Elective endovascular stent-grafting of abdominal aortic aneurysms

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CHAPTER 8

Glasgow Aneurysm Score predicts survival after endovascular stenting of abdominal aortic aneurysm in patients from the EUROSTAR registry

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Abstract

**Background:** The aim of the present study was to evaluate the efficacy of the Glasgow Aneurysm Score (GAS) in predicting the survival of 5498 patients who underwent endovascular repair (EVAR) of an abdominal aortic aneurysm (AAA) and were enrolled in the EUROpean collaborators on Stent-graft Techniques for abdominal aortic Aneurysm Repair (EUROSTAR) Registry between October 1996 and March 2005.

**Methods:** The GAS was calculated in patients who underwent EVAR and was correlated to outcome measurements.

**Results:** The median GAS was 78.8 (interquartile range 71.9-86.4, mean 79.2). Tertile 30-day mortality rates were 1.1 per cent for patients with a GAS less than 74.4, 2.1 per cent for those with a score between 74.4 and 83.6, and 5.3 per cent for patients with a score over 83.6 (p<0.001). Multivariate analysis showed that GAS was an independent predictor of postoperative death (p<0.001). The receiver-operator characteristic curve showed that the GAS had an area under the curve of 0.70 (95 per cent confidence interval 0.66 to 0.74; s.e. 0.02; p<0.001) for predicting immediate postoperative death. At its best cut-off value of 86.6, it had a sensitivity of 56.1 per cent, specificity 76.2 per cent and accuracy 75.6 per cent. Multivariable analysis showed that overall survival was significantly different among the tertiles of the GAS (p<0.001).

**Conclusion:** The GAS was effective in predicting outcome after EVAR. Because its efficacy has also been shown in patients undergoing open repair of AAA, it can be used to aid decisions about treatment in all patients with an AAA.
Introduction

Elective endovascular repair (EVAR) of abdominal aortic aneurysms (AAAs) has been practised for more than a decade. A lower 30-day mortality rate after EVAR compared with elective open aortic repair has been reported in randomized clinical trials (1.2-1.7 versus 4.6-4.7 per cent). Although the immediate postoperative mortality rates after EVAR are low, they are not negligible and have been reported to be somewhat higher in other series. In a recent EVAR trial that included patients unfit for open AAA repair, the 30-day mortality rate was 9 per cent. This makes the identification of patients at high risk of immediate postoperative death of major importance, as it allows better preoperative patient selection. The Glasgow Aneurysm Score (GAS) has been shown to be a good predictor of immediate postoperative death after elective open repair of AAA. The aim of the present study was to evaluate the efficacy of the GAS in predicting the outcome of patients who underwent EVAR for an asymptomatic, unruptured infrarenal AAA.

Patients and methods

This study was conducted in cooperation with the Division of Cardiothoracic and Vascular surgery of Oulu University Hospital, Oulu, Finland, and the EUROPean collaborators on Stent-graft Techniques for abdominal aortic Aneurysm Repair (EUROSTAR) Registry. Patients with a non-ruptured, asymptomatic infrarenal AAA who underwent elective EVAR and gave written consent were enrolled prospectively into a database (www.eurostar-online.org) that provided online data entry to participating physicians (KIKA Medical, Nancy, France). All patients received commercially available self-expanding stent-grafts (Table 1). Technical details of stent deployment have been described previously. A total of 5498 patients from 160 centres who underwent EVAR between October 1996 and March 2005 were included in the present analysis. Patients with a maximum aneurysm diameter of less than 40 mm and those treated with a withdrawn endograft were excluded from the study. All the patients had a minimum follow-up of 1 month unless death, aneurysm rupture or conversion to open repair occurred before the first outpatient visit. Follow-up visits were scheduled at 1, 3, 6, 12, 18 and 24 months after surgery, and annually thereafter. Reporting was in accordance with the guidelines of the ad hoc Committee for Standardized Reporting Practices in Vascular Surgery of the Society for Vascular Surgery/American Association for Vascular Surgery.
The GAS was calculated from data entered prospectively online according to the following formula: risk score = (age in years) + (7 points for myocardial disease) + (10 points for cerebrovascular disease) + (14 points for renal disease). Myocardial disease refers to previously documented myocardial infarction and/or ongoing angina pectoris. Cerebrovascular disease refers to all grades of stroke and includes transient ischaemic attack. Renal disease refers to a history of acute or chronic renal failure and/or a creatinine level above 133 µmol/L and/or creatinine clearance below 50 mL/min, that is a Society for Vascular Surgery/International Society of Cardiovascular Surgery risk score of 1 or more.

Table 1. Types of stent-graft used for Endovascular Aneurysm Repair.

<table>
<thead>
<tr>
<th>Type of Stent-graft</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zenith (William Cook) a</td>
<td>1926</td>
<td>34.8</td>
</tr>
<tr>
<td>Talent (Medtronic/AVE) b</td>
<td>1557</td>
<td>28.3</td>
</tr>
<tr>
<td>AneuRx (Medtronic/AVE) b</td>
<td>907</td>
<td>16.5</td>
</tr>
<tr>
<td>Excluder (W.L. Gore) c</td>
<td>737</td>
<td>13.4</td>
</tr>
<tr>
<td>Lifepath (Edwards Lifesciences) d</td>
<td>119</td>
<td>2.2</td>
</tr>
<tr>
<td>Powerlink (Endologix) e</td>
<td>92</td>
<td>1.7</td>
</tr>
<tr>
<td>Fortron (Cordis/Johnson &amp; Johnson) f</td>
<td>77</td>
<td>1.4</td>
</tr>
<tr>
<td>EVT (Guidant) g</td>
<td>69</td>
<td>1.3</td>
</tr>
<tr>
<td>Anaconda (Sulzer Vascutek) h</td>
<td>24</td>
<td>0.4</td>
</tr>
</tbody>
</table>

a William Cook, Bloomington, Indiana; b Medtronic/AVE, Santa Rosa, Calif; c W. L. Gore, Flagstaff, Ariz; d Edwards Lifesciences, Irvine, Calif; e Endologix, Irvine, Calif; f Cordis/Johnson & Johnson, Fort Lauderdale, Fla; g Guidant, Menlo Park, Calif; h Sulzer Vascutek, Inchinnan, UK.

Statistical analysis

Statistical analysis was performed using SPSS® version 12.0.1 (SPSS, Chicago, Illinois) and SAS® version 8.00 (SAS Institute, Cary, North Carolina) statistical software. Continuous data were reported as median (interquartile range, i.q.r.). The Chi² test was used for univariate analysis of categorical data. The Mann-Whitney U test was used for univariate analysis of the distribution of the GAS in subgroups. Receiver-operator characteristic (ROC) curves were used to evaluate the performance of the GAS and to identify its best cut-off value in predicting immediate postoperative death. Multivariate logistic regression with backward selection was used to
determine independent associations of risk factors with 30-day mortality rate. Kaplan-Meier analysis with the log rank test and multivariate Cox proportional hazards regression analysis with backward selection were used to estimate the influence of different variables on long-term outcome. p<0.050 was considered statistically significant.

Results

In total, 5498 patients (94.1 per cent men) with a median age of 72.7 (i.q.r. 67.3 - 77.7) years and a median aortic diameter of 56 (i.q.r. 51 - 63) mm underwent elective EVAR. Co-existing myocardial disease was present in 59.5 per cent of patients, 5.7 per cent had cerebrovascular disease and 18.2 per cent had renal disease. The median GAS was 78.8 (i.q.r. 71.9-86.4, mean 79.2).

Thirty-day postoperative mortality

One hundred and fifty-five patients (2.8 per cent) died within 30 days of the initial procedure. Univariate analysis showed that preoperative aneurysm diameter (p<0.001) and GAS (p<0.001) were associated with an increased risk of death within 30 days. Tertile 30-day mortality rates were 1.1 per cent for patients with a GAS less than 74.4, 2.1 per cent for those with a score between 74.4 and 83.6, and 5.3 per cent for patients with a score over 83.6 (p<0.001). Multivariate analysis showed that GAS independently predicted postoperative death (p<0.001).

Analysis of the ROC curve showed that the GAS had an area under the curve of 0.70 (95 per cent confidence interval (c.i.) 0.66 to 0.74; s.e. 0.02; p<0.001) for predicting postoperative death. According to this curve, the best cut-off value was 86.6, which yielded a sensitivity of 56.1 per cent, specificity 75.6 per cent, accuracy 75.6 per cent, positive predictive value 6.4 per cent and negative predictive value 98.4 per cent. The 30-day mortality rate was 1.6 per cent in patients with a score below the cut-off value and 6.4 per cent among those with a higher score (p<0.001).

Long-term outcome

The median follow-up was 18 (i.q.r. 6-24) months. The overall 1-, 2- and 5-year survival rates were 91.7, 87.1 and 76.7 per cent respectively. Multivariate analysis showed that overall survival differed significantly among the tertiles of the GAS (p<0.001) (Fig. 1).
The overall 1-, 2- and 5-year rupture rates were 0.2, 0.6 and 1.7 per cent respectively. Five, thirteen and nine aneurysm ruptures were observed in the lowest, middle and highest tertiles of the GAS respectively. The cumulative rates of aneurysm rupture were not significantly different between the tertiles (p=0.225).

Figure 1. Overall survival according to Glasgow Aneurysm Score (GAS) tertiles. \( p<0.001 \), lower versus middle tertile; \( p=0.008 \), middle versus upper tertile; \( p<0.001 \), lower versus upper tertile (log rank test).
Discussion

The present results suggest that the GAS is a valuable risk scoring method in predicting immediate postoperative death after EVAR. Even though the area under the ROC curve was not optimal, its value in identifying high-risk patients is satisfactory. Three of the four variables included in the GAS were significantly associated with 30-day postoperative mortality. This study suggested that the median GAS was higher (78.8 versus 73), and its best cut-off value much higher (86.6 versus 76) than in a previously reported large nationwide study on patients undergoing open aneurysm repair in Finland. This observation confirmed that EVAR was associated with low immediate postoperative mortality rates despite a higher notional operative risk.

Although aneurysm diameter is an important determinant of survival, its efficacy in predicting immediate postoperative death was inferior to that of the GAS, with an area under the ROC curve of 0.65 (95 per cent c.i. 0.60 to 0.70).

The GAS appeared to be a good predictor of long-term overall survival. Patients with a score of more than 83.6 had a 30-day postoperative risk of death of 5.3 per cent and a 5-year overall survival rate of 65.2 per cent.

Besides its efficacy, the GAS has the merit of simplicity as it can easily be calculated at bedside, providing a quick estimation of the operative risk. It could aid decisions in low-risk patients who can safely be treated by open aneurysm repair with an expected low risk of late graft-related complications. On the contrary, as in the present study, high-risk patients can be treated by EVAR with an acceptable risk of immediate postoperative death and fairly good long-term outcome.

Acknowledgements

A list of collaborating EUROSTAR centres has been published elsewhere.
References

