METASTASES OF INTRACRANIAL TUMORS

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It is generally believed that intracranial tumors do not metastasize outside the cranial and spinal dura mater. Metastases inside the dura—in the leptomeninges and in the substance of the brain and spinal cord—are known to occur frequently with medulloblastomas and occasionally with other malignant intracranial tumors. The more benign gliomas, such as astrocytoma and oligodendroglioma, have not until recent years been considered capable of giving rise to metastases. The report of Cairns and Russell (1) has been especially stimulating in this respect.

We are presenting in this paper a case of medulloblastoma of the cerebellum with definite metastatic nodules in the bodies of the vertebrae. We have also reviewed the literature and collected the cases of metastases of intracranial tumors.

METASTASES OUTSIDE THE CRANIOSPINAL DURA

The older literature contains occasional reports of distant metastases of intracranial tumors. These publications appeared prior to the present detailed classification of intracranial tumors, when a large proportion of such growths were called "sarcoma," and prior to the recognition of the frequency and metastatic potencies of such tumors as carcinoma of the lung. None of these reported cases appears to be a certain example of metastasizing intracranial tumor. Typical of such reports are those of Westphal (2) and Olivecrona (3).

In the literature of the last ten years, we have found 7 reports of metastasizing intracranial tumors. One of these (4), including 2 cases, can be dismissed from further consideration because there was no anatomical examination of the distant masses. Doubt as to the authenticity of some of the remaining 6 has been expressed either by the author himself or by readers. The 6 cases are here briefly summarized.
Case 1 (Sachs, Rubinstein, and Arneson, 1936) (5): Male, thirty-eight. Medulloblastoma of right cerebellar hemisphere (diagnosis confirmed by P. Bailey). Time from symptoms to death, between four and a half and five and a half years. Two operations; radiation. Survival after first operation, four years and a half. Shortly before death enlargement (size not stated) was observed over the sternum. Biopsy revealed a tumor of the same kind as had been removed from the cerebellum. Radiation caused this mass to disappear promptly. Though no autopsy was done, it appears reasonable to accept this case as one of metastasizing medulloblastoma. A photomicrograph is included.

Case 2 (Mittelbach, 1935) (6): Male, thirty-nine. Glioblastoma multiforme of left cerebral hemisphere. Time from first symptoms until death, eighteen months. Operation; no radiation. Postoperative survival six months. Autopsy showed several round nodules, the largest the size of a hazelnut, in all the lobes of the lungs except the lower right, and hilar nodes, some as large as a plum, filled with tumor, of the same structure as the brain tumor. No primary growth was found in the lung, and no tumor elsewhere than in the lungs, hilar nodes, and brain. Metallic impregnation was not conclusive. Microscopically the tumor had invaded the cranial blood sinuses. A gross photograph is included.

This case was briefly mentioned and discussed at the 1934 meeting of the German Pathological Society; Fischer-Wasels believed that a carcinoma of the lung as the primary tumor had to be ruled out (7).

Case 3 (Brandt, 1934) (8): Male, sixty-four. Spindle-cell sarcoma of dura of hypophyseal region. Time from first symptoms to death, four months. No operation; no radiation. There were three round nodular metastases, the largest the size of a walnut, in the liver. One gross photograph is included.

This case is presented very briefly (10 lines) at the end of a report of five cases of multiple gliomas. More details would be desirable.

Case 4 (Foot and Zeek, 1931) (9): Male, forty-five. Melanoma of meninges of right temporal lobe. Time from first symptoms to death, six weeks. No operation; no radiation. There were a dozen melanotic nodules in the lungs. The authors made a careful search for a primary melanoma, but could find none elsewhere than in the meninges, and therefore concluded that the lung nodules were metastases.

Case 5 (Wohlwill, 1930) (10): Female, nine months. Medulloblastoma of mid-cerebellum, and a tumor of the right supraclavicular region one and one-half times the size of the patient's fist (at autopsy). Symptoms of short duration. Radiation; no operation. The supraclavicular tumor had the appearance of a ganglioneuroma. The author considered the supraclavicular tumor probably a metastasis from the medulloblastoma of the cerebellum, with unusual differentiation. Photomicrographs are included.

Case 6 (Davis, 1928) (11): Female, thirty-one. Spongioblastoma multiforme of left cerebral hemisphere. Time from first symptoms to death, nine months. Two operations; radiation. Survival six months after first operation. Two months before death a tumor as large as a walnut was observed on the posterior aspect of the right arm. Later, tumors were found in the left axilla, over the ribs, and in the substance of the right pectoral muscle. At autopsy three nodules, up to 1.5 cm. in diameter, were found in the left lung. Photomicrographs accompany the article. The brain tumor and metastatic nodules were diagnosed by Penfield as spongioblastoma multiforme; Bailey (12) does not accept the case as a metastasizing intracranial tumor.

Of the above cases, the first seems to be a fairly certain case of metastasizing medulloblastoma; the second, fifth, and sixth seem more or less doubtful; the data in the third case are insufficient; in the fourth case, the meningeal melanoma may well have been primary, but it must be recognized that it is very difficult to rule out all other sources.

Metastases Inside the Craniospinal Dura

A great many cases of metastases occurring inside the dura mater have been reported. In the literature prior to the last decade the reports are
often difficult to interpret. A variety of tumors were diagnosed “sarcoma,”
the autopsies were often incomplete, metastatic tumors were confused with
primary growths, and many papers were poorly illustrated. The distinction
between extension and metastasis and between multiple primary tumors and
metastases is often difficult to make. Courville (13) has recently collected
134 cases of multiple primary brain tumors.

Mention should be made here of the condition usually known as “diffuse
sarcomatosis of the meninges,” also as “sarcomatous meningitis,” “primary
sarcoma of the meninges,” and by a half-dozen other names. The German
literature especially, from 1890 to 1926, contains several dozen articles on
this subject. Among the more extensive contributions are those of Ford and
Firor (14) and Schuberth (15). A large percentage of these cases are appar­
tently medulloblastomas; some appear to be metastases from malignant tumors
elsewhere in the body, some meningiomas, and some non-pigmented mela­
nomas. True intracranial sarcomas are rare; Cushing (16) lists 14 sarcomas
among 2023 verified intracranial tumors.

In 1928 Russell and Cairns (17) reported the first metastasis of an astro­
cytoma. This finding stimulated them to examine the spinal cord routinely
in all their cases of brain tumor, and in 1931 they (1) found metastases in 7
of 21 cases of intracranial tumor (we exclude theirs and other cases of neuro­
epithelioma of the retina because this is not strictly an intracranial tumor).
The only other recently published series of intracranial tumors studied with
respect to metastases is that of Mittelbach (6), who reviewed the 223 cases of
brain tumor coming to autopsy between 1921 and 1933 at Prague. In this
series the spinal cord had not been examined routinely, but the author found
metastases in 7 cases, including one case of metastatic astrocytoma, and one
of glioblastoma multiforme reported as metastasizing to the lungs. Ostertag,
in a discussion at a symposium on gliomas (7), stated that he had found
metastases in 18 per cent of one year’s series of brain tumors.

We have collected from the literature 25 cases in which there is at least
a fair probability that an intracranial tumor has metastasized inside the dura
(Table I). As mentioned previously, this is often difficult to judge and our
table therefore probably contains errors and omissions. Metastases inside
the dura of medulloblastomas, and apparent medulloblastomas reported under
older names, are omitted from the table because of their frequency. If looked
for carefully, they would probably be found in 25 to 50 per cent of medullo­
blastomas.

**MISCELLANEOUS CASES OF TUMORS OF BRAIN TISSUES OCCURRING
OUTSIDE THE CENTRAL NERVOUS SYSTEM**

About a half-dozen cases of “carcinoma of the brain,” some with intra­
cranial and extracranial metastases, and with the origin ascribed usually to
the choroid plexus or ependyma, have been reported. These have been re­
viewed by Kufs (38), who considers them doubtful.

Gliomas occurring outside the central nervous system are not necessarily
metastatic. There may be recurrence in or extension through an operative
wound in the skull, as in the cases of Hamperl (39), Bailey and Bucy (40),
<table>
<thead>
<tr>
<th>Author</th>
<th>Age (in years)</th>
<th>Type of tumor</th>
<th>Location</th>
<th>Time from symptoms to death</th>
<th>Operation</th>
<th>Radiation</th>
<th>Post-operative survival</th>
<th>Metastases</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cairns and Russell,</td>
<td>F. 9</td>
<td>Glioblastoma multiforme (?)</td>
<td>3rd ventricle</td>
<td>3 mo.</td>
<td>+</td>
<td>+</td>
<td>1 mo.</td>
<td>Leptomeninges of cord below 8C; patches on cord and cauda up to 1 × 2 cm</td>
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<td>1931 (1)</td>
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<tr>
<td>Cairns and Russell,</td>
<td>M. 56</td>
<td>Glioblastoma multiforme</td>
<td>Left frontal lobe</td>
<td>6 wk.</td>
<td></td>
<td>0</td>
<td>0</td>
<td>Leptomeninges of cord and cerebellum; nodules on spinal roots and cauda</td>
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<tr>
<td>1931 (1)</td>
<td></td>
<td></td>
<td>and corpus callosum</td>
<td></td>
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<tr>
<td>Brannan, 1926 (18)</td>
<td>F. 13</td>
<td>Glioma</td>
<td>Left optic thalamus</td>
<td>6 mo.</td>
<td>+</td>
<td>0</td>
<td>Post-op. death</td>
<td>Diffuse in meninges of base and cord</td>
<td>Probable glioblastoma multiforme</td>
</tr>
<tr>
<td>Löwenburg, 1921 (19)</td>
<td>F. 12</td>
<td>Glioma</td>
<td>Right optic thalamus</td>
<td>2 yr.</td>
<td></td>
<td>0</td>
<td>0</td>
<td>Leptomeninges of base, cerebellum and cord</td>
<td>Probable glioblastoma multiforme</td>
</tr>
<tr>
<td>Lahmeyer, 1913 (20)</td>
<td>M. 36</td>
<td>Glioma sarcomatodes</td>
<td>Under genu of corpus</td>
<td>6 mo.</td>
<td></td>
<td>0</td>
<td>0</td>
<td>Nodular thickening, leptomeninges of base, cord, and cauda</td>
<td></td>
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<tr>
<td>callosum</td>
<td></td>
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<td>callosum</td>
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<tr>
<td>Schupfer, 1908 (21)</td>
<td>M. 43</td>
<td>Gliosarcoma</td>
<td>Right temporal lobe</td>
<td>2½ yr.</td>
<td></td>
<td>0</td>
<td>0</td>
<td>Leptomeninges of cord below 2C; 2 nodules in upper cord</td>
<td></td>
</tr>
<tr>
<td>Cairns and Russell,</td>
<td>——</td>
<td>Papilloma of choroid plexus</td>
<td>4th ventricle</td>
<td>——</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Roof of 4th ventricle studded with nodules</td>
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<tr>
<td>1931 (1)</td>
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<tr>
<td>Van Wagenen, 1930 (22)</td>
<td>M. 13</td>
<td>Papilloma of choroid plexus</td>
<td>Left lateral and 3rd</td>
<td>14 mo.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Implants on walls of right lateral ventricle</td>
<td></td>
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<tr>
<td>Töppich, 1926 (23)</td>
<td>M. 2</td>
<td>Papilloma of choroid plexus</td>
<td>4th ventricle</td>
<td>3 mo.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Nodules in leptomeninges of cerebrum; cerebellum and cord below mid-thoracic</td>
<td></td>
</tr>
<tr>
<td>Author</td>
<td>Age (in years) and sex</td>
<td>Type of tumor</td>
<td>Location</td>
<td>Time from symptoms to death</td>
<td>Operation</td>
<td>Radiation</td>
<td>Post-operative survival</td>
<td>Metastases</td>
<td>Comment</td>
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<tr>
<td>Bielschowsky and Unger, 1906 (24)</td>
<td>F. 43</td>
<td>Papilloma of choroid plexus</td>
<td>4th ventricle</td>
<td>6 mo.</td>
<td>+</td>
<td>0</td>
<td>3 mo.</td>
<td>Implants in meninges</td>
<td></td>
</tr>
<tr>
<td>Cairns and Russell, 1931 (1)</td>
<td>M. 59</td>
<td>Ependymoma</td>
<td>Vermis of cerebellum</td>
<td>44 mo.</td>
<td>0</td>
<td>0</td>
<td></td>
<td>Few small nodules in leptomeninges of cord opposite 5T</td>
<td></td>
</tr>
<tr>
<td>Jacob, 1916 (25)</td>
<td>M. 28</td>
<td>Glioma</td>
<td>Cerebellum</td>
<td>2 yr.</td>
<td>+</td>
<td>0</td>
<td>1 mo.</td>
<td>Nodules in ventricular walls and leptomeninges of brain and cord</td>
<td>Probable ependymoma</td>
</tr>
<tr>
<td>Gordinier and Sawyer, 1911 (26)</td>
<td>F. 50</td>
<td>Ependymoma</td>
<td>Lateral ventricles and frontal lobes</td>
<td>2 yr.</td>
<td>0</td>
<td>0</td>
<td></td>
<td>Leptomeninges of cord and brain stem</td>
<td>Diagnosis confirmed by Mallory</td>
</tr>
<tr>
<td>Spiller, 1907 (27)</td>
<td>F. 48</td>
<td>Ependymoma</td>
<td>4th ventricle</td>
<td>18 mo.</td>
<td>0</td>
<td>0</td>
<td></td>
<td>Nodule 1 cm. on lower thoracic cord</td>
<td>Diagnosis confirmed by P. Bailey (28)</td>
</tr>
<tr>
<td>Martin, 1931 (29)</td>
<td>M. 43</td>
<td>Oligodendroglialoma</td>
<td>Left parietal lobe</td>
<td>4 yr.</td>
<td>+</td>
<td>0</td>
<td>1 yr.</td>
<td>Nodule 1 cm. in scalp near cerebral hernia; 2 nodules walls of right lateral ventricle</td>
<td>First established instance of cerebral tissue growing outside central nervous system</td>
</tr>
<tr>
<td>Cairns, 1929 (30)</td>
<td>M. 43</td>
<td>Oligodendroglialoma</td>
<td>Right frontal lobe</td>
<td>4 yr.</td>
<td>+</td>
<td>0</td>
<td>3½ yr.</td>
<td>Lateral and 4th ventricles</td>
<td></td>
</tr>
<tr>
<td>Mittelbach, 1935 (6)</td>
<td>M. 1½</td>
<td>Astrocytoma</td>
<td>Floor of diencephalon</td>
<td>1 yr.</td>
<td>0</td>
<td>0</td>
<td></td>
<td>Leptomeninges of base and cord, anterior roots, 3rd ventricle</td>
<td></td>
</tr>
<tr>
<td>Author</td>
<td>Age (in years) and sex</td>
<td>Type of tumor</td>
<td>Location</td>
<td>Time from symptoms to Operation (in months)</td>
<td>Radiation</td>
<td>Post-operative survival</td>
<td>Metastases</td>
<td>Comment</td>
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<tr>
<td>Russell and Cairns, 1930 (17)</td>
<td>M. 28</td>
<td>Astrocytoma</td>
<td>Right optic thalamus</td>
<td>9 mo.</td>
<td>0</td>
<td>+</td>
<td>Leptomeninges of cord and pineal region</td>
<td>See comment by Bailey and Bucy (31) and reply by Cairns and Russell (32). See also O. T. Bailey (33). Tumor cells in spinal fluid</td>
<td></td>
</tr>
<tr>
<td>Cairns and Russell, 1931 (1)</td>
<td>F. 25</td>
<td>Adenoma</td>
<td>Pituitary</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>2 small nodules in leptomeninges of cord and 1 at tip of cauda</td>
<td>Inferior surface right cerebellum</td>
<td></td>
</tr>
<tr>
<td>Bielschowsky and Henneberg, 1928 (34)</td>
<td>F. 11</td>
<td>Ganglioneuroma</td>
<td>Right temporal lobe</td>
<td>7 yr.</td>
<td>0</td>
<td>0</td>
<td>Inferior surface right cerebellum</td>
<td>Implant on floor of 3rd ventricle</td>
<td></td>
</tr>
<tr>
<td>Horrax and Bailey, 1925 (35)</td>
<td>M. 12</td>
<td>Pinealoma</td>
<td>Pineal region</td>
<td>1 yr.</td>
<td>0</td>
<td>0</td>
<td>Nodules to 1 cm. on cauda</td>
<td>Pea-sized nodules on dural flap at re-operation</td>
<td></td>
</tr>
<tr>
<td>Bailey, 1933 (36)</td>
<td>F. 19</td>
<td>Sarcoma</td>
<td>Meninges of brain</td>
<td>3 mo.</td>
<td>+</td>
<td>+</td>
<td>Nodules throughout spinal canal</td>
<td>Leptomeninges of base and cord below 3C</td>
<td></td>
</tr>
<tr>
<td>Cushing, 1932 (37)</td>
<td>M. 17</td>
<td>Perithelial sarcoma</td>
<td>Right precentral</td>
<td>6 yr.</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cushing, 1932 (37)</td>
<td>8</td>
<td>Sarcoma</td>
<td>Anterior to brain stem</td>
<td>—</td>
<td>+</td>
<td>+</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ford and Firor, 1924 (14)</td>
<td>M. 49</td>
<td>Sarcoma</td>
<td>Right lateral ventricle and hippocampus</td>
<td>2 mo.</td>
<td>0</td>
<td>0</td>
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</table>
and Mittelbach (6). There may be extension through some of the thinner cranial bones, as in the so-called nasal glioma (41). The tumor may arise from some embryonic remnant, as in glioma of the buttock (42).

Two cases of metastatic glia (not glioma) have been reported, by Askanazy (43) and by Hückel (44). One was in a newborn male, the other in a boy of four. Both had cerebral hernias and numerous glial nodules in the lungs. The blood stream was considered the route of metastasis. These were probably developmental anomalies rather than metastatic growths.

Neuhäuser (45) and Nordmark (46) have reported cases of ovarian teratomas, in girls of twelve and eleven years, where the tumors were partly composed of glia and there were peritoneal implants composed entirely of glia.

Case Report

R. H., a white male railway clerk twenty-four years old, first consulted a physician Sept. 4, 1931, because of attacks of nausea and vomiting for one year, unrelated to food. He had no abdominal pain or headache. The family history was unimportant; the previous history negative except for mumps. Physical and laboratory examinations were essentially negative. Diagnoses: neurosis, chronic tonsillitis. A tonsillectomy was done Sept. 9, 1931.

The patient was readmitted Nov. 18, 1931, because of attacks of vomiting every seven to ten days since the previous admission. The Wassermann test was negative. A neuro-psychiatrist made a diagnosis of gastric neurosis. The patient was again admitted Feb. 5, 1932, complaining of blinding flashes followed by intense headache and vomiting. The diagnosis at this time was migraine or epileptic equivalent.

On the fourth admission, March 19, 1932, the patient complained of severe frontal headache, pain and stiffness in the neck muscles, and dimness of vision in the left eye. The neurologic findings were as follows: patient restless; head retracted to relieve pain; coarse nystagmus to left; questionable Kernig sign on right; right fundus negative; left disc swollen; two hemorrhages in fundus. The spinal fluid was clear; the pressure over 300 mm. water; 4 cells per cubic mm.; gold curve 0021000000; Wassermann reaction negative. The blood pressure was 120/70. A ventriculogram was unsatisfactory. Diagnosis: undetermined. The patient was discharged April 9, 1932, with a diagnosis of migraine.

On readmission, April 18, 1932, the spinal fluid showed 3 cells per cubic mm. A brain tumor was now suspected, but the patient desired to go to another hospital.

On May 6, 1932, at Rochester, Minn., a soft vascular tumor of the right cerebellar hemisphere was partially removed. (The microscopic diagnoses at Rochester and elsewhere will be considered later.) Postoperative radiation was given. The patient improved greatly and remained in relatively good condition for two years, until May 1934. The headaches then recurred, becoming marked by July and severe by September.

On Sept. 19, 1934, at Tacoma, Washington, a second operation was performed, and a large soft recurrent tumor in the cerebellum was removed. Recovery was delayed by leakage of spinal fluid from the wound. There was some difficulty with speech and vision. Radiation therapy was given. On Feb. 6, 1935, it was noted that the patient felt better, that speech and writing were improved, and that "he has retained his faculties so that he is capable of driving an auto."

The patient's last admission was on June 13, 1935, when he walked into the hospital, complaining of headache, thick and slow speech, and stiffness in the right side of his body. From then on he grew rapidly worse. On July 2, 1935, he was unable to control the right leg; July 10, daily catheterization was begun; July 15, left arm became paralyzed; July 31, rise of temperature for three days, bedsores appearing; Aug. 5, burning sensation on elbows; Aug. 14, rise of temperature; Aug. 19, death, with terminal rise of temperature to over 107°F.

Autopsy was performed by the writer three hours after death. The findings, other than those in the skull and central nervous system, were: moderate emaciation; superficial bedsores; thickening and edema of bladder wall, and slight inflammation of its mucosa.
old pleural adhesions, right; redundant sigmoid colon; slight atherosclerosis of aorta; spermatocele 1 cm., left. The lungs showed no consolidation or tumor. The heart, bronchi, pulmonary arteries, spleen, liver, gallbladder, pancreas, adrenals, kidneys, gastro-intestinal tract, prostate, seminal vesicles, testes, right epididymis, thyroid, and parathyroids showed nothing of note.

The skull showed extensive operative defects in the occipital region, and a trephine hole in the right parietal bone. The posterior one-third to one-half of the cerebellum was composed of soft, gray-red, partly necrotic tumor. On section, the anterior border of the tumor could be seen infiltrating diffusely into the cerebellum. Elsewhere the tumor was plastered to the dura, and this in turn was densely adherent to the edges of the operative defect in the skull. The leptomeninges anterior to the tentorium, and those of the pons, medulla, and first inch of the spinal cord were macroscopically normal. The various parts of the brain, other than the cerebellum, showed no tumor on gross section. The skull bones showed no evidence of tumor.

The spinal cord, from an inch below the medulla to the end, was encircled by a sheath of white, moderately firm tumor tissue, varying from 1 to 7 mm. in thickness. It was thickest posteriorly. There were compression and distortion of the cord, and some infiltration by tumor, in a large part of its length, more marked in the lower portion. The cord with its surrounding sheath of tumor tissue measured from 1.8 to 2.2 cm. in diameter throughout the greater part of its extent (Fig. 1). The inner surface of the spinal dura

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**Fig. 1. Spinal Cord Encircled by Tumor Sheath**

The cord is disorganized and infiltrated by tumor.

**Fig. 2. Vertebral Bodies with Discrete Tumor Nodules**

The largest nodule, 8 mm. in diameter, not shown here, was used for microscopic sections.
appeared quite normal, but some of the nerve roots going through the dura were thickened. The cauda equina showed very little tumor.

The spinal cord was removed by the anterior route. The bony surfaces surrounding the vertebral foramina showed nothing of note; neither did the vertebral column from the anterior aspect. At the time of the autopsy, it was not suspected that tumor would be found in the vertebral bodies. However, for no particular reason, four of the lower thoracic vertebral bodies were saved. On sawing through them later, several round, white, fairly dense nodules up to 8 mm. in diameter were seen (Fig. 2). Further sections revealed a total of at least a dozen visible white nodules in the four vertebral bodies.

**Fig. 3. Cerebellar Tumor with Typical Structure of Medulloblastoma, Showing Invasion of White Matter of Cerebellum**

The large cells near the top and bottom of the photograph are Purkinje cells.

**Microscopic Examination:** The tissues were fixed in formalin and stained with hematoxylin-eosin and azocarmine; Perdrau-Bielschowsky silver impregnation was also done.

**Hematoxylin-eosin Stain: Cerebellar Tumor:** The cerebellar tumor is composed of small to medium-sized cells with little cytoplasm and hyperchromatic round and oval nuclei (Fig. 3). The cytoplasmic borders are ragged. Mitoses are frequent; there are occasional multinucleated cells, small masses of calcium, and a few pseudo-rosettes. There are numerous small and large capillaries. Some parts of the tumor contain practically no stroma. In other places there is a slight to moderate amount of fibroblastic stroma, apparently the result of irradiation. The nuclei of the stroma are easily distinguished from those of the tumor cells; they are the typical elongated nuclei of fibroblasts with finely divided chromatin.

**Spinal Cord:** The tumor cells in the sheath around the cord are the same as those in the cerebellum, but there is a greater amount of dense fibrous stroma. The collagenous fibers form a net-like meshwork, breaking up the tumor cells into small groups (Fig. 4). Here again the stroma nuclei are totally different from those of the tumor cells. The tumor is invading the cord from the periphery, and there is marked disorganization of the cord structure. A section of the cord just below the pyramidal decussation shows the meninges thickened in places by diffuse infiltration of tumor cells. In a few places these have broken through the pia and are penetrating the cord for a short distance.

**Vertebrae:** Sections of the nodules show circumscribed round tumor masses composed of the same cells as are seen in the cerebellum and spinal cord, with a slight to moderate amount of fibrous stroma (Fig. 5). The bone trabeculae are still present in the regions occupied by tumor; the bone marrow outside the tumor nodules shows nothing of note.
Spinal Nerve Roots: Some of the nerve roots show patchy tumor infiltration between the bundles of nerve fibers as well as in the meninges. The spinal dura is not involved by tumor except at the points where the nerve roots pass through.

Cerebrum: A section from the motor area shows no tumor. Sections of kidney, liver, spleen, adrenal, lung, thyroid, parathyroid, testis and epididymis show nothing of note.

Mallory-Heidenhain Stain (Azocarmine): This stains collagenous and reticular fibers blue, muscle red, and does not stain neuroglia. The tumor sections from the various regions are entirely different in appearance from a fiber-producing sarcoma, which is the only sort of tumor with which this could be confused. The tumor cells are not producing fibers, but are broken up into small and large groups by a network of fibroblastic stroma. The fibers are not concentric around the blood vessels, as in the usual meningeal sarcoma, but rather radiate out from them.

Perdrau-Bielschowsky Silver Impregnation: The findings with silver impregnation are the same as with the azocarmine stain.

Diagnoses: The cerebellar tumor originally removed was diagnosed by Dr. J. W. Kernohan as an atypical medulloblastoma. Through the courtesy of Dr. Kernohan we have obtained some of this tissue, which appears the same as the tumor found at autopsy. At the second operation the cerebellar tumor was diagnosed by Dr. B. T. Terry as apparently glioma. The tumor obtained at autopsy was diagnosed by Drs. E. T. Bell and A. B. Baker of the University of Minnesota as medulloblastoma. Sections of this tumor were sent to Dr. Kernohan, who replied that he thought it a mixed sort of growth, perhaps originating from the granular layer of the cerebellum.

Sections of the tumor were also sent to Dr. P. Bailey, whom we wish to thank here for examining the sections. He felt that in this case it would be very difficult to differentiate between a medulloblastoma and a meningeal sarcoma, especially after irradiation. He had not seen or read of any proved case of either tumor metastasizing outside the spinal canal.

Discussion

This tumor is undoubtedly a primary intracranial tumor, and, as far as the literature is concerned, unique in forming discrete bone metastases. The reason for this, we believe, is that such metastases have not been looked for;
the finding in this case was more or less accidental. We believe without ques-
tion that the tumor is a medulloblastoma; in the remote event that it is some
other type of intracranial tumor, the finding of bone metastases is of equal
interest.

The features in favor of medulloblastoma of the cerebellum as the diag-
nosis in this case are as follows: (1) The finding of a tumor in the cere-
bellum at the first operation; (2) the excellent response to radiation, medul-
loblastomas being outstanding among intracranial tumors in this respect; (3)
the typical encircling of the spinal cord by a sheath of tumor tissue; (4) the
microscopic picture: cells with dark round and oval nuclei and little cytoplasm,
easily distinguishable from the stroma cells; no formation of collagenous or
reticular fibers by the tumor cells; fibers not concentric around blood vessels
but radiating out from them; no evidence of perivascular tumor origin.

The apparent looseness of parts of the tumor structure is due to dropping out of cellular
elements during the long process of decalcification of the bone. Same magnification as Fig. 3.

The age of the patient, twenty-eight years at death, is not against the
diagnosis of medulloblastoma. Although these tumors commonly occur in
the mid-cerebellum in children, Cushing (47) found 8 of a series of 61 (13
per cent) occurring in the cerebellar hemispheres of adults.

The amount of fibrous stroma (most marked in the spinal cord) is not
against the diagnosis of medulloblastoma. Some is apparently the result of
irradiation; the rest is undoubtedly connective-tissue reaction such as occurs
when medulloblastomas invade the leptomeninges (48).

**Summary**

1. A case of medulloblastoma of the cerebellum with discrete metastases
to the vertebral bodies is reported.

2. The reported cases of metastases of intracranial tumors are reviewed.
32. Reference 1, p. 408.