Prior Cardiac and Thoracic Aortic Surgery as a Complication Risk Factor for Abdominal Aortic Aneurysm Repair

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Background: Patients with both cardiothoracic lesions and abdominal aortic aneurysm (AAA) are increasing in Japan. The objective of this study was to clarify the effect of 2-staged surgery on complication rates.

Methods and Results: Three hundred and forty-six patients who underwent elective surgery for infrarenal AAA were entered. History of cardiac and thoracic aortic surgery within 1 year before AAA repair was recorded. A retrospective study regarding perioperative complications was performed. Operative mortality and complication rates were 0.6% and 10.7%, respectively. Seventy patients (20.2%) underwent prior cardiac and thoracic aortic surgery before AAA repair. There was no significant difference in preoperative characteristics between the group with prior cardiac and thoracic aortic surgery and the group without prior surgery. Significant risk factors for postoperative morbidity were: (1) prior cardiac and thoracic aortic surgery (odds ratio [OR] 2.5; 95%CI 1.1–5.1); (2) open aneurysm repair (OAR) (OR 2.7; 95%CI 1.3–5.1); and (3) VSG-CRI score ≥6 (OR 2.9; 95%CI 1.2–6.8). Subanalysis revealed that, although prior cardiac and thoracic aortic surgery was still a risk within patients undergoing open aneurysm repair (EVAR), it was not a risk factor for patients undergoing endovascular aneurysm repair (EVAR).

Conclusions: Prior cardiac and thoracic aortic surgery carries high risk for AAA repair. To lower complication rates, we propose to perform EVAR on these patients if they are anatomically suitable. (Circ J 2012; 76: 1380–1384)

Key Words: Abdominal aortic aneurysm; Cardiac surgery; Endovascular aneurysm repair; Thoracic aortic; Risk factor
>4.5 cm in diameter. As a basic rule, EVAR has been offered only since July 2007 at our hospital to patients with suitable anatomical characteristics who were either >75 years of age or who had a history of more than 2 major abdominal laparotomies that could lead to severe intestinal adhesions.

In addition to the pre-and intra-operative general characteristics, a history of open cardiac and thoracic aortic surgery within 1 year before AAA repair was recorded. The Vascular Study Group of New England Cardiac Risk Index (VSG-RCI) score was also calculated before AAA repair for each patient as a tool for pre-operative risk evaluation. Complications of the patients were retrospectively reviewed. The primary endpoint of this study was operative complication rates, termed as a composite of operative mortality and post-procedural moderate or severe complications within 30 days. Complications were classified and graded according to the standards of the Ad Hoc Committee for Standardized Reporting Practices in Vascular Surgery of the Society for Vascular Surgery/International Society for Cardiovascular Surgery. Complications that were graded as mild according to these standards were not considered in this analysis.

Risk factors were multivariately analyzed by logistic regression analysis. A P value of <0.05 was considered significant. All data were analyzed using JMP 5.0 software (SAS Institute Inc).

**Results**

We examined data from 346 patients with AAA who underwent elective aneurysm repair and who were followed up for a mean of 751 (7–2,521) days. Among them, 105 (30.3%) underwent EVAR. Operative mortality and complication rates within 30 days were 0.6% (n=2) and 10.7% (n=37). Survival rates at 1, 3 and 5 years were 97.8%, 93.3% and 93.3%, respectively. Seventy (20.2%) patients had cardiac and thoracic aortic surgery at a mean of 855±70 days (median, 61 days; range 13–325 days), before AAA repair. Characteristics of the patients categorized by having a history of prior cardiac and thoracic aortic surgery within 1 year of AAA repair or not, were compared, as in Table 1. This revealed that there was no significant difference between the 2 groups regarding preoperative characteristics, including the VSG-CRI score, which was calculated just before the AAA repair. In contrast, intraoperative blood transfusion and postoperative was worse in the prior surgery group. Table 2 shows the cardiac and thoracic aortic surgery performed.

Perioperative complications are shown in Table 3. Univariate analysis of the risk factors is shown in Table 4. Prior cardiac and thoracic aortic surgery, VSG-CRI score ≥6 and open AAA repair were the significant factors. The multivariate logistic regression analysis (Table 5) revealed that significant risk factors for postoperative morbidity comprised cardiac and thoracic aortic surgery within 1 year before abdominal aneurysmal repair (odds ratio [OR] 2.5; 95% CI 1.1–5.1), OAR (OR 2.7; 95% CI 1.3–5.1) and VSG-CRI score ≥6 (OR 2.9; 95% CI 1.2–6.8). On the contrary, prior cardiac and thoracic aortic surgery did not have any significant effect on long-term survival (data not shown).

We then performed a subanalysis regarding risk of prior cardiac and thoracic aortic surgery in patients of certain groups. Because open surgery was another risk factor for complication, we performed the first analysis for the open and EVAR group. The characteristics of each group are shown in Table 6. Apart from age, there were no differences in preoperative factors. Within each group, a multivariate analysis for operative complications was performed, for the factors that were sig-
Tables 7 and 8 revealed that although prior cardiac and thoracic aortic surgery were still a risk within patients undergoing OAR, it was not a risk factor for patients undergoing EVAR.

Our second subanalysis was performed for the patients who had undergone prior cardiovascular surgery and those who had not. Although not significant due to the low number of patients in each group, EVAR tended to be associated with a low complication rate compared with OAR, among patients who had undergone cardiac and thoracic aortic surgery within 1 year before AAA repair (23.1% vs. 5.6% P=0.07). In addition, the interval time between the 2 surgeries did not have any significant in the overall analysis.
effect on the results of AAA repair. In contrast, for patients who did not undergo prior cardiac and thoracic aortic surgery, EVAR and OAR were comparable (10.0% vs. 5.8%, P=0.22).

### Discussion

The results of recent studies comparing EVAR and OAR\(^1\)\(^-\)\(^4\) indicate that, provided that the AAA was fit for both EVAR and OAR, patients at high risk for surgery are candidates for EVAR, and those who seem likely to overcome perioperative complications are candidates for OAR.

This inevitably leads to the question of how to define patients at high risk. Several scoring systems have been proposed to address this issue,\(^5\)\(^-\)\(^8\) but they seem rather ineffective in distinguishing between candidates suitable for EVAR and OAR.\(^9\)\(^-\)\(^10\) These modalities seem to consider coronary artery disease as a risk factor, but intervention carries little weight.

The estimated incidences of simultaneous coronary artery disease or thoracic aortic disease in patients with AAA are 30–71%\(^18\)\(^-\)\(^21\) and 10–20%,\(^12\)\(^-\)\(^15\)\(^22\) respectively. We postulated that undergoing coronary artery bypass itself is an independent risk factor, which is quite invasive because it might lead to complications such as cerebral infarction. We also included open surgery of the thoracic aorta into consideration based on the same rationale. In addition, a thoracotomy might lead to worsening of pulmonary function that might end in pneumonia. Therefore, these concomitant states are quite frequently encountered, and their risks associated with AAA repair should be calculated.

Our study is the only study so far to investigate the effect of prior cardiac and thoracic aortic surgery, which might be quite frequent, as stated above. The present study found that cardiac and thoracic aortic surgery within 1 year before elective AAA repair proved to be a risk factor that was comparable with that of the established predictors of postoperative morbidity.

One may point out that the disease needing prior surgery (eg, coronary artery disease) is the risk factor and not the surgery itself. We think that this is not the case in our study because Table 1 shows no significant difference between the 2 groups regarding pre-operative characteristics.

Some may point out that cardiac and pulmonary function after the cardiothoracic surgery is the reason for high risks. Although this cannot be ruled out absolutely, the VSG-CRI score, in which coronary and pulmonary disease are taken into account, which was calculated just before the AAA repair, did not show any significance too. This meant that there was not so much difference regarding risk factors even after the prior cardiac and thoracic aortic surgery. We think that the overall condition after the prior surgery including cardiac, pulmonary, nutritional and mental state plays part in high risks for AAA repair.

Another point that must be made clear is that surgeries on other regions (eg, pulmonary or gastrointestinal) might also be a risk factor too. In this study, there were no patients that underwent other types of prior operations. This means that we cannot say anything about the risk of other operations, although we believe that a major operation of any kind is in fact a risk factor if performed first. However, practically, if there were a gastrointestinal or pulmonary disease in patients with AAA, a majority of the patients would undergo AAA repair first, which means that there might be a possibility of prior AAA repair becoming a risk factor for gastrointestinal surgery. This is another different study altogether.

In contrast, a history of prior cardiac and thoracic aortic surgery did not have any effect on long-term prognosis. These results indicate that treating both cardiothoracic disease and AAA can result in good life expectancy but can cause high complication rates during the second operation, which is most likely to be AAA repair, and this must be taken into consideration.

The next issue would be how to lower perioperative complication rates in patients with multi-vascular diseases. One option is to avoid surgeries if possible. These surgeries might be surgeries for an asymptomatic disease of the coronary arteries that were diagnosed just by chance and might have little effect during AAA repair.\(^23\) In contrast, we still believe that

### Table 6. Characteristics of the Patients Grouped by Open or EVAR

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Open (n=241)</th>
<th>EVAR (n=105)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>72.4±7.6</td>
<td>76.8±6.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>205/36</td>
<td>93/12</td>
<td>0.39</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>29 (12.0%)</td>
<td>12 (11.4%)</td>
<td>0.87</td>
</tr>
<tr>
<td>Diabetes</td>
<td>36 (14.9%)</td>
<td>16 (15.2%)</td>
<td>0.94</td>
</tr>
<tr>
<td>COPD</td>
<td>9 (3.7%)</td>
<td>4 (3.8%)</td>
<td>0.97</td>
</tr>
<tr>
<td>Current or ex-smoker</td>
<td>138 (57.3%)</td>
<td>49 (46.7%)</td>
<td>0.07</td>
</tr>
<tr>
<td>Creatinine</td>
<td>8 (3.3%)</td>
<td>4 (3.8%)</td>
<td>0.82</td>
</tr>
<tr>
<td>VSG-CRI score (mean ± SD)</td>
<td>4.1±1.3</td>
<td>4.3±1.4</td>
<td>0.09</td>
</tr>
<tr>
<td>Maximum aortic diameter (mm)</td>
<td>53.6±11.0</td>
<td>52.8±10.9</td>
<td>0.57</td>
</tr>
<tr>
<td>Intraoperative blood transfusion (ml)</td>
<td>0±1,540</td>
<td>0±14.7</td>
<td>0.0001</td>
</tr>
<tr>
<td>Post-operative hospital stay (days)</td>
<td>14.7±8.3</td>
<td>9.2±5.6</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

### Table 7. Logistic Regression Analysis of Operative Complication Rates Within Patients Undergoing OAR

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>OR</th>
<th>95%CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior cardiac and thoracic aortic surgery</td>
<td>2.9</td>
<td>1.2–6.4</td>
<td>0.01</td>
</tr>
<tr>
<td>VSG-CRI score ≥6</td>
<td>2.6</td>
<td>0.9–6.9</td>
<td>0.09</td>
</tr>
</tbody>
</table>

OAR, open aneurysmal repair. Other abbreviations see in Tables 1,5.

### Table 8. Logistic Regression Analysis of Operative Complication Rates Within Patients Undergoing EVAR

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>OR</th>
<th>95%CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior cardiac and thoracic aortic surgery</td>
<td>1.1</td>
<td>0.2–22.9</td>
<td>0.91</td>
</tr>
<tr>
<td>VSG-CRI score ≥6</td>
<td>4.8</td>
<td>0.8–28.3</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Abbreviations see in Tables 1,5.
symptomatic patients with coronary artery disease should undergo revascularization of the coronary arteries before AAA repair. Although McFalls et al reported that revascularization of the coronary artery is not necessary before elective major vascular surgery,2 their study was not limited to AAA repair and the endpoint was a long-term outcome, not perioperative complications.

The second option is EVAR for patients who have already undergone cardiac and thoracic aortic surgery. Our findings tend to support this notion. While prior cardiac and thoracic aortic surgery was a risk factor for perioperative complication rates in patients undergoing OAR, it failed to become a risk factor in candidates for EVAR. In addition, perioperative complication rates in patients with prior cardiac and thoracic aortic surgery for EVAR and OAR were 5.6% and 23.1%, respectively.

One limitation of this study is that we could not determine a strategy to treat AAA in patients who had undergone prior thoracic surgery and who were not anatomically suitable for EVAR. Because this was a retrospective study, all patients who underwent EVAR were anatomically suitable. A comparison of high-risk patients who are anatomically unfit for EVAR yet who underwent EVAR and OAR is needed to reach a conclusion. Until then, high-risk patients with no choice but to undergo OAR must be treated and followed up with extreme caution.

A second limitation is that, due to the retrospective nature of this study, we were unable to analyze the patients according to the intention-to-treat analysis. In other words, few patients were unable to undergo AAA repair due to complications after prior surgery (data not shown). But we think that including these patients could have worsened the results of the prior surgery group, leading to more significant results.

Conclusion
Prior cardiac and thoracic aortic surgery also carries a high risk for AAA repair in addition to known risk factors. We propose to performing EVAR on anatomically suitable patients if the patients had undergone prior cardiac and thoracic aortic surgery. In contrast, although performing EVAR on patients without prior cardiac and thoracic aortic surgery leads to less time for a hospital stay and fewer blood transfusions, it might confer little benefit regarding perioperative complications.

Disclosures
Source of Financial Support: None.

References