Classification of Anterior Communicating Aneurysms as a Basis for Surgical Approach

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The anterior communicating arterial complex provides one of the most common sites for the development of saccular aneurysms. Estimates of frequency of involvement of this area vary from Dandy’s early report of 18.8% (25 of 133 cases) to Riggs’s report of 60% (79 of 131 cases found in 1437 consecutive autopsies). The figure of 27.4% (485 of 1769 aneurysms) in McKissock’s series as reported by Bull is probably a representative statistic.\(^3\)

The development of this aneurysm when untreated is disastrous; conservative management is associated with a 40% to 70% mortality rate.\(^{13-15}\) For this reason various methods of surgical treatment have been advocated and instituted.

Successful treatment of aneurysms by intracranial surgery requires careful planning of the surgical approach. Berry aneurysms are most commonly saccular in configuration and most often rupture at their fundi. It is logical, therefore, that they can best be treated if the neck is isolated from the circulation without disturbing the dome. Aneurysms of the anterior communicating complex more than aneurysms of any other location can project in a myriad of directions. Since the area of the anterior communicating artery can be approached from several different directions, it is desirable to separate these aneurysms into groups appropriate to the method by which they can best be attacked.

Following this basic philosophy, anterior communicating artery aneurysms are treated by two very distinct approaches at Walter Reed General Hospital. As a result, the preoperative arteriogram has become a key to planning the operative approach. In aneurysms that project superiorly, a subfrontal approach to the anterior communicating complex is used. However, all aneurysms which point inferiorly are approached from above by making an incision through the gyrus rectus. The technique of this unique procedure has been described in Operative Neurosurgery.\(^{11}\) Figure 1 illustrates the authors’ division of aneurysms of the anterior communicating complex in which these two techniques are used.

**Material**

We reviewed 100 consecutive cases of aneurysms of the anterior communicating artery covering a 12-year period at Walter Reed General Hospital. Preoperative and postoperative arteriograms were most signifi-

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cant, although operative narratives, drawings, photographs, and movies were helpful. Each aneurysm was categorized by the direction in which it projected (measured as a straight line from base to fundus): 1) inferior, 2) posterior-inferior, 3) posterior, 4) posterior-superior, 5) superior, 6) anterior-superior, 7) anterior, and 8) anterior-inferior. The lateral film of the carotid arteriogram was most helpful in making this classification. In each case, we tried to determine the exact origin of the base of the aneurysm. In this regard, oblique films, operative photographs, drawings, and narratives were of greatest assistance. We also tabulated all possible information concerning the anatomical configuration of the circle of Willis. The size and configuration of each aneurysm was noted. The size of the aneurysm was estimated by two different methods. The equation for the volume of a sphere \( V = \frac{4}{3} \pi r^3 \) in which \( r \) equals \( \frac{1}{2} \) the largest diameter proved to be a fairly reliable index to comparing the volumes of these aneurysms. As a check to this method, a second approximation was made using the formula which Di Chiro\(^\dagger\) has used to determine the volume of the sella turcica, namely, \( V = \frac{1}{2} \) (length \( \times \) width \( \times \) height).

**Results and Conclusions**

*Direction of Projection.* In 98 of 100 cases, a valid decision could be made as to which of the eight categories of projection applied. Significantly, 70.5\% of these aneurysms projected in a direction within the arc of the circle shown in Fig. 1 for which the gyrus rectus approach is used.  

*Size.* Assuming these aneurysms to be sphere-shaped, we found the average volume to be 947 cu mm, which represents the volume of an aneurysm approximately 12 mm in greatest diameter. Those aneurysms projecting superiorly were significantly larger than those pointing inferiorly. In 29 superiorly projecting aneurysms, the mean volume was 1996 cu mm, whereas in the 68 inferiorly projecting aneurysms it was only 500 cu mm. However, because of a few very large aneurysms that primarily projected superiorly, perhaps the median would be a more meaningful comparison. Indeed, the median size of all the aneurysms was 268 cu mm. The median volume of superiorly projecting aneurysms was 381 cu mm as compared with 268 cu mm for those pointing inferiorly. The median diameter of all aneurysms calculated in this manner would then be 8 mm. Therefore, the only conclusion that can be drawn from comparing the relative size of the various aneurysms is that giant aneurysms (those greater than 18 mm in diameter) tend to project superiorly, an observation that might have been anticipated from the anatomical position of the anterior communicating complex.

Assuming the shape of the aneurysms to be ellipsoid rather than spherical, we found the calculated volumes to be smaller. By this method the average volume was only 432 cu mm, which represents the volume of an aneurysm approximately \( 8 \times 9 \times 12 \text{ mm} \).

*Multiplicity.* Twelve patients had more than one aneurysm and two patients had more than two. These aneurysms varied so greatly in location that no statistically valid conclusion could be reached correlating the anterior communicating artery aneurysm with aneurysms at any other locus.

*Origin.* By reviewing oblique projections of carotid arteriograms and operative narrations, a statement could be made with regard to the origin of the base of the aneurysm in 44 of the cases, and in these the anterior portion of the circle of Willis was carefully studied. In 35, there was marked discrepancy in the size of the proximal anterior cerebral arteries on the two sides (Fig. 2). It is remarkable that in 24 of this group the aneurysm arose at the junction of the dominant anterior cerebral artery and the anterior communicating artery, while only five arose from the junction of the nondominant anterior cerebral artery and anterior communicating artery. The remaining six were broad-necked aneurysms arising from the anterior communicating artery itself. Testing the hypothesis that aneurysms should arise

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**Fig. 2.** Three diagrams showing sites of origin of anterior communicating artery aneurysms. The number of cases in which there was a marked asymmetry in the size of the two proximal anterior cerebral arteries were (from left to right) 6, 5, and 24 cases.
in a random location was not a specific purpose of this review. The finding was not expected and therefore can be tested for statistical significance. The observation that most anterior communicating artery aneurysms arise at the junction of the dominant anterior cerebral artery with the anterior communicating artery is statistically significant (p = < 0.01, using chi square).

Discussion

Review of these 100 cases of anterior communicating artery aneurysms has shown that a large majority (70.5%) project in an inferior direction. Although no large series is available to confirm this observation, it is consistent with Falconer's conclusion regarding 11 cases of anterior communicating artery aneurysms in which most projected "forwards and downwards." Norlén and Barnum also noted this direction of projection in most of their 19 cases. It is highly significant to note in these cases that if the commonly used subfrontal approach were utilized the fundus of the aneurysm would be reached before the anterior communicating artery itself. In this event, rupture of the aneurysm prematurely would seem to be a very great hazard.

The configuration of the anterior half of the Willisian polygon suggests an interesting observation that may be significant in understanding the etiology of cerebral aneurysms: the aneurysm is most likely to arise at the junction of the dominant anterior cerebral artery with the anterior communicating artery.

Arterial spasm is one of several factors that may account for the discrepancy in size of the two anterior cerebral arteries proximal to the anterior communicating artery. However, since spasm is most likely to occur in an area close to the origin of the aneurysm, it seems likely that it would cause the converse of the observed relationship; that the anterior cerebral artery on the side of the aneurysm would be more apt to show spasm than the contralateral artery.

A more likely explanation for this discrepancy in size lies in the congenital development of these vessels. Busse found the anterior communicating complex to be "normal" in only 43% of 400 autopsies. In Riggs' series of 1647 circles of Willis dissected at autopsy, 49% had unilateral focal hypoplasia. Alpers, et al., found filiform or string-like components in 27.5% of 350 circles of Willis. It has been previously observed that the incidence of inequality of the proximal anterior cerebral arteries is even more prevalent in those patients with aneurysms of the anterior communicating complex. Wilson, et al., found that 85% of 40 aneurysms of the anterior communicating artery were associated with hypoplasia of the anterior cerebral artery on one side. These authors, however, do not state the origin of the aneurysms in relation to this asymmetry. Riggs and Rupp in an earlier analysis of 1437 cases found that in 86% of intracranial aneurysms the aneurysm occurred in relation to abnormal formations of the circle of Willis. Padget noted that in individuals with aneurysms, variations in the circle of Willis were about two times as frequent as in those without aneurysms. In Falconer's series, five out of 11 patients with aneurysms of the anterior communicating artery had angiographic evidence of anomalies of the anterior portion of the circle of Willis. Norlén and Barnum noted in reviewing bilateral carotid arteriograms in 20 patients with anterior communicating artery aneurysms that the aneurysm and both distal anterior cerebral arteries filled from one side in 15 cases. Krigis, et al., noted an unusually high incidence of aneurysms in this location with their "anterior trifurcation syndrome."

The frequency with which aneurysms arise at the junction of the dominant anterior cerebral and anterior communicating arteries merits some additional comment with regard to aneurysmal etiology. Forbus pointed out that medial defects are very common at bifurcations of cerebral vessels. On the other hand, Bremer has suggested that persistent remnants of embryonic vessels might lead to aneurysmal formation. A third view was held by Hackel who described a progressive fragmentation of the elastic layer occurring at areas of bifurcation of cerebral vessels. Whether one believes in congenital defects or postnatal changes as the etiology of aneurysms, the obvious hemodynamic implications of this observation are of interest. Perhaps a structural malformation, by producing local alterations in intravascular hemodynamics, may provide a mechanical basis
for the development of an aneurysm in an area where a bifurcation defect is pre-existent.

Sahs,20 in introducing the Report on the Cooperative Study of Intracranial Aneurysms and Subarachnoid Hemorrhage, wrote: "The theory that peculiar hemodynamic factors affect bifurcations in such a way as to exert unusual stress on certain apical regions while providing for the proliferation of intimal pads in a proximal location is a plausible one, and should be investigated further." We believe that this study has provided additional proof of this theory.

Summary

We have classified 100 aneurysms of the anterior communicating complex on the basis of their preoperative arteriograms. Approximately 70% projected inferiorly and 30% superiorly. We have used two distinct surgical approaches based on this classification.

The aneurysms were also analyzed with regard to size, multiplicity, and origin. We have discussed the relationship of the origin of these aneurysms to the configuration of the anterior portion of the circle of Willis as a clue to the etiology of cerebral aneurysms.

References


