Eur J Vasc Endovasc Surg (2009) **37**, 425–430

Is There a Benefit of Frequent CT Follow-up After EVAR?

N.V. Dias*, L. Riva, K. Ivancev, T. Resch, B. Sonesson, M. Malina

Vascular Center Malmö-Lund, Malmö University Hospital, Entrance 59 – 7th floor, 205 02 Malmö, Sweden

Submitted 27 August 2008; accepted 25 December 2008
Available online 23 February 2009

KEYWORDS
Abdominal aortic aneurysm (AAA);
Endovascular aneurysm repair (EVAR);
Computed tomography (CT);
Follow-up

Abstract *Objective:* Imaging follow-up (FU) after endovascular aneurysm repair (EVAR) is usually performed by periodic contrast-enhanced computed tomography (CT) scans. This study aims to evaluate the effectiveness of CT-FU after EVAR.
Methods: In this study, 279 of 304 consecutive patients (261 male, aged 74 years (interquartile range (IQR): 70–79 years) with a median abdominal aortic aneurysm (AAA) diameter of 58 mm (IQR: 53–67 mm)) underwent at least one of the yearly CT scans and plain abdominal films after EVAR. All patients received Zenith stent-grafts for non-ruptured AAAs at a single institution. Patients were considered asymptomatic when a re-intervention was done solely due to an imaging FU finding. The data were prospectively entered in a computer database and retrospectively analysed.
Results: As a follow-up, 1167 CT scans were performed at a median of 54 months (IQR: 34–74 months) after EVAR. Twenty-seven patients exhibited postoperative AAA expansion (a 5-year expansion-free rate of 88 ± 2%), and 57 patients underwent 78 postoperative re-interventions with a 5-year secondary success rate of 91 ± 2%. Of the 279 patients, 26 (9.3%) undergoing imaging FU benefitted from the yearly CT scans, since they had re-interventions based on asymptomatic imaging findings: AAA diameter expansion with or without endoleaks ($n = 18$), kink in the stent-graft limbs ($n = 4$), endoleak type III due to stent-graft limb separation without simultaneous AAA expansion ($n = 2$), isolated common iliac artery expansion ($n = 1$) and superior mesenteric artery malperfusion due to partial coverage by the stent-graft fabric ($n = 1$).
Conclusions: Less than 10% of the patients benefit from the yearly CT-FU after EVAR. Only one re-intervention due to partial coverage of a branch by the stent-graft would have been delayed if routine FU had been based on simple diameter measurements and plain abdominal radiograph. This suggests that less-frequent CT is sufficient in the majority of patients, which may simplify the FU protocol, reduce radiation exposure and the total costs of EVAR. Contrast-enhanced CT scans continue, nevertheless, to be critical when re-interventions are planned.

* Corresponding author. Tel.: +46 40 331000; fax: +46 40 338097.
E-mail address: nuno.dias@med.lu.se (N.V. Dias).

1078-5884/$34
doi:10.1016/j.ejvs.2008.12.019

Endovascular aneurysm repair (EVAR) has been subject to intensive follow-up programs since its introduction. In contrast to open repair, EVAR relies on the remote insertion of a stent-graft without disrupting the physical integrity of the aneurysm wall. This has allowed the use of the aneurysm diameter as one of the main surrogate indicators of successful EVAR. Preventing expansion of the aneurysm sac is, therefore, defined as one of the principal aims of EVAR.[1]

Imaging follow-up after EVAR evaluates usually not only the aneurysm size, but also the endoleak status, stent integrity and migration of the stent-graft. Imaging protocols, particularly when stainless-steel-based stent-grafts are used, involve periodic contrast-enhanced spiral computed tomography (CT) scans and plain abdominal films. This intensive imaging follow-up provides a great amount of information, but the relevance of the information acquired has not been evaluated in relation to improving results obtained with successive generations of stent-grafts.[2,3] An increasing number of periodic examinations may therefore be required before an adverse event needing re-intervention is identified. However, repeated contrast-enhanced CT scans involve risks to the renal function[4] and have a carcinogenic potential.[5] Moreover, imaging follow-up has been shown to be a contributor to the high costs associated with EVAR.[6,7] The optimisation of the follow-up protocol after EVAR is therefore essential, especially considering that any benefit will be amplified by the increasing use of this technique in the treatment of abdominal aortic aneurysms (AAAs)[8,9] in recent years.

This study aims to evaluate the outcome of CT follow-up in patients who underwent EVAR of AAA with a recent generation of stent-grafts.

Methods

Patients and procedures

This study included 304 consecutive patients who were treated for non-ruptured AAA with the standard Zenith stent-graft (Cook Europe A/S, Bjaeverskov, Denmark) between May 1998 and February 2006.

The patients receiving fenestrated and/or branched stent-grafts and those undergoing EVAR of ruptured AAAs, pseudo-aneurysms and aortic ulcers were excluded. Anatomical suitability for EVAR included proximal neck diameter ≤ 30 mm, angulation $\leq 90^{\circ}$ and length ≥ 12 mm. For distal implantation, at least one common iliac artery with a distal diameter ≤ 20 mm was required. Table I describes the patient characteristics and stent-grafts used.

Table I Patients' characteristics and stent-graft configuration

	Median (IQR)	n (%)
Age	74 (70—79)	
Gender (Male/Female)		261 (86 %)/ 43 (14 %)
AAA diameter (mm)	58 (53—67)	
AAA-related symptoms		
Asymptomati		54 (18 %)
Symptomatic		250 (82 %)
Stent-graft configuration		
Bifurcated		278 (91 %)
Aorto-uniiliac		24 (8 %)
Aorto-aortic		2 (1 %)

All stent-grafts used were Zenith (Cook Europe A/S, Bjaeverskov, Danmark).

Follow-up after EVAR

Postoperative follow-up included clinical assessment at 1 and 12 month(s) after EVAR. The imaging follow-up consisted of periodic contrast-enhanced CT scans and plain abdominal films. The periodicity of the examinations changed during the study period, but all protocols included at least yearly imaging. The CT scans were obtained at 1, 3 and 6 month(s) postoperatively and every half year thereafter until the year 2000. Subsequently, the CT scans were performed at 1 month and yearly thereafter. Since 2002, the need for a 1-month CT scan was left to the discretion of the operator.

The AAA diameters were measured in axial CT scans perpendicular to the maximum diameter in order to avoid errors caused by vessel tortuosity. The AAA shrinkage or expansion was defined when the diameter decreased or increased by 5 mm or more, respectively.[1]

Considering the changes in our follow-up protocol, yearly CT scans were assumed for the analysis of the outcome. The end-points for the follow-up included the following: freedom from AAA expansion and rupture or AAA-related death and the performance of re-interventions on an elective basis before the development of symptoms. Benefit from CT follow-up was assumed whenever adverse events were identified at an earlier stage than if routine imaging follow-up had not been performed. Asymptomatic patients undergoing re-interventions prompted by a CT finding without AAA expansion would not have been offered a re-intervention based solely on clinical symptoms and simple diameter measurements. Primary clinical success was defined according to the reporting standards.[1] The definition of secondary success was simplified by assuming all re-interventions that allowed the maintenance of clinical success, independently of the technique used (endovascular or open).

Study setting, data collection and presentation

The study was conducted at a university tertiary referral centre. Data from all patients undergoing EVAR of AAA were prospectively entered into a database. Patients fulfilling the inclusion criteria were retrospectively selected for the study. The study was approved by the local ethical committee and the patients gave their informed consent before the procedures.

The values for continuous variables are shown as median (interquartile range (IQR)). Survival was calculated using life-tables and is presented as mean $\pm$ standard deviation. Survival plots were based on Kaplan—Meyer curves. Non-parametric tests were used for comparisons, with a significance level of $p < 0.05$. The SPSS 16.0.1 software (SPSS Inc., Chicago, IL, USA) was used.