PROGNOSIS OF SUBARACHNOID HEMORRHAGE
A COMPARISON BETWEEN PATIENTS WITH VERIFIED ANEURYSMS AND PATIENTS WITH NORMAL ANGIOGRAMS

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(Received for publication December 23, 1956)

It is a well-known fact that the prognosis of subarachnoid hemorrhage is serious; about a third of the patients die from the first bleeding, another third from recurrent hemorrhage, whereas a considerable number of the survivors are incapacitated. 1,6,9,12,14,21 Most authors do not differentiate between the prognosis for patients with proven aneurysms and the prognosis for patients with normal angiographic findings; we have studied these two groups separately. Parkinson18 has made a similar survey on a smaller scale; out of his 8 conservatively treated patients with verified aneurysm, 7 died of recurrent hemorrhage within 2 to 8 weeks, whereas 21 patients without any verifiable aneurysm were alive after follow-up periods varying from 1 to 5 years. Among 18 conservatively treated patients with aneurysm Hamby5 had a mortality of 61 per cent. Dunsome and Polcyn4 reported 81 cases of subarachnoid hemorrhage without angiographically verified aneurysm. Of these patients, they managed to trace 71, 19 of whom had died from recurrent hemorrhage, all but 1 during the first year after the initial hemorrhage, the mortality rate being 27 per cent. However, bilateral angiography had not been performed on all patients in this series; at autopsy an aneurysm was found in 1 of them.

MATERIAL

We have divided our material into 2 groups.

(1) "Aneurysm series": 40 patients with intracranial aneurysm confirmed by angiography or at autopsy, and typical clinical symptoms and signs of subarachnoid hemorrhage even in those cases in which lumbar puncture was not performed during the episode of bleeding.

(2) "No-aneurysm series": 61 patients with subarachnoid hemorrhage verified by lumbar puncture, but with normal bilateral carotid angiograms.

The first group comprises all those patients who were admitted to the neurosurgical department of the Finnish Red Cross Hospital from 1938 to 1955, and on whom no operations were performed, either because they were hospitalized during the early period when we did not treat aneurysms surgically, or because they refused to be operated on or operation was deemed inadvisable. The second series includes all patients from the same period that fulfill the criteria stated above. This means that nearly all patients up to 1947 had to be omitted, because of the fact that, until then, bilateral angiography was seldom performed. Only a small number of the patients were submitted to vertebral angiography.
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It should also be mentioned that in either series very few of the patients were admitted to the hospital during the acute stage of bleeding, the majority of them having been treated in other hospitals during that time.

During the same period about 100 aneurysms were treated surgically, the majority by intracranial approach.

AGE AND SEX

In the aneurysm series the ages of the patients ranged from 19 to 68 years, the average age being 41. The sex distribution was 20 males and 20 females.

In the no-aneurysm series the ages ranged from 16 to 64 years, the average age being 40. The sex distribution was 27 males and 34 females.

NEUROLOGICAL SIGNS

With regard to possible prognostic significance we noted the occurrence of unconsciousness and/or major neurological signs in association with the attacks of hemorrhage. Hemiplegia or hemiparesis were regarded as major neurological signs, as were convulsions, and severe or long-standing mental symptoms, but not ophthalmoplegia, which can occur without simultaneous bleeding.

In the aneurysm series 10 patients were unconscious and displayed major neurological signs during the attack of bleeding; 4 displayed major neurological signs only, and 10 were unconscious only.

In the no-aneurysm series the ratio was: 6 out of 61 had been unconscious with neurological signs, 14 displayed major neurological signs only, and 19 were unconscious without pareses or mental symptoms.

NUMBER OF ATTACKS BEFORE DIAGNOSIS

In the aneurysm series 28 patients had had only 1 attack prior to definite diagnosis; 11 patients had had 2 attacks. One patient had chronic symptoms (probably several small bleedings).

In the no-aneurysm series 46 patients had had 1 subarachnoid hemorrhage only, 13 had had 2, and 2 patients had had 3 attacks.

Here we have also counted unverified episodes of bleeding, for the verification of a subarachnoid hemorrhage in a patient makes it most likely that recurrent attacks with similar clinical symptoms and signs stem from the same source.

HYPERTENSION

The material was divided into 2 groups: normotensive patients and hypertensive patients. All patients with a blood pressure above 150/100 were grouped as hypertensive.

In the aneurysm series 13 patients were hypertensive and 25 normotensive (in 2 cases no blood pressure was recorded in the file).

In the no-aneurysm series 12 patients were hypertensive and 49 normotensive.
ANATOMICAL LOCATION OF ANEURYSMS, AND MORTALITY RATE

Table 1 shows the location of the aneurysms and the result of the follow-up.

The patient recorded as having multiple aneurysms had one on both middle cerebral arteries respectively, and one on the left pericallosal artery. As it could not be decided clinically which of them had ruptured, we have placed this patient in a separate group.

All deaths have occurred from verified recurrent subarachnoid hemorrhage or at least there have been suggestive clinical signs. One of the patients, here recorded as living, died from thymoma 8 years after his first and only hemorrhage.

Table 1 shows that conservatively treated aneurysms of the internal carotid artery carry the worst prognosis, whereas patients with aneurysms of the anterior cerebral or anterior communicating artery seem to have the best chance of survival. There were only 3 patients with aneurysm of the vertebral system; all of them died from the first bleeding and the aneurysm was found at autopsy.

In our series, patients with aneurysm of the left hemisphere showed a higher mortality rate than did those with a lesion on the right side. Out of 13 patients with aneurysms of the left internal carotid or the left middle cerebral artery, 11 died; out of 12 patients with aneurysms of the corresponding arteries on the right side 5 died. However, these numbers are too small to be of any statistical significance.

Among the 18 survivors, only 2 had had recurrent subarachnoid hemorrhages during the follow-up period.

MORTALITY IN NO-ANEURYSM SERIES

During the follow-up time 3 patients in the no-aneurysm series died from recurrent hemorrhage. On 1 of them autopsy was performed but no aneurysm was found. In the other 2 cases autopsy was not performed.

Also in this series 2 patients had survived recurrent hemorrhage during the follow-up period. The remaining 56 patients had had no bleedings.

<table>
<thead>
<tr>
<th>Location of aneurysms, and mortality</th>
<th>Number of Patients</th>
<th>Deaths</th>
<th>Living</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal carotid artery</td>
<td>14</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Middle cerebral artery</td>
<td>11</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Anterior cerebral and anterior communicating arteries</td>
<td>11</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Vertebral system (basilar artery)</td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Multiple aneurysms</td>
<td>1</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>22</td>
<td>18</td>
</tr>
</tbody>
</table>
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PROGNOSTIC FACTORS

A comparison between the 2 groups shows that in the aneurysm series the mortality rate is more than 10 times as high as in the no-aneurysm series. Consequently the presence or the absence of an angiographically demonstrable aneurysm is the most significant prognostic factor.

Out of the total number of 25 deaths (in both series) 22 occurred within the first year after the initial hemorrhage (Table 2), 15 of these within the first 2 months. The fact that a patient survives the first 12 months after the hemorrhage does not, however, guarantee that the danger is passed; 2 patients in the aneurysm series and 1 in the no-aneurysm series died after this period, one of them (aneurysm) as late as 7 years after the first bleeding.

<table>
<thead>
<tr>
<th>Series</th>
<th>Months 0-1</th>
<th>1-2</th>
<th>2-6</th>
<th>6-12</th>
<th>Years 1-2</th>
<th>2-3</th>
<th>3-5</th>
<th>5-10</th>
<th>&gt;10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aneurysm series:</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Deaths</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Living</td>
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<td></td>
</tr>
<tr>
<td>No-aneurysm series:</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td>25</td>
<td>15</td>
<td>10</td>
<td>8</td>
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<td>Living</td>
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Dandy has reported still longer intervals. Consequently, the number of deaths may increase in the future.

No correlation between unconsciousness in connection with hemorrhage and chance of survival was found; nor does the prognosis appear to be influenced by the presence of major neurological signs in connection with the bleeding. Consequently, the condition of the patient during the attack of bleeding gives us no clue as to the prognosis. On this point, however, other opinions have been advanced. In these series the chances of survival are apparently uninfluenced by hypertension; in the no-aneurysm series none of the 3 patients who died had increased blood pressure, and out of the 13 hypertensive patients in the aneurysm series 7 died and 6 are alive, a ratio that equals the ratio between living and dead in the total aneurysm series.

At the follow-up the patients were asked to describe their working capacity as a result of the bleeding as "normal," "impaired," or "nil"; in some cases the disability was caused by other diseases and these patients have been grouped separately (Fig. 1).

With regard to the aneurysm series it is worth mentioning that 6 patients out of the 7 with normal working capacity were under 40 years of age at the episode of bleeding, whereas 4 patients out of the 5 completely incapacitated were past 40 at the time of bleeding. We should also like to stress that 6 patients out of the 7 with normal working capacity had their aneurysm
on the anterior cerebral or the anterior communicating artery. Thus, conservatively treated aneurysms of these arteries seem to carry the best prognosis both as regards chance of survival and working capacity.

In the no-aneurysm series the working capacity of the patients was, on the whole, better than in the aneurysm series. Out of the 58 survivors 33 patients regarded themselves as completely fit for work. Only 3 patients were, according to their own opinion, completely disabled as a result of the hemorrhage. The majority of the 13 patients with impaired working capacity had only slight and vague symptoms, as for instance, headache, dizziness, and tiredness, which, in fact, need not always have been caused by the bleeding. No influence of age can be proved, but it ought to be pointed out that 10 out of the 12 hypertensive patients belonged to the partly or entirely incapacitated groups; in fact, symptoms of this kind may equally well be caused by increased blood pressure.

DISCUSSION

The question that arises on comparing the 2 groups mentioned above is: how certain can we be that patients with normal carotid angiograms have
no aneurysm? Even though angiographic technique has been greatly improved, this does not guarantee that every aneurysm is visualized. In the Finnish Red Cross Hospital for the last 3 years we have done the angiograms in three projections: lateral, anteroposterior, and oblique. The oblique view has proved to be specially important in the visualization of aneurysms of the anterior communicating artery. Up to 1953 only lateral and anteroposterior projections were used. In 1 case bilateral angiography, with all three views, showed no aneurysm; when, after some time, the patient died from recurrent hemorrhage, autopsy revealed an aneurysm of the anterior communicating artery. This shows that an aneurysm can be overlooked despite thorough examination.

Opinions as to the value of stereoscopic angiograms still differ; this technique has not been used at the Finnish Red Cross Hospital.

One shortcoming in our series is that vertebral angiography was performed on only a few of our patients. It is, however, highly probable that very few aneurysms have been overlooked for this reason; aneurysm of the vertebral area and especially on the basilar artery is very seldom found in patients who have survived attacks of subarachnoid hemorrhage because most of them succumb to the attacks. Peripherally located aneurysms of the vertebral system can be visualized if the posterior cerebral artery is visible on the carotid angiogram; in that case vertebral angiography is of little value. In our series the posterior cerebral artery could be visualized by carotid angiography in somewhat less than one-fourth of the cases, but no aneurysm was found in this region. Yet, an arteriovenous malformation, filling from the vertebral artery only, must be taken into account; in such cases the hemorrhage is mainly venous and the patients’ chances of survival are much greater. We have observed 1 such case; the patient has survived several bleedings.

The source of bleeding in cases of subarachnoid hemorrhage with normal angiograms, still presents an unsolved problem. The possibility of an overlooked aneurysm has been mentioned above. The fact that among our cases of subarachnoid bleeding the incidence of angiographically verified aneurysms is lower than in Lofstedt’s series, goes to prove that we have not been able to visualize all aneurysms. The circumstance that 2 out of the 3 patients who died in our no-aneurysm series succumbed within 2 months after the initial hemorrhage also speaks strongly in favour of an overlooked aneurysm, this period being the most critical for patients with aneurysms that have bled. On the other hand we should like to point out that in our no-aneurysm series no arterial vasospasm worth mentioning could be seen. Such a vasospasm is fairly common in patients with aneurysm, especially during the first weeks after the bleeding. Yet the absence of vasospasm may have been ascribable to the comparatively late stage at which the angiograms were done.

The possibility of a spontaneous thrombosis of a small ruptured aneurysm should perhaps also be taken into account. Spontaneous thrombosis of
larger aneurysms is unlikely; we have never seen spontaneous thrombosis of an angiographically verified aneurysm, whereas an enlargement of the aneurysmal sac is a common finding after a bleeding. It is also a well-known fact that even a partial clipping of the aneurysmal stalk does not always cause thrombosis, although the application of the clip causes a lesion of the intima which ought to increase the tendency to clot.

In 1951 Margolis et al.\textsuperscript{15} described small angiomatous malformations causing intracerebral hematomas. One of their 4 patients had blood in the cerebrospinal fluid. These malformations may be a significant etiological factor of subarachnoid hemorrhage, being so small that they are not visible in angiograms. Telangiectases as a cause of subarachnoid bleeding have also been described.\textsuperscript{2,19}

In spite of all imaginable methods of examination, all clinical and pathological series of patients with subarachnoid hemorrhage contain cases in which the cause of the bleeding cannot be traced. Whatever the etiology, the fact remains that a patient with a normal angiogram has a good chance of survival whereas patients with aneurysms not treated surgically show a very high rate of mortality.

SUMMARY AND CONCLUSIONS

A series of 40 patients with intracranial arterial aneurysm verified by angiography or at autopsy, and another series of 61 patients with verified subarachnoid hemorrhage but normal bilateral carotid angiograms, are reported. All patients were treated conservatively. In the former group the mortality from recurrent hemorrhage was 55 per cent (22/40), in the latter, 5 per cent (3/61). Aneurysms of the internal carotid artery had the worst prognosis; those of the anterior cerebral and the anterior communicating arteries had the best. At the follow-up the patients in the no-aneurysm series showed a better condition and a better working capacity than did the patients in the aneurysm series.

The possible etiology of the hemorrhage in the patients with normal carotid angiograms is discussed.

It is not relevant to speak of the prognosis of subarachnoid hemorrhage in general; it is essential to differentiate between cases of aneurysms and cases in which the angiographic findings are normal. Even if the source of bleeding in the no-aneurysm group is unknown, a normal bilateral carotid angiogram points to a better prognosis than when an aneurysm is found, but left unoperated upon.

ADDENDUM

After finishing this paper we were informed that autopsy had been performed on another of the 3 deceased patients in the "no-aneurysm" group. A ruptured aneurysm of the right posterior cerebral artery was found.
REFERENCES


