A Study of the Incidence of Calcification in a Histological Survey of Surgical Biopsies of Meningiomas

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Calcification has long been recognized as an inconstant feature of meningiomas, both histologically and roentgenologically.

The exact histological incidence has not been well documented.

While reviewing the histology of 2,000 surgical biopsies of tumors of the central nervous system a special search was made for calcification and it is the purpose of this report to present the incidence of calcification noted in the entire group and thereafter to limit the report to the group of meningiomas.

Material and Methods

The material represents 2,000 consecutive cases of surgical biopsies removed at The National Hospital, Queen Square, London during the period April 1950 through December 1959.

The tissue was fixed mainly in 10 per cent formal-saline, embedded in paraffin and stained with hematoxylin and eosin, phosphotungstic acid hematoxylin, and van Gieson's stain.

The gliomas were classified according to Kernohan's classification. The meningiomas were classified according to Bailey and Bucy as follows:

Meningotheliomatous type (Fig. 1). (Meningothelial type I, Cushing and Eisenhardt;7 leptomeningioma, Globus;8 syncytial, Russell11).

Psammomatous type (Fig. 2). (Meningothelial type II, Cushing and Eisenhardt;7 primitive, Globus;8 transitional, Russell11.)

Fibroblastic type (Fig. 3). (Dural fibroblastoma, Globus;8 exotelioma laminar, Rio-Hortega.10)

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Fig. 1. Meningotheliomatous meningioma. Large islands of arachnoidal cells with abundant cytoplasm and indistinct boundaries. Nuclei are moderately large. There are no mitoses. There is a slight tendency toward whorl formation. Hematoxylin and eosin, X120.
Psammomatous meningioma. Arachnoidal cells tend to form whorls, in many of which are concentric laminations with calcium salts and iron deposits forming "psammoma (sand-like) bodies." Hematoxylin and eosin, X120.

Sarcomatous type (Fig. 4).
Angioblastic type (Fig. 5). (Angioblastic, Russell; Cushing and Eisenhardt; and Globus.)

In most cases one to several pieces of tissue were examined and no attempt was made to study the entire specimen. Therefore, the number of tumors showing calcification represents the minimal number. The degree of calcification was in the various forms or patterns shown in Figs. 6, 7 and 8. It is entirely likely that a more detailed study would reveal an even greater incidence of calcification.

Fibroblastic meningioma. Note elongated cells with slender nuclei and tendency to form interlacing bundles. In central portion of photograph there is a group of plump cells which resemble arachnoidal cells as seen in the meningothelialomatous type. Hematoxylin and eosin, X120.
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Fig. 4. Sarcomatous meningioma. There are bundles of slender spindle cells of different lengths and between them are cells with round or oval nuclei, and prominent nucleoli. Some cells have large and some have small hyperchromatic nuclei. There is loosely packed collagen and reticulin lying between the cells. Some cells have vacuolated cytoplasm. Mitotic figures are frequent. Hematoxylin and eosin, X130.

Observations

Table 1 shows the highest incidence of calcification to be in the meningiomas. There were 434 meningiomas with calcification occurring in 164 cases (37.78 per cent).

Thirteen of the 164 meningiomas were intra-orbital in location. There were 6 males and 7 females. Seven of the 13 intra-orbital meningiomas showed calcification, 4 occurring in males, and 3 in females.

Next in frequency of calcification were the oligodendrogliomas with a percentage inci-

Fig. 5. Angioblastic meningioma. There are numerous blood channels of arterial, venous and capillary type. Many cells have vacuolated nuclei. Mitotic figures are present. Hematoxylin and van Gieson’s stain.
of 28.39.

Almost half of the 2,000 tumors were gliomas (45.9 per cent) and in this group there was only 5.86 per cent incidence of calcification.

As is readily evident in Table 2 there is considerably more calcification in the intraspinal group of meningiomas than in the intracranial group.

Of the entire 2,000 tumors there was a total of 182 spinal tumors. Of the 182 intraspinal tumors 57 were meningiomas and in 46 of the 57 there was calcification.

In the 125 remaining intraspinal tumors there was calcification in only 1 tumor, namely an ependymoma.

The classification of meningiomas is that of Bailey and Bucy.9 Typical examples of the
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As is to be expected the highest incidence of calcification (Table 3) occurred in the psammomatous group. Second in frequency of calcification were the fibroblastic meningiomas.

The age range for the entire series of meningiomas in females was 12 to 82 and males 13 to 86. The over-all average age was 48.5 years, with an average of 48.6 years in females and 48.4 years in males. As shown in Table 4 the percentage of calcification in the various decades does not appear to be of particular note.

As shown in Table 5, there were 159 males and 275 females with meningiomas. In the entire group the incidence of calcification was also greater in the females (41.45 per cent females and 31.17 per cent males).

Further analysis shows a high incidence of intraspinal meningiomas in women. A second point in this connection is the very conspicuous incidence of calcification in the intraspinal meningiomas occurring in women.

Discussion

Calcification occurs in various types of tumors of the central nervous system and has been described by many authors.\textsuperscript{1-2,6-9,13} None of these authors gives the exact inci-

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**TABLE 1**

<table>
<thead>
<tr>
<th>Diagnosis of Tumor</th>
<th>No. of Cases</th>
<th>No. of Cases of Calcification</th>
<th>Calcification Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gliomas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Astrocytomas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grades I &amp; II</td>
<td>238</td>
<td>14</td>
<td>5.88</td>
</tr>
<tr>
<td>Grades III &amp; IV</td>
<td>507</td>
<td>12</td>
<td>2.36</td>
</tr>
<tr>
<td>Oligodendrogliomas</td>
<td>81</td>
<td>23</td>
<td>28.39</td>
</tr>
<tr>
<td>Ependymomas</td>
<td>53</td>
<td>3</td>
<td>5.66</td>
</tr>
<tr>
<td>Medulloblastomas</td>
<td>20</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Pinealomas</td>
<td>4</td>
<td>1</td>
<td>25.00</td>
</tr>
<tr>
<td>Total</td>
<td>903</td>
<td>53</td>
<td>5.86</td>
</tr>
</tbody>
</table>

| Meningiomas        | 484          | 164                           | 37.78                  |
| Neurofibromas      | 178          | 0                             |                        |
| Carcinomas and sarcomas | 143 | 1 | |
| Blood-vessel tumors | 66    | 1                             |                        |
| Congenital tumors  | 60           | 5                             |                        |
| Granulomas         | 6            | 0                             |                        |
| Miscellaneous & unclassified | 58 | | |
| Grand total        | 2,000        | 225                           | 11.25                  |
It was not the purpose of this paper to study the etiology or pathogenesis of calcification in these tumors.

An observation to be emphasized is the more frequent incidence of meningiomas in women, particularly intraspinal tumors. Calcification was also prominent in the meningiomas in women, occurring in 40 out of 44 intraspinal meningiomas. A similar incidence has been reported without giving exact figures. Bull reported that none of the neurofibromas was calcified and furthermore the writer is not aware of having seen calcification in any neurofibroma of the cranial nerves. On the other hand, calcification and/or ossification in spinal meningiomas is very common. This is readily apparent histologically. Unfortunately, actual figures cannot be given because calcification was not sought for specifically in the histological sections.

**Summary and Conclusions**

1. A special search for calcification was made in surgical biopsies of 2,000 cases of tumors removed from the central nervous system. A detailed analysis of the meningioma group was made.

2. Among the 2,000 cases the two main types of tumor were the gliomas and meningiomas. There were 903 gliomas and 434 meningiomas. Calcification was seen in 53 (5.86 per cent) of the 903 gliomas and in 164 (37.78 per cent) of the 434 meningiomas.

3. The 434 meningiomas comprised five types—meningotheliomatous, psammomatous, fibroblastic, sarcomatous and angio- blastic. The highest incidence of calcification occurred in the psammomatous type.

4. There were 377 intracranial meningiomas: calcification occurred in 118 (31.29
TABLE 5

Intracranial and intraspinal meningiomas
Incidence of calcification according to sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of Cases</th>
<th>Calcification</th>
<th>Intracranial</th>
<th>Intraspinal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. of Cases</td>
<td>Per Cent</td>
<td>No. of Cases</td>
</tr>
<tr>
<td>Males</td>
<td>159</td>
<td>50</td>
<td>31.17</td>
<td>146</td>
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<tr>
<td>Females</td>
<td>273</td>
<td>114</td>
<td>41.45</td>
<td>231</td>
</tr>
<tr>
<td>Total</td>
<td>434</td>
<td>164</td>
<td>37.78</td>
<td>377</td>
</tr>
</tbody>
</table>

per cent); and 57 intraspinal meningiomas: calcification occurred in 46 (80.7 per cent).

5. The age range of the series of meningiomas was 12–86 years with an average of 48.5 years. The average age for women was 48.6 years and for men was 48.4 years.

6. The total number of meningiomas in males was 159 and females was 275. The incidence of calcification was greater in females (41.45 per cent females and 31.17 per cent males). There was exceedingly high incidence of intraspinal meningiomas in women with conspicuous incidence of calcification (90.9 per cent).

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References

3. BLACKWOOD, W. Personal communication, 1960.
10. DEL RIO-HORTEGA, P. Cited by Russell.11