common indication for starting anticoagulants after EVAR was AF but full ascertainment of reasons and underlying cardiac or other diseases could not be detailed. Finally, analysis of antiplatelet drugs and type in the non-anticoagulated group of patients was not performed.

Conclusions

Medical therapy can affect the outcome of aneurysm repair and should be carefully managed during the perioperative period and in the years following operation to optimize the effect of invasive approach. The safety of anticoagulation therapy after EVAR may be debatable. Chronic anticoagulation drug use can lead to a poor long-term outcome. A critical and balanced decision-making approach should be applied to patients with AAA and cardiac disease, who would also require prolonged anticoagulation treatment.

CONFLICT OF INTEREST

None.

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None.

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