



**PATIENTS ON ANTICOAGULATION ARE MORE LIKELY TO DEVELOP ENDOLEAKS AFTER EVAR**

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**CONFLICTS OF INTEREST**

• None

**BACKGROUND**

- Successful EVAR
  - Secure fixation at Proximal and Distal landing zones
  - Thrombosis in the aortic sac
- Type II Endoleaks
  - Persistent flow in the sac
  - Can lead to increase in sac diameter
- Long-term Anticoagulation
  - Potentially prevents thrombosis of outflow lumbar arteries/IMA
  - With aging population, more and more patients are expected to be on anticoagulation

**PUBLISHED DATA**

Primary author	Falman et al <sup>1</sup>	Bisbal et al <sup>2</sup>	Johnson et al <sup>3</sup>	Lai et al <sup>4</sup>	Wild et al <sup>5</sup>	Bobadilla et al <sup>6</sup>	Abulnaga et al <sup>7</sup>	De Rango et al <sup>8</sup>	Seike et al <sup>9</sup>
Year Published	2002	2005	2013	2015	2014	2010	2010	2014	2017
Journal	J Vasc Surg	J Endovasc Ther	J Vasc Surg	J Vasc Surg	Ann Vasc Surg	J Vasc Surg	J Vasc Surg	Eur J Vasc Endovasc Surg	Interact Cardiovasc Thor Surg
Study Description	Single center, retros, pective	Single center, retros, pective	Single center, retros, pective	42 VA medical centers, retros, pective	Single center, retros, pective	Single center, retros, pective	Single center, retros, pective	Single center, retros, pective	Single center, retros, pective
Total EVAR	232	182	365	439	407	127	595	1409	209
Persistent endoleaks	18%	12%	12%	30.50%	12.50%	30%	23%	18%	29%
Anticoagulation	15%	12%	19%	9.6%	1%	19%	12%	7.5%	16%
Follow-up	Mean 18 months	Mean 16 months	Median 29 months	Mean 74 months	Median 18 months	Mean 25 months	Median 35 months	1 and 60 months	Mean 37 months
Conclusions	No significant increase in type II endoleaks in anti-coagulated patients	No significant increase in endoleaks in anti-coagulated patients	No significant increase in endoleaks in anti-coagulated patients	No significant increase in endoleaks in anti-coagulated patients	No significant increase in endoleaks in anti-coagulated patients	significant increase in endoleaks in anti-coagulated patients	significant increase in type II endoleaks in anti-coagulated patients	significant increase in endoleaks in anti-coagulated patients	significant increase in type II endoleaks in anti-coagulated patients

**METHODOLOGY**

- Dataset: Society for Vascular Surgery Vascular Quality Initiative (SVS-VQI)
- EVAR Module
- Time Period: 2013 – 2019
- Original Sample Size: 46,551 Patients
- Patients with complete information about endoleaks at completion angiogram and at long-term outcomes: 29,783 Patients

**DEFINITIONS**

**Endoleaks**

- Index Endoleak: Endoleak identified immediately on completion angiogram after EVAR
- Late Endoleaks: Endoleak identified on 1-year follow up
  - Persistent Index Endoleaks
  - New Endoleaks on follow-up

**Therapeutic Anticoagulation**

- Not anticoagulated
- Anticoagulated before EVAR, but not after EVAR
- Anticoagulated after EVAR, but not before EVAR
- Anticoagulated before and after EVAR

**Types of Therapeutic Anticoagulation**

- No anticoagulation
- Warfarin
- NOAC's (Dabigatran or Rivaroxaban)
- Other Anticoagulants

### LATE ENDOLEAKS

- Group 1: No Endoleaks (27,614 patients, 92.7%)
- Group 2 : Endoleaks (2,169 patients, 7.3%)
  - Type I: 206 patients, 9.5%, 0.7% over all
  - Type II: 1,551 patients, 71.5%, 5.2% overall
  - Type III: 41 patients, 1.9%, 0.1% overall
  - Type IV: 371 patients, 17.1%, 1.2% overall

#### MULTIVARIATE ANALYSIS OF FACTORS ASSOCIATED WITH LATE ENDOLEAKS

Variable	Unadjusted OR (95% CI)	P Value	Adjusted OR (95% CI)	P Value
Anticoagulation				
Anticoagulation before EVAR	1.0 (0.97-1.2)	150	0.26 (0.18-0.38)	<.001
Anticoagulation after EVAR	2.32 (2.09-2.60)	<.001	1.98 (1.62-2.40)	<.001
Anticoagulation before and after EVAR	2.78 (2.41-3.22)	<.001	4.23 (3.57-5.06)	<.001

### ANTICOAGULATION & PRIMARY LATE OUTCOMES

#### ASSOCIATION OF ANTICOAGULATION WITH LATE OUTCOMES

	Late endoleaks			Aneurysm sac growth at 1 year			EVAR-related reinterventions					
	Overall population, n = 25,783 (100%)	No late endoleak, n = 27,614 (92.72%)	Late endoleak, n = 269 (7.28%)	Overall population, n = 25,782 (100%)	No sac growth, n = 23,648 (91.99%)	Sac growth, n = 134 (0.49%)	Overall population, n = 25,783 (100%)	No intervention, n = 23,119 (97.77%)	New intervention, n = 664 (2.23%)			
Never anti-coagulated	25,145 (94.43)	23,396 (93.05)	1,747 (6.95)	<.001	25,144 (94.43)	24,046 (95.64)	94 (0.37)	<.001	25,145 (94.43)	24,660 (98.07)	485 (1.93)	<.001
Anticoagulated before EVAR only	2,335 (7.84)	2,280 (97.64)	55 (2.36)		2,335 (7.84)	2,325 (99.57)	10 (0.43)		2,335 (7.84)	2,316 (99.19)	19 (0.81)	
Anticoagulated before and after EVAR	142 (4.77)	181 (83.11)	240 (6.89)		142 (4.77)	1405 (96.87)	16 (11.3)		142 (4.77)	1343 (94.51)	78 (5.49)	
Anticoagulated after EVAR only	882 (2.96)	755 (85.60)	127 (14.40)		882 (2.96)	868 (96.41)	14 (1.59)		882 (2.96)	800 (90.70)	82 (9.30)	

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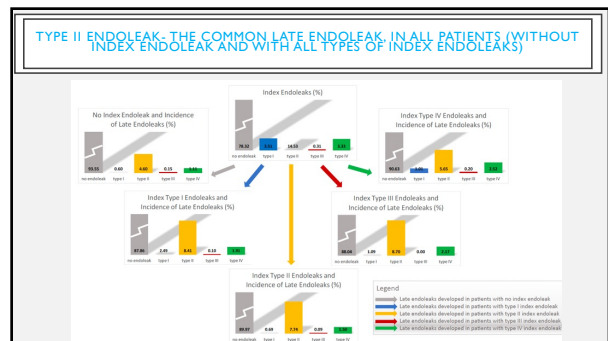
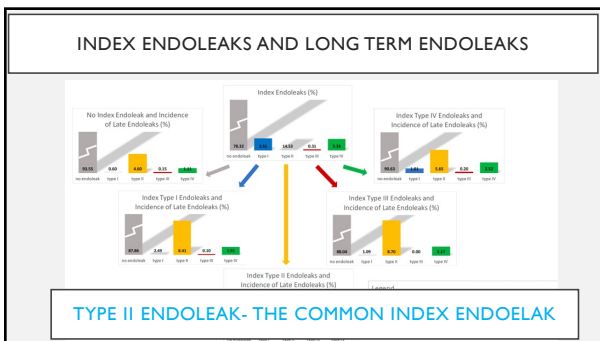
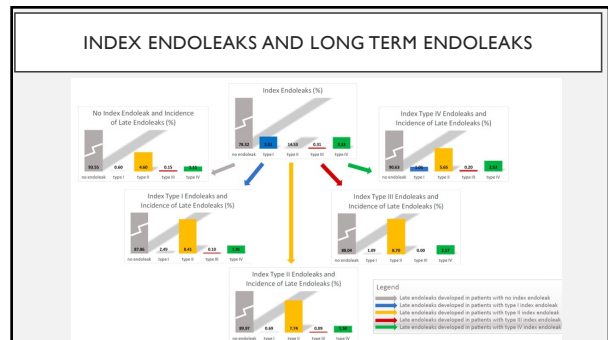
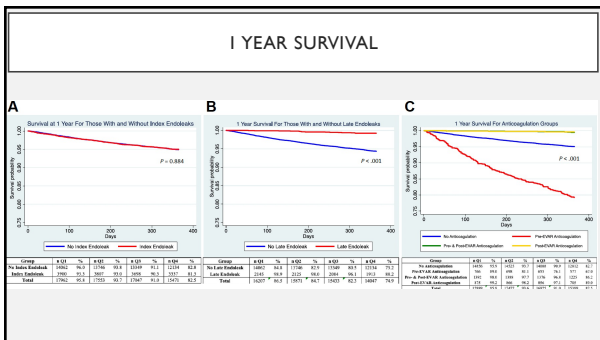
### TYPE OF ANTICOAGULATION

### RELATIONSHIP BETWEEN TYPES OF ANTICOAGULATION AND LATE ENDOLEAKS

Pre-EVAR anticoagulation only				Before and after EVAR anticoagulation				After EVAR anticoagulation only						
Overall population	No late endoleak	Late endoleak		Overall population	No late endoleak	Late endoleak		Overall population	No late endoleak	Late endoleak				
n = 29,783	n = 27,634	n = 2,149	P	n = 29,783	n = 27,634	n = 2,149	P	n = 29,783	n = 27,634	n = 2,149	P			
(95.9%)	(92.72%)	(7.28%)	value	(100%)	(92.72%)	(7.28%)	value	(95.9%)	(92.72%)	(7.28%)	value			
None	26,027 (97.39)	24,153 (92.80)	1876 (7.20)	0.06	None	26,362 (95.23)	26,435 (99.20)	729 (2.79)	<.001	None	27,479 (92.26)	25,677 (93.44)	1802 (6.56)	<.001
Warfarin	2152 (7.23)	1971 (91.59)	181 (8.41)		Warfarin	898 (3.25)	748 (84.42)	150 (16.70)		Warfarin	1354 (4.91)	132 (9.76)	202 (14.82)	
NOAC	778 (2.61)	708 (91.00)	70 (9.00)		NOAC	228 (0.77)	186 (81.58)	42 (18.42)		NOAC	457 (1.64)	375 (82.08)	84 (18.38)	
Other	826 (2.77)	762 (94.67)	64 (5.33)		Other	159 (0.53)	125 (78.62)	34 (21.38)		Other	515 (1.83)	422 (81.76)	93 (18.24)	
					Anti coagulant changed	136 (0.46)	122 (89.71)	14 (10.29)						

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ASSOCIATION OF ANTICOAGULATION WITH TYPE OF INDEX ENDOLEAK AND LATE ENDOLEAK

Index Endoleaks if Identified	Total	No Late Endoleak	Late Endoleak	p value
No Endoleak 23328 (78.32%)	No Anticoagulation	23328 (100%)	21622 (93.56%)	< .001
	Pre-EVAR Anticoagulation	16988 (72.82%)	16888 (99.41%)	
	Pre- and Post-EVAR Anticoagulation	10312 (44.11%)	9088 (88.13%)	
Type I Endoleak 1048 (3.37%)	No Anticoagulation	1048 (100%)	898 (85.78%)	< .001
	Pre-EVAR Anticoagulation	882 (84.42%)	777 (88.09%)	
	Pre- and Post-EVAR Anticoagulation	166 (15.58%)	121 (72.83%)	
Type II Endoleak 4227 (14.52%)	No Anticoagulation	4227 (100%)	3892 (92.05%)	< .001
	Pre-EVAR Anticoagulation	3672 (86.91%)	3312 (90.20%)	
	Pre- and Post-EVAR Anticoagulation	555 (13.09%)	580 (104.50%)	
Type III Endoleak 882 (3.37%)	No Anticoagulation	882 (100%)	81 (9.18%)	0.025
	Pre-EVAR Anticoagulation	72 (7.94%)	0 (0%)	
	Pre- and Post-EVAR Anticoagulation	810 (92.06%)	81 (10%)	
Type IV Endoleak 982 (3.37%)	No Anticoagulation	982 (100%)	898 (91.55%)	< .001
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**SUMMARY**

- Therapeutic anticoagulation post EVAR
- Two-fold increase in incidence of all late endoleaks
- Regardless of the choice of anticoagulant (Coumadin or NOACs)
- When anticoagulation is stopped post EVAR
  - Reduced incidence of late endoleaks
  - Increased all cause mortality
- Type of late Endoleak
  - Correlates with index endoleak (at completion angiogram at EVAR)
  - Type II is the most common type of endoleak
    - In all patients without index endoleak
    - In patients with all different types of index endoleaks

**The fate of endoleaks after endovascular aneurysm repair and the impact of oral anticoagulation on their persistence**

Tanya R. Flohr, MD, Rachael Snow, MD, and Falah Aziz, MD, Hershey, Pa

**ABSTRACT**

**Background:** The impact of anticoagulation on late endoleaks after endovascular aneurysm repair (EVAR) is unclear despite multiple investigators studying the relationship. The purpose of this study was to determine if long-term anticoagulation impacted the development of late endoleaks and if specific anticoagulants were more likely to exacerbate the development of endoleaks.

**Methods:** Using the Society for Vascular Surgery Vascular Quality Initiative database, patients undergoing EVAR between 2003 and 2020 for abdominal aortic aneurysms were evaluated. Patients were divided into two groups: those without a late endoleak and those with a late endoleak. Bivariate analysis was performed to assess preoperative, intraoperative, postoperative, and long-term follow-up variables. A multivariable analysis was done to determine associations of independent variables with late endoleaks. Patients were further subcategorized based on anticoagulation status before and after EVAR, specific type of anticoagulation, and the presence of an index endoleak diagnosed at the time of EVAR to determine the subsequent frequency of late endoleaks.

**Results:** A total of 20,782 patients were analyzed with 2910 (14%) having a late endoleak identified. Several risk factors were related to late endoleaks, including anticoagulation before and after EVAR (odds ratio [OR] 4.23, 95% confidence interval [CI] 3.57-5.06,  $P < .001$ ; anticoagulation after EVAR OR 1.88, 95% CI 1.53-2.28,  $P < .001$ ), and index endoleak OR 1.45, 95% CI 1.26-1.66,  $P < .001$ ). The frequency of late endoleaks in patients anticoagulated before and after EVAR and after EVAR as compared with those never anticoagulated was 16.89% and 14.20% vs 6.99%, respectively (both  $P < .001$ ). No difference in late endoleaks were noted for patients treated with warfarin and novel oral anticoagulants. The most common type of index and late endoleak identified was type II, but patients with type I, type II, and type IV index endoleaks were more commonly found to have type I, type II, and type IV late endoleaks, respectively. The frequency of late endoleaks in patients with both an index endoleak and anticoagulation after EVAR was 20.42% as compared with patients with only anticoagulation after EVAR (8.63%,  $P < .0001$ ) and with patients with index endoleaks not anticoagulated (0.50%,  $P < .00001$ ).

**Conclusions:** Late endoleaks were more common in patients treated with anticoagulation after EVAR. No difference in late endoleak frequency was detected between anticoagulation with warfarin and novel oral anticoagulants. Patients on anticoagulation and those with an index endoleak were at a higher risk of having a late endoleak. *J Vasc Surg* 2022;71:101

**Key words:** Aneurysm, Anticoagulation, Endoleak, Endovascular aneurysm repair (EVAR)



**THANK YOU!**