CEREBRAL ASTROCYTOMAS IN CHILDHOOD
A CLINICAL STUDY
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The relatively benign form of cerebral astrocytoma is found only infrequently in childhood; thus Ingraham and Matson12 were able to describe only 15 examples of the lesion, while French7 found only 10 such cases in his series of brain tumors in childhood. Others1,8,14,21 confirmed the scarcity of the neoplasm. The relative rarity of this growth is even more remarkable considering the frequent occurrence of its histological equivalent in the cerebellum of children and the cerebrum of adults. The often proposed congenital origin of cerebellar astrocytomas cannot account for the difference, since the arguments favoring a congenital origin apply equally to the supra- and infratentorial form of astrocytoma.

The purpose of this communication is to describe 20 cases of histologically confirmed, relatively benign astrocytomas in childhood, pointing out their remarkably good prognosis as compared with the outlook occasioned by similar lesions in the adult. The series was confined to patients up to the age of 15 years, a commonly accepted limit of childhood.

The case histories forming the subject of this paper were obtained from the records of the National Hospital for Nervous Diseases, Queen Square, London, and the Children’s Hospital, Great Ormond St., London; the records of the Methodist and Hermann Hospitals, Houston, Texas; and private records by the kind courtesy of Mr. Wylie McKissock, O.B.E., F.R.C.S., James Greenwood, Jr., M.D., J. Randolph Jones, M.D., and George J. Ehni, M.D.

Etiology. In 1895 Stroebe23 described cysts lined with ciliated epithelium in cerebral gliomas and stated that the epithelial cells probably originated from primitive neural-canal lining cells, thus relating gliomas to a developmental defect. He cited Buchholz1 as a source of a similar histological observation. The same finding was mentioned also by Storch,22 who thought that the lining cells were rests originally cut off from the ventricular system but accepted the possibility that glioma cells might resume an ependymal form. Some years later Saxter,19 who had seen such lining cells in gliomatous cavities, firmly proposed that these cells were indeed only altered glioma cells.

Another proponent of the congenital-origin theory, Marburg,14 described ependymal rests in the brain of children, which appeared to have been originally connected with the ventricles of the cerebrum and cerebellum. Since he also found ependyma-lined cavities in cerebral gliomas he concluded that gliomas arose around these ependymal rests and that ependyma-lined cysts could develop from them even without tumor formation.

The above statements were but a small part of a very considerable discussion concerning the possible congenital origin of astrocytomas. Whether such theories were justified or not, there appears to be a striking difference in prognosis between these tumors in childhood, and in adult life.

Incidence. The comparative rarity of the tumor is illustrated by the small collections of cases in the literature already mentioned. In our experience9 the tumor represents less than 9 per cent of the relatively benign cerebral astrocytomas of all age groups. Table 1 shows that very few of the patients presented themselves before the age of 5 years but there is of course little significance in computing a mean-age figure, since an arbitrary age limit of 15 years is used. Of the 20 patients only 6 were male which is rather remarkable in view
TABLE 1

Summary of 20 cases of cerebral astrocytoma in children

<table>
<thead>
<tr>
<th>Case Age</th>
<th>History (Mos.)</th>
<th>Main Complaints</th>
<th>Main Signs</th>
<th>Skull Films</th>
<th>Site of Lesion</th>
<th>Type Astrocytoma</th>
<th>Survival (Mos.)</th>
<th>Category of Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>6AB 15 M</td>
<td>30</td>
<td>Headache, vomiting, visual loss</td>
<td>Papilledema, drowsy, visual loss</td>
<td>Suture diastasis</td>
<td>Parietal</td>
<td>Grade I Cystic</td>
<td>72</td>
<td>I</td>
</tr>
<tr>
<td>6HM 6 F</td>
<td>1</td>
<td>Headache, vomiting, visual loss, diplopia</td>
<td>Papilledema, sensory &amp; motor defects</td>
<td>Parietal bone change</td>
<td>Parietal</td>
<td>Grade II Cystic</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>89PF 10 M</td>
<td>3</td>
<td>Headache, visual loss</td>
<td>Papilledema, visual loss</td>
<td>Normal</td>
<td>3rd vent.</td>
<td>Grade II Solid</td>
<td>Op. death</td>
<td></td>
</tr>
<tr>
<td>89VC 4 F</td>
<td>3</td>
<td>Headache, vomiting, ataxia, diplopia</td>
<td>Papilledema, visual loss</td>
<td>Suture diastasis</td>
<td>3rd vent.</td>
<td>Grade II Cystic</td>
<td>Op. death</td>
<td></td>
</tr>
<tr>
<td>33MT 14 F</td>
<td>24</td>
<td>Paresis, major seizures</td>
<td>Papilledema, paresis, dysphasia</td>
<td>Suture diastasis</td>
<td>Hemi-spheral</td>
<td>Grade I Cystic</td>
<td>Op. death</td>
<td></td>
</tr>
<tr>
<td>37NH 6 F</td>
<td>12</td>
<td>Headache, vomiting, paresis, diplopia</td>
<td>Papilledema, paresis</td>
<td>Normal</td>
<td>Thalamus &amp; 3rd vent.</td>
<td>Grade I Solid</td>
<td>Op. death</td>
<td></td>
</tr>
<tr>
<td>40DB 5 M</td>
<td>3</td>
<td>Headache, vomiting, diplopia</td>
<td>Papilledema, drowsy, ataxia</td>
<td>Clinoids eroded</td>
<td>3rd vent.</td>
<td>Grade I Solid</td>
<td>36</td>
<td>II</td>
</tr>
<tr>
<td>48JS 14 F</td>
<td>36</td>
<td>Headache, vomiting, visual loss</td>
<td>Papilledema, visual loss</td>
<td>Clinoids eroded</td>
<td>3rd vent.</td>
<td>Grade II Solid</td>
<td>72</td>
<td>II</td>
</tr>
<tr>
<td>48SW 11 F</td>
<td>36</td>
<td>Headache, minor seizures, diplopia</td>
<td>Papilledema, visual loss</td>
<td>Sella eroded</td>
<td>Temporal-parietal</td>
<td>Pilocystic Cystic</td>
<td>90</td>
<td>III</td>
</tr>
<tr>
<td>58PR 9 F</td>
<td>6</td>
<td>Headache, vomiting, diplopia</td>
<td>Papilledema, visual loss</td>
<td>Sella eroded</td>
<td>3rd vent.</td>
<td>Grade II Solid</td>
<td>60</td>
<td>I</td>
</tr>
<tr>
<td>89BG 9 F</td>
<td>4</td>
<td>Headache, vomiting, paresis</td>
<td>Papilledema, paresis</td>
<td>Cerebral calcification</td>
<td>Parietal-frontal</td>
<td>Grade I Cystic</td>
<td>12</td>
<td>I</td>
</tr>
<tr>
<td>101MS 12 F</td>
<td>1</td>
<td>Headache, diplopia, paresis</td>
<td>Papilledema, ataxia</td>
<td>Normal</td>
<td>3rd vent.</td>
<td>Grade II Solid</td>
<td>Op. death</td>
<td></td>
</tr>
<tr>
<td>17DS 10 M</td>
<td>12</td>
<td>Headache, major seizures</td>
<td>Papilledema</td>
<td>Temporal bone change</td>
<td>Temporal</td>
<td>Fibrillary Cystic</td>
<td>168</td>
<td>I</td>
</tr>
<tr>
<td>19DC 12 F</td>
<td>12</td>
<td>Headache, vomiting, diplopia</td>
<td>Papilledema, paresis</td>
<td>Hydrocephalus</td>
<td>Temporal</td>
<td>Giant-cell Cystic</td>
<td>192</td>
<td>III</td>
</tr>
<tr>
<td>33DB 10 F</td>
<td>4</td>
<td>Major &amp; minor seizures</td>
<td>Papilledema, visual loss, dysphasia</td>
<td>Suture diastasis</td>
<td>Temporal</td>
<td>Grade I Cystic</td>
<td>6</td>
<td>III</td>
</tr>
<tr>
<td>38PT 8 F</td>
<td>9</td>
<td>Headache, vomiting, drowsy, seizures</td>
<td>Papilledema, visual loss, dysphasia</td>
<td>Normal</td>
<td>Temporal</td>
<td>Grade II Solid</td>
<td>36</td>
<td>III</td>
</tr>
<tr>
<td>15CG 15 F</td>
<td>84</td>
<td>Minor seizures, ataxia</td>
<td>Motor &amp; sensory defects</td>
<td>Clinoids eroded</td>
<td>Frontal</td>
<td>Fibrillary Cystic</td>
<td>120</td>
<td>III</td>
</tr>
<tr>
<td>16F 13 F</td>
<td>21</td>
<td>Minor seizures, headache</td>
<td>Papilledema</td>
<td>Normal</td>
<td>Frontal</td>
<td>Cellular Solid</td>
<td>150</td>
<td>I</td>
</tr>
<tr>
<td>16GE 12 F</td>
<td>120</td>
<td>Major &amp; minor seizures</td>
<td>Normal</td>
<td>Cerebral calcification</td>
<td>Occipital</td>
<td>Fibrillary Solid</td>
<td>116</td>
<td>II</td>
</tr>
<tr>
<td>GKK 10 M</td>
<td>6</td>
<td>Headache, vomiting, visual loss</td>
<td>Papilledema, reflex changes</td>
<td>Suture diastasis</td>
<td>Frontal</td>
<td>Grade I Cystic</td>
<td>11</td>
<td>I</td>
</tr>
</tbody>
</table>

of the slight preponderance of males among those with astrocytomas generally.9,10 However, the number of cases admittedly is small.

Clinical Features. The mean length of history in our cases was 9 months, a figure not very different from the one seen in a large series of cerebral astrocytomas of all ages.9

The over-all picture in children showed few distinctive characteristics when compared with similar lesions in adults. Headache, vomiting and epilepsy were the most common complaints. It was noted that vomiting occurred with greater facility in children than in adults suffering from similar intracranial tumors. Epilepsy, both major and minor, whenever it occurred, was one of the earliest symptoms. Diplopia or a squint was noted in 6 cases and appeared to be a rather frequent symptom in childhood while being relatively infrequent with similar tumors in adults. Paresis, drowsiness, impairment of vision, and ataxia were other features described.

On examination the most frequent sign was papilledema; this was present rather more consistently (80 per cent) than in adults
suffering from similar lesions. Facial paresis and paralysis of the limbs were seen in 7 and 6 cases respectively. Alteration of tone, reflexes and coordination accompanied paresis, as would be expected. Reflex changes in the absence of paresis were recorded but infrequently and the same applied for ataxia and alteration of tone in the absence of paresis. Other signs found commonly were sensory defects, visual impairment, pupillary changes and drowsiness.

Electroencephalography. This was performed in 8 cases. In 2 cases of temporal-lobe tumors and 1 case of frontal-lobe tumor the electroencephalogram detected the lesion exactly. In 2 cases of very large lesions the electroencephalogram suggested an extensive hemispherical lesion. In a case of 3rd ventricle tumor the electrogram showed diffuse slow activity. In 2 cases the lesion was indicated in an incorrect area of the affected hemisphere. The abnormalities were mostly foci of slow waves and areas of depressed activity.

Thus there were no entirely incorrect electrograms nor were there any within normal limits, and all of these investigations were useful, though their exact localizing value was rather limited in the majority of cases.11

Radiology. The radiological findings in this series were interesting because of the very high incidence of abnormalities in the plain roentgenograms of the skull. Fourteen cases showed distinct radiological changes in the skull suggestive of the presence of a space-occupying lesion.

Enlargement of the sella turcica with erosion of the clinoid processes was noted in 9 cases and diastasis of the sutures in 5 instances. Calcification of the tumor4 15 16 was obvious in 2 cases and hydrocephalus in 1. Two patients showed local deformity of the skull caused by the presence of the lesion; in 1, the temporal fossa was enlarged and the bone was thinned out; in the other, bulging and thinning of a parietal bone revealed the site of the neoplasm.

Only 3 arteriograms were performed; all of them showed satisfactorily the location of the tumor. Air studies, mostly ventriculograms, were routine and were performed in all but 1 case. The usual very satisfactory demonstrations of lesions were obtained by this method, which remains the most efficient way of localizing an intracranial neoplasm.

Pathology. All tumors in this series were histologically confirmed relatively benign astrocytomas. The material submitted for examination varied from biopsy fragments to autopsy specimens. For purposes of classification the most malignant section or part of section reported was taken as denoting the nature of the lesion, although it was realized that considerable variation could occur in each lesion.28 When multiple histological reports were given, the report denoting the highest degree of malignancy was taken as the guiding one. Unfortunately the pathological terminology has changed through the years and therefore rather than interpreting all terminologies in the terms of one, the original descriptions are cited below.

| Astrocytoma, Grade I | 7 cases |
| Astrocytoma, Grade II | 7 cases |
| Piloid or fibrillary astrocytoma | 4 cases |
| Cellular astrocytoma | 1 case |
| Giant-cell astrocytoma | 1 case |

It can be seen that over half of the tumors were of the least malignant type of astrocytoma, Grade I or piloid-fibrillary. Even so, as will be seen, no distinction in prognosis existed between this group and the remaining neoplasms.

Macroscopically more than half of the lesions were cystic, an incidence twice that seen in a large series of astrocytomas of all ages. The most frequent form of cystic tumor was that of a nubbin of tumor inside an apparently nontumorous cyst, thus showing a remarkable resemblance to many of the cerebellar astrocytomas.10 It should be noted that in our series of 194 cases of relatively benign astrocytomas there were only 5 cases of this particular form of cystic neoplasm and all of them occurred in patients under the age of 18, thus suggesting that the
lesion develops exclusively during childhood. Four other cystic neoplasms were in the form of a single cyst within the tumor while another 2 were polycystic, thus leaving 9 solid lesions.

Taking note of the site of the tumor the astonishingly high proportion of intraventricular or mainly intraventricular lesions can be seen. There were 7 such cases, representing 35 per cent of all patients. By comparison in 177 adult cases of cerebral astrocytomas, intraventricular lesions were seen only 5 times, i.e., in less than 3 per cent.3

It appears that the site of the lesion in children as well as the macroscopic appearance show important differences when compared with similar tumors in adults.

Treatment. Excision of the tumor was attempted in all but 2 patients. One of the latter died soon after a ventriculogram, having been admitted in deep coma with fixed dilated pupils; the lesion proved to be a tumor of the 3rd ventricle. The second patient was treated by a Torkildsen’s shunt procedure.

In the remainder, routine excision of the tumor or affected lobe was attempted, but when the lesion appeared to be of a nodule within a cystic type, only the mural nodule was removed. A rather circumspect attitude was adopted with regard to some intraventricular tumors and thus, in 3 cases of a 3rd ventricle tumor, only the part obstructing the foramen of Monro was excised. The remainder of the tumor was treated successfully by radiotherapy. In all, 5 patients received irradiation in addition to surgery.

Survival. The results of treatment exemplified the astonishingly benign course of the lesion. There were 5 deaths, but all of these were operative mortalities. It should be understood that all patients dying while still in the neurosurgical units were considered operative mortalities, regardless of the interval following the operation.

Of the 5 deaths 4 followed attempted removal of a 3rd ventricle tumor. In retrospect, the mortality of a direct attack on 3rd ventricle tumors was very high—4 out of 7—and a shunt procedure followed by radiotherapy would seem to have been preferable.

There were no interim deaths at the time of writing, 15 of the patients being alive and well at last follow-up, which was up to date in all cases, though in some of the oldest cases the patients reported at 1–2 year intervals. Indeed not only were all patients who survived the operation alive, but possibly only 1 of them showed evidence of recurrence, a very gratifying feature considering the length of survival in some of the cases.

Survival times at time of writing:

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 years</td>
<td>5</td>
</tr>
<tr>
<td>5 years</td>
<td>4</td>
</tr>
<tr>
<td>Less than 5 years</td>
<td>6</td>
</tr>
</tbody>
</table>

It should be noted that only 5 patients had radiotherapy; all of these are alive. This includes 3 cases of a 3rd ventricular tumor treated only by partial excision and irradiation. Good results were described also by Ingraham and Matson12 who mentioned that in their 15 cases of astrocytoma of the cerebrum in children, 10 of the patients were still alive at the time of writing.

The quality of survival denotes the functional success of the patient as an individual following surgery. For this purpose the patients were graded as follows:

Category I—Patients with minimal or no neurological deficits able to lead a normal existence.

Category II—Patients with moderately severe neurological abnormalities but still able to lead a normal life.

Category III—Patients with a severe neurological deficit who were unable to continue with normal schooling or maintain themselves fully through their own efforts.

There were 6 cases in Category I, 2 in Category II and 5 in Category III. In 2 other patients the follow-up was not adequate for full evaluation.

SUMMARY AND COMMENT

Twenty cases of relatively benign cerebral astrocytomas of childhood have been presented. The theory of a congenital origin of these tumors possibly may explain the differ-
ent course and prognosis as compared with similar lesions in adults.

The lesion is comparatively rare and in this series the majority of patients were female.

The clinical features were mostly typical of intracranial lesions in general and need little comment.

Radiological investigations disclosed a very high (14 out of 20) incidence of abnormalities of the skull in the plain films, most of the abnormalities denoting increased intracranial pressure, but in 2 cases the films showed calcification in the tumor and in 2 instances the shape of the skull was altered by the tumor. Air studies were used routinely and proved to be most effective in localizing the lesion.

All tumors were histologically proven relatively benign astrocytomas. Notable was the high incidence of cystic lesions (11 out of 20), and particularly interesting were those in the form of a nodule within the cystic type of lesion (5), reminiscent of many cerebellar astrocytomas. This particular form of cerebral tumor probably is extremely rare in adult life.

Another interesting point was the very high incidence (35 per cent) of intraventricular lesions; these appeared to be 10 times more frequent than in adult cases of similar cerebral astrocytoma.

Resection of the tumor was attempted in all but 2 cases. In addition, 5 of the 15 survivors received radiotherapy.

In view of the inconclusive evidence regarding the efficacy of irradiation in cases of cerebral astrocytoma, it is interesting to note that all of the irradiated patients, with known macroscopic remnants of tumor, were alive at the time of writing. Indeed all patients who survived the operation were alive at the time of writing and there was but a single case of some deterioration which may have been caused by a recurrence.

Nine patients have already survived for 5 years or longer thus demonstrating a remarkably benign prognosis for the tumor. Follow-up notes show that of 13 patients with adequate notation for full evaluation, 6 were leading a normal life with minimal or no neurological deficits. Two patients led a relatively normal life, though showing an obvious neurological abnormality. Five patients were partially or entirely disabled.

The results thus indicate that children with the lesion under discussion have a relatively good prognosis, far better than adults with a similar neoplasm, and good enough to cause one to regard the tumor as being virtually benign.

The author, in gathering this case material, would like to express sincere thanks to Mr. Wylie McKissock, O.B.E., F.R.C.S., George Ehni, M.D., James Greenwood, M.D., and J. Randolph Jones, M.D. for permitting access to their records.

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