Microsurgical technique in the treatment of intracranial aneurysms.

Ephraim I. Zlotnik, M.D., Fedor V. Oleshkevich, M.D., and Joseph Z. Stolkarts

Division of Neurosurgery, Byelorussian Scientific Research Institute of Neurology, Neurosurgery and Physiotherapy, Minsk, U.S.S.R.

A consecutive series of 137 patients with cerebral aneurysms operated on with microsurgical techniques is presented. Occlusion of the aneurysm was performed in 133 patients. Good results were obtained in 85.5% of the entire series and in 92.6% of the patients who were in satisfactory condition preoperatively. The overall mortality rate was 5.8%, and 3.7% for the patients in satisfactory condition. The preoperative and operative factors that influenced the results are discussed.

Key Words • microsurgery • aneurysms

A study of unoperated patients with aneurysms seen 6 weeks or more after hemorrhage revealed a very good natural prognosis. Thus, surgery performed on patients who are in good condition 2 to 5 weeks or more after the rupture of an aneurysm should ideally result in very low mortality and morbidity rates. The operating microscope is a valuable aid in the handling of these cases. Krayenbühl, et al.,9 reported successful microsurgical treatment in 112 cases of intracranial aneurysm; there were no deaths in his series.

We have been using an operating microscope for 7 years. In presenting our experience we shall discuss the principal complications of surgical intervention, namely, the danger of rupture of the aneurysm during operation and the clipping of functionally significant arteries. We will also present our postoperative results and mortality rate.

Clinical Material and Method

Between February, 1968, and November, 1975, we carried out 137 operations in patients with saccular aneurysms of the internal carotid artery and its branches. In each case we used the operating microscope. In 133 patients the neck of the aneurysm was occluded. The location of the aneurysms and the preoperative condition of the patients are noted in Table 1.

Craniotomy was performed through a linear incision. Aneurysms of the internal carotid artery (ICA) were approached subfrontally along the sphenoid wing. Middle cerebral artery (MCA) aneurysms were exposed by separation of the Sylvian fissure. In cases of anterior cerebral-anterior communicating artery (ACA-ACoA) aneurysms a unilateral frontal craniotomy was performed; the approach to these aneurysms was...
E. I. Zlotnik, F. V. Oleshkevich and J. Z. Stolkarts

TABLE 1
Preoperative condition of patients and distribution of aneurysms

<table>
<thead>
<tr>
<th>Location of Aneurysm</th>
<th>Preoperative Condition*</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>internal carotid artery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>anterior cerebral —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>anterior comm. artery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>middle cerebral artery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Good = Grades I and II; fair = Grade III; and poor = Grades IV and V on the Botterell scale.

made through the interhemispheric fissure. The operating microscope was focused after trephination. Microsurgical manipulations at \( \times 5 \) to \( \times 12.5 \) were begun after the large vessels near the aneurysm had been exposed.

**Summary of Cases**

**Complications During Operation**

The aneurysm ruptured during the operation in 11 patients (8%) (Table 2). In seven of these 11 patients no postoperative complications were noted. In two cases persistent hemiparesis occurred. Two patients with ICA aneurysms (Cases 6 and 7) died following occlusion of the ICA performed to arrest hemorrhage.

Erroneous occlusion of a large artery occurred in only one patient who was operated on for an ACA-ACoA aneurysm (Case 3). In this case the Ao segment arose from the ACoA and was closely adherent to the posterior wall of the aneurysm. This artery was not visualized on angiogram, and was clipped with the neck of the aneurysm. The patient died, and autopsy revealed infarction of the medio-basal regions of both frontal lobes and basal ganglia.

**Outcome and Mortality**

The relationship of outcome of surgical treatment to preoperative condition and site of aneurysm is summarized in Tables 3 and 4. Results were considered good when the patients made a practically complete recovery (117 of 137 cases). The 10 cases with fair results had neurological lesions that had existed before the operation. In the three cases with poor results the patients became disabled as a consequence of complications during surgery. Seven patients (5.8%) died during the postoperative period. Postoperative mortality in patients whose preoperative condition was satisfactory was 3.7%. Brief reports on the course of the patients who died follow.

**Case 1.** This 26-year-old woman was admitted in satisfactory condition with an ACA-ACoA aneurysm. On January 30, 1968, the neck of aneurysm was clipped, and she immediately became comatose. A second operation the next day disclosed diffuse edema of the frontal lobes. The patient died 6 days later. Autopsy revealed infarction of the medial part of the right frontal lobe and frontal third of the subcortical ganglia and edema and dislocation of the brain. The clip was found to have occluded the neck of the aneurysm and the ACA was patent.

**Case 2.** This 40-year-old man was admitted in poor condition with an ACA-ACoA aneurysm and hematoma in the right frontal lobe. On February 21, 1972, the neck of the aneurysm was clipped and the hematoma

TABLE 2
Incidence of aneurysm rupture and type of operation performed in 11 patients

<table>
<thead>
<tr>
<th>Location of Aneurysm</th>
<th>Total Cases</th>
<th>Aneurysm Rupture</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dissection</td>
<td>Occlusion of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Aneurysm Neck</td>
</tr>
<tr>
<td>internal carotid artery</td>
<td>45</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>anterior cerebral —</td>
<td>62</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>anterior comm. artery</td>
<td>30</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>middle cerebral artery</td>
<td>137</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>
Results of microsurgery of aneurysms

evacuated. The patient's condition steadily deteriorated to coma, and he died on April 13, 1972. Autopsy revealed an ischemic infarction of both frontal lobes and the basal ganglia of the right hemisphere. The clip had occluded the neck of the aneurysm; all arteries were patent.

Case 3. This 49-year-old man was admitted in fair condition with an ACA-ACoA aneurysm. On April 14, 1973, the neck of the aneurysm was clipped. During the first 8 postoperative days his condition was stable, but then gradually deteriorated to coma, and the patient died on July 5, 1973. At autopsy, infarction of the mediobasal parts of both frontal lobes and subcortical ganglia was found. The clip applied to the neck of the aneurysm had occluded the A2 segment.

Case 4. This 41-year-old woman was admitted in satisfactory condition with an ACA-ACoA aneurysm. On April 15, 1974, the aneurysm neck was clipped. Besides the ruptured ACA-ACoA aneurysm there was a left MCA aneurysm and an infraclinoid ICA aneurysm. The day after surgery her condition worsened dramatically and the operative site was re-exposed. A massive intracerebral hemorrhage into the lateral and third ventricles was revealed and evacuated. This hemorrhage was not connected with the aneurysm. She remained in critical condition and died on April 23, 1974. Autopsy revealed traces of an evacuated hematoma in the left hemisphere with blood clots in all ventricles. The left MCA aneurysm was not ruptured. The clip had occluded the neck of the ACA-ACoA aneurysm.

Case 5. This 39-year-old man had a right supraclinoid ICA aneurysm. On June 10, 1969, the neck of the aneurysm was clipped. The patient was in poor condition, stuporous, and with left-sided hemiparesis, having suffered diffuse arterial spasm 48 hours previously. His condition remained grave, and he died 3 days postoperatively. Autopsy showed an infarction in the right hemisphere and edema and dislocation of the brain. The clip had occluded the neck of the aneurysm, and the ICA remained patent.

Case 6. This 41-year-old woman was admitted in satisfactory condition with an aneurysm of the supraclinoid portion of the left ICA. On March 18, 1974, during clipping, there was a massive hemorrhage from the neck of the aneurysm that could be stopped only by clipping the ICA proximal and distal to the aneurysm. The ICA was occluded when the systolic arterial pressure was 60 mm Hg. After the operation her condition remained grave, and 4 days later she died. Autopsy revealed infarction of the left hemisphere and edema and dislocation of the brain.

Case 7. This 41-year-old woman was admitted in satisfactory condition with a

### TABLE 3

<table>
<thead>
<tr>
<th>Preoperative Condition</th>
<th>No. of Cases</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Good</td>
</tr>
<tr>
<td>poor</td>
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<td>3</td>
</tr>
<tr>
<td>fair</td>
<td>23</td>
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<td>109</td>
<td>102</td>
</tr>
<tr>
<td>total</td>
<td>137</td>
<td>117</td>
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</tbody>
</table>

### TABLE 4

<table>
<thead>
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<th>Location of Aneurysm</th>
<th>No. of Cases</th>
<th>Results</th>
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<tbody>
<tr>
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<td>Good</td>
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<tr>
<td>internal carotid artery</td>
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<td>35</td>
</tr>
<tr>
<td>anterior cerebral –</td>
<td>62</td>
<td>53</td>
</tr>
<tr>
<td>anterior comm. artery</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>middle cerebral artery</td>
<td>137</td>
<td>117</td>
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</table>
supraclinoid aneurysm of the right ICA. On April 23, 1974, as the ICA was being exposed, a profuse hemorrhage occurred which could be arrested only by clipping the vessels proximal and distal to the aneurysm. The next day the patient died. The autopsy revealed infarction of the right hemisphere and dislocation of the brain. The clip had occluded the ICA.

Discussion

All neurosurgeons using the operating microscope are favorably impressed with it. With microsurgical techniques, occlusion of the aneurysmal neck can be achieved in practically all cases except for those of very large aneurysms, with minimal risk for the patients' life and brain function.

The results of these operations depend on how completely the aneurysm is excluded from the blood flow. According to some reports, the aneurysm still communicated with the blood flow after occlusion of the neck in 4% to 17% of cases. In such cases, Drake and Allcock recommend reoperation, considering the risk to be less than that of repeated rupture. Microsurgical technique permits precise clip application and decreases the incidence of partial occlusion of the neck of the aneurysm. Of 126 patients in our series discharged after occlusion of the neck of the aneurysm, 111 underwent follow-up angiography. Complete exclusion of the aneurysm from the blood flow was confirmed in all cases.

The complication of aneurysm rupture during surgery is not infrequent; Pertuiset, et al., reported ruptures in 80 of 190 cases, and Krayenbühl, et al., in 48 of 231. With the help of an operating microscope it is possible to identify tissues more precisely and to perform delicate and exact manipulations, thus reducing the risk of rupture. Aneurysm rupture during operation occurred in 11 of our patients (8%); in seven of them the neck of the aneurysm was successfully occluded.

Oclusion of functionally significant vessels when clipping the neck of the aneurysm is a grave complication that sometimes occurs with ordinary operative technique. Microsurgical technique makes it possible almost always to avoid this complication. In only one patient in our series of 133 patients was a large anomalous cerebral artery (A2 segment) clipped erroneously with the neck of the aneurysm.

Microsurgery and careful interpretation of indications for operation have made it possible to reduce postoperative mortality to between 2% and 6%. This has been confirmed by our experience: of a total of 137 operated patients, seven died (5.8%), and of 109 patients operated on in good condition, four died (3.7%). Thus our findings show that microsurgical technique makes it possible to improve results of operations for intracranial saccular aneurysms.

References

Results of microsurgery of aneurysms


*Address reprint requests to:* Ephraim I. Zlotnik, M.D., Division of Neurosurgery, Byelorussian Scientific Research Institute of Neurology, Neurosurgery and Physiotherapy, Minsk, U.S.S.R.