Is aortic surgery using hypothermic circulatory arrest in octogenarians justifiable?

Christian Hagl, Jan D. Galla, David Spielvogel, Steven L. Lansman, Rafael Squitieri, Carol A. Bodian, M. Arisan Ergin, Randall B. Griepp

Department of Cardiothoracic Surgery, Mount Sinai School of Medicine, New York, NY 10029, USA

Department of Biomathematics, Mount Sinai School of Medicine, New York, NY, USA

Received 18 October 2000; received in revised form 13 January 2001; accepted 22 January 2001

Abstract

Objective: This study was undertaken to analyze the risk of mortality and neurological complications after aortic surgery requiring hypothermic circulatory arrest (HCA) in octogenarians. Methods: All patients of ≥80 years at the time of aortic surgery requiring HCA since 1988 were examined. Of 51 patients, 23 were male; the median age was 83. Twenty-six (51%) had proximal repair; the arch was replaced in eight (16%), and 17 (33%) had descending aorta repair. Eleven (22%) were emergencies. Multivariate analysis was carried out to determine the risk factors for in-hospital mortality and/or stroke (adverse outcome) using variables with \( P < 0.1 \) after univariate analysis. Results: The hospital mortality was 16%. Five patients suffered strokes (9.8%); only one survived >6 months, and three died before discharge. The overall adverse outcome was 22%, but elective operation was associated with much better results, with an adverse outcome of only 3.6% after operations via a median sternotomy. Adverse outcome was strikingly higher with more distal resections via a left thoracotomy: 47 vs. 8.8% for ascending aorta/arch resections ( \( P = 0.003 \)). Emergency operation via a lateral thoracotomy was associated with a prohibitively high adverse outcome. Twenty-nine patients (73%) had temporary neurological dysfunction (TND). Multivariate analysis revealed emergency operation ( \( P = 0.01 \); odds ratio (OR), 10.6) and operations via a lateral thoracotomy ( \( P = 0.008 \); OR, 11) as independent preoperative predictors of adverse outcome. The overall survival was 66% at 2 years and 39% at 5 years, compared with 85 and 52% among age- and sex-matched controls. Conclusions: Aortic surgery utilizing HCA in octogenarians can be performed with an acceptable risk of mortality and stroke. From the evidence in this study, it seems that elective aneurysm repair via a median sternotomy can be undertaken for the usual indications, even in octogenarians. However, the enhanced vulnerability of the brain in the elderly is reflected by a high early mortality following stroke, and a high incidence of TND. Emergency operations increase the possibility of adverse outcome dramatically, and patients who require a lateral thoracotomy are at significantly higher risk than those operated via a median sternotomy. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Aortic surgery; Hypothermic circulatory arrest; Adverse outcome; Octogenarians; Neurological complications

1. Introduction

Escalating health care costs and the increasing life expectancy of the population in industrialized countries have raised a number of questions regarding appropriate indications for surgery in elderly patients. These questions can best be answered by examining the results of surgical procedures in the age cohort under discussion.

Patients in the ninth decade of life are usually at a higher surgical risk due to significant comorbidity from age-related diseases. In patients undergoing major surgery of the aorta which requires periods of hypothermic circulatory arrest (HCA), a clear correlation has been established between age and the incidence of both stroke [1] and adverse outcome [2], defined as permanent stroke or death. In addition, the incidence of temporary neurological dysfunction (TND) [1,3] has also been shown to increase with age. Related discussions, such as whether octogenarians should be considered as cardiac surgical candidates, have resulted in several publications concerning the outcome of patients undergoing coronary artery bypass grafting [4,5] or off-pump surgery [6]. However, there has only been one previous report dealing with the outcome of patients in the ninth decade of life after aortic surgery using HCA [7].

This retrospective review was undertaken to analyze the risk of death or lasting neurological sequelae in all patients...
over 80 years of age from one single institution. All patients who underwent aortic surgery with HCA during the interval of the study were included, whether approached via a median sternotomy or lateral thoracotomy.

2. Materials and methods

From May 1988 to October 1999, 51 patients older than 80 years at the time of surgery had operations on the thoracic aorta requiring HCA at the Mount Sinai Medical Center. This constitutes about 4% of all patients who were scheduled for aortic surgery during this time interval, and the number of elderly patients requiring aortic surgery seems to be increasing. Information was reviewed retrospectively using data gathered contemporaneously in our departmental database and supplemented from patient records. Follow-up was by direct telephone interview or by contact with the referring cardiologist.

There were 23 men and 28 women, whose ages ranged from 80 to 89 years (mean, 82.7 ± 2.4 years); the distribution can be seen Fig. 1. Of the entire cohort, 33 (65%) were operated on electively, seven (14%) urgently (within 72 h of admission), and 11 (22%) on an emergent basis (within 16 h after admission). Other preoperative patient characteristics are shown in Table 1.

Hypertension was the most common preoperative finding, followed by a history of smoking and of coronary artery disease. Patients with a positive previous neurological history (14%) had suffered either transient ischemic attacks, prolonged reversible neurological deficits, or transient or permanent strokes.

The underlying etiology was atherosclerosis in 29 (57%) and dissection in 13 (26%); nine patients (18%) had degenerative aneurysms or aneurysms of miscellaneous etiology, such as a mycotic aneurysms. Type A dissection was four times as common as type B dissection. A median sternotomy was performed in 34 patients (67%), and 17 (33%) were operated through a lateral thoracotomy. Table 2 gives further operative details including the frequency of concomitant procedures and of other possible risk factors for adverse outcome.

2.1. Surgical technique

The surgical approach was chosen in accordance with the diseased segment of the aorta. Proximal repair and total arch replacement were performed via a median sternotomy, whereas isolated distal arch resections or operations on the descending aorta were approached via a lateral thoracotomy. For all ascending aortic repairs, an open distal anastomosis was performed.

Aortic cannulation depended upon the surgical procedure being performed. In the earlier years of the study, it was either via the ascending aorta or the femoral artery. Within the last 2 years, however, arterial inflow was established more frequently via the left subclavian artery or the right axillary artery.

As previously described, deep HCA was used in all patients after reaching a core temperature of 10–13°C. In all operations since 1993, a jugular venous catheter was inserted to measure venous oxygen saturation to gain information concerning the metabolic rate of the brain [8]. HCA was induced when the venous saturation exceeded 95%. All patients received 2 g of methylprednisolone before HCA, and an additional 1.5 g of methylprednisolone were given during the following 48 h when the HCA duration exceeded 30 min.

In 15 (29%) patients with more extensive operations, selective antegrade perfusion (ACP) was performed according to the technique described by Ergin et al. [9]. Briefly, an island of native arch is excised and attached to an appropriately fashioned 16–20 mm Hemashield® graft using HCA. Antegrade selective cerebral perfusion is then started via an arterial cannula inserted into the graft and the brain is perfused with 10–12°C cold blood. Flows are regulated to maintain a perfusion pressure of approximately 50–60 mmHg, measured in the radial artery. As previously described [9], this technique allows an approach to the arch from either a median sternotomy or a lateral thoracotomy.

If excessive debris was encountered, a brief period of

![Fig. 1. Age distribution of all patients (n = 51).](image-url)
retrograde cerebral perfusion was established right after the start of HCA in some patients in an effort to avoid embolic strokes. This was done by inserting a cannula directly into the superior vena cava or by advancing a cannula from the femoral vein; the flow was adjusted to achieve a pressure of 15–20 mmHg in the SVC.

2.2. Definition of adverse outcome and neurological complications

In this study, adverse outcome was defined as intraoperative or in-hospital death, or the occurrence of permanent neurological injury. A stroke was considered permanent when patients were discharged with residual neurological symptoms.

TND was analyzed separately in all patients surviving the operation, excluding those who suffered strokes or who never regained consciousness after surgery. TND was defined as postoperative confusion, agitation, delirium, prolonged obtundation or Parkinson-like symptoms, with no focal deficit in computer tomography or magnetic resonance imaging if these studies were available [1].

2.3. Statistical methods

All patients were included in the analysis of preoperative factors impacting on adverse outcome. Patients with adverse outcomes were excluded from the analysis of TND.

All putative factors were analyzed initially by Fisher’s Exact or Mann–Whitney tests, as appropriate. Factors with a P value of less than 0.1 in the univariate analysis were entered into a multivariate logistic regression: first the preoperative factors and then the perioperative. A P value of less than 0.05 was considered significant. Survival was estimated by the Kaplan–Meier curve, and compared with the expected survival for an age- and sex-matched group of Americans from the Vital Statistics of the United States 1990 [10].

3. Results

3.1. Adverse outcome

One patient died in the operating room due to cardiac failure. There were another seven deaths before hospital discharge, resulting in an overall hospital mortality of 16% (Table 3). A total of five patients suffered permanent strokes (9.8%): four died within 6 months from stroke-related complications. There were no transient strokes in the present series.

Adverse outcome (n = 11) was strikingly higher with more distal resections via a left thoracotomy (47 vs. 8.8%; P = 0.003; Fig. 2). The stroke rate was also much higher after lateral thoracotomy: 24 vs. 2.9% (P = 0.04). None of the patients with descending aneurysm repair developed paraplegia, and no patient had delayed ischemic spinal cord injury.

In addition to operations via a lateral thoracotomy, univariate analysis revealed emergency operation (P = 0.007), atherosclerosis as the underlying etiology (P = 0.088), blood in the pericardium relating to rupture (P = 0.015), preoperative hemodynamic compromise (P = 0.015), and contained hematoma (P = 0.002) as risk factors for adverse outcome.

Among the other preoperative factors considered, gender, a history of hypertension, smoking, diabetes, coronary

---

Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Percentage/Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent of operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Via median sternotomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximal repair</td>
<td>26</td>
<td>51</td>
</tr>
<tr>
<td>Total arch</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Via lateral thoracotomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal arch + proximal descending</td>
<td>15</td>
<td>29</td>
</tr>
<tr>
<td>Descending only</td>
<td>2</td>
<td>3.9</td>
</tr>
<tr>
<td>Aortic valve replacement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical</td>
<td>2</td>
<td>3.9</td>
</tr>
<tr>
<td>Biological</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Aortic valve repair</td>
<td>3</td>
<td>5.9</td>
</tr>
<tr>
<td>Aortic valve resuspension</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Bentall procedure</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>Concomitant CABG procedure</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Blood in the pericardium</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Contained hematoma</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Visible clot or atheroma</td>
<td>22</td>
<td>43</td>
</tr>
<tr>
<td>CPB (min)</td>
<td>171</td>
<td>94–300</td>
</tr>
<tr>
<td>Aortic cross-clamp time (min)</td>
<td>90</td>
<td>24–301</td>
</tr>
<tr>
<td>HCA (min)</td>
<td>34</td>
<td>5–64</td>
</tr>
</tbody>
</table>

* Data include all patients of >80 years who underwent aortic surgery requiring HCA during the interval under study (n = 51).

---

Fig. 2. Adverse outcome – death or permanent stroke, as defined in the text – among patients of >80 years who underwent aortic surgery requiring HCA during the interval under study. Both emergency surgery and lateral thoracotomy were independent risk factors for adverse outcome in the multivariate analysis.
artery disease, and previous neurological injury did not emerge as significant in the univariate analysis. Intraoperative factors which were considered but were not significant included the performance of concomitant procedures, the presence of clot or atheroma, cardiopulmonary bypass (CPB) time, and HCA time (Table 3).

In the multivariate analysis for adverse outcome, independent preoperative risk factors were emergency operation ($P \leq 0.01$; odds ratio, (OR), 10.6) and lateral thoracotomy ($P = 0.008$; OR, 11; Table 4). The impact of these risk factors on adverse outcome is depicted graphically in Fig. 2.

### 3.2. Duration of hospitalization and complications

The median hospital stay was 21 days (0–140 days). One patient (2%) had to undergo re-operation due to significant postoperative bleeding. As shown in Table 5, respiratory complications (prolonged intubation for more than 24 h) occurred in almost 50% of all patients. Eleven patients had cardiac complications, usually requiring inotropic support in the early postoperative period.

Twenty-nine patients (73%) suffered TND: the proportion was slightly higher in patients operated through a median sternotomy (74 vs. 67% in patients with a lateral thoracotomy; Fig. 3).

### 3.3. Follow-up

Follow-up was completed in all but one of the 43 patients (97.7%) who were discharged from the hospital. The overall survival was 66% at 2 years and 39% at 5 years compared with 85 and 52% (National Center of Health Statistics) among age- and sex-matched controls (Fig. 4).

### 4. Discussion

With an increasing proportion of octogenarians in our population, the number of elderly patients referred for surgery for different types of aortic diseases has also grown. Whether or not it is a good idea to undertake aortic surgery in these older patients has to be evaluated more carefully, not only because such procedures may be subject to ethical scrutiny in view of limited resources, but also because it is not clear that the outcomes from such procedures always justify their being attempted, even from the individual’s point of view.

It has been shown that cardiac operations requiring CPB can be performed with an acceptable risk [4,11,12]. However, hospital morbidity and mortality are considerably higher in elderly patients, and the duration of hospitalization is usually prolonged. Furthermore, in 10 860 patients who underwent coronary operations, Puskas and coworkers [5] were able to show that age is a strong predictor (OR, 1.07/year) of postoperative stroke. These facts have led to a controversy as to whether patients in the ninth decade of

### Table 3

<table>
<thead>
<tr>
<th>Complication</th>
<th>Median sternotomy</th>
<th>Lateral thoracotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac failure (n)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Respiratory failure ± infection (n)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Neurological complication (n)</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

*Data include all patients of >80 years who underwent aortic surgery requiring HCA during the interval under study (n = 51).

### Table 4

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>P value</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency operation</td>
<td>0.01</td>
<td>10.6</td>
</tr>
<tr>
<td>Lateral thoracotomy</td>
<td>0.008</td>
<td>11.0</td>
</tr>
</tbody>
</table>

*Adverse outcome was defined as intraoperative or in-hospital death, or the occurrence of permanent neurological injury; stroke was considered permanent when patients were discharged with residual neurological symptoms.

*Data include all patients of >80 years who underwent aortic surgery requiring HCA during the interval under study (n = 51).

*All factors with a P value of <0.1 in univariate analysis were included in the multivariate model.

### Table 5

<table>
<thead>
<tr>
<th>Postoperative complications</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td>25</td>
<td>49</td>
</tr>
<tr>
<td>Cardiac</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Infection</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Renal failure</td>
<td>5b</td>
<td>9.8</td>
</tr>
</tbody>
</table>

*Data include all patients of >80 years who underwent aortic surgery requiring HCA during the interval under study (n = 51).

*b One dialysis.
Thoracic aortic aneurysms are usually considered serious medical problems since they require operative intervention in order to prevent rupture, dissection or death. Although not all patients with thoracic aneurysms are equally at risk for rupture, with some smaller aneurysms remaining stable in size over a period of many years without intervention, advancing age has been identified as one of the constitutional risk factors for rupture in natural history studies [14]. Unanticipated rupture is usually fatal, however, and emergency surgery, even when possible, still has a prohibitively high mortality and morbidity. In this study, we confirm that emergency operation is an important risk factor for adverse outcome, increasing the mortality from 3.6 to 33% in cases which can be approached via a median sternotomy, and from 33 to 80% in patients whose aneurysms require resection via a lateral thoracotomy.

However, even elective aortic surgery has serious risks, which are magnified in the elderly. It frequently requires periods of HCA, with an especially high incidence of postoperative neurological complications in older patients. It has been shown that the risks both of neurological complications and of adverse outcome (death or permanent neurological sequelae) increase with advancing age [1,2]. Furthermore, the proportion of patients with serious neurological complications (permanent rather than transient strokes) also rises steeply in the elderly [3].

Our results show that octogenarians undergoing procedures involving HCA have an overall in-hospital mortality of 16%, which is not strikingly higher than results from some centers in much younger individuals. In elective patients with operations via a median sternotomy, the risk of adverse outcome is actually surprisingly low. The stroke rate of 9.8% (all permanent) in this entire elderly cohort also seems quite acceptable in such a high-risk group of patients, but the chance of surviving a stroke is relatively small: 80% of patients who suffered strokes postoperatively died within the first 6 months after surgery.

The present study clearly shows that the chance of adverse outcome increases with more distal resections of the aortic arch and proximal descending aorta via a lateral thoracotomy, reaching a daunting 47%; 24% suffered a stroke and also the mortality was higher in lateral thoracotomy patients. If emergency surgery requires a lateral thoracotomy, the outcome is especially dismal. Also, in this group, more patients had respiratory complications requiring prolonged periods of mechanical ventilation, which may have increased the risk for infection and pneumonia. Although the more severe surgical trauma resulting from approaching the aorta via a left thoracotomy may have played a role in the increased incidence of respiratory disturbances in this subset of patients, the increased frequency of respiratory complications may have been related to a higher incidence of preexisting chronic obstructive pulmonary disease or pulmonary emphysema in this group. Unfortunately, we were not able to assess the incidence of chronic lung disease in many of our patients preoperatively (1/3 were operated on urgently or as emergencies) and we were therefore unable to include this factor in our multivariate analysis.

During the interval under study, no patients were refused operation at our center because of advanced age, but we cannot assess the possible impact of selection of better-risk patients by referring physicians. Nevertheless, our results in elective cases justify aortic surgery using HCA in octogenarians, especially when the procedure is expected to be relatively short, and can be carried out through a median sternotomy. However, elective surgery of atherosclerotic aneurysms requiring a lateral thoracotomy may require more careful scrutiny, and emergency surgery via a lateral thoracotomy must be recognized to carry a prohibitively high risk.

A high incidence of TND in this study was also noted, and reflects the vulnerability of the brain in geriatric patients. Despite prolonged, thorough cooling, and monitoring of jugular venous saturations in the later years of the experience to be sure that residual metabolism had been reduced to minimal levels before the start of HCA, slow awakening, postoperative confusion and/or agitation were observed in almost 3/4 of the patients. Prolonged obtundation may be related to the slower metabolism of anesthetic drugs in the elderly, but we feel that confusion and agitation most likely reflect inadequate cerebral protection during HCA.

In order to reduce the incidence of TND, our current strategy of cerebral protection relies principally upon antegrade cerebral perfusion as an adjunct to HCA when longer durations of HCA are anticipated, as has consistently been advocated by Bachet [15] and others [16]. In the present study, we were unable to show any beneficial effects of antegrade perfusion on the incidence of TND, but this may be because of the small number of patients in whom it was used; we continue to believe that reduction of the duration of HCA will have a favorable effect on the incidence of this complication. Although the likelihood that TND will occur in an elderly patient is not a reason to reject surgery for a life-threatening condition, it can nevertheless...
lead to a permanent, albeit subtle, loss of cognitive function and may therefore influence a decision regarding elective surgery.

Retrograde cerebral perfusion was also utilized during the interval under study to try to improve cerebral recovery, mainly in an effort to reduce embolization, but has recently been abandoned since most rigorous studies have failed to show any benefit with its use [3,17]. We think that the use of alternative cannulation sites (e.g. the right axillary or left subclavian artery) may prove beneficial in reducing strokes and stroke-related mortalities, and this belief also influences our current strategy.

5. Conclusions

From our experience, there is no justification for refusing a patient an aortic operation just because he has entered the ninth decade of life. Elective operations which can be done via a median sternotomy are associated with a very low risk of stroke or death, and should be undertaken for appropriate indications without undue hesitation. However, emergency operations dramatically increase the likelihood of adverse outcome, and even elective patients who require a lateral thoracotomy are at much greater risk than those in whom the surgical approach can be made via a median sternotomy: in these elderly patients, the decision to operate should be weighed carefully. The combination of emergency surgery and lateral thoracotomy seems to be especially disastrous.

Although the overall incidence of adverse outcome in this geriatric cohort is acceptable, the enhanced vulnerability of the brain in the elderly is reflected by a high early mortality after stroke and a very high incidence of TND. The numbers in this study were too small to demonstrate a trend, but we feel strongly that recent changes in operative technique, including the more liberal use of antegrade cerebral perfusion and of alternative cannulation sites (axillary or subclavian artery) may improve the outcome in octogenarians who require aortic surgery.

References


Appendix A. Conference discussion

Dr I. Munoz (Cordoba, Spain): My question is, in cases of elective patients, in this group of patients, in the case of atherosclerotic aneurysm, what is your opinion as to the limit in size to indicate surgery under or without circulatory arrest?

Dr Hagl: Limited size?

Dr Munoz: The size of the aneurysm. In the case of the octogenarian, what is the limit in diameter of the aneurysm to indicate elective surgery?

Dr Hagl: The results of this study suggest that the outcome of replacement of the ascending aorta and arch through a median sternotomy are not significantly worse in octogenarians than in younger patients, especially when undertaken electively. So for this elderly group, we would use essentially the same criteria as for younger patients: we would probably operate electively on an asymptomatic ascending aortic aneurysm at about 6 cm, and at a smaller size if there were symptoms such as pain or hoarseness, or if the aneurysm were irregular in contour or seen to be expanding rapidly.

With a distal arch aneurysm, or one which involves the proximal descending aorta, the decision is more difficult, given the much higher mortality in patients approached via a lateral thoracotomy. In these cases,
we would use the formula which we have derived for predicting the rupture of descending thoracic aortic aneurysms, which considers constitutional factors as well as size, and we would recommend operation if the formula predicts a likelihood of rupture within a year which exceeds the anticipated operative mortality. Although the operative outcome in the cases approached via a lateral thoracotomy in our series was very high, the results of elective operation were still much better than if operation was undertaken as an emergency, and previous data demonstrate that the risk of aneurysm rupture increases with advancing age. We do not have a good answer to the question of what to do when faced with an emergency situation in this group, knowing that the choice is between an emergency lateral thoracotomy with a predicted adverse outcome of 80%, and certain death without surgery.

**Dr W. Harringer (Hannover, Germany):** I am wondering whether you have included cannulation site as a single predictor for adverse outcome in your analysis. Especially with the left thoracotomy, one could speculate that the cannulation site might have had a significant impact on the stroke rate. Secondly, were there any patients in the median sternotomy group cannulated via the femoral artery and was there any neurological difference in those patients.

**Dr Hagl:** It is true that the observation period in this study was very long – 12 years – so a lot of things changed. At the beginning of the study, most patients undergoing repair via a lateral thoracotomy were cannulated via the femoral artery, and this may be one of the reasons why the outcome was so bad. For the past 2 or 3 years at Mount Sinai, cannulation has been carried out more or less exclusively using either the subclavian or the axillary artery to avoid dislodging emboli during retrograde arterial perfusion. Cannulation site is definitely an important factor, but one which we didn’t look at specifically in this relatively small group of patients with a lateral thoracotomy.

**Dr M. Turina (Zurich, Switzerland):** You are putting all the blame on the lateral thoracotomy. This is basically a univariate analysis. If you subject all your material to the multivariate analysis, does it still appear as the main factor or does it get diluted by all other variables, for instance, the place of cannulation, the nature of the disease, etc.; multivariate versus univariate?

**Dr Hagl:** The problem is that we did not have a lot of patients in the lateral thoracotomy group – just 17 – which we felt was too small a number for a meaningful multivariate analysis. We thought the diagrams would provide much more information. Most of the aneurysms approached via a lateral thoracotomy were atherosclerotic aneurysms, and we know from previous studies that atherosclerosis is a very important risk factor for stroke and for adverse outcome; but the location of the distal arch and proximal descending thoracic aortic aneurysms and the greater surgical trauma associated with resection via a lateral thoracotomy also contribute to the adverse outcome in this group.

**Dr J. Bachet (Paris, France):** Keeping on this matter, don’t you think also that the strokes in this group could be explained by the fact that distancing the arch in patients under deep hypothermia and circulatory arrest is extremely difficult and that some of those strokes could be due to air embolism?

**Dr Hagl:** I would say it is possible, but not likely.

**Dr Turina:** The substantial mortality which you and we all are observing, wouldn’t it induce you to consider endoaoic prosthesis for some of these patients? You cannot do it in the arch, but you can do it in the descending aorta.

**Dr R. Griepp (New York, NY, USA):** I believe that endoprostheses can be utilized very satisfactorily in the descending thoracic aorta, but all of these patients had aneurysms that involved the origin of the left subclavian artery or had evidence of atheromatous disease in the proximal descending and distal arch, making it unwise to clamp the proximal descending aorta or to attempt to land an endoprosthesis there. Open anastomosis under HCA was felt to be the only safe way to reduce the risk of cerebral embolization in these patients. I would emphasize that the fraction of patients undergoing descending thoracic and thoraco-abdominal aortic resections that require HCA for management of the proximal anastomosis is small.

We have in the last few years changed our cannulation technique from the femoral artery to a side graft on the left subclavian artery and have become increasingly reluctant to manipulate or dissect the atheromatous distal arch or proximal descending aorta until the circulation is arrested. We think this is reducing the incidence of stroke in this patient group, but we don’t have enough patients yet to prove it.

**Dr S. Takamoto (Tokyo, Japan):** The cases with left thoracotomy are probably distal aortic arch aneurysms. Probably, the octogenarian or patient who has a distal aortic arch aneurysm also has atherosclerosis in the proximal arch. So the indication of the left thoracotomy should be limited for the pure distal arch aneurysm with an intact proximal arch. So, if the atherosclerosis existed in the proximal arch or ascending aorta, those patients should be entered through median sternotomy and total aortic arch replacement should be done; and also, as the previous paper said, using a stent graft is an easy way to omit distal anastomosis in such a case.

**Dr Hagl:** It is true that how you chose your incision for a distal arch aneurysm depends upon the extent of the disease. In some cases, which involve the proximal descending aorta as well as the distal arch, the repair requires a lateral thoracotomy.