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Computed Tomography of Gliosarcoma

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Five cases of rare gliosarcoma are described with pathologic correlation. Because of its sarcomatous component, gliosarcoma tends to present as a sharply defined, round or lobulated, hyperdense solid mass with relatively homogeneous contrast enhancement and peritumoral edema. Sharp demarcation of the tumor from surrounding tissue may lead to complete removal and prolonged survival despite high malignancy. However, aggressive tumor regrowth occurs often after incomplete resection. The genesis of gliosarcoma is also discussed.

Gliosarcoma is a relatively rare malignant primary brain tumor. It has a reported incidence of 1.7% [1] to 2.5% [2] of all gliomas and 5% [3] of astrocytomas. To our knowledge, there has been no previous computed tomographic (CT) report of this rare tumor in adults. We report five cases of gliosarcoma, with emphasis on CT findings and pathologic correlation.

Case Reports

Case 1

A 28-year-old woman developed headaches, nausea, and vomiting in November 1981. A CT scan of the brain revealed a well circumscribed, round, hyperdense mass in the left posterior parietal lobe, with solid contrast enhancement and significant peritumoral edema (fig. 1). Arteriography was not performed. Total removal of a sharply demarcated, firm mass was reported, and a pathologic diagnosis of malignant glioma was made at an outside institution. Subsequently, she received 6500 rad (65 Gy) local brain irradiation, and a 1½ year course of oral CCNU, 5-FU, and vincristine chemotherapy. Postoperatively, she remained free of neurologic deficits except for occasional seizures and increasing speech difficulty. In February 1984 CT clearly demonstrated a recurrent tumor. A gross total resection was again attempted at our institute the next month. The main bulk of recurrent tumor was described as a gray white firm mass; however, tumor infiltration was noted at the margins. After a review of material from the original surgery and of the specimen from the second operation, a diagnosis of gliosarcoma was made. In May 1984, 2 months after the reoperation, the tumor recurred along the deep margin. On her most recent follow-up in October 1984, further progression of tumor was seen with local subependymal extension despite three monthly courses of intracarotid chemotherapy with BCNU and cisplatin.

Case 2

A 44-year-old man was seen at an outside hospital in February 1983 after a transient episode of dizziness and memory loss while playing tennis. A CT scan of the brain showed a sharply circumscribed, hyperdense mass in the left temporal lobe that enhanced with central hypodensity and peritumoral edema after intravenous administration of contrast medium (fig. 2A). Arteriography was not performed. A gross total resection was performed followed by whole brain irradiation of 2875 rad (29 Gy), and the pathologic diagnosis was grade II astrocytoma. In the next 1½ years, due to rapid tumor growth, he had two reoperations,

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additional local brain irradiation of 2875 rad (29 Gy) and three courses of intracarotid chemotherapy with BCNU and cisplatin. However, in July 1984, CT still showed a large, recurrent, solid, enhancing tumor (fig. 2B)

A fourth operation was performed, this time at our institute. The tumor was described as "extremely firm, gritty, and variegated in appearance," and final histologic diagnosis was gliosarcoma. The boundary between the tumor and the normal brain tissue was well defined. Unfortunately, gross total resection was impossible due to tumor adhesion to the floor of the left middle cranial fossa and tumor encasement of the left middle cerebral artery. Follow-up CT 6 weeks later revealed rapid tumor regrowth with distant parenchymal and subependymal extensions (figs. 2C–2E). The most recent follow-up in October 1984 revealed further progression of the tumor.

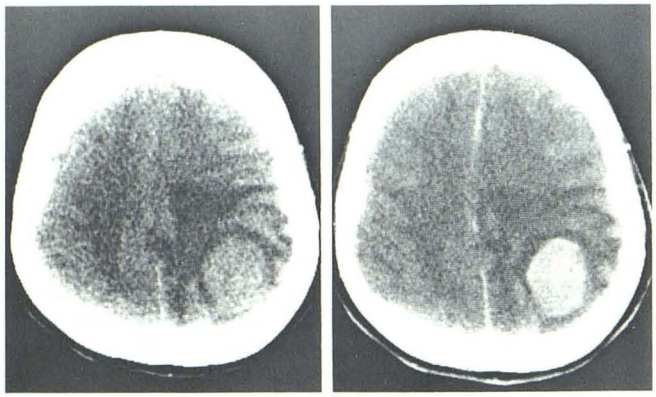


Fig. 1.—Case 1. **A**, Noncontrast scan. Well circumscribed, round, hyperdense mass with extensive peritumoral edema in left parietal lobe. **B**, Contrast-enhanced scan. Solid contrast enhancement of tumor without demonstration of central necrosis.

Case 3

A 55-year-old right-handed man was seen at an outside institution with a 2-month history of increasing difficulty in writing and progressive expressive aphasia. On the initial CT brain scan in March 1983, a well marginated, hyperdense, enhancing mass was found in the high convexity of the anterior left frontal lobe (fig. 3). Arteriography was not performed. Subsequently, a total gross resection of the tumor was performed, and a diagnosis of an intermediate-grade astrocytoma was made. There was no detailed description of the consistency and configuration of the tumor at surgery. He received postoperative local brain irradiation of 6000 rad (60 Gy) and was free of symptoms but remained steroid-dependent. However, follow-up CT scans failed to demonstrate residual or recurrent tumor. In August 1983, tumor recurrence was identified by CT scan, and a subtotal resection was performed at our institute. The recurrent tumor was described in surgery to be generally well demarcated and firm. After review of the histology from both surgeries, a diagnosis of gliosarcoma was made. Despite aggressive postoperative intracarotid

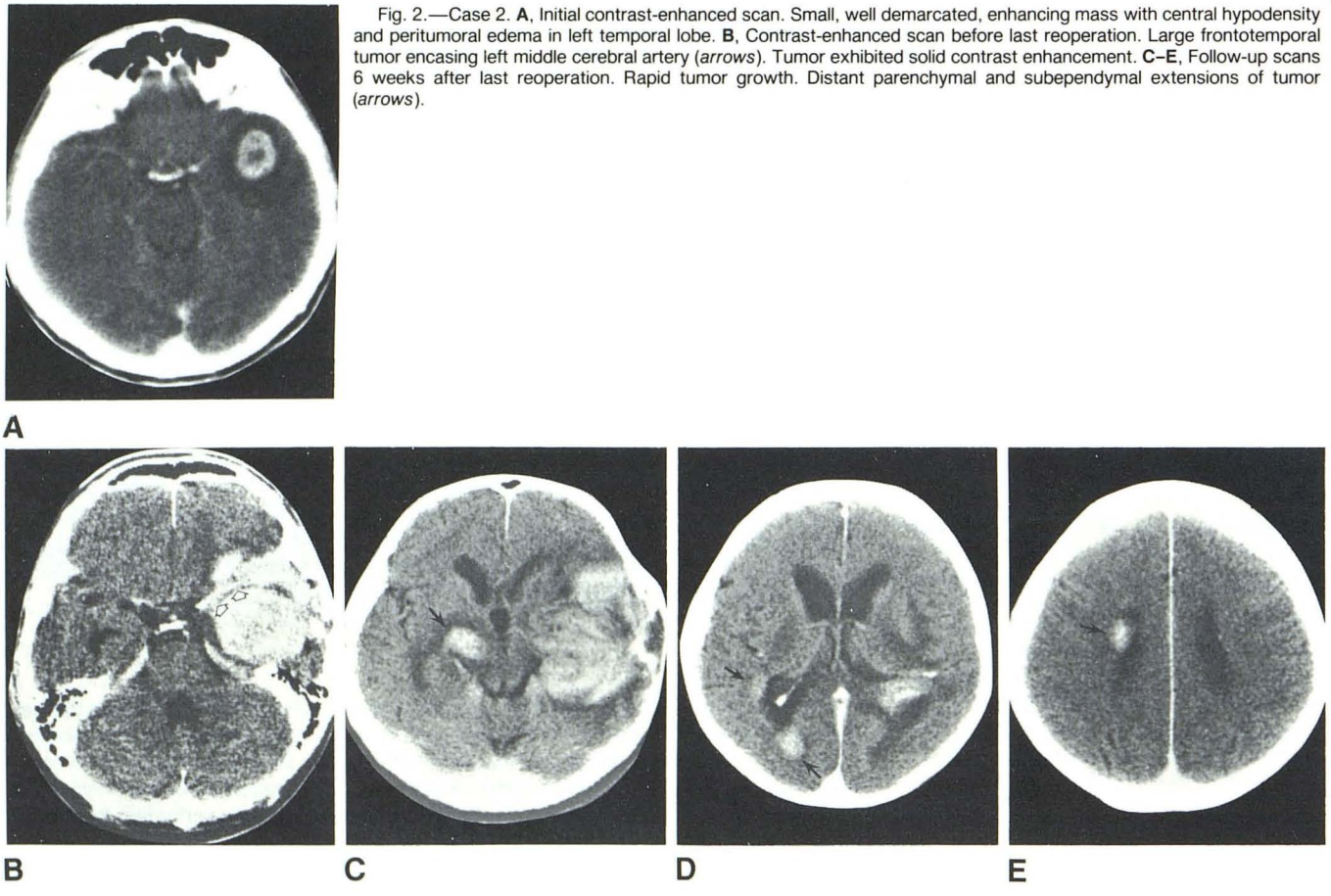


Fig. 2.—Case 2. **A**, Initial contrast-enhanced scan. Small, well demarcated, enhancing mass with central hypodensity and peritumoral edema in left temporal lobe. **B**, Contrast-enhanced scan before last reoperation. Large frontotemporal tumor encasing left middle cerebral artery (*arrows*). Tumor exhibited solid contrast enhancement. **C–E**, Follow-up scans 6 weeks after last reoperation. Rapid tumor growth. Distant parenchymal and subependymal extensions of tumor (*arrows*).

chemotherapy with BCNU, cisplatin, and then VP-16, the tumor recurred progressively. A third operation was performed in January 1984, with almost complete resection. Unfortunately, the tumor recurred again at the posterior margin in the motor cortex. The patient died in May 1984; an autopsy was denied.

Case 4

A 12-year-old boy with a 1-week history of nausea, vomiting, and headaches was admitted to our institute in July 1983. A CT scan of the brain showed a large, lobulated, solid, enhancing mass in the right frontal lobe associated with extensive peritumoral edema and midline shift (fig. 4). Arteriography was not performed. His history included mixed-cell Hodgkin disease, stage IIA, involving the right cervical lymph nodes in 1976. He remained free of evidence of disease after 3000 rad (30 Gy) local irradiation and six courses of MOPP chemotherapy, which ended in January 1978. A well demarcated vascular mass with a consistency described as "intermediate solid, not rubbery, but harder than glioma" was totally resected. The intraoperative frozen section was interpreted to be malignant glioma, but the final pathologic diagnosis was gliosarcoma. He received local brain irradiation of 6000 rad (60 Gy) by 6½ weeks after surgery. The CT scan at his most recent follow-up in November 1984 showed no evidence of residual or recurrent tumor.

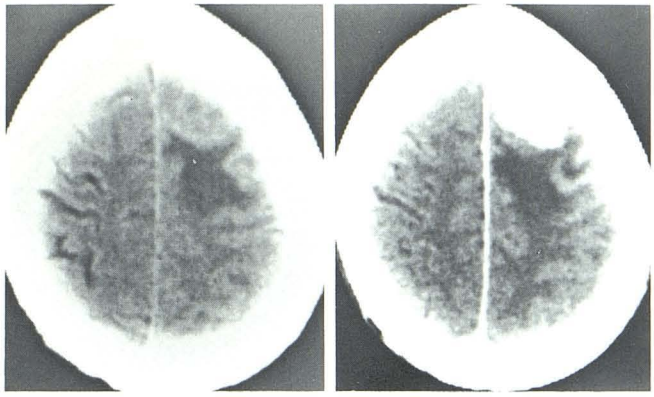


Fig. 3.—Case 3. **A**, Noncontrast scan. Left frontal high-convexity hyperdense mass with peritumoral edema. **B**, Dense contrast enhancement of tumor.

Case 5

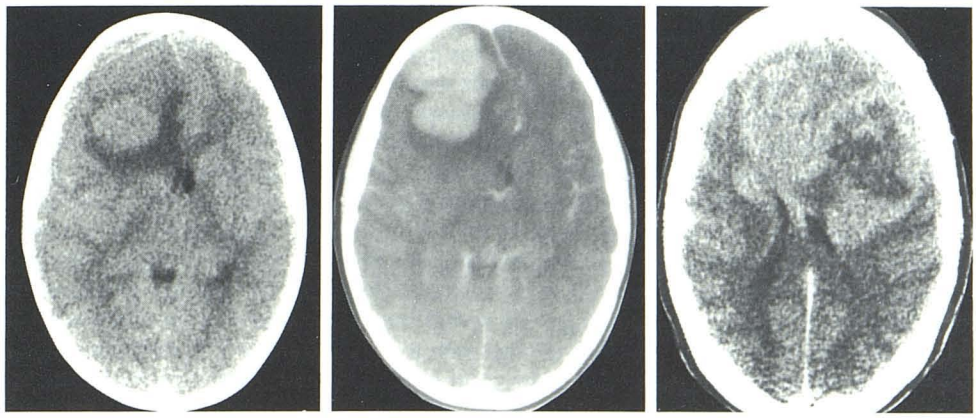
A 17-year-old girl was referred for psychiatric hospitalization in February 1984 because of progressive withdrawal and speech problems of unknown duration. CT of the brain after admission revealed a huge, multilobulated, hyperdense enhancing mass involving the frontal lobes, communicating through the genu and anterior body of the corpus callosum (fig. 5). An area of necrotic hypodensity was noted in the left frontal portion, but the main bulk of the tumor was solid and well marginated, with extensive vasogenic edema and mass effect. Arteriography was not performed. A left frontal craniotomy with only partial resection was performed at our institute. Some parts of the resected tumor were of a soft, gelatinous consistency, while other parts were more firm. The frozen section was believed to be a malignant astrocytoma, but the final diagnosis was gliosarcoma. The patient died 10 days after surgery due to extensive progression of the disease; a request for an autopsy was denied.

Discussion

Gliosarcoma was first used by Stroebe [4] in 1895 to describe a primary brain tumor composed of both gliomatous and sarcomatous components. After the initial description of this tumor, gliosarcoma came to be used to describe a form of glioma that is now called *anaplastic astrocytoma.* This confusion in making the correct diagnosis arose from the fact that both of these tumors, the true gliosarcoma and the anaplastic astrocytoma, show associated hypertrophy and hyperplasia of the endothelial elements of the blood vessels (primarily capillaries). In general, the higher the grade of the astrocytoma, the more marked the degree of hypertrophy and hyperplasia of the vascular endothelium becomes [3]. At times, the changes in the vascular endothelium progress beyond the bounds of hyperplasia and hypertrophy to marked cellular atypia and invasion through the vessel wall into surrounding tissues. This tumor then represents the true gliosarcoma. As the tumor grows, the gliomatous and sarcomatous components may be well demarcated from each other, but more often they are closely intermixed (fig. 6A). This hypothesis of the genesis of gliosarcoma represents the consensus of opinion of most authors on this subject [3, 5–7]. Light and electron microscopic studies have also tended to support this hypothesis [6]. It should be pointed out,

Fig. 4.—**A**, Noncontrast scan. Large, slightly hyperdense mass in right frontal lobe with peritumoral edema and midline shift. **B**, Contrast-enhanced scan in wider window and higher level. Adjacent calvaria is intact without destruction or hyperostosis. Strong homogeneous contrast enhancement of well demarcated, lobulated mass.

Fig. 5.—Case 5. Contrast-enhanced scan. Huge bifrontal multilobulated enhancing mass with necrotic hypodensity. Main bulk of tumor was solid and well marginated.



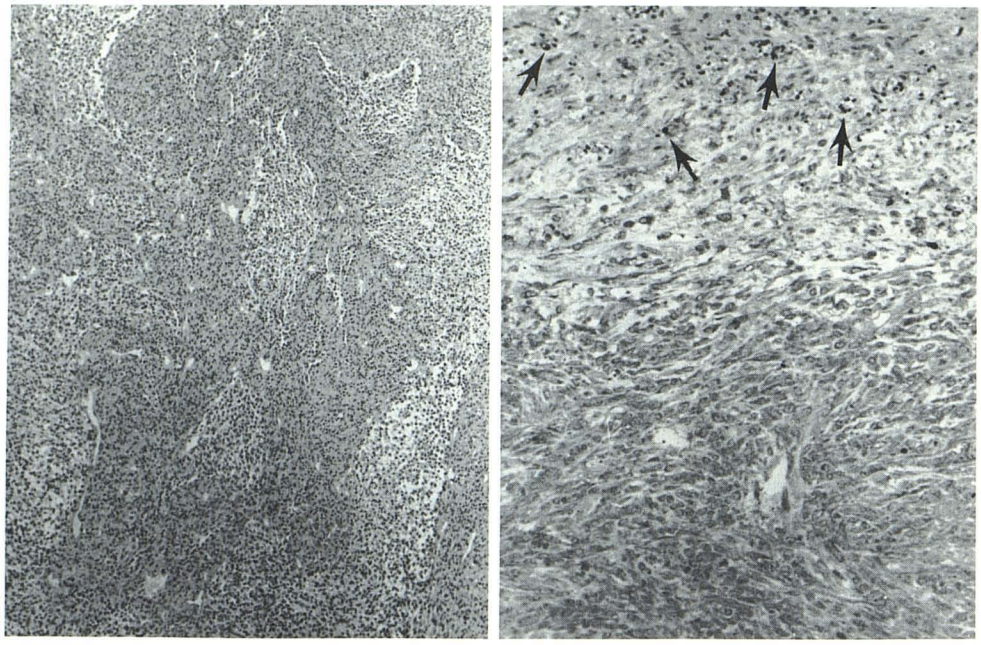


Fig. 6.—Case 4. Islands of lightly stained gliomatous component intermixed with densely stained sarcomatous components. (H and E ×20). **B**, Positively stained dense particles (*arrows*) readily identified in cytoplasms of neoplastic glial cells, but not in sarcomatous cells. (GFAP ×200.)

however, that there have been reports of cases where the concurrent appearance of glioma and sarcoma of the brain were probably coincidental and unrelated [8–10], as well as cases where the sarcoma appeared to be the initial tumor with the glioma having developed secondarily in a manner similar to that described above, the so-called *sarcoglioma* [11]. Glial fibrillary acid protein (GFAP) stain is of particular assistance to the pathologist in making the correct diagnosis. GFAP is a biochemically and immunologically distinct protein specific for glia-derived cells, which can be immunohistochemically detected [12]. The gliomatous elements of the tumor show a positive reaction while the sarcomatous parts remain negative (fig. 6B). Adequate tissue sampling on biopsy or resection, the pathologist's familiarity with all of the entities described above, and use of the GFAP stain are all helpful in making the correct diagnosis, as demonstrated in our first three cases.

The highly vascular proliferation and/or hypercellularity of both sarcomatous element and its counterpart, anaplastic gliomatous element, are probably responsible for the slightly increased attenuation (hyperdensity) on the precontrast CT scan and the homogeneous contrast enhancement on the postcontrast study. However, no presurgical arteriograms were obtained for possible angiographic correlation in any of our patients. Hypodensities, usually relatively small if present, frequently represent necrotic areas seen in the gliomatous component. On CT, the tumor may mimic meningioma when it is located superficially near the inner table; however, closer observation with proper bone settings will reveal that the tumor does not have a broad base in contact with the inner table of the calvaria, and no calvarial destructive or reactive changes are noted (fig. 4B). In addition, the tumor invariably has associated vasogenic edema due to its malignancy and

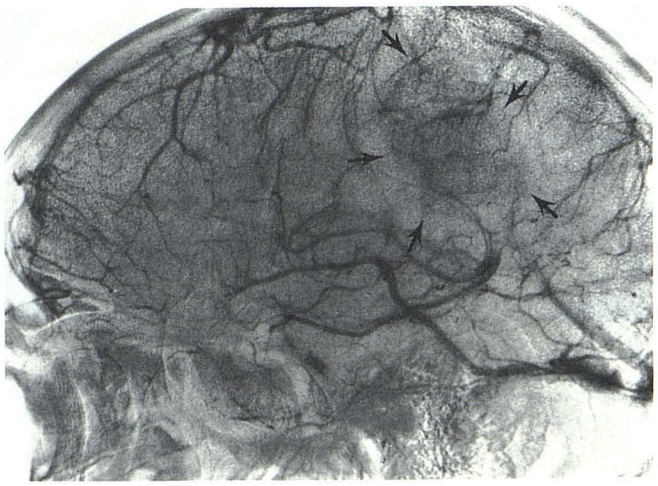


Fig. 7.—Well demarcated vascular stain of left parietal gliosarcoma (*arrows*) with peritumoral edema.

intraaxial location even when it is relatively small. The CT observations in our five cases are strikingly different from a previous CT report of a congenital malignant gliosarcoma, which appeared as a large, partly calcified cystic mass in a 4-month-old child [13]. Also, it should be mentioned that the CT findings of gliosarcoma cannot be completely differentiated from malignant glioma, although the latter tends to be of mixed attenuation and to be poorly marginated [14].

The sarcomatous component is responsible for the gross characteristics of gliosarcoma: firm consistency and sharp demarcation described in the surgical and pathologic speci-

men [15]. When located peripherally near the surface of the cerebral hemisphere, sometimes the tumor is mistaken for a meningioma at surgery. There are reports of prolonged survival in gliosarcoma despite the fact that it appears more aggressive than malignant glioma microscopically [15, 16]. To a large extent, the prolonged time until recurrence reflects the peripheral location of the initial tumor as well as the adequacy of initial resection, which often is aided by sharp delineation between normal brain and tumor. One of our patients (case 4) had tumor amenable to total gross resection. Eighteen months after the initial diagnosis, he was asymptomatic without CT evidence of recurrence, and a long survival is possible. Also of interest is that after incomplete resection the sarcomatous part of the tumor tends to outgrow the glial component and may exhibit extremely aggressive characteristics with rapid, unrelenting regrowth, as shown in case 2.

Addendum

Since acceptance of our manuscript, another case of gliosarcoma was encountered in a 69-year-old man. CT showed a sharply demarcated hyperdense solid mass in the left parietal lobe with dense homogeneous contrast enhancement and peritumoral edema. The arteriogram revealed a well marginated faint vascular stain of the tumor (fig. 7).

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