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REVIEW

# Aneurysm Sac Pressure after EVAR: The Role of Endoleak

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***Objective***. *The relation between endoleak and aneurysm sac pressure is not completely clear. This review evaluates the effect of endoleaks on aneurysm sac pressure and summarizes the present knowledge regarding aneurysm sac pressure after EVAR.*
***Methods***. *A systematic search of literature was carried out using MEDLINE, EMBASE and Web of Science. Studies were included if aneurysm sac pressure measurements as well as systemic pressure measurements were performed during or after EVAR. Mean pressure indices (MPI), ratio mean aneurysm sac pressure to mean systemic pressure), in the absence of endoleaks and in the presence of different type of endoleaks were compared.*
***Results***. *Stent-graft deployment does not seem to result in immediate reduction of aneurysm sac in the absence of an endoleak. Aneurysm sac pressure is elevated in the presence of an endoleak. However, the MPIs differ widely between studies both in the absence and presence of an endoleak.*
***Conclusion***. *MPI is not specific to the type of endoleak. This implies that the same type of endoleak does not necessarily pose the same MPI and by this the same hazard of aneurysm rupture, because the aneurysm sac pressure is directly related to the aneurysm wall stress.*


*Keywords: EVAR; Endoleak; Endotension; Abdominal aortic aneurysm; AAA; Pressure; Follow-up.*

## Introduction

Endovascular aneurysm repair (EVAR) was introduced in 1991 as a less-invasive alternative for abdominal aortic aneurysm (AAA) therapy.[1,2] EVAR aims at prevention of aneurysm rupture with exsanguinations and acute death. Endoleaks are the Achilles heel of EVAR. An endoleak is defined as persistence of blood flow outside the stent-graft, but within the aneurysm sac. Endoleaks occur approximately in 20% of the patients treated by EVAR.[3]

The absence of an endoleak on conventional imaging tools, such as Computer tomography (CT) or angiography, does not exclude the possibility of high pressure in the aneurysm sac and the persistent risk of rupture.[4] Therefore the concept of endotension is formulated as persistent or recurrent pressurization of the aneurysm sac following endovascular repair.[5]

The success of EVAR relies on the extent of isolation of the aneurysm sac from systemic blood flow and systemic pressure. The evaluation of this extent of isolation is difficult. Firstly, it is not known what happens to the aneurysm sac pressure after EVAR without detectable endoleak nor is it known how much pressure is required to cause rupture. Secondly, it is difficult to predict whether and when re-intervention is justified in the presence of endoleaks, solely based on imaging. Graft related endoleaks (Type I and III) are associated with a risk of late rupture and it is assumed but not proven that this is because such endoleaks are associated with significant pressurization of the aneurysm sac.[4] The treatment of endoleaks from collateral back-flow (Type II) remains controversial. Many state that Type II endoleaks will seal.[4,6] It has been proposed that most Type II endoleaks that seal are those detected at the original procedure.[4] Little is known about their impact on the aneurysm sac pressure and the risk of aneurysm rupture. The clinical significance of Type V endoleaks, defined as aneurysm growth without detectable endoleaks, also remains uncertain.

Elucidation of the relationship between endoleak and pressure may help clinical decision making. This review evaluates the effect of endoleaks on aneurysm

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sac pressure and summarizes the present knowledge regarding aneurysm sac pressure after EVAR.

## Methods

### *Search strategy for identification of studies*

A systemic search of literature was conducted until December 2006 using PubMed, EMBASE and Web of Science. Our search strategy is given in Table 1 (PubMed), Table 2 (EMBASE) and Table 3 (Web of Science). There was no restriction on language.

### *Criteria for considering studies for this review*

Articles of in-vitro, animal and patient-studies were selected by Pubmed, EMBASE and Web of Science, respectively. The abstracts of each article were studied after checking for duplication between the databases. If it appeared that aneurysm sac pressure measurements was concurrently performed with systemic pressure measurements during or after EVAR the full text was studied. Additional articles were sought by checking the reference lists of the relevant articles.

### *Data extraction*

Particular attention during evaluation of the selected studies was paid to the type of study (in-vitro, animal or patient), the pressure measurement technique, the presence or absences of endoleaks, the time of pressure measurement and the used analysis of pressure measurements. The endoleak classification is given in Table 4.[6]

The interval between pressure measurement and EVAR might be relevant for the interpretation and comparison of measurements. Therefore, we categorized the studies, in which an endoleak was absent, in 4 groups (Group 1: $<$ 1 week after EVAR, Group 2: 1 week to 1 year after EVAR, Group 3: 1 to 2 years after EVAR, Group 4: 2 to 4 years after EVAR). We divided the studies, in which a Type II endoleak was present, in 2 groups (Group 1: 0 to 1 month after EVAR, Group 2: $>$ 1 month after EVAR). Time of pressure measurement is probably less relevant in the presence of a Type I and III leak, because there is a direct connection between the systemic circulation and the aneurysm sac. Consequently, it is not likely that the ratio between aneurysm sac pressure and systemic blood pressure changes over time. Type IV and V endoleak studies were not categorized in moment of pressure measurement, because these endoleaks are investigated only in a small number of studies.

**Table 1. Search strategy used for PubMed**

| Search | |
|---|---|
| #1 | "aortic aneurysm" [MeSH] OR aortic aneurysm* [Text word] |
| #2 | "stents" [MeSH] OR stent* [Text Word] |
| #3 | "blood vessel prosthesis" [MeSH] OR "blood vessel prosthesis implantation" MeSH] OR blood vessel prosthe* [Text Word] |
| #4 | evar [All Fields] OR "endovascular therapy" [All Fields] |
| #5 | #2 OR #3 OR #4 |
| #6 | #1 AND #5 |
| #7 | endovascular [All Fields] AND ("aneurysm" [MeSH Terms] OR aneursym* [Text Word]) AND (repair* [Text Word] OR treat* [Text Word] OR therap* [Text Word] OR explode therapy [Subheading] OR "therapeutics" [MeSH]) |
| #8 | "pressure" [MeSH] OR pressure* [Text Word] OR "manometry" [MeSH] OR manomet* [All fields] OR leak* [All Fields] OR endoleak* [All Fields] OR tension [All fields] OR endotension [All Fields] |
| #9 | #8 AND (#6 OR #7) |

**Table 2. Search strategy used for EMBASE (OVID)**

| Search | |
|---|---|
| 1 | exp aorta aneurysm/OR aortic aneurys$.ft |
| 2 | stent/OR stent$.ft |
| 3 | exp blood vessel prosthesis/OR blood vessel prosthe$.ft |
| 4 | endovascular therap$.ft |
| 5 | evar.ft OR endovascular aneurysm repair.ft |
| 6 | endovascular aneurysm treat$.ft OR endovascular aneurysm therap$.ft |
| 7 | (1 AND (2 OR 3 OR 4)) OR (5 OR 6) |
| 8 | pressure/OR pressure measurement/OR pressure$.ft |
| 9 | manometry/OR manomet$.ft |
| 10 | tension/OR tension.ft |
| 11 | leakage.ft OR endotens$.ft OR endoleak$.ft |
| 12 | exp prosthesis failure/OR prosthesis fail$.ft |
| 13 | 8 OR 9 OR 10 OR 11 OR 12 |
| 14 | 7 AND 13 |

### *Analysis of data*

Peripherally measured systolic and diastolic pressure does not always reflect corresponding pressures in the aorta. The systolic pressure in the brachial artery over-estimates the central aortic systolic pressure.[7] So the comparison of the ratios between the systolic or

**Table 3. Search strategy used for Web of Science**

| Search | |
|---|---|
| #1 | TS = (pressure* or manomet* or leak* or endoleak* or tension or endotension) |
| #2 | TS = aortic aneurysm* |
| #3 | TS = (stent* or blood vessel prosthe* or evar or endovascular therap*) |
| #4 | TS = endovascular |
| #5 | TS = (repair* or treat* or therap*) |
| #6 | #3 AND #2 |
| #7 | TS = aneurysm* |
| #8 | #7 AND #5 AND #4 |
| #9 | #8 OR #6 |
| #10 | #9 AND #1 |