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IS EXTENDED ARCH REPLACEMENT FOR ACUTE TYPE A AORTIC DISSECTION AN ADDITIONAL RISK Factor FOR MORTALITY?

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Abstract

Background.
We report our experience with surgery for acute type A aortic dissection with involvement of the aortic arch.

Methods.
From January 1986 to December 2001, 277 patients underwent surgery for acute type A aortic dissection. In 70 patients (25.3%), surgery was extended into the aortic arch: hemiarch and total arch replacement in 53 (75.7%) and 17 (24.3%) patients, respectively. Deep hypothermic circulatory arrest was used in 19 patients, antegrade selective cerebral perfusion in 38, and combined deep hypothermic circulatory arrest with antegrade selective cerebral perfusion in 13.

Results.
Operative mortality was 18.6% (13/70) after extended replacement into the arch versus 21.7% (45/207) after surgery limited to the ascending aorta (p=0.62). Multivariate analysis did not reveal significant risk factors for operative mortality. Postoperatively, 5 patients (8.1%) had a new postoperative cerebral vascular accident (CVA). Multivariate analysis showed an earlier date of operation as the only independant determinant for a new postoperative CVA (p=0.0162, RR=0.80/year, 95% CI=0.67 to 0.96). None of the patients, operated on with antegrade selective cerebral perfusion, had a new cerebral deficit. Comparing the different methods of cerebral protection, multivariate risk analysis revealed antegrade selective cerebral perfusion as a significant protective factor against new postoperative CVA (p=0.0110, OR=0.12, 95% CI=0.02 to 0.61). Survival at 5 and 10 years was 66.6% and 40.0%, respectively, after replacement of the aortic arch versus 68.7% and 57.7%, respectively, after replacement of the ascending aorta (p=0.96). Freedom from aortic arch reoperation was 96.3% at 5 and 77.0% at 10 years versus 86.6% and 75.1% in both groups, respectively (p=0.21).

Conclusions.
Extended replacement into the aortic arch during surgery for acute type A dissection does not influence early and late results. The best cerebral protection seems to be obtained with antegrade selective cerebral perfusion.
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Introduction

Surgery for acute type A dissection consists of replacement of the ascending aorta if the intimal tear is located in the ascending aorta. Partial or total arch replacement is necessary if the tear is located in the proximal or distal aortic arch. In situations when only the ascending aorta is replaced, a reasonable extent of diseased distal aorta remains after the operation, requiring fairly common reoperation. Therefore, the approach to the distal aorta has become more aggressive in order to potentially decrease the risk of late reoperation. However, a more extended initial aortic arch replacement might increase operative risk compared with surgery limited to the ascending aorta. However, despite improvements in different techniques of cerebral protection, neurologic complications are still prevalent.

The aim of this retrospective study was to determine the influence of arch replacement on operative mortality, neurologic outcome, survival, and the risk of reinterventions on the aortic arch for patients treated for acute type A aortic dissection.

Material and methods

Between January 1986 and December 2001, a total of 277 consecutive patients underwent surgery for acute type A aortic dissection in our hospital. All patients underwent emergency surgery within 14 days after the onset of symptoms. Seventy of these patients (25.3%) underwent extended replacement of the aortic arch in order to excise the segment with the intimal tear. The 70 patients of this present study consisted of 49 (70%) men and 21 (30%) women, with a mean age of 61.7±12.0 years. Figure 1 shows the distribution of arch replacement and ascending aorta replacement throughout the study period. Preoperative neurologic complications consisted of transient (fully recovered at the time of operation) neurologic disorders in 5 patients and permanent neurologic disorders in 3 patients. Surgical treatment was performed with protection of the brain by deep hypothermic circulatory arrest in 19, antegrade selective cerebral perfusion in 38, and combined deep hypothermic circulatory arrest and antegrade selective cerebral perfusion in 13 patients. Follow-up data were collected from patients' files, regular clinic visits, or by telephone interview and were 100% complete. Additionally, the group of 70 arch replacement patients was compared with the group of 207 patients, operated on for acute type A dissection without arch replacement, regarding neurologic disorders and mortality, in order to assess possible
differences between those two groups.

Figure 1. Distribution of arch replacements and ascending aorta replacements per 3 years.

Operative techniques
During the 16-year period, there was a variability of operative techniques used, but the following reflects our actual general operative approach. Patients suspected of suffering an aortic dissection were transferred to the operating theater, where they were routinely prepared for cardiac surgery. After induction of general anesthesia, a transesophageal echocardiographic probe was inserted to confirm the diagnosis. All patients underwent surgery for acute type A dissection on an emergency basis and were operated on through standard median sternotomy. After systemic heparin administration, total cardiopulmonary bypass was instituted by retrograde femoral artery cannulation with venous return through the right atrium. The use of cannulation of the subclavian artery has recently been introduced in our clinic, but this technique was not used in the patients of this study.

After opening the ascending aorta, the heart was arrested by direct antegrade administration of cold crystalloid cardioplegia into both coronary ostia, keeping myocardial temperature lower than 11°C.
The ascending aorta, containing the intimal tear, was resected and replaced with a woven Dacron graft. The extent of aortic replacement was determined by the location of the intimal tear in order to excise the segment of aorta containing the intimal tear. Inspection and replacement of the aortic arch was performed with the patient under deep hypothermic circulatory arrest in 19 cases. Mean duration of circulatory arrest was 41±16 minutes at an average cooled nasopharyngeal temperature of 15.1°C ± 3.1°C with an iso-electrical electroencephalogram. In the early experience, additionally to deep hypothermic circulatory arrest, cerebral protection was obtained with bilateral antegrade selective cerebral perfusion in 13 patients. More recently, all patients (n=38) were operated on with bilateral antegrade selective cerebral perfusion as a single method of cerebral protection. Our technique has been described previously [1]. The selective cerebral artery canulas were inserted in the brachiocephalic artery and left common carotid artery under direct vision, as soon as the aortic arch lumen was opened under hypothermic circulatory arrest (25°C nasopharyngeal temperature). Cerebral perfusion pressure was maintained at right radial artery pressures of approximately 40 to 70 mm Hg with a cerebral perfusion flow rate of 10 ml/kg/min. Nasopharyngeal and blood temperatures were maintained at 25°C. The left subclavian artery was occluded during antegrade selective cerebral perfusion. After resection of the aortic arch, the distal aortic anastomosis was performed first by means of the open aortic technique. The aortic arch was partially replaced in 53 patients (75.7%) with an intimal tear located in the proximal aortic arch, and totally replaced in 17 patients (24.3%) with an intimal tear in the distal arch. For hemiarch replacement, the aortic arch with concomitant arch vessels was, shaped as a peninsula, anastomosed to the obliquely trimmed graft and, for total arch replacement, the arch vessels were reconstructed in an “en bloc” or island fashion. Once the distal anastomosis was finished, the cerebral perfusion canulas were removed and antegrade cardiopulmonary bypass was resumed through a side branch of the graft. While rewarming, the proximal ascending aorta was trimmed and the proximal anastomosis performed. Finally, the two grafts were anastomosed. Teflon felt strips between the layers of the aorta were used in 29 patients (41.4%) and gelatin-resorcinol-formaldehyde (GRF) glue was used in 20 patients (28.6%) to reinforce the distal aortic stump. In 2 patients, GRF glue and Teflon felt were both used for this purpose. Cardiopulmonary bypass time avaraged 221±58 minutes.

Concomitant procedures performed during the same operation were aortic valve resuspension in 23 patients, aortic valve replacement in 2, and composite graft
replacement in 4.

**Statistical analysis**

All statistical analyses were calculated with Statistical Analysis Software (version 8.2 for Windows, SAS Institute, Cary, NC). Univariate analysis of potential risk factors (see Appendix) was used to identify statistically significant (p < 0.05) risk factors, and was followed by logistic regression analysis (binary outcome) or Cox proportional hazard regression analysis (time related binary outcome) to determine independent risk factors. Kaplan-Meier life tables were used for survival rates, and groups were compared with the log-rank test. Continuous data are expressed as means ± SD.

**Results**

The groups of patients, operated on with hemiarch replacement or total arch replacement, were compared regarding all examined preoperative and perioperative patient related variables (Appendix). There were no statistical differences between those two groups at baseline. Regarding the outcome values for survival and new postoperative cerebral vascular accident (CVA), arch replacement was not a clinically relevant nor statistically significant risk factor (univariately and multivariately).

**Operative mortality**

Operative mortality was 18.6% (13/70) in the group that underwent aortic arch surgery, and 21.7% (45/207) for the group of patients in which surgery was limited to the ascending aorta (p=0.62). Operative mortality, compared between the groups of patients with and without replacement of the proximal or total aortic arch, was not statistically different (Table 1). During the first 30 postoperative days or within the initial hospital stay, 3 of the 70 patients died due to cardiac failure, 3 due to stroke, 5 due to sepsis, and 2 due to hemorrhage. Univariate and multivariate analysis did not show statistically significant risk factors for operative mortality.
Table 1. Operative mortality

<table>
<thead>
<tr>
<th>Replacement</th>
<th>Patients</th>
<th>No. who died</th>
<th>%</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arch</td>
<td>70</td>
<td>13</td>
<td>18.6</td>
<td>0.62</td>
</tr>
<tr>
<td>Ascending aorta</td>
<td>207</td>
<td>45</td>
<td>21.7</td>
<td></td>
</tr>
<tr>
<td>Total group</td>
<td>277</td>
<td>58</td>
<td>20.9</td>
<td></td>
</tr>
<tr>
<td>aHemiarch</td>
<td>53</td>
<td>9</td>
<td>17.0</td>
<td>0.72</td>
</tr>
<tr>
<td>aTotal arch</td>
<td>17</td>
<td>4</td>
<td>23.5</td>
<td></td>
</tr>
</tbody>
</table>

Neurologic outcome

Of the patients who underwent aortic arch replacement, 8 patients presented with a neurologic dysfunction before surgery; 3 patients had a transient ischemic attack (TIA), and 5 patients had a permanent CVA. Therefore, 65 patients were at risk for a new postoperative neurologic event. Of those patients at risk, 12 patients developed a new postoperative neurologic event: a TIA in 5 and a CVA in 7 patients. Multivariate analysis for possible risk factors for a new postoperative CVA revealed a recent date of surgery as a protective factor (p=0.0162, RR=0.80/year, 95% CI=0.67 to 0.96). The different methods of cerebral protection did not show a significant difference regarding new postoperative CVAs between the groups with or without aortic arch replacement (Table 2), although none of the patients who underwent arch replacement with antegrade selective cerebral perfusion developed a new postoperative CVA. Four of the 14 patients operated on with deep hypothermic circulatory arrest developed a new postoperative CVA (28.6%), as did 1 of the 11 patients operated on with combined deep hypothermic circulatory arrest and antegrade selective cerebral perfusion (9.1%). Multivariate risk analysis in a model to predict a new postoperative CVA, regarding the different methods of cerebral perfusion in 247 patients at risk for such a new neurologic event, showed the use of antegrade selective cerebral perfusion as a significant protective factor (p=0.0110, OR=0.12, 95% CI=0.02 to 0.61). Replacement of the aortic arch was no predictor for a new postoperative neurologic deficit (p=0.43).

Survival

Total cumulative follow-up of the 70 patients after arch replacement was 183 patient-years, with a median of 1.4 years. Mean follow-up was 2.6 years, with a
Table 2. Neurologic events

<table>
<thead>
<tr>
<th>Arch replacement</th>
<th>No arch replacement</th>
<th>Arch vs no arch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At risk</td>
<td>CVA</td>
</tr>
<tr>
<td>DHCA</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>DHCA+ASCP</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>ASCP</td>
<td>37</td>
<td>0</td>
</tr>
<tr>
<td>No</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>5</td>
</tr>
</tbody>
</table>

DHCA=deep hypothermic circulatory arrest, ASCP=antegrade selective cerebral perfusion, CVA=cerebral vascular accident.

range of 0 to 14.5 years. Eight of the 70 patients died within the follow-up period. Cause of late death was rupture of a remote postdissection aortic aneurysm in 1, heart failure in 3, and sudden death with unknown cause in 3 patients. Estimates for cumulative survival of the patients after arch replacement at 5 and 10 years postoperatively were 66.6% and 40.0%, respectively, and 68.7% and 57.7% at 5 and 10 years for patients after surgery limited to the ascending aorta, without a statistical difference between those two groups (p=0.96) (Figure 2). Also, survival between the groups operated on with hemiarch or total arch replacement appeared not to be significantly different (p=0.84).

Aortic arch reoperation

During the study period, reoperation with replacement of the aortic arch occurred in 2 patients after replacement of the proximal aortic arch at initial surgery. The initial distal reconstruction in both patients was made without the use of Teflon felt. GRF-glue was used in one of them to reinforce the distal aortic stump. There were too few patients to perform statistical analysis. In 1 patient, reoperation was performed with replacement of the ascending aorta, aortic arch and elephant trunk; in the second patient, a Bentall procedure with replacement of the aortic arch and proximal descending aorta was performed. In the first patient, the cause of reoperation was a postdissection aneurysm of the residual distal aortic arch; in the second patient, reoperation was performed because of a postdissection aneurysm of the residual proximal and distal native aorta. None of the patients who
underwent initial replacement of the total aortic arch required reoperation with replacement of the aortic arch. Freedom of reoperation with replacement of the aortic arch was 96.3% at 5 years and 77.0% at 10 years postoperatively for patients who underwent arch replacement initially, and 86.6% and 75.1%, respectively, for patients after surgery limited to the ascending aorta initially, p=0.21 (Figure 3). Other aortic reoperations performed during follow-up included two descending aorta replacements, two thoracoabdominal aorta replacements, and three abdominal aorta replacements. Cause of reoperation was a postdissection dilatation of the aorta in all cases. There were no deaths at these additional reoperations, and all patients were discharged in good condition without paraplegia.

Figure 2. Cumulative survival (p=0.96).

Influence of the intimal tear located in the distal ascending aorta
Out of the 207 patients who underwent surgery limited to the ascending aorta, 150 (72.5%) patients had a primary intimal tear detected in the proximal or mid
ascending aorta, and 17 (8.2%) between the distal ascending aorta and the aortic arch. The exact location of the intimal tear in the ascending aorta remained retrospectively unknown in 40 (19.3%) patients because this information was not specifically mentioned in the operation reports. However, because those patients had undergone surgery limited to the ascending aorta, we have considered them to have had their primary intimal tear located in the ascending aorta. We have compared the 17 patients who had an intimal tear located between the distal ascending aorta and the aortic arch with the 70 patients who underwent replacement of the aortic arch, in order to assess whether the first group, in retrospect, might have had benefit of replacement of their aortic arch as well. Operative mortality of this group of patients with an intimal tear in the distal ascending aorta was 11.8% (2/17), without a statistical difference compared with the 70 patients who underwent replacement of the aortic arch (p=0.73). Survival of those 17 patients at 5 years postoperatively was 81.9% (p=0.47) and the freedom of reoperation on the aortic arch was 84.9% at 5 years postoperatively (p=0.41).

Figure 3. Freedom of reoperation on the aortic arch (p=0.21).
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Comment

Aortic arch replacement is usually performed in patients with acute type A dissection whose intimal tear is located in the aortic arch. The benefits of an extension of the replacement into the aortic arch are the protection of the aortic arch rupture and a decrease in the risk of possible subsequent reoperations [2]. However, there remains discussion whether such an extended arch replacement for acute type A dissection increases the risk of early mortality and subsequently results in less satisfactory outcome compared with surgery limited to the ascending aorta. Previous studies reported early mortality rates after simultaneous ascending aorta and arch replacement ranging from 7.9% to 55% [3,4,5,6]. In our series of 277 consecutive patients with acute type A dissection, overall operative mortality was 20.9.6% and 18.6% for the 70 patients who underwent ascending aorta and arch replacement, respectively. This means that replacement of the aortic arch did not contribute to excessive operative mortality compared with ascending aorta replacement without aortic arch replacement, which might be explained by patient selection and probably due to the surgical learning curve. Ascending aorta replacements were performed since the earlier series, whereas replacement of the aortic arch was performed in the more recent series [7]. Operative date was not a longitudinal risk factor of mortality. This is in accordance to our previous report, where we already showed that; although the development and adoption of newer surgical techniques and strategies have aided surgeons to achieve successful results, mortality remained comparatively stable over the past years [8]. We do, of course, need to consider the retrospective, nonrandomized nature of this study and the results of different surgeons, some of them less trained in aortic surgery, using a variety of available techniques.

Because methods of cerebral protection have evolved in recent years, aortic arch replacement for acute aortic dissections has become a more accepted additional surgical treatment for these patients [3-6,9,10]. Recently, several authors have described antegrade selective cerebral perfusion as a useful method of cerebral protection during surgery on the aortic arch for acute type A dissection, achieving a longer duration of safe cerebral protection using antegrade selective cerebral perfusion than using deep hypothermic circulatory arrest [1,2,11,12]. Antegrade selective cerebral perfusion is considered to offer a better protection of the brain because the oxygenated blood flows antegrade into the brain; furthermore, because this method is less time-limited than deep hypothermic circulatory arrest, the reconstruction of the friable dissected aortic arch can be performed unhurried
In our experience, inspection of the arch for positioning of the necessary bicarotid canulas and for intimial tears can be done adequately, and the use of this technique does not restrict the operative field adversely. Transecting the ascending aorta gives a good view of the arch until the level of the left subclavian artery. In our series, none of the 37 patients who underwent aortic arch replacement with the use of antegrade selective cerebral perfusion experienced a CVA postoperatively. On the other hand, 28.6% of the patients who had their aortic arch replaced with deep hypothermic circulatory arrest had a new postoperative CVA. Subsequently, we showed that antegrade selective cerebral perfusion, compared with alternative cerebral protective procedures in surgery with arch replacement, was a protective factor for new postoperative CVA.

Late reoperations after the initial surgical treatment for acute type A dissection are relatively common due to persistence of a patent distal false lumen with subsequent aortic aneurysmal dilatation because of shear stress on the fibrotic aortic wall. There is general agreement that the distal repair of the dissected aorta should be extended sufficiently in order to exclude the segment of the aorta containing the intimal tear [15,16], although the incidence of patency and blood flow within the false lumen still reaches 50 to 70% of patients who underwent surgery for acute type A dissection [6,17]. In this study, we focused on reoperations involving the aortic arch to investigate whether initial replacement of the aortic arch reduces the incidence of reoperations on this segment of the aorta, for which reintervention with a new median sternotomy is necessary. The risks of a reoperation, through median sternotomy, on the proximal aorta fall of course to zero if the reoperation is not needed as a result of a patent total replaced aortic segment. In our series, only 2 patients required a reoperation through median sternotomy for new replacement of the aortic arch after initial replacement of the proximal aortic arch. This suggests, in accordance to the results of Kazui and associates, that extended replacement of the aortic arch helps to avoid reoperation through median resternotomy, which has been a well-known risk factor for reoperation-related mortality and morbidity [7]. However, compared with the group of patients who were operated on without arch replacement, the difference was not significant, although the trend remains clear that extended arch replacement might reduce the risk of reoperation. Our satisfactory results are in accordance with the results of several authors, who advocate systematic extended or total aortic resection for the initial emergent surgical procedure of acute type A dissection, irrespective of the location of the intimal tear [10,18,19]. Nevertheless, we agree with Kirsch and coworkers [20] that, although distal extent of aortic
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Resection at the initial operation does not significantly influence the risk of reoperation, systematic extensive or total aortic replacement in an emergency setting will necessarily increase the already high operative risk and will outweigh the relatively low incidence of reoperation (77.0% freedom of aortic arch reoperation at 10 years in our series) and the associated operative risk. The trend towards enhanced durability of aortic root repair when GRF glue was used, as reported previously [21], appeared not to be consistent for the use of GRF glue for distal aortic stump reconstruction in this present series. There was, in accordance with the results of Kazui and associates [19], no significant difference in freedom of aortic arch reoperation between patients whose initial distal aortic anastomoses were constructed with or without GRF-glue, in contrast to the results of Nguyen and associates [22].

There was also no significant difference in operative mortality, survival, and freedom of reoperation on the aortic arch between the group of patients who underwent replacement of the aortic arch, to excise an entry tear in the arch, and the subgroup of patients who had undergone surgery limited to the ascending aorta to exclude an intimal tear between the distal ascending aorta and the aortic arch. The location of the intimal tear was no significant risk factor for those three endpoints either. This confirms that the choice of treatment, replacement of the aortic arch or not, can be properly made based on the location of the intimal tear without adverse effects on the operative results.

**Conclusion**

Surgery for acute type A dissection with graft replacement of the proximal or total aortic arch leads to satisfactory results. Operative mortality after replacement of the aortic arch is similar to operative mortality after replacement of the ascending aorta without arch replacement; therefore, replacement of the aortic arch, in order to exclude the intimal tear in the arch, is not an additional risk factor for mortality after surgery for acute type A dissection.

Antegrade selective cerebral perfusion seems to provide optimal protection of the brain during extensive surgery for acute type A dissection.
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References


