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My approach to the Type 2 Endoleak after EVAR

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UK HD

Disclosures

- Consultant
  - Arsenal, Cook, Endologix, Gore, Medtronic, Cook
- Research Grant /research support
  - Cook, Gore, Maquet, Medtronic, Siemens
- Advisory Board
  - Endologix, Gore, Medtronic, Siemens
- Paid speaker
  - Cook, Endologix, Gore, Maquet, Medtronic, Siemens
- Major stokeholder
  - none

Type 2 EL = graft related complications after EVAR

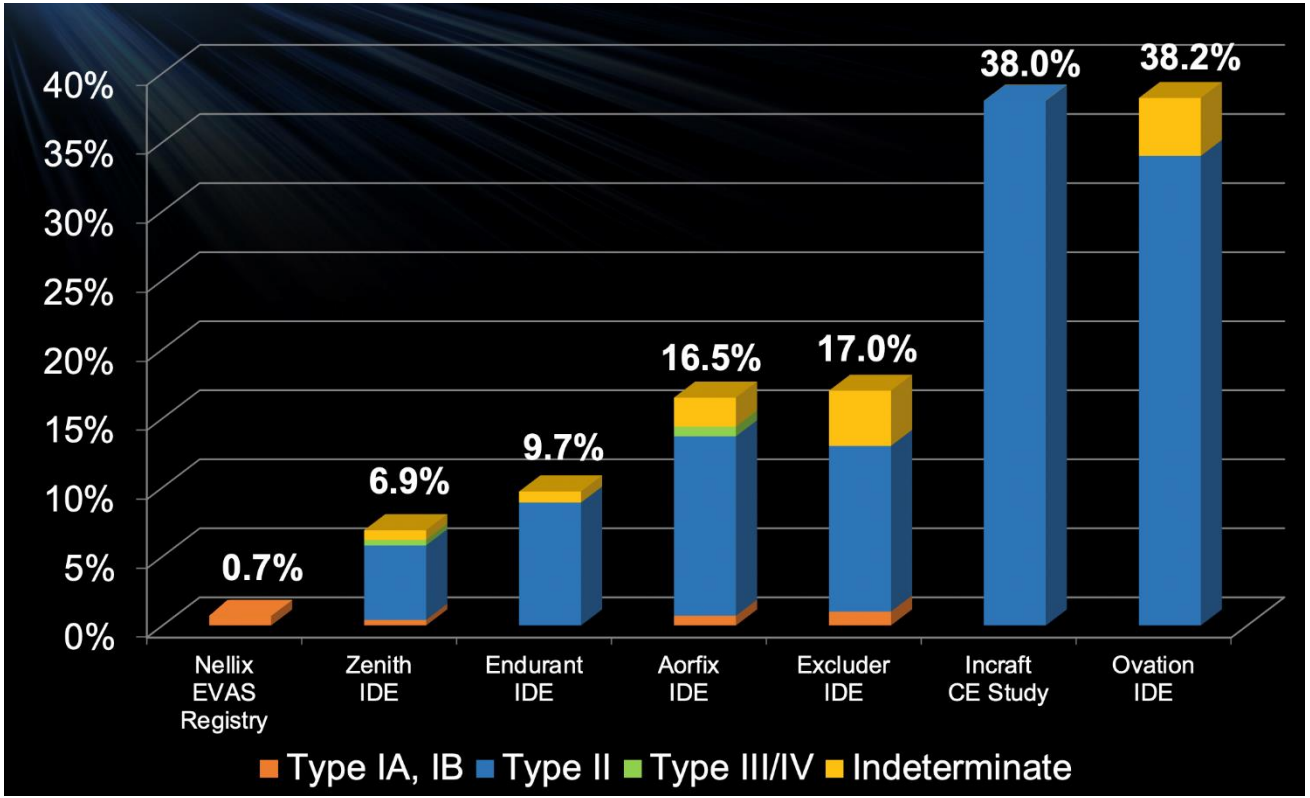
Complications	Definition	Estimated frequency during 5 year follow up
Type I endoleak	Peri-graft flow occurring from attachment sites	5%
A	proximal end of stent graft	
B	distal end of stent graft	
C	iliac occluder	
Type II endoleak	Perigraft flow occurring from collateral branches to the aneurysm; inferior mesenteric artery (IIA) and lumbar arteries (IIB)	20–40%, 10% persistent at 2 years
	Categorised as early or late/delayed (before or after 12 months) and as transient or persistent (resolved or not resolved <6 months)	
Type III endoleak	Peri-graft flow occurring from stent graft defect or junction sites	1–3%
A	leak from junctions or modular disconnection	
B	fabric holes	
Type IV endoleak	Peri-graft flow occurring from stent graft fabric porosity <30 days after placement	1%
Endotension	AAA sac enlargement without visualised endoleak	<1%
Migration	Movement of the stent graft in relation to proximal or distal landing zone	1%
Limb kinking and occlusion	Graft thrombosis or stenosis	4–8%
Infection	Stent graft infection	0.5–1%
Rupture	Aortic rupture	1–5%

Incidence of Type 2 Endoleak after EVAR

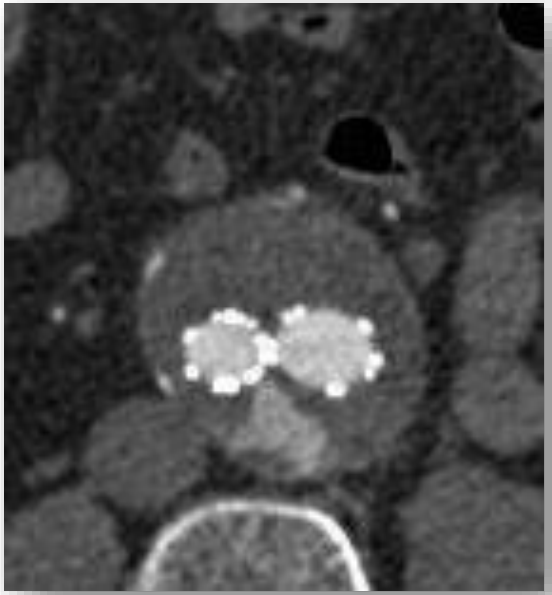
Lo RC et al Risk factors and consequences of persistent type II endoleaks. J Vasc Surg 2016;63:895e901.

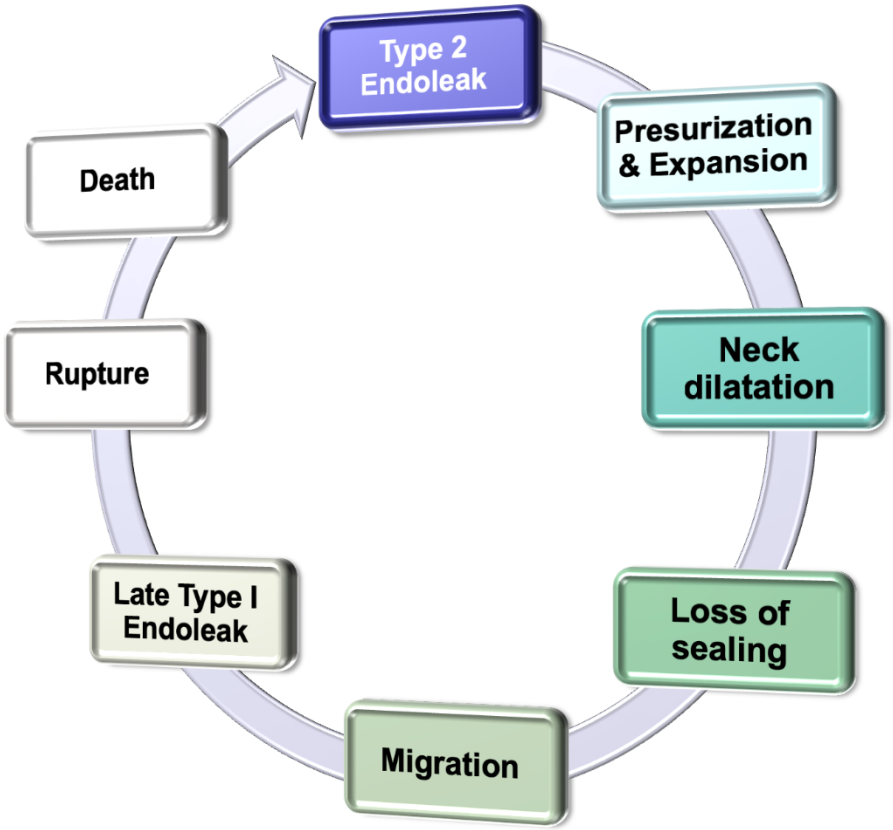
Early but spontaneously resolved	18 %
Persisting Type 2 Endoleak	5 %
New onset during follow up	11 %
- half of them develop sac growth	
- with 50% reintervention	
Low rupture risk	< 1%

Persisting Type 2 EL after EVAR at 1 year

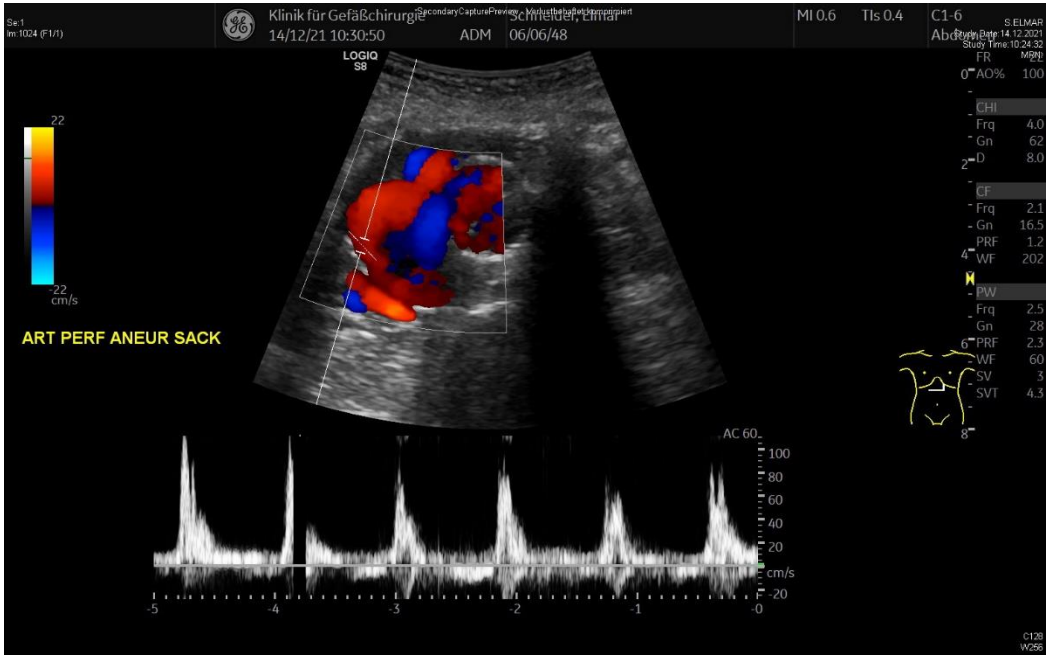


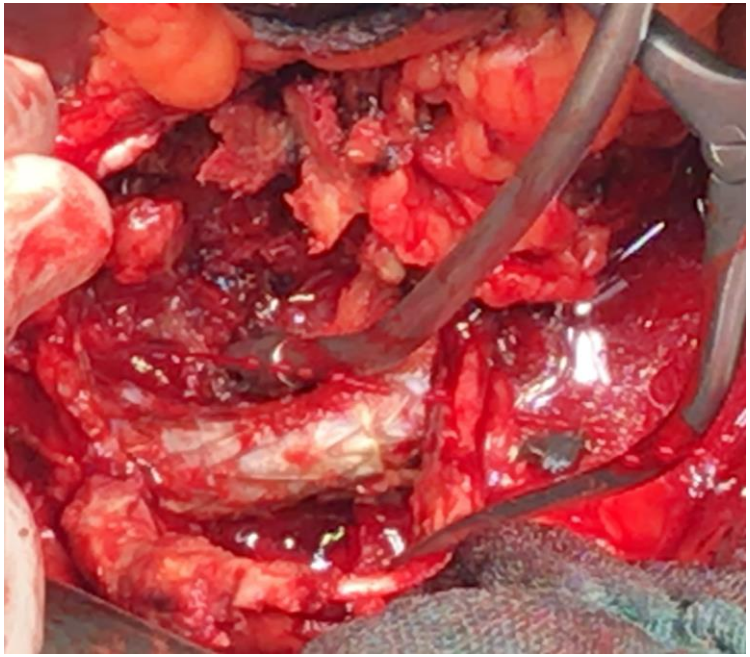
Potential Consequences of Type 2 Endoleak



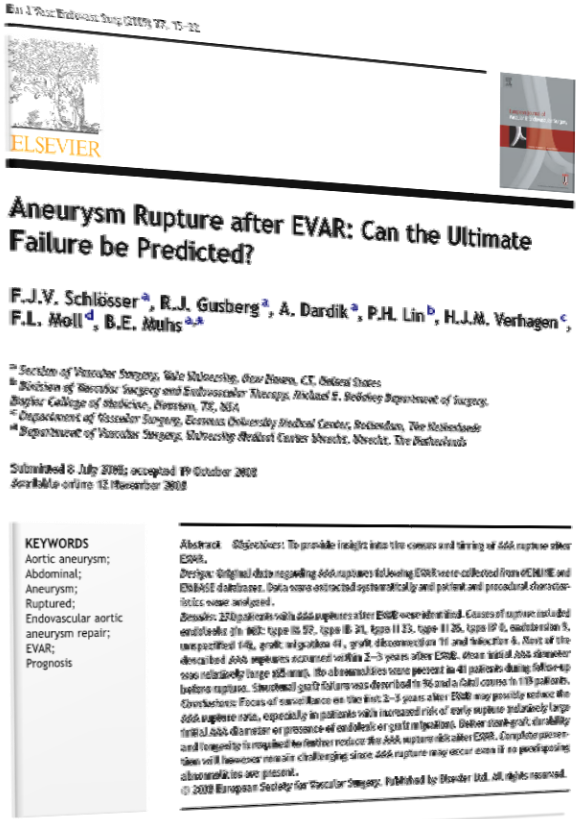


Aneurysm Sac Pressurization





AAA Rupture after EVAR – Type 2 Endoleak



ELSEVIER

Aneurysm Rupture after EVAR: Can the Ultimate Failure be Predicted?

F.J.V. Schlösser[a], R.J. Gusberg[a], A. Dardik[a], P.H. Lin[b], H.J.M. Verhagen[c], F.L. Moll[d], B.E. Muhs[a,*]

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Submitted 8 July 2008; accepted 19 October 2008
Available online 12 December 2008

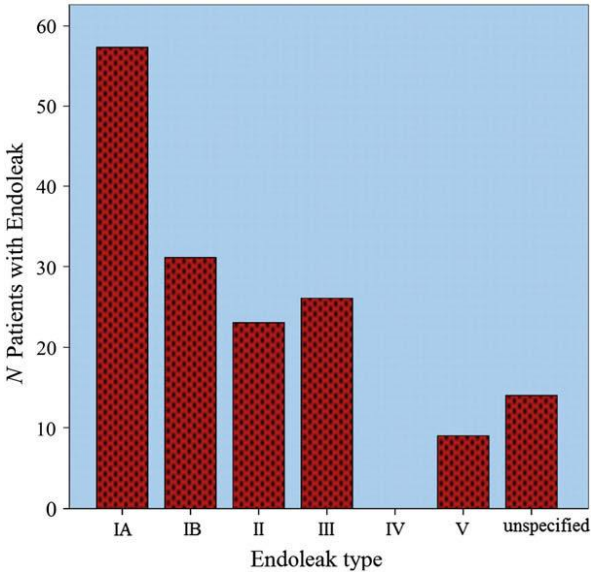
KEYWORDS
Aortic aneurysm;
Abdominal;
Aneurysm;
Ruptured;
Endovascular aortic aneurysm repair;
EVAR;
Prognosis

Abstract Objectives: To provide insight into the causes and timing of AAA rupture after EVAR.

Design: Original data regarding AAA ruptures following EVAR were collected from ENGINE and EVALIFE databases. Data were extracted systematically and patient and procedural characteristics were analyzed.

Results: 270 patients with AAA ruptures after EVAR were identified. Causes of rupture included endoleaks (n = 163: type Ia 57, type Ib 31, type II 23, type III 26, type IV 0, conversion 5, unspecified 14), graft migration 41, graft disconnection 11 and infection 4. Most of the described AAA ruptures occurred within 2–3 years after EVAR. Mean initial AAA diameter was relatively large (65 mm). No abnormalities were present in 41 patients during follow-up before rupture. Structural graft failure was described in 16 and a CAT-scan in 113 patients.

Conclusions: Focus of surveillance on the first 2–3 years after EVAR may possibly reduce the AAA rupture rate, especially in patients with increased risk of early rupture (relatively large initial AAA diameter or presence of endoleak or graft migration). Better stent-graft durability and longevity is required to further reduce the AAA rupture risk after EVAR. Complete prevention will however remain challenging since AAA rupture may occur even if no predisposing abnormalities are present.



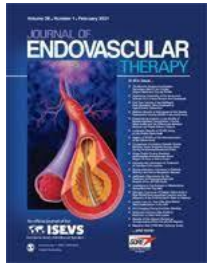
270 post EVAR ruptures

160 Endoleaks = 59 %

23 Endoleaks Type II =8.5%

Single Center Study – Heidelberg

accepted for publication



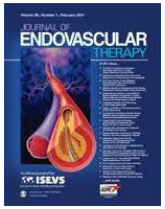
EVAR
N=773
(2004 - 2018)

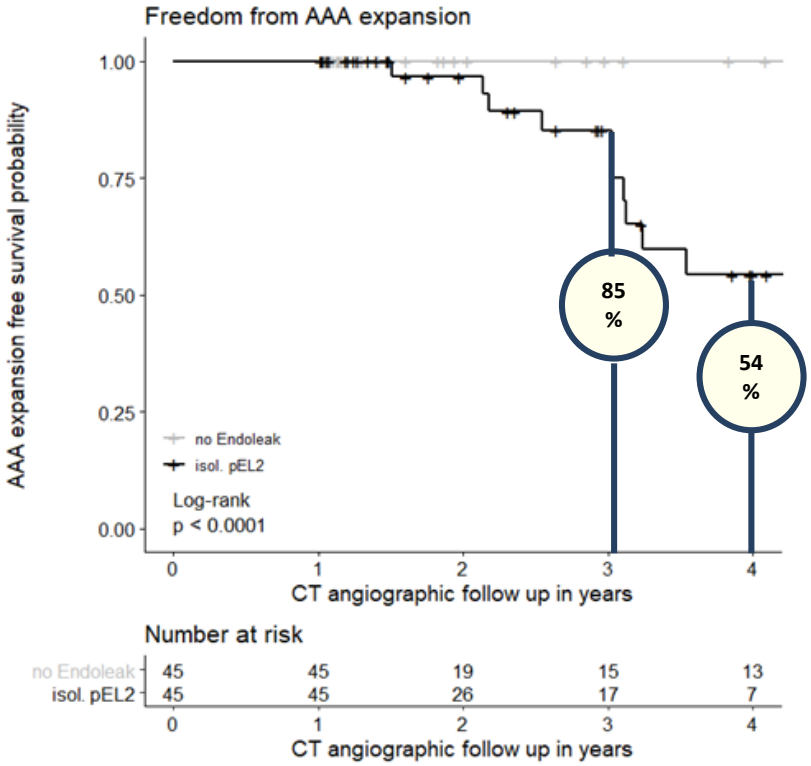
Endoleak Type 2
N=286
(37.0%)

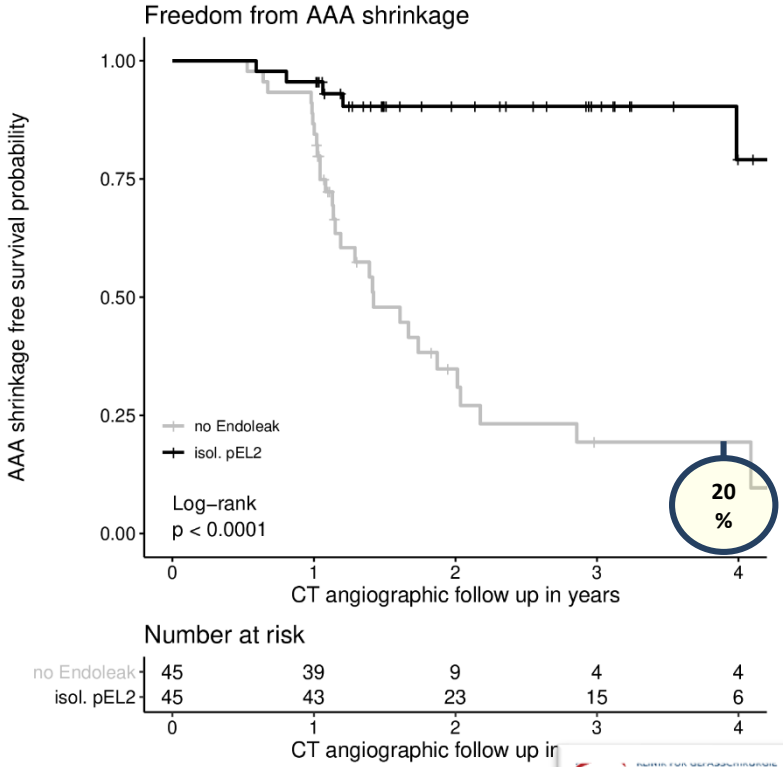
N=45 Persisting EL2
@ 1 yr.
(5.8%)

Control group
No Endoleak
N=45

Results Single Center Experience Heidelberg

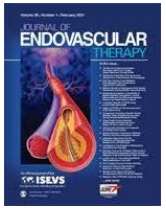






Predictors of Persisting Type 2 Endoleckage

accepted for publication



Predictors	Median (range)	n (%)	p-value
No. of lumbar arteries	4 (1-8)	3 (0-8)	0.0005
Proportion of patent IMA	33 (82.5%)	25 (59.5%)	0.04
Proportion of patent MSA	20 (50.0%)	9 (21.4%)	0.013
Max. Diameter of lumbar art.	2.3 (1.4-3.5)	2.3 (1.4-3.2)	0.46
Max. Diameter AMI	2.6 (1.6-4.3)	2.6 (1.0-4.3)	0.43

* IMA= inframesenteric artery * * MSA =median sacralis artery

Predictors of Persisting Type 2 Endoleak

Wanhainen A et al ESVS AAA Guidelines, EJVES 2018

- Coil embolization of hypogastric arteries
- Distal graft extension
- Age > 80 years
- Anatomical factors
  - No of patent side branches
  - Sac thrombus
  - Diameter of lumbar or inferior mesenteric artery

Sac regression = indirect sign for successsfull AAA exclusion

Aneurysm sac expansion is independently associated with late mortality in patients treated with endovascular aneurysm repair

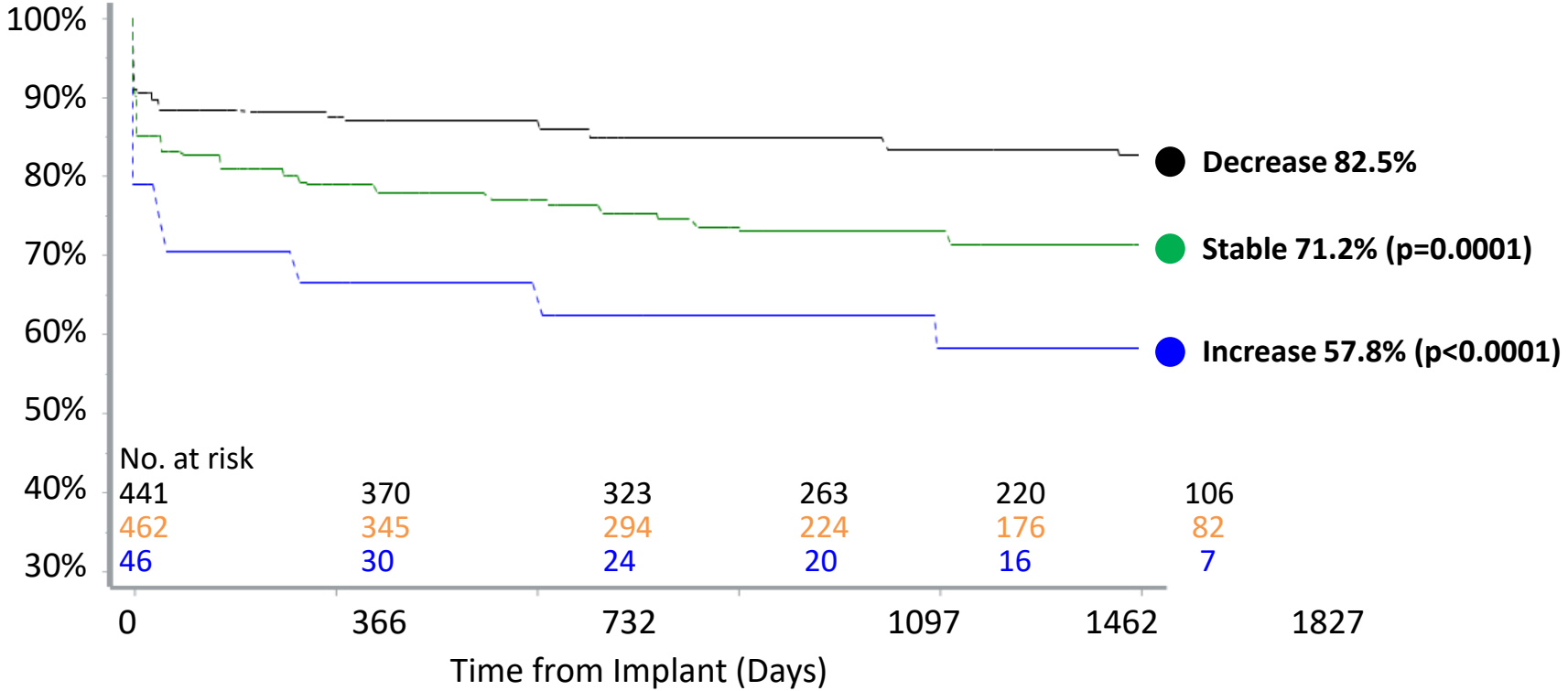
Sarah E. Deery, MD, MPH,[a] Emel A. Ergul, MS,[a] Marc L. Schermerhorn, MD,[b] Jeffrey J. Siracuse, MD,[c] Andres Schanzer, MD,[d] Philip P. Goodney, MD, MS,[e] Richard P. Cambria, MD,[a] *and* Virendra I. Patel, MD, MPH,[a] for the Vascular Study Group of New England, *Boston and Worcester, Mass; and Lebanon, NH*

Aneurysm sac failure to regress after endovascular aneurysm repair is associated with lower long-term survival

Thomas F. X. O'Donnell, MD,[a] Sarah E. Deery, MD, MPH,[a] Laura T. Boitano, MD,[a] Jeffrey J. Siracuse, MD,[b] Marc L. Schermerhorn, MD,[c] Salvatore T. Scali, MD,[d] Andres Schanzer, MD,[e] Robert T. Lancaster, MD, MPH,[a] *and* Virendra I. Patel, MD, MPH,[f] *Boston and Worcester, Mass; Gainesville, Fla; and New York, NY*

Correlation of Sac Dynamics and Type II Endoleaks

Chung , Böckler, Schermerhorn et al., submitted for publication



p-values are for comparisons to the sac decrease group

When to treat Type 2 Endoleak...?

Eur J Vasc Endovasc Surg (2018) ■, 1–97

European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms

Anders Wanhainen [a,i,*], Fabio Verzini [a,i], Isabelle Van Herzeele [a], Eric Allaire [a], Matthew Bown [a], Tina Cohnert [a], Florian Dick [a], Joost van Herwaarden [a], Christos Karkos [a], Mark Koelemay [a], Tilo Kölbel [a], Ian Loftus [a], Kevin Mani [a], Germano Melissano [a], Janet Powell [a], Zoltán Szeberin [a]

ESVS Guidelines Committee [b], Gert J. de Borst, Nabil Chakfe, Sebastian Debus, Rob Hinchliffe, Stavros Kakkos, Igor Koncar, Philippe Kolh, Jes Lindholdt, Melina de Vega, Frank Vermassen

Document reviewers [c], Martin Björck, Stephen Cheng, Ronald Dalman, Lazar Davidovic, Konstantinos Donas, Jonothan Earnshaw, Hans-Henning Eckstein, Jonathan Golledge, Stephan Haulon, Tara Mastracci, Ross Naylor, Jean-Baptiste Ricco, Hence Verhagen

Recommendation 87	Class	Level	References
Expansion of sac diameter ≥1 cm detected during follow up after endovascular abdominal aortic aneurysm repair using the same imaging modality and measurement method may be considered as a reasonable threshold for significant growth.	IIb	C	[628]

Recommendation 88	Class	Level	References
Re-intervention for Type II endoleak after endovascular abdominal aortic aneurysm repair should be considered in the presence of significant aneurysm growth (see Recommendation 87), primarily by endovascular means.	IIa	C	[628]

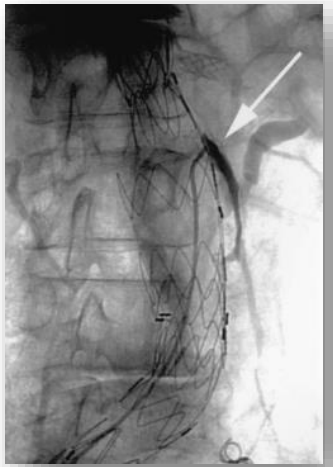
How to treat Type 2 EL ...?

Embolisation techniques (success rate 60-80%):

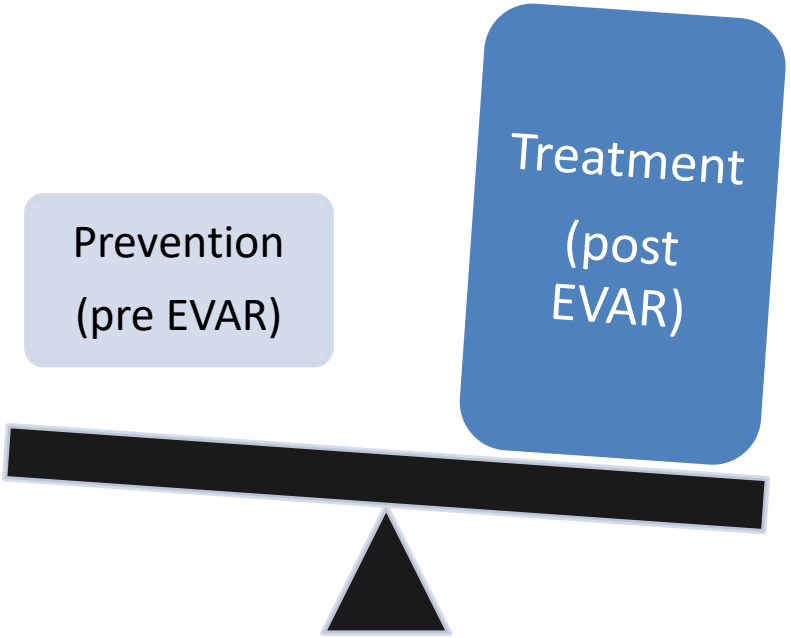
- Transarterial
- Translumbar =highest success rate (Sidloff et al. Type II endoleak after endovascular aneurysm repair. Br J Surg 2013;100:1262e70).
- Transcaval
- Transsealing

Surgical techniques :

- Laparoscopic clipping
- Open ligation of sidebranches
- Suturing after opening the sac
- Conversion and stentgraft explant



Management of Type 2 Endoleak



Literature for Pre-EVAR Embolisation

Inferior Mesenteric Artery Embolization before Endovascular Repair of an Abdominal Aortic Aneurysm: Effect on Type II Endoleak and Aneurysm Shrinkage

Terhi Nevala, MD, Fausto Biancari, MD, PhD, Hannu Manninen, MD, PhD, Pekka Matsi, MD, PhD, Kimmo Mäkinen, MD, PhD, Kari Ylönen, MD, and Jukka Perälä, MD, PhD

Nevala et al, JVIR 2010;21:181-185

Strategies to Reduce the Rate of Type II Endoleaks: Routine Intraoperative Embolization of the Inferior Mesenteric Artery and Thrombin Injection Into the Aneurysm Sac

Carl Muthu, MBChB; Jason Maani, MBChB; Lindsay D. Plank, D Phil; Andrew Holden, FRACR; and Andrew Hill, FRACS

Auckland Regional Endovascular Unit and Interventional Radiology Services, Auckland City Hospital, Auckland, New Zealand.

Muthu et al, JEVT 2007;14;661-668

Endovascular Aneurysm Repair With Inferior Mesenteric Artery Embolization for Preventing Type II Endoleak

A Prospective Randomized Controlled Trial

Makoto Samura, MD, Noriyasu Morikage, MD, Ryo Otsuka, MD, Takahiro Mizoguchi, MD, Yuriko Takeuchi, MD, Takashi Nagase, MD, Takasuke Harada, MD, Osamu Yamashita, MD, Kotaro Suehiro, MD, and Kimikazu Hamano, MD

Objective: This study aimed to evaluate the effect of inferior mesenteric artery (IMA) embolization during endovascular aneurysm repair (EVAR) in patients at high risk of type II endoleak (T2EL) in randomized controlled trial (RCT).

Summary Background Data: Several studies have demonstrated a reduction of T2EL by IMA embolization before EVAR. However, there have been no RCT confirming the efficacy of IMA embolization.

Methods: Patients scheduled for elective EVAR between April 2014 and March 2018 were eligible. Patients at high risk of T2EL (IMA patency with IMA ≥3 mm, LAs ≥2 mm, or an aortoiliac-type aneurysm) were prospectively randomized to receive EVAR with or without IMA embolization. The primary endpoint was occurrence of T2EL during follow-up. Secondary endpoints included aneurysmal sac changes, adverse events from IMA embolization, and reintervention rate due to T2EL. This trial is registered with the University Hospital Medical Information Network, number UMIN000022147.

Results: One hundred thirteen patients had high risk and 106 were randomized. In the intention-to-treat analysis, the incidence of T2EL was significantly lower in the embolization group [24.5% vs 49.1%; $P = 0.009$, absolute risk reduction = 24.5%; 95% confidence interval (CI), 6.2–40.5, number needed to treat = 4.1; 95% CI, 2.5–16.1]. The aneurysmal sac shrunk significantly more in the embolization group (−5.7 ± 7.3 mm vs −2.8 ± 6.6 mm; $P = 0.037$), and the incidence of aneurysmal sac growth related to T2EL was significantly lower in the embolization group (3.8% vs 17.0%; $P = 0.030$). There were no complications related to IMA embolization or reinterventions associated with T2EL.

Conclusions: Our results demonstrated the effectiveness of IMA embolization during EVAR in high-risk patients for the prevention of T2EL, which is suggested for avoiding aneurysmal sac enlargement related to T2EL.

Keywords: endovascular aneurysm repair, inferior mesenteric artery embolization, type II endoleak

(*Ann Surg* 2020;271:238–244)

From the Division of Vascular Surgery, Department of Surgery and Clinical Science, Yamaguchi University Graduate School of Medicine, Minami-kogushi, Ube, Japan.

The authors report no conflicts of interest.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.annalsofsurgery.com).

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DOI: 10.1097/SLA.0000000000003299

Endovascular aneurysm repair (EVAR) for abdominal aortic aneurysms (AAAs) has showed lower perioperative mortality and complication rates than open repair.[1–3] However, the reintervention rate after EVAR in the long-term analyses has also been reported to be significantly higher than in open repair.[3,4] Endoleak, defined as incomplete exclusion of the aneurysmal sac from circulation, is the most common complication after EVAR and a primary cause of reintervention. Type II endoleak (T2EL) is retrograde perfusion into the aneurysmal sac from the aneurysmal side branches, such as the inferior mesenteric artery (IMA), and is the most common type.[5] T2EL has been shown to result in a significantly higher rate of reintervention, conversion to open repair, and rupture subsequent to sac enlargement in long-term outcome analyses.[6]

In recent years, the anatomical risk factors associated with the occurrence of T2EL have gradually become clear.[5,7–11] In our previous study, we discovered that IMA patency with IMA ≥3.0 mm, lumbar arteries (LAs) ≥2.0 mm, or an aortoiliac-type aneurysm were independent risk factors of T2EL.[12]

Adequate management of T2EL has been widely discussed in the literature, but remains unclear. Treatment of aneurysmal sac enlargement due to T2EL is challenging.[13] Therefore, it could be preferable to prevent T2EL rather than treat it. Several studies have demonstrated a reduction of T2EL by IMA embolization before EVAR.[14–18] However, these studies were retrospective and nonrandomized. Moreover, patent IMAs were routinely embolized in these studies. Conversely, we believe that IMA embolization should not be routine, but instead limited to those patients at risk of T2EL considering the associated time, cost, and safety.

Therefore, to elucidate the effectiveness of preventive IMA embolization, the present study aimed to evaluate the effect of EVAR with or without IMA embolization in patients at high risk of T2EL.

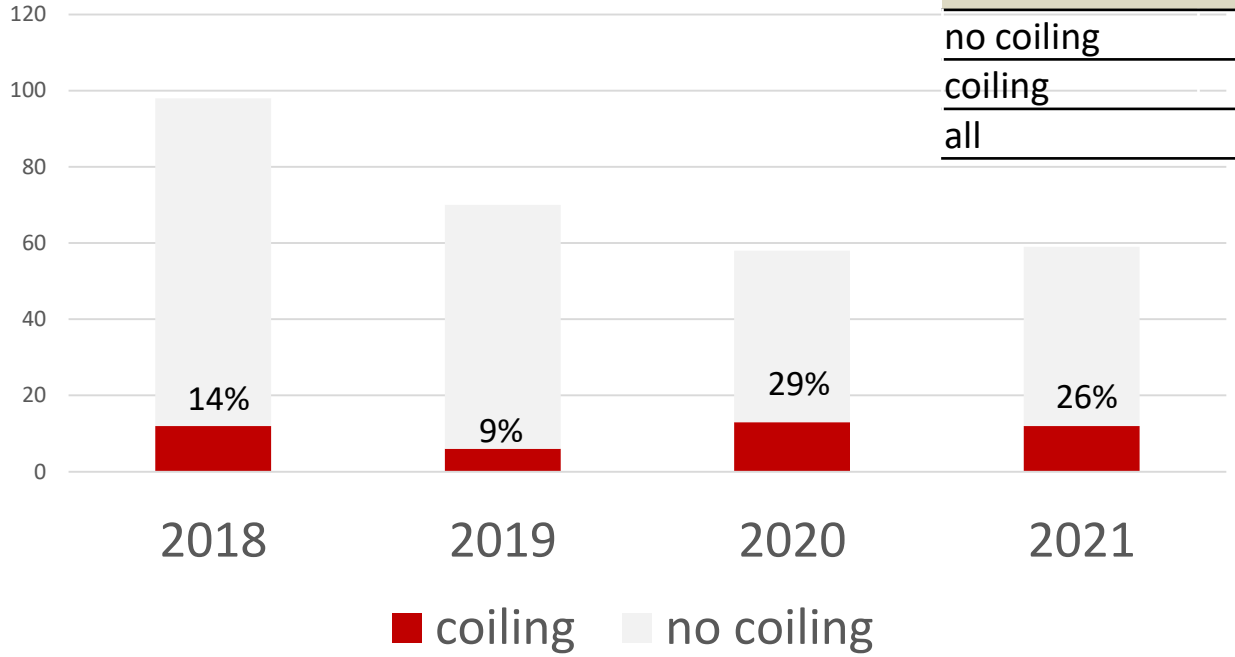
METHODS

Study Design

This study was a prospective, single-center, two-arm, parallel-group, randomized controlled trial (RCT) comparing EVAR with IMA embolization (embolization group) to EVAR without IMA embolization (nonembolization group) in patients at high risk of T2EL undergoing elective EVAR for an AAA. Patients without risk factors of T2EL were considered at low risk and were not included in this trial, but received the same follow-up protocol as the high-risk group. This trial was registered as a RCT titled "Prevention of Type II Endoleak With Embolization of IMA Before Endovascular Aneurysm Repair" with the University Hospital Medical Information Network (UMIN) registration number UMIN000022147.

Patients were recruited from our department from April 2014 to March 2018. In this trial, patients scheduled for elective EVAR

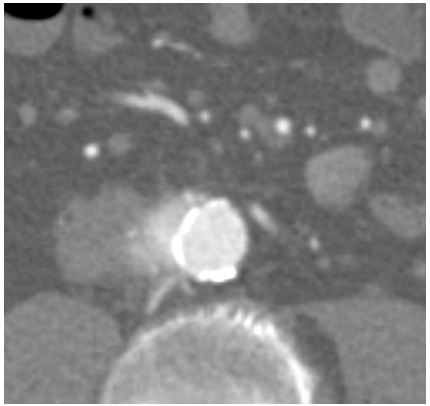
Pre-EVAR Embolisation in Heidelberg

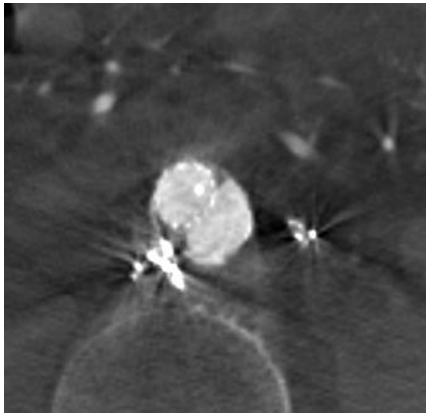


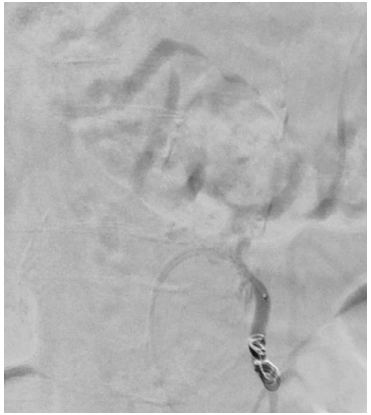
EVAR	2018	2019	2020	2021
no coiling	74	58	32	35
coiling	12	6	13	12
all	86	64	45	47

Technical success rate:
72.0%
(31/43)

Case example of Pre-EVAR Embolisation





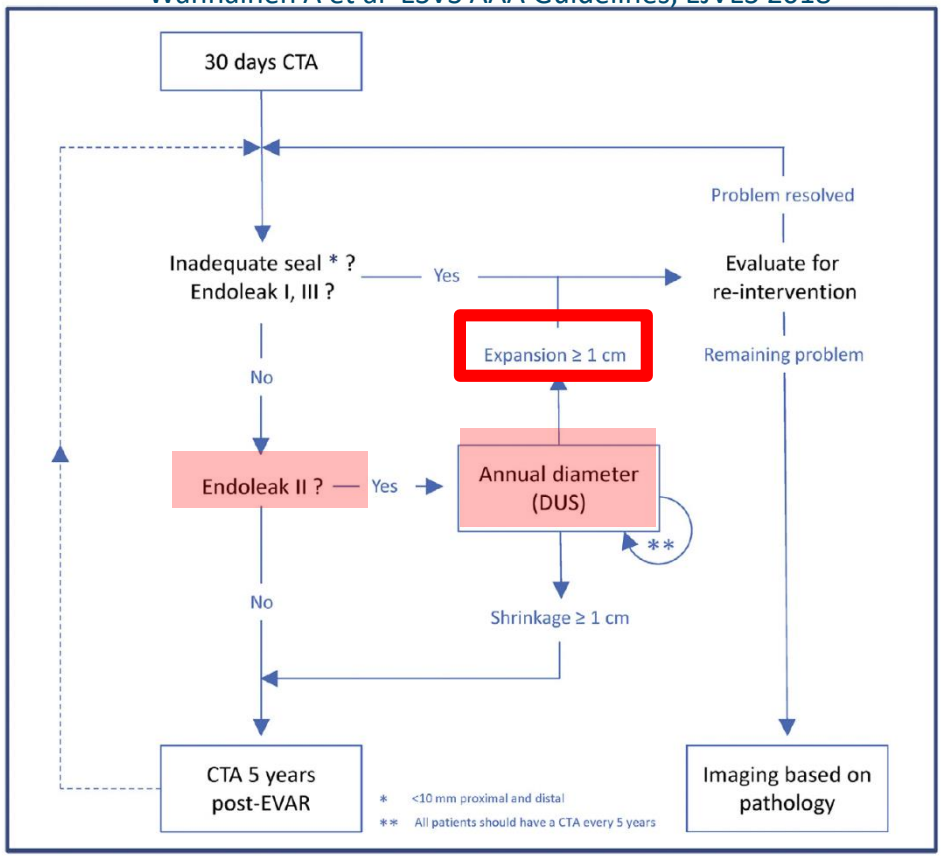


How my standardized approach looks like....

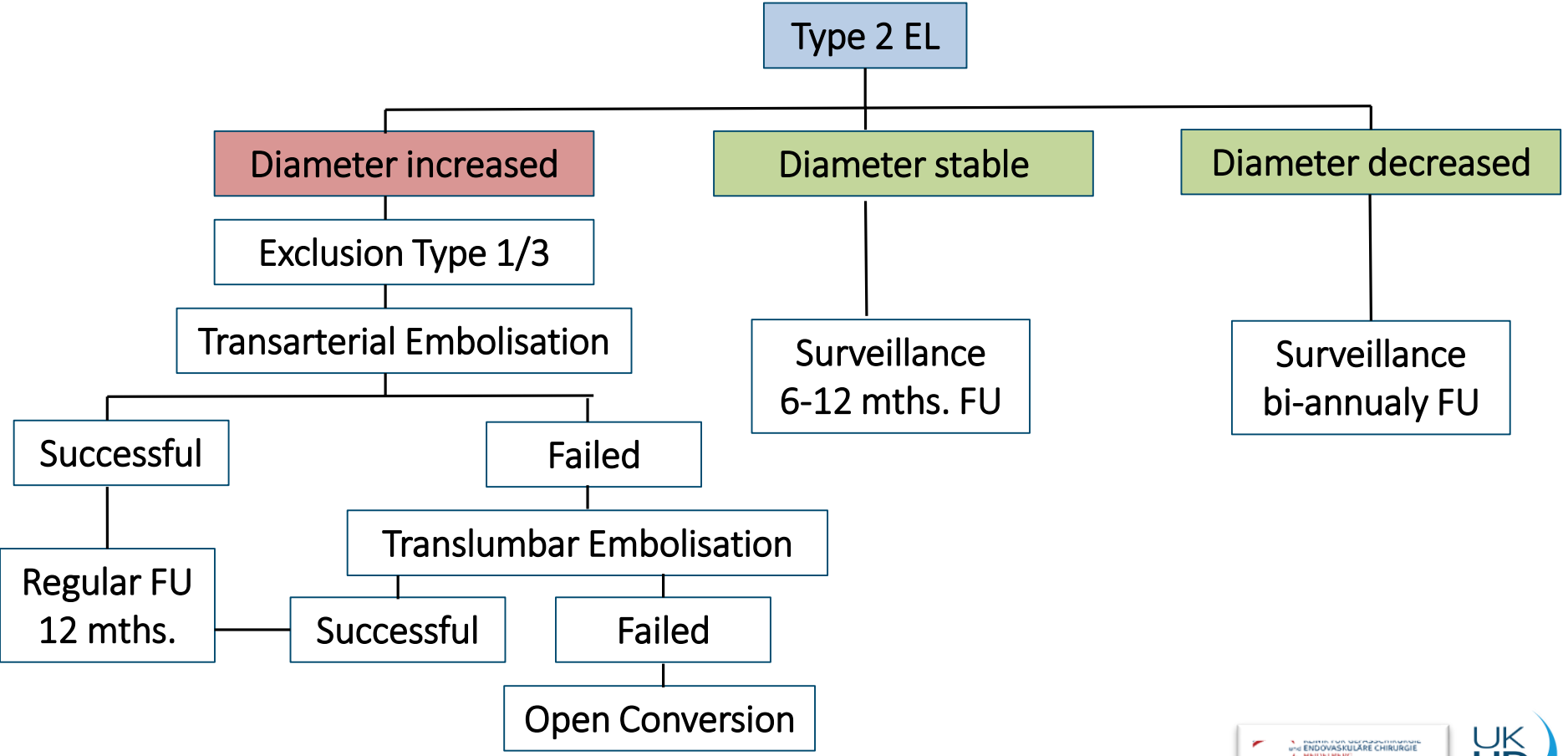
- I prevent Type 2 EL in selected cases (pre-EVAR embolization)
- I search for Type 1/3 in recurrent new type 2 Endoleak
- I do indicate treatment of persisting Type 2 EL according to ESVS - guideline recommendations: 1 cm / year
- I start with transarterial followed by translumbar embolization
- I use coils for pre-evar and Onyx for post-EVAR embolization

Type 2 Endoleak & Follow up

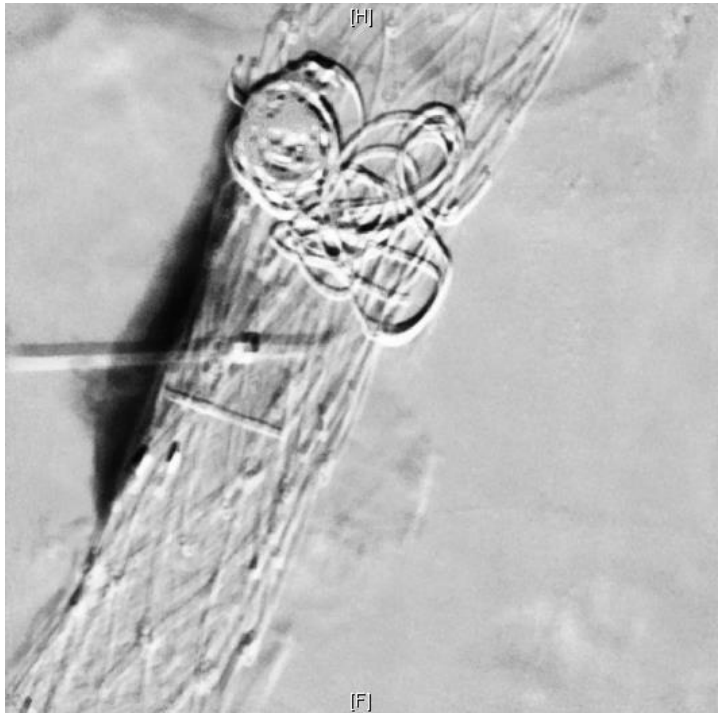
Wanhainen A et al ESVS AAA Guidelines, EJVES 2018

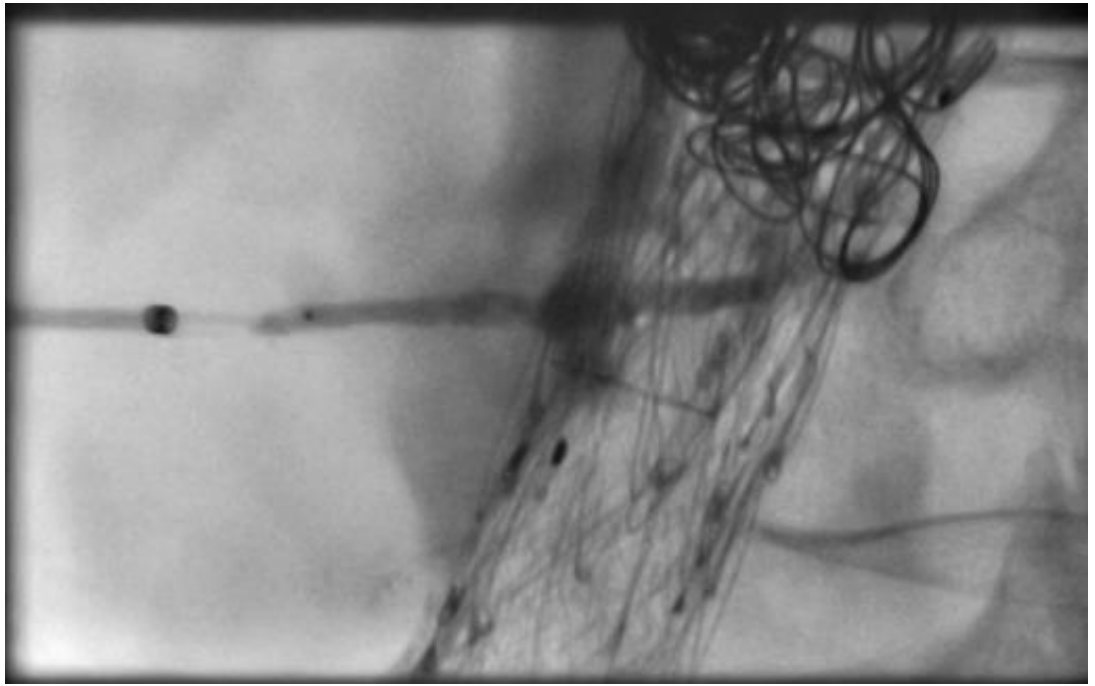


My approach to Type 2 EL after EVAR



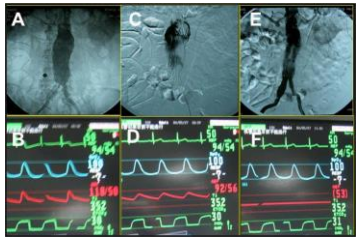
Case example of Post-EVAR translumbar Embolisation



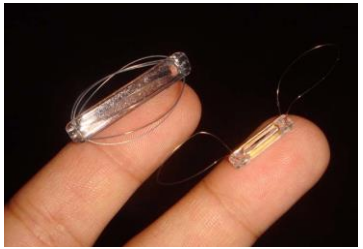


I do not use...

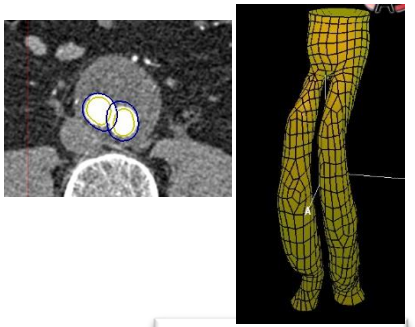
- Intrasac pressure measurments



- CardioMEMS endosendor



- Finite Element Analysis



Summary

- Type 2 Endoleak have impact on EVAR outcome (reintervention, rupture)
- Pre-EVAR embolisation is applied in selected cases (predictors)
- Persisting Type 2 EL are treated according guidelines recommendations
- Transarterial > translumbar embolisation is first choice