

## Mid-term Survival and Costs of Treatment of Patients with Descending Thoracic Aortic Aneurysms; Endovascular vs. Open Repair: a Case-control Study

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**Objectives.** To evaluate the results of open surgery or endovascular stent graft repair of descending thoracic aortic aneurysm (TAA).

**Design, materials and methods.** This is a retrospective multicenter study of 95 patients undergoing TAA repair (42 stent grafts, 53 open repair). The median age was 67 years. Post-operative complications, mid-term survival and costs were assessed. The results were pooled with data in the literature.

**Results.** After a mean follow up of 26 months (open group) and 15 months (endovascular group) survival was similar for patients treated by either repair method. Post-operative pneumonia was more in the open group ( $p < 0.02$ ). The hospital costs of open treatment were 40% more than that of the endovascular procedure. Combining the present results with pooled data from the literature the peri-operative mortality and paraplegia rate was less in the endovascular group ( $p < 0.05$ ).

**Conclusions.** These retrospective data suggest that endografting of descending thoracic aneurysms can be performed with less peri-operative morbidity, at lower hospital costs, but with equal mid-term life expectancy, compared with open grafting.

**Keywords:** Thoracic; Descending; Aneurysm; Endovascular; Grafting; Mortality; Survival; Paraplegia; Costs.

### Introduction

Open 'conventional' surgical repair of descending thoracic aortic aneurysms is still considered to be the standard reference treatment. However, this operation is associated with significant peri-operative morbidity and mortality. In large series mortality rates of 5.5–8.8% and paraplegia rates of 2.7–14.3% have been reported.<sup>1–6</sup>

Endovascular thoracic stent graft repair offers the theoretical advantage of a minimal invasive operation combined with a short aortic occlusion time. In 1997 the first large series of 44 patients were reported in which aneurysms were repaired using home made stent grafts. Outcome was favourable with a mortality rate of 6.8% and a paraplegia rate of 4.3%.<sup>7</sup> To date there are no randomised trials available comparing open and endovascular repair of descending thoracic aneurysms.

The present study was performed to evaluate the survival and treatment costs of all patients treated for a descending thoracic aortic aneurysm by either open surgery (OPEN) or endovascular stent graft repair (ENDO) in three vascular centres in Amsterdam.

### Materials and Methods

Medical records of all consecutive patients operated between January 1997 and April 2003 for a descending thoracic aneurysm in three hospitals. (Academic Medical Center (AMC), Vrije Universiteit Medical Center (VUMC) and Onze Lieve Vrouwe Gasthuis (OLVG)) were reviewed. All consecutive patients with elective presentations with a chronic fusiform or saccular aneurysm of the descending aorta were included. Patients with trauma, aortoenteric fistulas, type B dissection or an acute ruptured aneurysm were excluded.

In 1997 all patients were treated by open repair. Endovascular treatment was introduced in January 1999 and from the year 2001 on this technique has been first choice treatment in the three vascular centres.

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### Operative technique

#### *Transthoracic aneurysm repair*

Open surgery was performed by a left lateral thoracotomy and graft replacement of the descending aorta. Atriofemoral shunting was used by surgeon preference and availability. CSF drainage was used routinely.<sup>8</sup>

#### *Endovascular repair*

Vascular access for the endovascular treatment was obtained through surgical exposure of the common femoral artery or common iliac artery in case of an external iliac artery diameter of less than 8 mm. A five French pigtail catheter was positioned in the ascending aorta, to be changed by a 0.035 in. diameter back-up Meier guide wire (Boston Scientific-Schneider, Bülach, Switzerland). In selected patients an additional angiography catheter was inserted in the ascending aorta through the right brachial artery. Angiography was performed before and after stent graft deployment. If necessary, balloon dilatation of the proximal and distal anchoring zones further expanded the stent grafts. Three types of stent graft have been used: the AneuRx™ thoracic stent graft (Medtronic AVE, CA, USA) in 1 patient, the Gore™ thoracic aortic graft in (WL Gore and Associates, AZ, USA) in 17 patients and the talent™ thoracic endoprosthesis (Medtronic AVE, CA, USA) in 24 patients.

These two groups were compared in a case-control study with regard to post-operative complications and mid-term survival. Post-operatively patients were followed by 6 (endovascular group) or 12 monthly (open group) CT-scans. Survival was assessed by review of patients' notes since when a patient died during follow up a note, extracted from the registrar's office, is made in the file. Pooled data for post-operative paraplegia and mortality from the literature were then compared to our results.

The mean costs of the diagnostic process, the operative procedure, the costs of implants and adjunctive procedures were calculated for each patient from the mean outcome values of the study-cohort.

Statistical analysis was performed using univariate analysis ( $\chi^2$ -test and Fisher's exact test when necessary) for pre- and post-operative variables. Multivariate Cox regression analysis was used to identify the independent predictors of survival. Several possible factors were analysed which might influence the survival in a step-wise model. Factors that were associated with a change of more than 10% in the regression coefficient were left in the model for identification of independent predictive factors of survival. Odds ratios (OR) and 95% confidence

intervals were calculated in univariate analysis for pre- and post-operative parameters. The hazard ratio (HR) was calculated for predictive factors of survival in the multivariate model. A *p*-value of less than 0.05 was considered statistically significant. Analysis was done in SPSS version 11.0.

### Results

Between January 1997 and April 2003, 95 consecutive (59 males, 36 females) patients with a mean age of 67 years (range 39–81 years; no statistically significant differences between the open and endovascular group) were operated on for a descending thoracic aneurysm. Sixteen patients were operated non-electively (recent onset of pain or contained rupture): 9 in the open group and 7 in the endovascular group. The mean diameter of the aneurysm was 65 mm (range 45–90 mm) in the open group and 61 mm (range 40–80 mm) in the endovascular group. All aneurysms commenced at least 1 cm distal to the subclavian artery and there was at least 3 cm of non-dilated aorta proximal to the celiac trunk.

Patient characteristics and pre-operative risk factors are listed in Table 1. Fifty-three patients underwent open surgical repair (AMC *n*=20, VUMC *n*=21, OLVG *n*=12), 42 patients were treated with stent grafts (AMC *n*=18, VUMC *n*=9, OLVG *n*=15). A mean of 2.1 endografts (range 1–4) per patient were implanted. The pre-operative risk factors were not statistically different between groups.

The mean anaesthesia time (300 vs. 160 min; *p*<0.0001), in hospital time (30 vs. 10 days; *p*<0.0001) and mean length of stay on the intensive care (11 vs. 14 days; *p*<0.0001) was statistically significant different, in favour of the endovascular group. Blood loss was also less in the endovascular group, but too many missing values prohibited calculation of significance. There was no difference in post-operative morbidity between the two groups, except that pneumonia appeared significantly more in the open group (29 vs. 9%, odds ratio 0.3, 95% confidence interval 0.08–0.8; *p*<0.02) (Table 2).

Reoperations during the same admission were performed in 13 patients in the open group. The reasons for reinterventions were: post-operative bleeding (*n*=11), duodenal perforation (*n*=1) and persistent thoracic duct leakage (*n*=1). There were 5 early reinterventions in the endovascular group due to post-operative bleeding at access site in one patient, type I endoleak in 2 patients requiring additional stent graft implantation and paraplegia in 1 patient in whom an emergency open procedure was performed.<sup>9</sup>

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