Angiographic study of the growth of intracranial aneurysms

JOHN M. ALLCOCK, M.D., F.R.C.P. (C), AND PETER B. CANHAM, M.Sc., Ph.D.

Departments of Diagnostic Radiology and Biophysics, University of Western Ontario, London, Ontario, Canada

The authors have attempted to assess whether there is any standard rate of growth of intracranial aneurysms. Angiographic studies were performed on 67 patients with 82 aneurysms with intervals between angiograms ranging from a few days to 10 years. Examination of these records showed no consistent rate of change in size, possibly partly because of inherent inaccuracies in the method, which are discussed. The clinical reasons for the repeat studies are briefly mentioned. It is concluded that it is unwise to wait and see what may happen to any but perhaps the smallest aneurysm.

KEY WORDS • cerebral aneurysm • rate of growth

It is generally accepted that most untreated intracranial aneurysms will get larger and that beyond a certain critical size, about 0.5 to 0.7 cm in diameter, the risk of rupture becomes higher. However, there is little if any information about the rate of growth of these lesions.

Clinical Material and Method

In an attempt to assess this rate of growth, the records of 67 patients who had more than one angiographic examination were reviewed. Eleven of these had two aneurysms and two patients had three, so that there were 82 aneurysms in all available for study. The interval between the angiograms ranged from a few days to 10 years. The reasons for not treating these patients surgically were varied. In some the sac was too small or too large; others were investigated elsewhere and later sent to this center for treatment. In some of the patients with multiple aneurysms the sac that had ruptured was operated on and another sac treated later.

The best film was chosen from each suitable angiographic sequence. To facilitate measurement, each aneurysm profile was magnified × 5 and a tracing made. Most of the examinations were done with the same radiographic equipment, but when done elsewhere the projection was scaled if necessary to maintain uniform magnification. The cross-sectional area, perimeter, and greatest length were determined by means of a Hewlett-Packard electronic digitizer and desk-top computer.*

Suitable radiographs were available for more than one projection for 75% of the patients; the projected areas were averaged and the mean cross-sectional area was used to calculate the surface area of the sac, which was considered to be spherical in shape.

The degree to which the aneurysms were spherical was determined by comparing the diameter, $d_0$, of a structure of equal area to

*Digitizer and computer manufactured by Hewlett-Packard (Canada) Ltd., 6877 Goreway Drive, Mississauga, Ontario, Canada L4V 1L9.
the maximum projected length, \( l_0 \), measured from the radiograph. The ratio of \( d_0/l_0 \) was 0.83 ± 0.21 SD for 187 radiographs, the value of 1.0 indicating a sphere.

**Results**

The size of an aneurysm at each examination is plotted against time measured from the first angiogram in Fig. 1. It can be seen that many of the angiograms were concentrated in the period soon after detection, but there is a wide range with regard to size and time. The surface areas shown correspond to diameters of 1 mm up to 3 cm.

The change in surface area for each sac plotted against the time between the angiograms for 82 aneurysms is shown in Fig. 2. The striking feature is the biological variability, some aneurysms enlarging rapidly but many not growing significantly even over several years, or becoming apparently smaller.

An attempt was made to determine if aneurysms might enlarge in proportion to their size, \( A \), on first detection by plotting \( \Delta A/A \) versus time (\( \Delta A = \) the change in size between two angiograms). The aneurysms were divided into three groups depending on initial diameter: less than 0.7 cm, between 0.7 and 1.5 cm, and greater than 1.5 cm (Fig. 3). In none of these groups was there any suggestion of a standard rate of growth. It is perhaps of interest that in the first group (up to 0.7 cm in diameter), none of the sacs became much smaller with time, and this may reflect lack of thrombus formation in these small aneurysms.

Figure 4 demonstrates the biological variability in the growth of aneurysms for four patients who each had at least four angiograms. In three patients the sacs were small at
Growth of aneurysms

the first examination. Of these three aneurysms, one remained the same size for about 4 years, another grew slowly over the same period, and the third grew rapidly in a short time. In the last patient the aneurysm was large when first detected, and it did not vary much in size over the years.

As it was clear that the rate of growth of the sac could not be related to time, we thought that there might be some relationship to age or blood pressure. Neither of these factors seemed significant, except in the group of aneurysms initially less than 0.7 cm in diameter. In this group there was a negative correlation of growth with the age of the patient, significant to the 1% level; this agrees with the clinical impression that aneurysms in young people grow more rapidly.

We thought that it would be of interest to analyze the reasons why these patients had further angiograms. These patients underwent repeat angiography for various reasons. These included hemorrhage from a previously intact aneurysm, repeat hemorrhage from a previously ruptured sac, the patient's increasing neurological signs, and to check on another aneurysm that had been treated surgically. For this analysis the aneurysm sacs were divided into three broad groups: 1) those in which there was a less than 10% variation in size; 2) those that decreased in size; and 3) those that increased in size. The results of these findings are shown in Table 1. Of particular interest in these figures is the fact that four out of the 12 aneurysms discovered inci-

**TABLE 1**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Change in Aneurysm Size</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smaller</td>
<td>Same*</td>
</tr>
<tr>
<td><strong>ruptured aneurysms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rebled</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>signs</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>check</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>aneurysms associated with sac that had bled</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bled</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>signs</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>check</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>aneurysms discovered incidentally</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bled</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>signs</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

*Less than 10% variation in size.
FIG. 3. Graphs show change in size of aneurysm relative to initial size on detection plotted against time between examinations. Upper: Aneurysm sac less than 0.7 cm in diameter. Center: Aneurysm sac between 0.7 and 1.5 cm. Lower: Aneurysm sac greater than 1.5 cm.
Growth of aneurysms

FIG. 4. Graph shows change in surface area plotted against time for four aneurysms that were observed at numerous examinations over long periods of time.

dentally did rupture later. Four of the 33 aneurysms associated with a sac that had bled also ruptured subsequently. Eleven of the 37 ruptured aneurysms bled again. Bleeding, re-bleeding, and increasing neurological signs tended to be associated with an increase in the size of the sac.

Discussion

There does not appear to be any consistent rate of growth of aneurysmal sacs. One problem is that it is not known how long a sac has been present at the time of the first angio-

gram, unless one subscribes to the theory that they are all congenital in origin.1 The other difficulty is that aneurysms frequently contain varying amounts of thrombus, which may explain why some of the sacs studied appeared to get smaller. It is not unusual for a neurosurgeon to complain that the sac found at surgery was much larger than suggested on angiography, and this is usually due to the presence of thrombus within the sac. Some estimate of the actual size can often be obtained by the displacement of neighboring vessels, and it is hoped that computerized tomographic scanning may lead to a better realization of the true size of the aneurysm.

An accurate determination of the rate of growth of aneurysms cannot be given. A sac may stay the same size or appear to get smaller over the years or increase in size very slowly. However, a sac that has appeared to be identical on repeat angiography may suddenly increase in size. One cannot, therefore, afford to wait and have another look in 6 months except perhaps in the case of very small aneurysms. In the interval, it may have ruptured or grown much larger.

References


This work was supported in part by the Ontario Heart Foundation.

Address reprint requests to: John M. Allcock, M.D., Department of Diagnostic Radiology, University Hospital, 339 Windermere Road, London, Ontario, Canada N6A 5A5.