

# Reintervention after abdominal aortic aneurysm repair – who is to blame?

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## ABSTRACT

**INTRODUCTION:** Endovascular repair of abdominal aortic aneurysm (EVAR) is often recommended as first option for patients with suitable abdominal aortic aneurysm (AAA) anatomy. Nevertheless, this treatment carries higher reintervention rates and possibly higher aneurysm and all cause-related mortality in the long run versus open surgery. This narrative review aims to convey recent data about surveillance and the frequency and indications for reintervention after EVAR.

**METHODS:** A comprehensive narrative review was conducted, providing a critical and objective analysis of the current knowledge on a topic.

**RESULTS:** EVAR-1 trial reported lower total and aneurysm-related mortality in the first 6 months after EVAR patients, with increasing follow-up time the mortality rate increased, leading to a higher total and aneurysm-related mortality, comparing with the open surgical repair group.

There is no consensus on EVAR surveillance, and in the 15-year follow-up of EVAR-1 trial they found that EVAR is associated with a reintervention rate of up to 20% in the first 4 years. There is a press in need for a homogeneity and contemporary appraisal of surveillance after EVAR and in indications for reintervention. In order to accomplish that, it is of paramount importance that centers undergoing EVAR programs publish their results about the compliance of follow up after EVAR and reintervention rates

**CONCLUSION:** Long term outcomes are the Achilles heel of the endovascular AAA repair. Adequate follow up and reintervention are of paramount importance for EVAR to achieve its full potential.

**Keywords:** Abdominal aortic aneurysm; surveillance; surgery; endovascular.

## INTRODUCTION

Since it was introduced in 1991, endovascular aortic aneurysm repair (EVAR) emerged as a safe and effective treatment for abdominal aortic aneurysms (AAA).<sup>[1]</sup> Several Randomized Controlled Trials (RCTs) including the EVAR 1 trial,<sup>[2]</sup> DREAM,<sup>[3]</sup> OVER<sup>[4]</sup> and ACE<sup>[5]</sup> trials, have compared open surgical repair (OSR) and endovascular treatment of AAA in patients with suitable anatomy, suggesting a significant short-term survival benefit for EVAR over OSR (Table).<sup>[6]</sup> EVAR is now considered the preferred treatment modality in most patients.

Data on the mid- and long-term efficacy of EVAR is emerging and shows that EVAR patients are more likely to experience both aortic complications, including graft failure (stenosis, angulation, kinking, device migration, stent fractures and modular disconnections) and endoleak (extra-luminal filling of the aneurysmal sac)<sup>[7]</sup> and reinterventions, which can be as high as 20% in the first 5 years,<sup>[2,8]</sup> when compared to OSR patients. For instance, although EVAR-1 trial reported lower total and aneurysm-related mortality in the first 6 months after EVAR patients, with increasing follow-up time the mortality rate increased, and after 8 years of follow-up both



total and aneurysm-related mortality were significantly higher in the EVAR group when compared to the OSR group.<sup>[9]</sup> Furthermore, the rate of reintervention, aimed to reduce aneurysm-related deaths predominantly deriving from secondary sac rupture, was higher in the EVAR group at all follow-up timepoints.<sup>[8,9]</sup>

As such, EVAR follow-up with lifelong image surveillance is of paramount importance to reduce mid- and long-term mortality in these patients. This aim of this narrative review is to convey recent data about surveillance and the frequency and indications for reintervention after EVAR.

**Table:** Characteristics and complications rate in four randomized trials that compared EVAR versus open aortic repair in patients with abdominal aortic aneurysm.

	EVAR 1	DREAM	OVER	ACE
Patient recruitment period	September 1999 –September 2004	November 2000 – December 2003	October 2002 – October 2008	March 2005 – March 2008
Final recruitment	626 EVAR + 626 open aortic repair	173 EVAR + 178 open aortic repair	444 EVAR + 437 open aortic repair	150 EVAR + 149 open aortic repair
Follow-up for complications (years)*	5.3 (2.5)	5.2 (2.2)	5.2 (2.1)	2.8 (1.1)
No. of complications per person-years after EVAR (rate per 100 person-years)	315 of 3381 (9.3)	125 of 906 (13.8)	209 of 2334 (9.0)	103 of 419 (24.6)
Re-intervention definition	Endoleaks, graft rupture, anastomotic aneurysm, graft migration at proximal or distal ends of device, graft kinking, graft thrombosis, graft stenosis, distal embolization from graft, graft infection, dilatation of the aortic neck, sac or iliac landing zones following graft placement, aortic perforation/ dissection and renal infarction.	Thrombo-occlusive disease, endoleak type 1 or endotension, endograft migration, prosthesis infection, graft-material failure, para-anastomotic aneurysm, and aneurysm rupture), wound-related indications, and local or systemic indications; the decision to perform a secondary intervention was made by the individual surgeon.	Secondary therapeutic procedures, were selected through <i>International Classification of Diseases, 9th Revision</i> (ICD-9) codes (ICD-9 codes 38.34, 38.36, 38.44, 38.46, 39.41, 39.49, 39.52, 39.71, and 39.79; CPT codes 33880 through 33891, 34800 through 35142, 35472, 35537 through 35540, 35637, 35638, 35721, and 35840).	Includes graft replacement and endovascular or open repair of endoleaks, occlusions or stenoses.

\*values are mean (standard deviation).

## METHODS

We searched the PubMed database and Scopus for articles about EVAR surveillance and reintervention after EVAR published up to March 2021. The literature search was restricted to articles published in English, Spanish, and Portuguese. The studies used in this review were selected based on their study design, sample size and contemporaneity. Articles were also retrieved from additional sources, namely by cross-referencing. When not available, the full texts were requested from the authors, and only full text articles were included in this review.

## RESULTS

### Reintervention after EVAR

An increasing number of RCTs and observational studies reporting long-term outcomes of EVAR vs open surgery have been published in the recent years. In the 15-year follow-up of EVAR trial 1 they found that EVAR is associated with a reintervention rate of up to 20% in the first 4 years<sup>[2,8,10]</sup> and also 12-year follow-up of DREAM demonstrated that EVAR was associated with higher reintervention rates at every time point. Furthermore, the same results were found in large observational studies.<sup>[11]</sup>

The EVAR trial represents the benchmark trial for the worldwide care of abdominal aortic aneurysms.<sup>[9]</sup> It was a multicentre randomised controlled trial including 1,252 patients with aneurysms of at least 5.5cm in diameter, treated with first-generation endografts and followed out to 15 years.<sup>[9]</sup> None of the devices used in this trial are still available on the market. In the last 2 decades, new endovascular devices were developed with lower-profile and more hydrophilic delivery sheaths, user-friendly mechanisms and with a more compliant structure that better adapts to underlying anatomy. The ENGAGE registry is a multicenter study that includes 1263 patients with abdominal aortic aneurysm that were submitted to EVAR with Endurant Stent Graft System, a newer generation endograft.<sup>[12]</sup> The four-year results for ENGAGE showed a 30% (11% lower than with EVAR 1's first-generation devices) complication rate for EVAR with Endurant and a 13% reintervention rate (7% lower than in EVAR 1).<sup>[12]</sup> Thus, the lower complication rate in the ENGAGE patient cohort led to fewer reinterventions when compared with the EVAR 1 outcomes.

In the majority of the cases, EVAR complications can be identified and treated effectively. However, less than 50% of patients adhere to the standard postoperative EVAR follow-up protocol.<sup>[11]</sup> Godfrey *et al.* showed that only 12.5% of patients undergo regular surveillance by 4 years after EVAR.<sup>[13]</sup> The increasing number of patients lost to follow-up leads to worse survival outcomes.<sup>[11]</sup>

## Follow up after EVAR

There is no consensus on EVAR surveillance, either regarding timing or imaging modality.<sup>[14]</sup> The Society for Vascular Surgery clinical guidelines recommends computed tomography angiography (CTA) 1 month after EVAR. If the first CTA does not show any abnormalities, the next CTA is planned after 1 year; if the 1-year CTA shows no abnormalities, the yearly CTA may be replaced by duplex ultrasonography (DUS). However, CTA should still be performed at least once every 5 years.<sup>[15]</sup> The new European guidelines recommend stratified follow up after EVAR based on risk of failure, with annual imaging only in patients with potential complications (endoleak or short sealing zone).<sup>[1]</sup> NICE Guidelines state that patients submitted to EVAR should be followed in a surveillance program, whose frequency should be tailored to patient's risk of EVAR-related complications. However, in these guidelines, they do not specify any timing in which patients should be submitted to exam.<sup>[16]</sup>

Cohen et al. showed that a post-EVAR surveillance program leads to a higher follow-up compliance and lower rates of reintervention.<sup>[17]</sup> This data reinforces the importance of careful lifetime surveillance in long-term care. This raises particular concern when some reports indicate that surveillance guidelines are rarely followed in clinical practice.<sup>[18]</sup>

CTA is commonly regarded as the gold standard for EVAR surveillance and detection of post-EVAR complications, but is associated with a risk of radiation and nephrotoxic contrast exposure is not despicable.<sup>[2,10]</sup> Regarding EVAR trial 1, overall there was no difference in cancer-related mortality between the groups, it seems to increase in the EVAR group after 8 years of follow-up.<sup>[9]</sup> An alternative strategy to reduce surveillance-related morbidity is the use of non-nephrotoxic imaging modalities. There is an increased reliance on DUS or contrast enhanced DUS that might be a safe strategy in selected patients. Finally, the modality, timing and overall necessity of surveillance, they all account for a significant proportion of the long-term excess cost of EVAR compared to open repair.

In the other hand, some studies showed that compliance to post-EVAR surveillance is not a predictor for better outcomes. Milk et al. found in their systematic review that patients that are compliant with surveillance have higher secondary rupture or mortality rates compared to partial/noncompliance, in a median follow-up time of 31.7 months.<sup>[19]</sup> Also, Grima et al. found that re-intervention rate was significantly higher in compliant patients between 3 and 5 years after EVAR and furthermore, compliance with surveillance was not associated with a lower aneurysm related mortality.<sup>[20]</sup> However, these data cannot be evaluated in a simple way, because any of these analysis found a direct link between surveillance and survival, and this results could be explained by many possible reasons. Sicker patients underwent more imaging for unrelated problems and therefore show a higher rate of overall mortality in patients in the compliant group. Additionally, healthy patients probably are less likely to attend surveillance, and this can result in better survival.

## Future remarks

There is a pressing need for a homogeneity and contemporary appraisal of surveillance after EVAR and in indications for reintervention. In order to accomplish that,

it is of paramount importance that centers undergoing EVAR programs publish their results about the compliance of follow up after EVAR and reintervention rates. The lack of consensual definitions of EVAR-related reintervention is a major problem. Adherence to standard reports for reintervention after EVAR might mitigate this limitation.

## CONCLUSION

The loss of early EVAR survival benefit, followed by inferior late survival benefit and durability compared with OSR, needs to be addressed by lifelong surveillance of EVAR and prompt re-intervention if necessary. Consequently, adequate follow up adjusted to the patient's risk for complications and reinterventions are of paramount importance for EVAR to achieve its full potential

## Author contributions

Filipa Jácome: study design, data collections, data analysis, writing

Beatriz Ribeiro: study design, data analysis, writing

Marina Dias-Neto: study design, data analysis, writing

**Conflicts of interest** None

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## REFERENCES

1. Wanhainen A, Van Herzele I, Allaire E, Bown M, Cohnert T, et al. Editor's Choice e European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms. *Eur J Vasc Endovasc Surg*. 2019;57:8-93
2. EVAR trial participants. Endovascular aneurysm repair versus open repair in patients with abdominal aortic aneurysm (EVAR trial 1): randomised controlled trial. *Lancet*. 2005;365:2179-86.
3. Prinssen M, Verhoeven E, Buth J, Cuypers P, van Sambeek M, Balm R, et al. Randomized Trial Comparing Conventional and Endovascular Repair of Abdominal Aortic Aneurysms. *N Engl J Med*. 2004;351:1607-18.
4. Pitton MB, Jungmann F, Kloeckner R, Schotten S, Wirth G, Mittler J, et al. Visceral artery aneurysms: Incidence, management, and outcome analysis in a tertiary care center over one decade. *Eur Radiol*. 2015;25:2004-14.
5. Becquemin JP. The ACE trial: a randomized comparison of open versus endovascular repair in good risk patients with abdominal aortic aneurysm. *J Vasc Surg*. 2009;50:222-4.
6. Powell J, Ulug P, Blankensteijn JD, Lederle FA, Becquemin JP, Greenhalgh RM, et al. Meta-analysis of individual-patient data from EVAR-1, DREAM, OVER and ACE trials comparing outcomes of endovascular or open repair for abdominal aortic aneurysm over 5 years. *Br J Surg*. 2017;104:166-78
7. Mazzei M, Mazzei FG, Squitieri NC, Notaro D, de Donato G, Galzerano G, et al. Follow-up of endovascular aortic aneurysm repair: Preliminary validation of digital tomosynthesis and contrast enhanced ultrasound in detection of medium- to long-term complications. *World J Radiol*. 2016;28:530-6.
8. Patel SR, Allen C, Grima MJ, Brownrigg JRW, Patterson BO, Holt PJ, et al. A Systematic Review of Predictors of Reintervention After EVAR: Guidance for Risk-Stratified Surveillance. *Vasc Endovascular Surg* 2017;51:417-28.
9. Patel R, Powell JT, Greenhalgh RM, for the EVAR trial investigators. Endovascular versus open repair of abdominal aortic aneurysm in 15-years' follow-up of the UK endovascular aneurysm repair trial 1 (EVAR trial 1): a randomised controlled trial. *Lancet*. 2016;388:2366-74.
10. Baderkhan H, Haller O, Björck M, Mani K. Editor's Choice – Detection of Late Complications After Endovascular Abdominal Aortic Aneurysm Repair and Implications for Follow up Based on Retrospective Assessment of a Two Centre Cohort. *Eur J Vasc Endovasc Surg*. 2020;60:171-9.
11. Li BB, Khan S, Salata K, Hussain MA, Mestra CI, Greco E, et al. A systematic review and meta-analysis of the long-term outcomes of endovascular versus open repair of abdominal aortic aneurysm. *J Vasc Surg* 2019;70:954-69.

- 12.** Teijink J, Böckler D, Peeters P, Sterkenburg S, Bouwman L, Verhagen HJ, et al. Editor's Choice – Five Year Outcomes of the Endurant Stent Graft for Endovascular Abdominal Aortic Aneurysm Repair in the ENGAGE Registry. *Eur J Vasc Endovasc Surg.* 2019;58:175-81.
- 13.** Godfrey AD, Morbi AH, Nordon IM. Patient Compliance with Surveillance Following Elective Endovascular Aneurysm Repair. *Cardiovasc Intervent Radio.* 2015;38:1130-6.
- 14.** Karthikesalingam A, Page AA, Pettengell C, Hinchliffe RJ, Loftus IM, Thompson MM, et al. Heterogeneity in Surveillance after Endovascular Aneurysm Repair in the UK. *Eur J Vasc Endovasc Surg.* 2011;42:585-90.
- 15.** Chaikof EL, Dalman RL, Eskandari MK, Jackson BM, Lee WA, Mansour MA, et al. The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm. *J Vasc Surg.* 2018;67:2-77.
- 16.** NICE. Abdominal aortic aneurysm: diagnosis and management. NICE guidelines. 2020. <https://www.nice.org.uk/guidance/ng156>
- 17.** Cohen J, Pai A, Sullivan TM, Alden P, Alexander JQ, Cragg A, et al. A Dedicated Surveillance Program Improves Compliance with Endovascular Aortic Aneurysm Repair Follow-up. *Ann Vasc Surg.* 2017;44:59-66.
- 18.** Garg T, Baker LC, Mell MW. Adherence to postoperative surveillance guidelines after endovascular aortic aneurysm repair among Medicare beneficiaries. *J Vasc Surg.* 2015;61:21-7
- 19.** de Mik SML, Geraedts ACM, Ubbink DT, Balm R. Effect of Imaging Surveillance After Endovascular Aneurysm Repair on Reinterventions and Mortality: A Systematic Review and Meta-analysis. *J Endovasc Ther.* 2019;26:531-41.
- 20.** Grima MJ, Boufi M, Law M, Jackson D, Stenson K, Patterson B, et al. Editor's Choice – The Implications of Non-compliance to Endovascular Aneurysm Repair Surveillance: A Systematic Review and Meta-analysis. *Eur J Vasc Endovasc Surg.* 2018;55:492-502