The authors have reviewed 167 cases of subarachnoid hemorrhage (SAH) occurring in patients aged 20 years and younger in a 23-year period. The modes of presentation and etiology of SAH are similar in childhood and adolescence and in the adult population, but there was a different incidence of the specific pathology producing the bleeding in this series. Twenty-six percent of cases were due to bleeding arteriovenous malformations, 52% were due to ruptured aneurysms, and in 19% no cause was found. Aneurysms in this young age group differed in several important respects from those in the adult population: there was a male predominance, a higher incidence of internal carotid bifurcation aneurysms was seen, and multiple aneurysms were encountered less commonly.

**Key Words**: subarachnoid hemorrhage □ berry aneurysm □ pediatric surgery □ arteriovenous malformation □ childhood □ adolescence

**Summary of Cases**

**Clinical Material**

The series comprised 167 cases of proven SAH presenting to the Regional Neurological Centre at Newcastle General Hospital between 1960 and 1983. The patients were all 20 years of age or younger (neonates were excluded from the series). All the patients underwent cerebral angiography and, since 1976, computerized tomography (CT) to investigate the etiology of the hemorrhage. These investigations were undertaken as soon as possible after diagnosis, providing the patient’s condition was satisfactory. Most of the patients with proven SAH and normal four-vessel angiography were followed for varying periods of time. In 135 cases (80.8%) a specific cause for the SAH was established, but in 32 cases (19.2%) no cause was found (Table 1).

**Aneurysm Group**

In the group of patients with SAH due to aneurysms (87 cases), the male to female ratio was 1.7:1. The ages of these patients at the time of presentation with SAH are shown in Fig. 1. Aneurysmal SAH was most common during the second decade; only two such patients presented under the age of 10 years, the youngest being...
FIG. 1. Age at presentation of the 87 patients with subarachnoid hemorrhage due to aneurysm rupture.

FIG. 2. Age at presentation of the 44 patients with subarachnoid hemorrhage due to arteriovenous malformations.

6 years old. A total of 95 aneurysms were found in these 87 patients; only eight patients (9.2%) had multiple aneurysms. The location of the aneurysms is shown in Table 2. A high incidence of internal carotid artery (ICA) bifurcation aneurysms was noted.

Arteriovenous Malformation Group

In the group of 44 patients with arteriovenous malformations (AVM's) causing SAH, there were 19 males and 25 females, for a male to female ratio of 1:1.7. Most patients presented in the second decade (Fig. 2). The youngest patient was 6 years of age. In 40 cases (91%) the AVM was supratentorial in location, while in four cases (9%) it was infratentorial. The most commonly involved sites were the parietal lobe (37.5%) and the temporal lobe (20.5%). The size of the AVM's varied, but most of the lesions (24 cases) were less than 2 cm in diameter. The AVM's were supplied principally by the middle cerebral artery (55%), posterior cerebral artery (29%), and anterior cerebral artery (8.5%). In three (7.5%) of the 44 cases the main supply was from the ICA, the anterior choroidal artery, or the superior cerebellar artery.

Pathology Unknown

Of the 32 patients in whom no cause for the SAH was found, we were able to follow 26 cases for periods varying between 2 to 10 years. Recurrent hemorrhage occurred in four patients (15.4%) 5 to 10 years later. In these patients, angiography revealed an AVM in two patients and an internal carotid bifurcation aneurysm in one, and in one patient no abnormality was seen.

Discussion

The commonest mode of presentation of SAH in childhood and adolescence is the sudden onset of headache with nausea and vomiting which may or may not be associated with an impairment of consciousness. This symptomatology is similar to that in adults. The exception is in infants in whom coma and hemiparesis are the more common presenting features. The etiology of SAH in children and adolescents is similar to that in the adult population, but the specific incidence of the cause varies. In this series, 52.1% of SAH's were due to aneurysms and 26.3% to AVM's, and in 19.2% of cases no lesion was demonstrable. Table 3 compares our findings with those of other authors. These findings contrast with those in the adult population in the same center, where SAH is caused by aneurysms in 73.4% of cases and by AVM's in 6.4% (VL McAllister, et al., unpublished data, 1983).

A comparison of this present series with earlier studies shows that over the years there has been an increase in the number of cases due to aneurysm and a decrease in the number in which no lesion was found (Table 3). It is also worth noting that of the last 20 cases we have seen since January, 1980, a specific etiology was demonstrated in all. It is likely that these findings are related to more widespread use of and improvement in angiographic techniques, as well as the introduction of CT scanning.
SAH in childhood and adolescence

In this large series of patients, aged 20 years or younger, with SAH, the mode of presentation was found to be similar to that in adults. Our results confirm the findings of other authors with respect to the cause of the hemorrhage. Several interesting features relating to the sex distribution, site, and multiplicity of the aneurysms have been shown. We were able to demonstrate a cause for the SAH in the majority of cases (80.8%), and even in those with an unidentified pathology (19.2%) there appears to be a good long-term prognosis.

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References


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**Table 3**

Common causes of subarachnoid hemorrhage reported in several series

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>No. Aged 0-20 Yrs</th>
<th>Cause*</th>
<th>Aneurysm</th>
<th>AVM</th>
<th>No Lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laitinen, 1964</td>
<td>59</td>
<td>35.5</td>
<td>20.3</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Locksley, 1966</td>
<td>128</td>
<td>32</td>
<td>31.2</td>
<td>36.7</td>
<td></td>
</tr>
<tr>
<td>Sedzimir &amp; Robinson, 1973</td>
<td>124</td>
<td>40.4</td>
<td>26.6</td>
<td>25.8</td>
<td></td>
</tr>
<tr>
<td>Hourihan, <em>et al.,</em> 1984</td>
<td>167</td>
<td>52.1</td>
<td>26.3</td>
<td>19.2</td>
<td></td>
</tr>
</tbody>
</table>

* Numbers are percentages of the total number of patients aged 0 to 20 years in the series. AVM = arteriovenous malformation.

Aneurysms in childhood are usually symptomatic; few are found incidentally at routine angiography or autopsy.\(^{4,15}\) In adult patients with aneurysmal SAH, there is a female preponderance of 3:2, whereas in this younger age group there is a male predominance of 1:7:1. The locations of aneurysms in children and adolescents are different from those in adults. In this series, 29.5% of aneurysms were demonstrated at the ICA bifurcation, whereas in a study of adults reported by Sahs, *et al.,*\(^{12}\) only 4.5% were found at this location. Patients 20 years of age were included in our series as they showed a similar distribution of aneurysms as the younger patients. A high incidence of ICA bifurcation aneurysms in young people was also reported by Sedzimir and Robinson\(^{13}\) and Patel and Richardson.\(^{10}\)

Subarachnoid hemorrhage in early childhood is very rare, and there were no patients under the age of 5 years in our series. Orozco, *et al.,*\(^{9}\) collected 27 cases in which the patients were under 2 years of age; they found a marked male predominance and a high incidence of middle cerebral artery aneurysms. Eight of our patients (9.2%) had multiple aneurysms; this figure is low when compared to the 29% incidence seen in adults in our center (VL McAllister, *et al.,* unpublished data, 1983).

In this series, SAH was due to AVM’s in 44 patients (26.3%). Perret and Nishioka\(^{11}\) recorded an incidence of less than 20% in their series. The vessel most commonly supplying the AVM was the middle cerebral artery (55% of cases), which is in agreement with reports by Matson,\(^{7}\) Moyes,\(^{8}\) and So.\(^{14}\)

Hemorrhage due to AVM’s has not been described in the newborn and is rare in early infancy. Patients in this latter group usually present either with congestive heart failure due to shunting or with obstructive hydrocephalus due to the position of the AVM. In the older children, SAH and seizures are more frequent presenting features.

In the group with idiopathic SAH, 32 (19.2%) of the 167 patients had proven SAH and negative four-vessel angiography. Possible etiological factors, such as hematological disorders, were excluded. This incidence is lower than the 25.7% figure reported by Sedzimir and Robinson,\(^{13}\) but higher than the 13% incidence in the adult population in our center (VL McAllister, *et al.,* unpublished data, 1983). Some of these hemorrhages may have been due to small or largely thrombosed AVM’s not detectable at angiography, or, alternatively, the AVM may have been destroyed at the time of the bleed. The low incidence of recurrent hemorrhage in our patients in whom no lesion was found is similar to the 7% rate of occurrence reported by Sedzimir and Robinson.\(^{13}\)

There are several rare causes of SAH. Cerebral tumors occasionally give rise to intracranial hemorrhage, and there were two such cases in this series (Table 1). One patient had a glioma and the other a choroid plexus papilloma. Moyamoya disease can lead to cerebral infarction, cerebral hemorrhage, and SAH, although the latter is unusual in patients younger than 15 years of age. Coarctation of the aorta favors the development of aneurysms, although intracranial hemorrhage may also occur without associated aneurysms.\(^{1}\)

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