The Prediction of Morbidity and Mortality in Anterior Communicating Aneurysms Treated by Proximal Anterior Cerebral Ligation

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Any attempt to solve the problem of proper treatment for intracranial aneurysms must commence with delineation of the factors determining prognosis. Once these factors are known, they may be combined into a single expression of prognosis which has been called a discriminative function or equation.¹⁻³,⁸ We have already described a discriminative function for the prediction of the natural course of aneurysms of the anterior¹⁵ and posterior¹³ communicating arteries.

In anterior communicating aneurysms, the age, blood pressure, level of consciousness, direction in which the aneurysm points, shape of the aneurysm and time elapsed since the original bleeding episode were all found to be closely correlated with the incidence of rebleeding. We derived a formula which weighted each factor and combined them all into a single equation. By means of this equation a score was obtained that could be compared with the expected mortality rate if the patient was simply treated with 6 weeks of bed rest. Thus it was possible to determine for each individual with this type of aneurysm, the statistical probability of rebleeding if only conservative therapy was undertaken.

This paper presents a discriminative function by which mortality can be predicted in one type of operative approach to anterior communicating aneurysms, namely the procedure described by Logue.⁹ This consists of occlusion of the proximal anterior cerebral artery on the side from which the aneurysm fills best.

Methods

The case records and radiographs of 94 patients were studied to determine the influence of 10 possible prognostic factors. These patients had been admitted to Atkinson Morley's Hospital or the National Hospital at Queen Square, London, under the care of Mr. Wylie McKissock, Mr. L. S. Walsh or Mr. A. E. Richardson.

Criteria for Selection:
1. There had been at least one subarachnoid hemorrhage.
2. A single aneurysm arising at the junction of the anterior cerebral and anterior communicating arteries had been demonstrated by bilateral carotid angiography.
3. In cross compression studies both anterior cerebral arteries filled with contrast material when either carotid artery was injected.
4. The operative procedure employed was a clip occlusion of the proximal anterior cerebral artery on the side from which the aneurysm was seen to fill best during angiography.
5. The operative procedure was usually carried out under hypothermia and hypotension via a small frontal bone flap without sacrifice of the frontal lobe.

Potential Prognostic Factors Considered:
1. Age.
2. Sex.
3. Systolic blood pressure.
4. Diastolic blood pressure.
5. Level of consciousness.
6. Presence or absence of spasm as determined by angiography.
7. Quality of cross flow. This was considered "good" if upon compression of one common carotid artery both middle cerebral arteries were filled by injection of the other carotid.
8. Direction in which the aneurysm pointed.
9. Ratio of the length of the aneurysm to its breadth.
10. Time interval from the original ictus to the operation.

Factors 8 and 9 were considered because the previous study on the prediction of mortality under conservative therapy¹⁸ had shown that there was a significant relationship between these factors and the incidence of rebleeding in patients treated only by 6 weeks of bed rest. Those factors which proved to have a significantly high correla-
tion with operative morbidity or mortality were then analyzed for interdependence and only those which had an accurate and relatively independent prognostic value were retained. A discriminative function was then derived which weighted each factor and combined them into a single expression of prognosis.

Results

The following factors were found to have significance in predicting mortality or gross disability because of the operation (Table 1): age, sex, blood pressure, spasm, level of consciousness, and quality of cross flow.

It is interesting to note that the “better” the cross flow, the worse the prognosis after occlusion of the proximal anterior cerebral artery. This unexpected finding may be related to adequacy of the vertebro-basilar circulation. Thus when compression of the carotid artery results in filling of both middle cerebral trunks from unilateral carotid injection, we may suppose that the vertebral basilar contribution to the middle cerebral artery is not as great as when the middle cerebral does not fill.

TABLE 1

Factors significant in predicting mortality or gross disability from operation

<table>
<thead>
<tr>
<th>Factors</th>
<th>Morbidity &amp; Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age:</td>
<td></td>
</tr>
<tr>
<td>under 40</td>
<td>17%</td>
</tr>
<tr>
<td>between 40 and 59</td>
<td>38%</td>
</tr>
<tr>
<td>over 60</td>
<td>69%</td>
</tr>
<tr>
<td>Sex:</td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>28%</td>
</tr>
<tr>
<td>female</td>
<td>56%</td>
</tr>
<tr>
<td>Blood pressure:</td>
<td></td>
</tr>
<tr>
<td>systolic under 140 mm. of Hg</td>
<td>12%</td>
</tr>
<tr>
<td>systolic between 140-169 mm. of Hg</td>
<td>35%</td>
</tr>
<tr>
<td>over 169 mm. of Hg</td>
<td>74%</td>
</tr>
<tr>
<td>diastolic under 100 mm. of Hg</td>
<td>25%</td>
</tr>
<tr>
<td>diastolic over 100 mm. of Hg</td>
<td>71%</td>
</tr>
<tr>
<td>Arterial spasm:</td>
<td></td>
</tr>
<tr>
<td>present</td>
<td>58%</td>
</tr>
<tr>
<td>absent</td>
<td>32%</td>
</tr>
<tr>
<td>Level of consciousness:</td>
<td></td>
</tr>
<tr>
<td>fully alert</td>
<td>16%</td>
</tr>
<tr>
<td>drowsy</td>
<td>61%</td>
</tr>
<tr>
<td>comatose</td>
<td>100%</td>
</tr>
<tr>
<td>Cross flow with compression:</td>
<td></td>
</tr>
<tr>
<td>both anterior cerebals only fill</td>
<td>22%</td>
</tr>
<tr>
<td>both middle cerebals fill</td>
<td>49%</td>
</tr>
</tbody>
</table>

The morphology of the aneurysm itself (direction and length-breadth ratio) did not prove significant.

The patients were divided into an alert group and a drowsy group. The mortality for the “alert” group was low (13%) on any given day and that for the drowsy group high (64%). Since the operative mortality for alert patients did not improve with time, immediate operative intervention seems advisable in this group. Although the mortality for a drowsy patient is high at any time, there is the possibility that he may become alert and thus become a better surgical candidate. Age and diastolic blood pressure are not included because these two factors did not significantly increase the accuracy of prediction based upon the other factors. However, as seen in Table 1, they did have independent predictive value.

**Discriminative Function.** The discriminative function or equation which emerged from these factors is as follows. Rebleeding score = 1.34 (if female) + (0.08 × systolic blood
pressure) + level of consciousness (0 if alert; 2.62 if drowsy; 4.85 if very drowsy) + 1.42 (if spasm is present) + 0.61 (if cross flow extends to middle cerebral).

Fig. 1 relates the score obtained to the expected morbidity and mortality. If 6.5 is taken as a critical value beyond which all patients may be predicted to die or be disabled by operation, then the accuracy of prediction is about 81%. The overall morbidity and mortality for this procedure was 34%; of these patients 4% bled again. Re-bleeding occurred at 5 days, 2 months, 6 months, and 15 months. This is comparable to another recently reported series. The follow-up period ranged from 6 months to 5 years (average 3 years).

Discussion

If surgical therapy was uniformly effective in the treatment of anterior communicating aneurysms or if, on the other hand, all patients ultimately bled again, there would be no problem in patient selection since all cases would need surgery. But the results in unselected operative series are not always good while the results in non-operative series are by no means uniformly bad. What is needed is a way of selecting the best treatment for each individual case, reserving surgery for those individuals in whom the prognosis with conservative therapy is poor. There are clinical and angiographic features that determine which patients will rebleed and which will not survive operation. For example, the level of consciousness has obvious prognostic value. Had we only operated upon alert patients we might have reported an “overall” mortality and morbidity of 16%. Furthermore, hypertension and age influence the outcome; with considerable confidence we can predict an unfavorable outcome for a moribund 75-year-old hypertensive patient and a favorable result for an alert, 18-year-old normotensive patient. Between these extremes, prediction is less easy and it is here that discriminative function analysis may be useful. This technique has been successfully applied in paleoanthropology and is potentially applicable in many but not all phases of cerebrovascular disease. Moreover, an unsuccessful attempt to find factors of prognostic value for hydrocephalic children has recently been reported.

Traditionally reported overall statistics are of course almost entirely dependent upon patient selection and therefore only occasionally meaningful. For instance, it is valuable to know that a reasonable mortality rate is at least possible in the surgical treatment of basilar aneurysms. However, when confronted with the individual, such statistics are of little significance. The surgeon and neurologist must evaluate present-day surgical therapy against the natural history of the disease and in this situation recourse to clinical impression or overall mortalities from a selected series is irrelevant. What does matter are the determinant clinical and angiographic features in each case.

Discriminative function analysis is potentially applicable as an objective method for deciding on the treatment of aneurysms. The same method of treatment is not appropriate for everyone. Some patients will have the best prognosis if bed rest only is employed; other may benefit from hypothermia, clipping of the proximal anterior cerebral artery or direct attack on the aneurysm. In any case the proper decision should not be a matter of chance but should depend upon factors peculiar to the individual patient and the individual aneurysm. These factors may be appreciated by the analysis of large series of uniformly treated cases, whether random or selected. Discriminative function analysis may then be employed to combine the factors and thus deduce the best treatment for each individual.

A major defect in the present study is that the equation derived has not been tested upon an independent group of cases. This must be done before it can be considered valid.

Summary

We have derived a formula (discriminative function) by which the mortality and morbidity for one type of operative procedure for anterior communicating aneurysms can be predicted. We had previously described an equation for the prediction of mortality without operation. We have found that a comparison of these two statements may give a valuable indication of which form of therapy will carry the lowest mortality. We have indicated the desirability of future verification and extension of this technique.
References