CALCIFICATION of intracranial tumors has been the subject of numerous histological and roentgenological studies. Martin and Lemmen7 studied 1577 intracranial neoplasms and found that calcification occurred microscopically in 207 cases (13.1 per cent); in 104 cases of this group calcium was visible in the roentgenogram (54.2 per cent). These authors described four different types of histological patterns of calcification, but did not mention ossification and with the exception of a case of mixed ependymoblastoma and osteoblastoma reported by Mackay6 we were unable to find in the literature on gliomas of the central nervous system cases in which ossification had occurred. We have observed ossification in 2 cases; one was in an astrocytoma of the cerebellum of long duration (25 years); the second was in an oligodendroglioma of 9 years' duration. It is known that calcification is common in both of these types of gliomas.

Mabon et al.5 reviewed 131 cases of astrocytomas of the cerebellum and found calcification radiologically in 11 cases (8.5 per cent) and microscopically in 21 (16.3 per cent). Cushing2 reported calcification visible radiologically in only 1 of 76 cases of cerebellar astrocytomas. In neither of these papers was there mention of the presence of ossification. Earnest et al.3 reviewed 200 cases of oligodendroglioma and found calcium deposits microscopically in 115 (69.7 per cent) and radiologically in 64 cases (38 per cent). There was no report of ossification.

REPORT OF CASES

Case 1. R.S., a 53-year-old white male, was admitted to the University Hospital on Jan. 3, 1955 with symptoms of severe suboccipital pain which radiated to behind the right ear, and muscle spasm in the neck which had persisted for the past 25 years. His wife stated that since their marriage years ago he had invariably complained of excruciating headaches during episodes of vomiting. Eighteen months prior to admission he had noted fatigue, increased sleepiness and blurring of vision. Six months later he developed difficulty in walking and a tendency to veer toward the left. In the last 2 months he was incapacitated.

Examination. The left pupil was larger than the right, and there was bilateral papilledema. He walked with a wide base and tended to stagger and fall backwards. There was mild decomposition of movement of both lower extremities. Deep tendon reflexes were hyperactive in both lower extremities and there was an equivocal Babinski sign bilaterally.
Roentgenograms of the skull revealed an area of calcification in the midline of the occipital region, roughly ovoid in shape, that could not be seen on the lateral views. Laminagrams showed that this area was 2 cm. above the foramen magnum, immediately dorsal and superior to the fourth ventricle (Fig. 1).

Fig. 1. Case 1. Laminagram of the skull showing a dense image of calcification in the posterior fossa.

Fig. 2. Case 1. Photomicrograph of the cerebellar astrocytoma removed at operation.
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Fig. 3. Case 1. Photomicrograph showing calcification and ossification of the neoplasm.

Fig. 4. Case 1. Higher power view of an ossified area shown in Fig. 3.
Operation. On Jan. 5, 1955, a suboccipital craniectomy and laminectomy of C1 was performed by Dr. E. A. Kahn and a large, stony-hard mass in the posterior vermis was completely removed.

Course. Convalescence was slow because of disturbance in gait and mental depression. The patient, however, was ready for discharge 1 month after operation and returned to work as an accountant 4 months later.

Histological Examination. The tumor is a fibrillary astrocytoma (Fig. 2) with hyaline degeneration and numerous calcium deposits most marked in the walls of the blood vessels. Within the tumor there is also an extensive area of calcification with irregular borders and no discernible vascular pattern. In the central portion of this calcified area there has developed well differentiated bone which contains bone-marrow spaces filled with fibrous connective tissue (Figs. 3 and 4).

Case 2. M.R., a 55-year-old white female, was admitted to the University Hospital on Mar. 9, 1953. She had been well until 1946 when she had an episode of unconsciousness, generalized convulsions, incontinence of bladder and bowel, and biting of the tongue. Numerous similar attacks had occurred at irregular intervals since that time. Medication relieved the symptoms for 1 year. When x-ray examination revealed an area of intracranial calcification (Fig. 5) she was referred to the University Hospital.

Examination. An arteriogram revealed evidence of a space-occupying lesion, presumably an oligodendroglioma in the right frontoparietal region. These findings were confirmed by radio-active iodine uptake studies and an electroencephalogram.

Course. Because of the extremely slow growth of this neoplasm and the relatively minor symptomatology, surgical treatment was deferred. Phenurone was added to her anticonvulsant medication and she was discharged on Mar. 13, 1953.

Readmission, Mar. 29, 1955. She had remained relatively well until 6 weeks pre-
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Previously, when she became mentally confused and relatively unresponsive. At the time of admission she was semicomatose.

Examination. Blood pressure was 170/90, pulse rate 96, and respiratory rate 20. She was very obtunded, but without dysphasia; she could name objects, count numbers and add. She was fairly well oriented but extremely slow in answering questions. She could not read or write. Funduscopic examination was negative except for rather full, nonpulsating veins. There was a left supranuclear facial weakness. She had slight paresis of the left arm. There was no sensory deficit. Deep tendon reflexes were slightly hyperactive on the left with a negative Hoffmann’s but equivocal Babinski sign on the left side.

Operation. On Mar. 31, 1955 a right frontal osteoplastic craniotomy was performed by Dr. E. A. Kahn and gross total removal of the neoplasm was accomplished.

Course. A few days postoperatively the mental state had returned to normal and the patient left the hospital in exceedingly good condition.

Histological Examination. The appearance of the neoplasm is characteristic of an oligodendroglioma (Fig. 6). This diagnosis is confirmed by the silver techniques. The decalcified fragments stained with hematoxylin and eosin show a deposition of calcium in concentric rings within which there is abundant membranous bone formation with typical Haversian canals and thick bony trabeculae. The bone-marrow spaces have been replaced by fibrous connective tissue (Figs. 7 and 8).
Fig. 7. Case 2. Photomicrograph of an area of calcification and ossification.

Fig. 8. Case 2. Detailed view of the bone formation adjacent to the neoplasm.
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COMMENT

The presence of bone formation within intracranial neoplasms and particularly within gliomas arouses speculation as to the origin of the osseous tissue. It is not possible from the study of these 2 cases to determine the source of ossification within gliomas. Although we have found no discussion of the subject in the literature some possibilities should be considered as to its origin. It has been suggested in other tumors, the meningiomas for example, that bone formation occurs secondary to degeneration of tumor cells¹ or that the bone is formed by the multipotential cells that make up the tumor itself.² Since the tumors of the glioma group are derived from the ectoderm of the primitive neural tube, it is reasonable to assume that the latter supposition could not be applied in these cases. Although the tumors contained calcium deposits and areas of necrosis it is also difficult to accept the origin of osteoblasts from the necrotic cells themselves. Perhaps it would be more logical to assume, as did Maximow and Bloom,⁵ that bone develops through a simple transformation of embryonic or adult connective tissue into a calcifiable tissue known as bone matrix (intramembranous formation). In pathological conditions, therefore, metaplastic bone formation might occur within the areas of calcified normal or necrotic tissue by direct transformation of mesenchymal cells of the blood vessels into osteoblasts, or they might arise from fibroblasts and reticular cells.

REFERENCES