Operative Factors Influencing Mortality in Intracranial Aneurysm Surgery: Analysis of 186 Consecutive Cases

RONALD L. PAUL, M.D.,* AND JAMES G. ARNOLD, JR., M.D.
Division of Neurological Surgery, Department of Surgery, University of Maryland Hospital, Baltimore, Maryland

Selected reports in the literature indicate that operative mortality rates in intracranial aneurysm surgery are impressively low in “good risk” patients. Pool and Potts\textsuperscript{15} reported a mortality of 4.7\% in 84 cases in 1965. Drake\textsuperscript{2} had a 5\% mortality in “good risk” patients, and Hunt and Hess\textsuperscript{6} more recently reported 1.4\% mortality in his “good risk” group. Norlén\textsuperscript{12} gives mortality rates of 5\% in supraclinoid internal carotid aneurysms and 5\% in both middle cerebral and anterior cerebral artery aneurysms; all are “good risk” patients. In contrast, higher mortality figures are also reported. Lougheed, et al.,\textsuperscript{9} in 1965 reported 13.1\%, and French, et al.,\textsuperscript{4} although not specifically grading their patients, recently reported a 15\% mortality, stating that: “Fortunately the majority of the patients in this series were in fairly good general condition and were neurologically stable at the time of admission...”

If one analyzes the data reported by the Cooperative Study of Intracranial Aneurysms,\textsuperscript{16} 272 patients are categorized as being symptom-free or having minor symptoms; these roughly correspond to Hunt and Hess’s\textsuperscript{6} Grade I in which there were 49 deaths (14.3\% mortality). If one includes in the “good risk” group Hunt and Hess’s third category, which includes patients with greater symptoms and signs but without changes in sensorium, the total number of patients in these three categories is 508, with 106 deaths (21\% mortality). This total group corresponds more closely to Pool and Potts\textsuperscript{15} “good risk” group and is identical to the “good risk” group reported here.

Over-all mortality rates also vary: Hunt and Hess\textsuperscript{6} 16\%; Drake\textsuperscript{2} 25\%; Pool and Potts,\textsuperscript{15} 21\%; McKissock, et al.,\textsuperscript{10} 38\% in 151 craniotomies; and Schwartz and Holmes,\textsuperscript{17} 29\%. The Cooperative Study reported an over-all mortality rate of 31\% in 979 cases, ranging from 24\% to 60\% depending on the reporting center.

Drake\textsuperscript{2}, commenting on Hunt and Hess’s\textsuperscript{6} report of 1.4\% mortality rate in “good risk” patients, suggests that the frequently quoted mortality figures of 30\% to 33\% are misleading and that the conservatives should be quoting these much lower figures. Certainly, the above figures indicate that acceptable low mortality can be achieved in selected patients. However, considering the variability of mortality rates even in “good risk” patients, it is obvious that a significant number of deaths occur even in this “good risk” group. Furthermore, having eliminated the factor of poor clinical grade, which has been extensively discussed in the literature, one must look elsewhere for factors contributing to mortality.

Drake has recently advocated the use of profound hypotension to avoid rupture of the aneurysm at the time of surgery, particularly in aneurysms of the basilar artery.\textsuperscript{1} Pool and Potts,\textsuperscript{15} referring to the dangerous practice of occluding major intracranial vessels, states: “This causes a serious risk of death or crippling from cerebral infarction because at least one major artery of the brain has been sacrificed...” Horwitz and Rizzoli\textsuperscript{5} have discussed the relationship between operative occlusion of major intracranial vessels, infarction, and mortality. While they recognize that infarction may result from aneurysmal rupture, they feel that not infrequently it results from operation. They refer to a paper by Laine\textsuperscript{7} in which he documented 11 operative anterior cerebral artery occlusions in 19 autopsied patients operated by Krayenhübl.
Although these factors have been recognized by all surgeons who perform this type of operation, the English literature is virtually devoid of analytical studies relative to the specific problem of operative mortality. The purpose of this report is to analyze a relatively large series of intracranial operations on cerebral aneurysms. The study began as an effort to determine our own mortality rates. As the study progressed, however, it became apparent that certain operative factors had a significant correlation with mortality, and a detailed study of operative and autopsy data was made. We have, therefore, attempted to document and quantitate the importance of aneurysmal rupture and clipping of major intracranial vessels at surgery.

Methods and Materials
The material consists of 186 consecutive cases of intracranial operation for cerebral aneurysms performed between 1950 and 1968 at the University of Maryland Hospital. All were aneurysms of the anterior circulation, and all were verified by angiography and surgery. There were 135 operations performed by 11 surgeons of the teaching staff and 51 by 14 members of the resident staff.

A detailed review of each clinical record was undertaken with special interest directed to the following: clinical grading at the time of surgery; use of steroids; operative data including anesthesia and adjuncts; technical difficulties encountered during operation; and mortality and postmortem data.

More specific data were then extracted as follows:
1. Clinical grading at the time of operation
2. Incidence of rupture of the aneurysm at the time of operation
3. Incidence of clipping of major intracranial vessels at operation
4. Incidence of the use of steroid therapy
5. Use of hypothermia and hypotension as surgical adjuncts

Clinical grading at the time of operation was done by classifying patients into five groups, as follows:

Grade 0. Third nerve palsy without subarachnoid hemorrhage.

Grade 1. Subarachnoid hemorrhage without specific neurologic deficit other than a third nerve palsy and without changes in the sensorium.

Grade 2. Subarachnoid hemorrhage with neurologic deficit greater than an isolated third nerve palsy but without changes in the sensorium.

Grade 3. Changes in the sensorium from lethargy through and including delirium with or without specific neurological deficit.

Grade 4. Stupor or coma.

All patients in Grades 0, 1, and 2 were considered to be “good risk” patients.

Where possible, control and experimental groups were constructed from the data to isolate the influence of one or more specific factors. Autopsy data and factors such as hypothermia, moderate hypotension, and steroid therapy have also been utilized for comparison purposes.

General Results
The general mortality rate was 37.6%. The surgical mortality reflected deaths occurring while in the hospital. The mortality rate referable to anatomical location was as follows: internal carotid, 34.2%; anterior communicating and anterior cerebral, 42%; middle cerebral, 31.7%. There were eight posterior communicating artery aneurysms resulting in four deaths, and six cases of two aneurysms attacked simultaneously and resulting in four deaths.

Mortality related to clinical grading is illustrated in Table 1. Lower mortality occurred in the better risk group, but even here mortality was significant. The overall mortality of the entire “good risk” group was 27.5%. When the entire series was roughly

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of Cases</th>
<th>Survived</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>58</td>
<td>41</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>28</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>52</td>
<td>33</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
<td>7</td>
<td>19</td>
</tr>
</tbody>
</table>

TABLE 1
Mortality rate relative to grade at operation

Deaths No.  %

20.0
27.5
30.0
38.5
73.1