Significance of Cerebrospinal Fluid Pressure in Determining Time for Repair of Intracranial Aneurysms*

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Although the optimum time for the repair of intracranial aneurysms has yet to be determined, the assessment and grading of the patient's clinical status has permitted certain implications with regard to surgical risk and prognosis. As shown by Hunt and Hess, patients graded I or II may be operated on early with some assurance of survival. Surgery in Grade III patients is accompanied by a high mortality. A lower operative mortality may be achieved in Grade III patients by treating them conservatively until their clinical condition has improved. However, patients in this group may deteriorate or die while awaiting improvement in their clinical condition. Early operation in this group would be desirable if a method could be determined that would reduce mortality.

It has long been the impression of one of us (W.B.H.) that patients in whom operation is delayed until the cerebrospinal fluid pressure has reached a normal level (less than 200 mm of water) fare better than those operated on with elevated pressures. The elevated pressure is not considered primarily significant, but, rather, that it indicates a brain remaining in a state of acute injury. The artificial reduction of elevated pressure by means of cerebrospinal fluid drainage or by the use of urea or Mannitol infusions would not be expected to lower the operative mortality, since the cause of the pressure elevation is not eliminated. The spontaneous return of cerebrospinal fluid pressure to a normal level suggests resolution of brain injury and implies that a previously traumatized and swollen brain can be more safely manipulated at the time of operation. Resolution of brain injury with reduction of pressure might occur before improvement in the status of the patient if the neurological deficit was due to persistent vasospasm. The validity of this theory has never been documented by case analysis. Review of the literature provides no evidence of the use of cerebrospinal fluid pressure measurement as a means of determining the time for surgical intervention.

In the 10-year period from 1958 to 1968, 123 patients were seen at the Cleveland Clinic with subarachnoid hemorrhage due to ruptured intracranial aneurysms and in whom cerebrospinal fluid pressures were monitored. All 123 patients were considered potential surgical candidates, and 112 subsequently underwent intracranial surgical procedures for the repair of aneurysms. These cases have been analyzed to evaluate the effectiveness of cerebrospinal fluid pressure monitoring as a means of determining the time for repair of intracranial aneurysms.

Method

Patients admitted to the service with subarachnoid hemorrhage were graded clinically, and subjected to lumbar puncture. Opening pressures were recorded and fluid removed slowly in quantities sufficient to reduce the pressure to one-half its original level. The object was to diminish the restlessness and discomfort caused by elevated pressure. When an intracerebral hematoma was suspected, angiography and the indicated surgery were performed the day of admission; otherwise angiography was done on the following morning. Patients were put on a basal living routine. If hypertension existed (blood pressure greater than 140/90 mm Hg), the blood pressure was controlled by medical therapy at a level near normal. If the initial cerebrospinal fluid (CSF) pressure was greater than 200 mm, lumbar puncture was repeated daily and the pressure...
slowly reduced by one-half each time. When the opening pressure had reached 200 mm, the patient was operated on. Patients with progressing neurological deficits were of course operated on sooner.

Patients were graded according to the method of Hunt and Hess. They were included in Grade I if they were asymptomatic, had minimal headache, or slight neck stiffness. They were rated Grade II if they had moderate-to-severe headache, neck stiffness, and no neurological deficit other than cranial nerve palsies. They were considered Grade III if they exhibited drowsiness, confusion, or mild focal deficit. Patients were rated Grade IV if they showed signs of stupor, moderate-to-severe hemiparesis, or possibly early decerebrate rigidity and vegetative disturbances.

Grade V was reserved for those who were in deep coma, showed decerebrate rigidity, or were obviously moribund. In this series no patient considered to be a Grade V risk was operated on. The presence of serious systemic disease such as hypertension, diabetes, severe arteriosclerosis, or chronic pulmonary disease placed the patient in the next less favorable category.

**Analysis of Cases**

*Surgical Treatment.* Of 112 patients who underwent intracranial surgical procedures, 29 died (26%); the operative mortality increased with the severity of the clinical grade (Table 1).

Of the 73 patients who underwent surgery with pressures below 200 mm of water, 14 died (19%); while of the 39 patients operated upon with pressures above 200, 15 died (38%). Although the difference in mortality was striking, even a 19% mortality is too high. Since each group contained both good and poor risk patients, the clinical status of the patient must also have been significant.

Table 2 summarizes the results when both the clinical grade and the cerebrospinal fluid pressure were considered. There was little difference in mortality between patients with low and elevated pressures in Grades I, II, and IV. However, of the 23 Grade III patients who underwent surgery with pressures below 200 mm of water, four died (17%); while of the 17 patients operated on with pressures above 200, seven died (41%). Cerebrospinal fluid pressure monitoring seemed to be most prognostic in this group.

*Results of Delay in Treatment.* Eleven patients considered potential surgical candidates died before surgery was performed. Three were Grade III risks with normal cerebrospinal fluid pressures, whose deaths could not be attributed to delay from cerebrospinal fluid pressure monitoring.

Of the remaining eight patients, all died while awaiting return of cerebrospinal fluid pressure to normal. Four patients were Grade III risks. It is questionable that sur-