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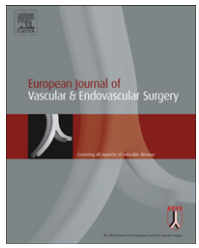

Intra-aneurysm Sac Pressure in Patients with Unchanged AAA Diameter after EVAR

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Abstract *Objective:* To study intra-aneurysm sac pressure and subsequent abdominal aortic aneurysm (AAA) diameter changes in patients without endoleaks that remain unchanged in AAA diameter more than 1 year after endovascular aneurysm repair (EVAR).
Methods: A total of 23 patients underwent direct intra-aneurysm sac pressure (DISP) measurements 16 months (IQR: 14–35 months) after EVAR. Tip-pressure sensors were used through translumbar AAA puncture. Mean pressure index (MPI) was calculated as the percentage of mean intra-aneurysm pressure relative to the simultaneous mean intra-aortic pressure. Aneurysm expansion or shrinkage was assumed whenever the diameter change was $\geq$ 5 mm. Values are presented as median and interquartile range.
Results: In 18 patients, no fluid was obtained upon AAA puncture (group A). In five patients, fluid was obtained (group B). In group A, follow-up continued for 29 months (IQR: 15–35 months) after DISP; five AAAs shrank, 10 remained unchanged and three expanded (MPIs of 26% (IQR: 18–42%), 28% (IQR: 20–48%) and 63% (IQR: 47–83%) and intra-sac pulse pressures of 3 mmHg (IQR: 0–5 mmHg), 4 mmHg (IQR: 2–8 mm Hg) and 12 mmHg (IQR: 6–20 mmHg), respectively, for the three subgroups). MPI and intra-sac pulse pressures were higher in AAAs that subsequently expanded ($P = 0.073$ and 0.017, respectively). MPI and pulse pressure correlated with total diameter change ($r = 0.49$, $P = 0.039$ and $r = 0.39$, $P = 0.109$, respectively). Pulse pressure had a greater influence than MPI on diameter change ($R^2 = 0.346$, $P = 0.041$, beta standardised coefficient of 0.121 for MPI and 0.502 for pulse pressure). Similar results with stronger, and significant correlation to pulse pressure were obtained when relative diameter changes were used ($r = 0.55$, $P = 0.017$). In group B, MPI and AAA pulse pressure were 32% (IQR: 18–37%) and 1 mmHg (IQR: 0–6 mmHg), respectively. After 36 months (IQR: 21–38 months), one AAA shrank, three continued unchanged while one expanded.
Conclusions: AAAs without endoleak and unchanged diameter more than 1 year after EVAR will often continue unchanged. Expansion can eventually occur in the absence of intra-sac fluid accumulation and is associated with higher and more pulsatile intra-sac pressure. However, in patients with intra-sac fluid, expansion can occur with low intra-sac pressures.

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Endovascular aneurysm repair (EVAR) was introduced as a less invasive option for the treatment of abdominal aortic aneurysms (AAAs). The theoretical premise of EVAR is that a successful treatment will exclude the AAA sac from the systemic arterial pressure and circulation. The outcome after EVAR has, nevertheless, been traditionally evaluated by imaging methods since intra-aneurysm sac pressure has been difficult to measure. The imaging follow-up assesses changes in the AAA diameter and the presence of endoleaks. AAA diameter expansion after EVAR is considered a clinical failure, as opposed to AAA shrinkage that is taken as treatment success.[1] Studies on intra-aneurysm sac pressure have reinforced these concepts by showing a significantly higher AAA sac pressurisation in expanding AAAs than in the shrinking in the absence of an endoleak.[2–4] However, clinical reports have also shown the possibility of AAA expansion, with varying degrees of pressurisation, due to the accumulation of translucent/whitish intra-sac fluid, that is, hygroma formation.[5,6] All AAA expansions in the absence of an endoleak are included in the currently accepted definition of endotension.[1] However, although the denomination of endotension implies an increased tension within the aneurysm sac, the definition does not mention the degree of AAA sac pressurisation. Furthermore, preliminary results have shown that intra-sac pressure may also be increased while the AAA continues unchanged in diameter. A subsequent aneurysm expansion may or may not occur.[3]

The significance of AAAs unchanged in diameter without endoleak following EVAR is, therefore, more uncertain. Unchanged AAA diameter has, nevertheless, been accepted as a treatment success since there is no proof of a failure.[1]

The aim of this study was to evaluate intra-aneurysm sac pressure in patients with unchanged AAA diameter for at least 1 year after EVAR.

Methods

Patients

Twenty-three patients (21 men, two women; 72 years (IQR: 69–77 years)) with unchanged AAA diameters after EVAR underwent direct intra-aneurysm sac pressure (DISP) measurement at 16 months (IQR: 14–35 months) post-operatively. Patient and AAA characteristics as well as stent grafts used are described in Table 1.

Patient selection for the study was based on the absence of an identifiable endoleak in an AAA with unchanged diameter at least 1 year after EVAR. Furthermore, patients had to be anatomically suitable for direct translumbar AAA puncture. Nine of these patients have been included in a previous report.[3] Drainage of fluid upon puncturing of the AAA sac was used as a criterion for patient group analysis (Table 2). The study received the approval of the regional ethical committee, and all patients gave informed consent for the procedure.

Study setting

All procedures were carried out in a tertiary university centre between November 2000 and October 2006, where EVAR has been performed since 1993 in more than 1000 patients due to abdominal, thoracic and thoraco-abdominal aneurysms. During the study period, 413 patients underwent EVAR of AAA. Anatomical suitability for the translumbar puncture of the AAA was 90%.[7] Furthermore, 75% of the patients were not candidates for this study since they exhibited AAA shrinkage 1 year after EVAR.[8]

Imaging

Computed tomography (CT) scans were done preoperatively and at least yearly after EVAR. Additional CT scans were performed whenever indicated. Preoperative CT was biphasic with scanning before and after intravenous non-ionic iodinated contrast enhancement. The postoperative CT scans were triphasic with an additional delayed scan. All CT scans were reconstructed with 0.75–3 mm axial slices. All patients underwent an extra CT a month before DISP. A digital subtraction angiography was performed at the time of DISP. The presence of an endoleak was an absolute exclusion criterion and was assessed by follow-up and pre-DISP CT scan and digital subtraction angiography at the time of DISP.

AAA diameters were measured by the same observer on axial CT reconstructions using the shortest transverse diameter at the widest portion of the aneurysm.[1] Diameter changes were calculated to express the diameter evolution over time until any re-intervention was performed.[3] Diameter changes were calculated by subtracting the first diameter to the latest. Diameter changes were considered significant when equalling or exceeding 5 mm, with AAAs being grouped into shrinking (≤ -5 mm), unchanged

Table 1 Characteristics of patients.

Group	No. of patients	Median (IQR)
Male/Female	21/2	
AAA diameter (mm)		60 (53–69)
AAA diameter change until DISP (mm)		0 (−3 to 1)
Timing DISP (months)		16 (14–35)
Stent grafts		
Zenith[a]	21[d]	
Vanguard[b]	1	
Home-made[c]	1	

[a] Cook Europe A/S, Bjaeverskov, Denmark.
[b] Boston Scientific, Nattick, MA.
[c] Based on full thickness Dacron graft (Vascutek Ltd., Inchinnan, Scotland) sutured to Gianturco Z- stainless steel stents (Cook Europe A/S, Bjaeverskov, Denmark) along all the stent-graft.
[d] Including 3 fenestrated Stent grafts and 1 Iliac-branched.