Vascular anomalies associated with aneurysms of the anterior communicating artery: microsurgical observations

AKIRA OGAWA, M.D., MICHIYASU SUZUKI, M.D., YOSHIHARU SAKURAI, M.D., AND TAKASHI YOSHIMOTO, M.D.

Division of Neurosurgery, Institute of Brain Diseases, Tohoku University School of Medicine, and Department of Neurosurgery, Stroke Center, Sendai National Hospital, Sendai, Japan

Direct operations were performed on 206 patients with aneurysms of the anterior communicating artery (ACoA) using a bifrontal craniotomy and an interhemispheric approach. A total of 44 (21.4%) of these patients had vascular anomalies in the vicinity of the ACoA; these included a median artery of the corpus callosum (MACC) in 27 cases (13.1%), duplication of the ACoA in 20 (9.7%), and duplication of the A1 segment of the anterior cerebral artery in one (0.5%). A retrospective study of the angiograms indicated that diagnosis of the A1 or ACoA duplication was not possible; only 11 (41%) of the 27 MACC's were easily identified, while eight (30%) could not be diagnosed. The majority of the cases of ACoA aneurysms with MACC (81.5%) showed trifurcation of the ACoA, A2, and MACC. The operative results in the patients with MACC did not differ significantly from the results of the entire ACoA aneurysm series. From the above study it is concluded that, regardless of whether a vascular anomaly has been identified preoperatively, ACoA aneurysm surgery should be undertaken with that possibility in mind. A bifrontal craniotomy and an interhemispheric approach has the advantage of allowing for a wide operative field and the attainment of a good understanding of the vascular structures near the ACoA. It is particularly useful in cases of vascular anomaly in this region.

KEY WORDS • anterior communicating artery • aneurysm • corpus callosum • vascular anomaly • operative approach

A variety of surgical approaches have been devised for treatment of anterior communicating artery (ACoA) aneurysms. We use a bifrontal craniotomy and an interhemispheric approach, which allows for both preservation of the olfactory nerves and treatment of the aneurysm after identification of the vascular structures around the ACoA, including the hypothalamic artery (which branches from the ACoA) and the A1 and A2 portions of the anterior cerebral artery (ACA) bilaterally. We have found a much higher incidence of vascular anomalies in the vicinity of the ACoA among our patients with ACoA aneurysms than has previously been reported. We discuss our findings and surgical results, and comment on the effectiveness of the operative methods.

Clinical Material and Methods

Operative Technique

This series included 206 patients with ACoA aneurysms, including multiple aneurysms, on whom radical operations were performed during a period of 5 1/2 years.

Briefly, the operative technique is as follows. A bifrontal craniotomy is carried out and a surgical microscope is used for all subsequent work. After both olfactory nerves are dissected as far as the olfactory trigone, the aneurysm is approached through the interhemispheric fissure. The ACA is identified bilaterally at the genu of the corpus callosum, then dissection proceeds in the interhemispheric fissure until the region of the ACoA is reached. At this point, 500 ml mannitol, 500 mg vitamin E, and 500 mg phenytoin are administered for cerebral protection. The vessels feeding the aneurysm are then temporarily occluded and the entire aneurysm is dissected. The hypothalamic artery and the origins of the A1 and A2 portions are identified bilaterally. Once an understanding of the relationship between the aneurysm and the surrounding vascular structures is obtained, the neck of the aneurysm is treated.

Study Methods

In the present study, the type and origin of the vascular anomalies of the ACoA and ACA were examined on the basis of the operative findings. A retro-
Vascular anomalies in cases of ACoA aneurysm

dpective study was made of the preoperative bilateral carotid angiograms in all cases in which vascular anomalies were found. It was then determined whether it would have been possible to make a preoperative diagnosis of the subsequently identified vascular anomalies. The operative results in patients with vascular anomalies were assessed and compared with those of ACoA aneurysm patients without such anomalies. The median artery of the corpus callosum (MACC) is defined as a vessel found at surgery to branch from the ACoA, with a diameter almost similar to that of the A2 portion, which perfuses the corpus callosum and bilateral cerebral hemispheres.

The time interval between the last subarachnoid hemorrhage and surgery was determined: less than 48 hours in 83 cases (acute-stage operations), between 2 and 7 days in 39 cases, between 1 and 2 weeks in 35 cases, and more than 2 weeks in four cases. Operations were also carried out in nine patients with unruptured aneurysms.

The Hunt and Kosnik5 classification was used for evaluating the patients' preoperative condition. Criteria such as vasospasm, chronic pulmonary disorders, arteriosclerosis, diabetes, or hypertension were not considered in the classification. For evaluation of the operative results, the following five-stage classification system was used at the time of discharge from the hospital: excellent, in which the patient is able to return to normal life; good, in which mild neurological symptoms remained, but social life is possible; fair, in which social life is not possible, but domestic life does not require assistance; poor, in which assistance is needed even in domestic life; and dead.

Results

Vascular Anomalies Found at Surgery

Forty-four (21.4%) of the 206 patients exhibited vascular anomalies of some kind. The most common anomaly was an MACC, found in 27 cases (13.1%); duplication of the ACoA was found in 20 cases (9.7%) and duplication of the A1 in one case (0.5%). An MACC and duplication of the ACoA coexisted in four cases. It was found that 22 of the 27 patients with MACC had the aneurysm at the trifurcation of the MACC, the branching point of the ACoA, and the ipsilateral A1 or A2 (Type A). In the other five patients the aneurysm arose at the bifurcation of the ACoA, and the ipsilateral A1 or A2 (Type B) (Fig. 1). There was a slight left-sided predominance of both types of abnormality: 14 Type A abnormalities were located on the left and eight on the right, and three Type B anomalies occurred on the left and two on the right.

Angiographical Findings

On retrospective examination of the angiograms, the MACC was visualized in unilateral carotid angiograms from the origin of the bilateral A2 portions in 11 of the 27 MACC cases. In eight further cases, unilateral carotid angiograms revealed the MACC and ipsilateral A2 portions, whereas contralateral carotid angiograms showed only the contralateral A2 segment (Fig. 2). Diagnosis of the MACC on the basis of preoperative angiograms was impossible in the remaining eight cases. Inability to diagnose the MACC was due to the narrow diameter of the MACC in five cases and to the poor quality of the angiograms in three. Preoperative diagnosis of the A1 duplication was not possible in the one patient with a coexisting A1 duplication and MACC.

Operative Results

The preoperative condition of the patients with an MACC was: Grade 0 in one case, Grade I in 11, Grade II in 10, Grade III in four, and Grade IV in one. The outcome assessed at the time of discharge from the hospital was excellent in 17 cases, good in seven, and fair in two; one patient had died (Table 1). These results compare favorably with those of the entire series of 206 patients with ACoA aneurysms, whose preoperative Grades were as follows: Grade 0 in nine cases, Grade I in 42, Grade Ia in 13, Grade II in 91, Grade III in 41, and Grade IV in 10. The outcome at discharge from the hospital of these 206 patients was excellent in 125, good in 46, fair in 20, and poor in four; 11 had died (Table 2). In other words, in this series of patients, there was no tendency for poorer operative results among the

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
</table>

Operative results in 27 cases of anterior communicating artery aneurysms associated with median artery of corpus callosum

<table>
<thead>
<tr>
<th>Preop Grade†</th>
<th>Operative Result‡</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Ia</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>III</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total cases</td>
<td>17</td>
<td>7</td>
</tr>
</tbody>
</table>

† For definition see text.
A. Ogawa, et al.

**Fig. 2.** Right carotid angiography (left) showing the right A2 segment and left carotid angiography (right) showing the left A2 segment and the median artery of the corpus callosum (MACC, arrows). There was a possibility of misidentification of the MACC as the contralateral A2 portion.

**TABLE 2**

Operative results in entire series of 206 cases of anterior communicating artery aneurysms

<table>
<thead>
<tr>
<th>Preop Grade*</th>
<th>Operative Result†</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>I</td>
<td>36</td>
<td>3</td>
</tr>
<tr>
<td>Ia</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>II</td>
<td>59</td>
<td>20</td>
</tr>
<tr>
<td>III</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>IV</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>V</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total cases</td>
<td>125</td>
<td>46</td>
</tr>
</tbody>
</table>

*Grading according to the classification of Hunt and Kosnik.†For definition see text.

**ACoA aneurysm patients with vascular anomalies in the vicinity of the ACoA.**

**Discussion**

It is well known that cases of anomaly in the region of the ACoA are numerous, and many studies have reported on ACoA aplasia, duplication of the ACoA or A1 segment, A1 hypoplasia or aplasia, azygous ACA, MACC, and related conditions. We found vascular anomalies in 44 (21.4%) of our 206 patients with ACoA aneurysm undergoing direct operation. Among these, 27 anomalies (13.1%) were MACC’s, 20 (9.7%) were duplications of the ACoA, and one (0.5%) was a duplication of the A1 portion.

Of particular clinical importance is the frequently encountered MACC which becomes one of the draining arteries of the ACoA aneurysm. Several terms have been used for the MACC, including “medial ACA,” “median callosal artery,” “superior callosal artery,” “third A2 artery,” “triplicated ACA,” and “accessory ACA.” As a branch of the ACoA, the MACC is known to supply blood to the corpus callosum, septal nuclei, septum pellucidum, rostral portions of the fornix, and a part of the frontal lobes. Because definitions of the MACC vary widely, so do their reported incidence. From autopsy studies, Lemos and Baptista reported an incidence of 89.2% and 99.4%, respectively. Relatively thick vessels which could easily be seen with the naked eye and which perfused a portion of the ACA region were found in 20% and 13.1% of these individuals, respectively. A 64% incidence in fetal and neonatal autopsy material and a 3.2% to 22.0% incidence in adult autopsy material have been reported. Although the MACC is considered a trunk vessel branching from the ACoA and perfusing part of the brain normally fed by the ACA, the number of reports of angiographic or operative identification of this vessel is...
Vascular anomalies in cases of ACoA aneurysm

quite small. Kwak, et al., identified an MACC in 13 (4.4%) of 296 cases either from angiograms or during direct operations on ACoA aneurysms.

The incidence of MACC in our series of 206 patients with ACoA aneurysms was 13.1% (27 cases), higher than that reported previously. We believe that this high incidence is due to our surgical technique rather than to differences in the makeup of our patients. That is, by approaching the ACoA interhemispherically and occluding feeder arteries, we obtain a sufficiently wide operative field and can completely dissect the aneurysm as well as identify the vascular structures in the vicinity of the ACoA, including the hypothalamic artery. It is also noteworthy that we undertake the surgery cognizant of the possibility of an MACC being present.

With regard to the preoperative diagnosis of these anomalies, it was found that even on detailed retrospective examination of the angiograms diagnosis of fenestration of the A1 portion or ACoA was difficult or impossible. In five cases the MACC was found at surgery to be small and not distinguishable in preoperative angiograms. Among the remaining 22 MACC cases in which preoperative diagnosis might have been possible, it was found that the MACC could be distinguished from the bilateral A1 portions in only 11 cases (50%) from unilateral carotid angiograms. In eight cases (36.4%) in which carotid angiography revealed both the ipsilateral A1 portion and the MACC and in which contralateral carotid angiography revealed the contralateral A2, the MACC could have been wrongly identified as the contralateral A2 portion. These findings indicate the need for careful examination of preoperative angiograms bearing in mind the possibility of the presence of an MACC. In some cases the quality of the angiography itself is poor, adding to the difficulty of definitive preoperative diagnosis of vascular anomalies near the ACoA.

We studied the problems which arise in direct surgery on ACoA aneurysms in patients with MACC's. The MACC runs parallel to and behind the normal pericallosal artery. It has been reported that it can be difficult to identify such aneurysms, depending upon their orientation, and it is easy to damage them during surgery. Although most ACoA aneurysms arise at the bifurcation of the ACoA and the A2 portion, in our series of 27 patients with MACC's we found that the aneurysm arose at the trifurcation of the ACoA, the A1 portion, and the MACC in 22 cases (81.5%). This finding suggests why there is a strong possibility of damaging any one of the three arteries feeding the aneurysm at the trifurcation, if surgery is undertaken assuming that it is a usual ACoA aneurysm without vascular anomalies.

From this study we conclude that, regardless of whether a vascular anomaly has been identified preoperatively, ACoA aneurysm surgery should be undertaken with the possibility of an MACC in mind. The surgical technique which we use (a bifrontal craniotomy and an interhemispheric approach) has the advantage of allowing a wide operative field and the attainment of a good understanding of the vascular structures near the ACoA. The use of this approach is particularly advantageous in patients with a vascular anomaly in this region. In fact, our operative results indicate that the outcome of such cases is slightly better than that of patients with ACoA aneurysms without an MACC. We conclude that use of this surgical method will not be a cause of poorer operative results with or without vascular anomalies in the vicinity of the ACoA.

The cause of death in our 11 fatalities (5.3% of the total 206 cases of ACoA aneurysm) was vasospasm, gastrointestinal bleeding, cardiac failure, or renal failure. No patient has died from problems arising during the operation, and we conclude that this surgical method is both reliable and safe.

References

Manuscript received July 26, 1988. Accepted in final form October 26, 1989.

Address reprint requests to: Akira Ogawa, M.D., Division of Neurosurgery, Institute of Brain Diseases, Tohoku University School of Medicine, 1-1 Seiryo-machi, Sendai 980, Japan.