Results of Immediate Surgical Treatment of All Acute Type A Dissections

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Background—Surgery for acute type A aortic dissection is associated with a high mortality rate and incidence of postoperative complications. This study was designed to explore perioperative risk factors for death in patients with acute type A aortic dissection.

Methods and Results—One hundred twenty-four consecutive patients with acute type A aortic dissection between 1984 and 1998 were reviewed. All underwent operation with resection of the intimal tear and open distal anastomosis: 107 patients had surgery within 24 hours and 17 patients had surgery within 72 hours of symptom onset. Median age was 62 years (23 to 89); 89 were men. Forty-three patients had ascending aortic replacement only, 72 had hemiarch repair, in 2 the entire arch was replaced, and in 7 replacement included the proximal descending aorta. The aortic valve was replaced in 54 patients, resuspended in 52, and untouched in 18. Hospital mortality rate was 15.3% (19 of 124): of these, 3 patients died during surgery, 4 had fatal rupture of the distal aorta before discharge, and 2 died of malperfusion-related complications. Multivariate analysis revealed age >60, hemodynamic compromise, and absence of hypertension as preoperative indicators of hospital death (P<0.05); the presence of new neurological symptoms was a significant preoperative risk factor in univariate analysis. Ominous intraoperative factors included contained hematoma and a comparatively low esophageal temperature but not cerebral ischemic time (mean 32 minutes). The site of the intimal tear did not influence outcome; but mortality rate was higher with more extensive resection: 43% with resection including the descending aorta died versus 14% with only ascending aorta or hemiarch replacement. Overall 5- and 10-year survival was 71% and 54%, respectively; among discharged patients (median follow-up 41 months) survival was 84% and 64% versus expected US survival of 92% and 79%.

Conclusions—Immediate surgical treatment of all acute Type A dissections with resection of the intimal tear and use of hypothermic circulatory arrest for distal anastomosis results in acceptable early mortality rates and excellent long-term survival. (Circulation. 2000;102[suppl III]:III-248-III-252.)

Key Words: aorta ■ aneurysm ■ surgery ■ mortality ■ cardiovascular diseases

A c·ute type A aortic dissection, with or without involve·ment of the transverse arch, represents an emergency situation that requires immediate surgical intervention to prevent death from intrapericardial hemorrhage. Surgical therapy consists mainly in replacing the ascending aorta, regardless of the extent of the pathological process. Acute aortic insufficiency, when present, is generally treated by valve resuspension or replacement.

Mortality rates from these operations have dramatically improved as the result of recent advances in preoperative recognition, intraoperative techniques, and postoperative surveillance.1–6 Nevertheless, operations for acute type A dissections are still associated with high mortality rates, often related to preoperative compromise necessitating emergency operation, and perioperative complications. This study was undertaken to analyze a large consecutive series of patients with acute type A dissection in the hope of finding ways to improve outcome in these high-risk patients.

Methods

Patient Population

All 124 consecutive patients who underwent operations for acute type A dissection at our institution from January 1984 to April 1998 were reviewed retrospectively with the use of information gathered contemporaneously in our departmental database and supplemented as necessary from patient records. There were 89 men and 35 women whose ages ranged from 23 to 89 years (mean 59±14 years); 69 patients (55.6%) were >60 years of age at the time of surgery. Of the entire cohort, 17 patients (13.7%) were operated on urgently (within 72 hours of admission) and 86.3% on an emergent basis (within 24 hours of admission). Only 7 patients in this series had Marfan’s syndrome.

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TABLE 1. Preoperative Patient Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex</td>
<td>89</td>
<td>72</td>
</tr>
<tr>
<td>Smokers</td>
<td>53</td>
<td>43</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>12</td>
<td>9.7</td>
</tr>
<tr>
<td>Hypertension</td>
<td>76</td>
<td>61</td>
</tr>
<tr>
<td>Diabetes</td>
<td>6</td>
<td>4.8</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td>7</td>
<td>5.6</td>
</tr>
<tr>
<td>Previous neurological history</td>
<td>8</td>
<td>6.5</td>
</tr>
<tr>
<td>Emergency operation (within 24 h)</td>
<td>107</td>
<td>86</td>
</tr>
<tr>
<td>Urgent operation (within 72 h)</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Reoperation</td>
<td>12</td>
<td>9.7</td>
</tr>
</tbody>
</table>

As seen in Table 1, a history of hypertension was the most common preoperative finding, and there was also a relatively high proportion of patients who were smokers. In addition, almost half of the patients had rupture, a contained hematoma, and aortic regurgitation, as shown in Table 2.

Surgical Technique

All patients had replacement of the ascending aorta with an open distal anastomosis during an interval of hypothermic circulatory arrest. The extent of operation was variable: The site of the tear was resected whenever possible. As seen in Figure 1, the location of the tear was in the ascending aorta in 69% of patients, but 20% had arch tears, and a few patients had multiple tears or no tears.

The surgical technique and the application of profound hypothermic circulatory arrest (HCA) throughout the study period were standard: The implementation of HCA has previously been described. Briefly, it consists of core cooling during cardiopulmonary bypass to an average core temperature of 12° to 15°C measured in the esophagus. The proximal repair is accomplished during this period of core cooling, which, in an average adult, requires at least 30 to 40 minutes. The part of the procedure that requires interruption of cerebral blood flow is then done during the period of circulatory arrest. The head is packed in ice to prevent warming of the central nervous system during prolonged circulatory arrest.

Operative Procedures

Forty-three patients (34.6%) had ascending aorta replacement only; 72 (58%) had a hemiarch replacement, 2 had ascending aorta plus total arch replacement, and in 7 patients the proximal descending aorta was also replaced. The aortic valve was replaced in 54 patients (43.5%). A mechanical valve was implanted in 49, and a biological valve was used in the remaining 5. In 53 patients (41.9%), the aortic valve could be resuspended, and it remained untouched in 18 patients (14.5%). In almost all patients (96.2%), an aortic valve-ascending aorta conduit was implanted, with some variant of the Bentall procedure. The button-Bentall, the most common way of implanting the coronary arteries, was used in 38 patients, and the Cabrol technique was used in 14. Only 2 patients had aortic valve replacement with a separate ascending aorta conduit.

Coronary bypass grafting was the most common concomitant procedure and was performed in 18 patients (14.5%) overall. Other additional procedures such as mitral valve replacement were done in 4.8% of the patients.

Table 3 shows important intraoperative variables. Median HCA time in this series was 32 minutes (range 12 to 70). Circulatory arrest time was kept <40 minutes in 73.3% of all patients: Only 31 patients had HCA intervals >40 minutes.

Assessment of Neurological Complications

The presence of neurological dysfunction at the time of discharge from the hospital, whether focal injury (stroke) or global (coma), was considered permanent neurological injury. Temporary neurological dysfunction, which could only be assessed in operative survivors without permanent neurological dysfunction, was defined as the occurrence of postoperative confusion, agitation, or transient delirium. CT, when performed on patients with temporary dysfunction, was usually normal.

Statistical Analysis

All pertinent risk factors for operative or hospital death were examined by χ² tests, with continuous variables grouped as appropriate. The univariate analysis was followed by stepwise logistic regression to determine independent risk factors. Preoperative factors were entered first. Those that were significant were retained in the model, and intraoperative factors were entered: A value of P<0.05 was considered statistically significant. Life tables were constructed to estimate long-term survival rates for all patients and separately for discharged patients. The latter survival curve is compared with that for US expected survival for the same calendar period and age and sex distribution.

Results

Nineteen of 124 patients overall (15.3%) died in the hospital: 3 during surgery, an additional 12 within the first month after surgery, and 4 thereafter. Hospital mortality rate was significantly lower in patients in whom only the ascending aorta or proximal arch was replaced than in those with resection including the descending aorta (14% versus 43%, P=0.07, Table 4). Four patients had fatal rupture of the distal aorta.

TABLE 2. Perioperative Observations

<table>
<thead>
<tr>
<th>Variable</th>
<th>No.</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>New neurological symptoms</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>Hemodynamic compromise</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>Blood in pericardium</td>
<td>53</td>
<td>43</td>
</tr>
<tr>
<td>Contained hematoma</td>
<td>56</td>
<td>45</td>
</tr>
<tr>
<td>Aortic regurgitation</td>
<td>73</td>
<td>59</td>
</tr>
<tr>
<td>Clot or atheroma in aorta</td>
<td>8</td>
<td>6.5</td>
</tr>
<tr>
<td>CABG</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Other concomitant procedures</td>
<td>6</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Figure 1. Location of primary tear in all 124 patients with acute dissection. AA indicates ascending aorta; DA, descending aorta.

TABLE 3. Intraoperative Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Median (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extracorporeal bypass time, min</td>
<td>201 (94–511)</td>
</tr>
<tr>
<td>Cerebral ischemic time, min</td>
<td>32 (12–70)</td>
</tr>
<tr>
<td>Minimal esophageal temperature before HCA, °C</td>
<td>13.2 (8.7–21.9)</td>
</tr>
<tr>
<td>Minimal rectal temperature before HCA, °C</td>
<td>18.1 (11.1–37.4)</td>
</tr>
</tbody>
</table>
before discharge, 2 died of malperfusion-related complications, and 1 death was related to a technical failure of the operation. Four patients died after neurological complications, 2 each died of bleeding and multiorgan failure, and 1 patient died secondary to infection.

Univariate analysis of the group as a whole revealed a number of preoperative, intraoperative, and immediate postoperative factors that were associated with hospital death (Tables 4 and 5). The preoperative risk factors were age >60 years, hemodynamic compromise, no history of hypertension, and new preoperative neurological symptoms. Among the intraoperative factors predicting a poor outcome, only 3 factors emerged as statistically significant: contained hematoma, a lower esophageal temperature before circulatory arrest, and extent of resection. The location of the intimal tear; duration of HCA; whether the aortic valve was untouched, replaced, or resuspended; the performance of concomitant procedures and the year of operation all failed to show any impact on hospital mortality rates. However, univariate analysis revealed that the occurrence of any postoperative complication also increased the chance of hospital death: infection, kidney failure, bleeding (requiring reoperation for hemostasis), or cardiac problems.

Multivariate analysis revealed that statistically significant independent preoperative predictors of adverse outcome were age >60 years, hemodynamic instability, and the absence of hypertension (Table 6). For the 121 operative survivors, additional procedural variables predictive of adverse outcome were contained hematoma and a lower esophageal temperature (Table 7). The occurrence of

<table>
<thead>
<tr>
<th>TABLE 4. Univariate Analysis of Preoperative Risk Factors for Hospital Death in All Patients (n=124)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>&lt;60 y</td>
</tr>
<tr>
<td>&gt;60 y</td>
</tr>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Hypertension</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Coronary artery disease</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
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<tr>
<td>Marfan syndrome</td>
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<td>No</td>
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<td>Previous neurological history</td>
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<tr>
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<tr>
<td>New preoperative neurological symptoms</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Hemodynamic compromise</td>
</tr>
<tr>
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<tr>
<td>No</td>
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<td>Urgency of operation</td>
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<td>Emergent</td>
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<tr>
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</table>

<table>
<thead>
<tr>
<th>TABLE 5. Univariate Analysis of Intraoperative Risk Factors for Hospital Death in All Patients (n=124)</th>
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</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Extent of replacement</td>
</tr>
<tr>
<td>Ascending aorta</td>
</tr>
<tr>
<td>Hemiarch</td>
</tr>
<tr>
<td>Ascending aorta+total arch</td>
</tr>
<tr>
<td>Ascending aorta+total arch+descending aorta</td>
</tr>
<tr>
<td>Location of tear</td>
</tr>
<tr>
<td>No visible tear</td>
</tr>
<tr>
<td>Ascending aorta</td>
</tr>
<tr>
<td>Aortic arch</td>
</tr>
<tr>
<td>Ascending aorta+arch</td>
</tr>
<tr>
<td>Ascending aorta+descending aorta</td>
</tr>
<tr>
<td>Aortic arch+descending aorta</td>
</tr>
<tr>
<td>Contained hematoma</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Free blood in pericardium</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>HCA time</td>
</tr>
<tr>
<td>&lt;40 min</td>
</tr>
<tr>
<td>&gt;40 min</td>
</tr>
<tr>
<td>Minimal esophageal temperature (as continuous variable)</td>
</tr>
<tr>
<td>Aortic valve</td>
</tr>
<tr>
<td>Untouched</td>
</tr>
<tr>
<td>Replaced</td>
</tr>
<tr>
<td>Resuspended</td>
</tr>
<tr>
<td>Concomitant procedures</td>
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<tr>
<td>None</td>
</tr>
<tr>
<td>CABG</td>
</tr>
<tr>
<td>Others</td>
</tr>
<tr>
<td>Any complication (n=121)</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

*Probability value that reflects the difference between the most extensive operation (ascending aorta+total arch+descending aorta) and all other less extensive procedures.

Probability values reflect differences among the listed categories for each variable with regard to hospital death.
postoperative complications was not included in the multivariate analysis.

**Neurological Dysfunction**

A total of 13 patients (10.4%) had permanent neurological deficits. The cause was more often focal (7.3%) than global (3.2%) (Figure 2).

Transient neurological dysfunction, which was evaluated only in patients surviving operation without permanent neurological sequelae, occurred in 39 patients (31.5%). Five of these 39 patients had a focal injury that had resolved at the time of discharge.

**Survival**

Overall 5- and 10-year survival was 71% and 54%, respectively (Figure 3). Among discharged patients (median follow-up 41 months), survival was 84% and 64% versus an age- and sex-matched US expected survival of 92% and 79% (Figure 4).

**Discussion**

Acute type A dissection is a catastrophic event that still represents a formidable surgical challenge. Treated nonsurgically, 90% of all patients with acute dissection will die within 2 weeks.8–10 The current management philosophy therefore favors immediate surgical intervention, for which results have been improving as the result of enhanced preoperative diagnosis, development of better prosthetic materials, amelioration of cardiac as well as cerebral protection, and increased surgical experience.4 In this study, an unselected consecutive series of 124 patients with acute type A dissection was analyzed to determine perioperative risk factors. The overall perioperative mortality rate of 15.3% in our study is comparable to other recent studies.11,12

Five variables were found to be statistically significant risk factors for death in our patient population: Of these, advanced age, hemodynamic instability, and the presence of a contained hematoma at the time of operation are not surprising. Both common sense and results reported by others would lead to the expectation that patients with frank or contained rupture would have a worse outcome than patients who are more stable before surgery, and it is the rare surgical series in which older patients fail to have a higher operative mortality rate.13

The other two factors—the absence of a history of hypertension and the presence of a lower esophageal temperature—are more puzzling. Looking at the univariate analysis, the high mortality rate among the few patients with more extensive resections is striking and probably accounts for the significance of a lower esophageal temperature: If a more extensive or technically difficult operation was anticipated, cooling to a lower esophageal temperature was usually carried out to provide maximal cerebral protection during an anticipated longer duration of HCA. In fact, when the patients with resections including the proximal descending aorta were examined, all had a duration of HCA >40 minutes, significantly longer than patients with more limited operations; they also had lower minimum temperatures during HCA, demonstrating that these variables are intertwined.

We speculate that the absence of a history of hypertension in patients with a high mortality rate after acute dissection may stem from a combination of factors. Some of the patients without a history of hypertension may have had severe but untreated hypertension before surgery, with consequently worse coronary and cerebrovascular disease than their treated counterparts, making

**Figure 2.** Neurological outcome in 98 patients surviving operation for acute dissection. Permanent (Perm) disability was defined as any dysfunction that persisted at time of discharge from hospital. Temporary indicates presence of syndrome of transient neurological dysfunction defined and discussed in text.

**Figure 3.** Actuarial survival curve with standard error bars for all 124 patients after operation for acute dissection.

**Table 6. Multivariate Analysis of Preoperative Factors Responsible for Deaths**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt;60 y</td>
<td>4.4</td>
<td>0.02</td>
</tr>
<tr>
<td>No history of hypertension</td>
<td>5.3</td>
<td>0.0005</td>
</tr>
<tr>
<td>Hemodynamic instability</td>
<td>4.9</td>
<td>0.0006</td>
</tr>
</tbody>
</table>

**Table 7. Multivariate Analysis of Preoperative and Operative Factors Responsible for Deaths**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>P</th>
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<tbody>
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<td>Age &gt;60 y</td>
<td>3.6</td>
<td>0.07</td>
</tr>
<tr>
<td>No history of hypertension</td>
<td>5.3</td>
<td>0.0008</td>
</tr>
<tr>
<td>Hemodynamic compromise</td>
<td>4.5</td>
<td>0.01</td>
</tr>
<tr>
<td>Contained hematoma</td>
<td>5.0</td>
<td>0.02</td>
</tr>
<tr>
<td>Minimal esophageal temperature (°C)</td>
<td>0.64</td>
<td>0.01</td>
</tr>
</tbody>
</table>
them higher-risk surgical candidates; it is also possible that patients with undiagnosed hypertension were more likely to have had poorer general medical care before surgery. Some of the remaining patients without hypertension and poor outcomes may have had more severe underlying aortic disease, in which dissection occurs even in the absence of hypertension. Although only a few patients had Marfan disease and it was not a significant risk factor, some of the other patients without a history of hypertension who died before leaving the hospital may have had previously unrecognized aortic degenerative disease with very friable aortas, which present a greater technical challenge and are more prone to rupture distal to the repair despite adequate blood pressure control than less intrinsically diseased vessels (4 patients died of distal aortic rupture in the immediate postoperative period).

It is encouraging that the duration of HCA was not a risk factor for hospital death in this series, indicating that inadequate cerebral protection was not a major contributor to adverse outcome. This suggests that meticulous attention to the implementation of HCA—thorough cooling to low temperatures, and packing the head in ice—results in sufficient protection to avert serious neurological morbidity for the duration of HCA required to resect the intimal tear and perform an open distal anastomosis in most cases of acute type A dissection. However, the occurrence of temporary neurological dysfunction in almost one third of patients warrants some concern, given that recent evidence suggests that this syndrome may be associated with permanent although subtle loss of cognitive function in a majority of the patients in whom it occurs. It is clear from a number of studies that the incidence of transient neurological dysfunction climbs steadily with increasing durations of HCA and that intervals of HCA >25 to 30 minutes are best avoided.14

That the location of the intimal tear and the performance of concomitant procedures failed to have any impact on mortality rates is also reassuring, suggesting that the current approach at our institution, which involves resecting the site of the intimal tear and performing adjunctive procedures when clinically indicated, is a reasonable way to deal with acute dissections in a setting in which aneurysm surgery is a routine procedure. A Bentall procedure was almost invariably carried out, but various different approaches to the aortic valve—leaving it untouched, replacing it, or resuspending the valve leaflets—also had no impact on mortality rate. Every attempt was made to limit the extent of aortic resection under these emergency conditions, but more extensive procedures were occasionally mandated by intraoperative circumstances and were associated with a higher mortality rate. It is possible that some aspects of these results may not easily be extrapolated to institutions with less experience with dissections and aneurysms, however, and since the principal object of emergency surgery for acute dissection is the immediate survival of the patient, more limited operations than those reported here may be appropriate under certain circumstances.

Finally, even under careful postoperative surveillance, 4 of our patients had fatal rupture before discharge from the hospital, emphasizing the need for continuing attention to adequate blood pressure control and monitoring of the distal aorta in all patients after repair of acute type A dissection.

In conclusion, surgical treatment of acute type A dissections with resection of the intimal tear and use of hypothermic circulatory arrest for distal anastomosis results in acceptable early mortality rates and excellent long-term survival, even in an unselected series such as this, which included patients with perioperative neurological compromise. But despite early diagnosis and immediate surgical intervention, hospital mortality rate after acute dissections appears to be fixed at ~15%; there was no influence of year of operation on mortality rate in our series. Therefore, it seems likely that any further reduction of mortality rate in patients with a predilection for dissection must come from earlier recognition of risk factors such as hypertension and aortic dilation, followed by elective operation with its much lower mortality and morbidity.

References

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