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Neuroradiologic Features of Primary Falx Osteosarcoma

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Primary osteosarcoma of the meninges is extremely rare, with only two cases reported in the literature [1, 2]. We report here a case of primary osteosarcoma of the falx. This case was diagnosed as falx meningioma preoperatively. The neuroradiologic studies performed are discussed, together with the known course and frequency of this lesion as described in the literature.

Case Report

A 56-year-old male high-school teacher developed a personality change over a 2-month period and became unable to keep his attention on his work. He was admitted to Brigham and Women’s Hospital in April 1984 after becoming severely disoriented.

Physical examination on admission revealed that the patient was alert and cooperative, but inattentive and indecisive, suggesting frontal lobe dysfunction. Motor function appeared intact. Cranial CT scans without and with intravenous administration of contrast medium (Figs. 1A and 1B) showed a large, partially calcified mass along the falx; dense and slightly inhomogeneous contrast enhancement with irregular margins in the bifrontal region was associated with marked surrounding brain edema. Both the CT scan (Fig. 1C) and skull radiographs showed the skull to be intact. A linear calcification was found underneath the inner table of the frontal bone on the lateral plain skull radiograph. Chest radiography and laboratory examinations were normal, and no other skeletal abnormality was found.

Bilateral internal and external carotid angiograms showed the tumor to have feeders bilaterally from both external (middle meningeal artery branches) and internal carotid arteries. Tumor vessels were seen at the arterial phase, a moderate degree of tumor blush appeared at the arterial phase and persisted through the capillary phase, and the anterior superior sagittal sinus was occluded (Fig. 1D). No early venous drainage was seen, and no homogeneous tumor stains were found. The preoperative diagnosis was falx meningioma.

Bifrontal craniotomy was performed. The falx tumor was removed together with portions of falx, the anterior one-half of the superior sagittal sinus, and a portion of calvarium. The tumor was approximately 13 × 9 × 2 cm, and consisted of a firm, multinodular, gritty mass that was adherent to resected dura and calvarium. The microscopic appearance was heterogeneous (Fig. 2). A majority of the tumor was composed of a poorly cellular, densely hyalinized matrix. Other areas were hypercellular, populated by pleomorphic, malignant cells with hyperchromatic nuclei and high mitotic rate. Adjacent to these hypercellular areas were multiple foci of malignant osteoid in which malignant cells were embedded. These areas were diagnostic of osteosarcoma. The osteoid was only partially mineralized and no neoplastic bone formation was present. Foci of chondroid and myxoid differentiation were also present. The tumor invaded and replaced portions of dural fibroconnective tissue. Poorly cellular tumor also formed a plaque on the inner calvarial surface, with focal invasion of the inner table. There was no histologic evidence of a primary site in bone.

The patient recovered well from the surgery, without complication, and was discharged in healthy condition. Radiation treatments were begun on June 15, 1984, and were concluded on August 1, 1984. Treatments were delivered on a 6-million eV linear accelerator with isocentric planning using opposed lateral technique. The patient received a total of 5940 rad (cGy) with the initial 4500 rad given with a 17 × 16 cm field, and the final 1440 rad given with a 14 × 17 cm field with lead blocks over the optic chiasm. Treatments were given with 180-rad fractions and the patient did not require a treatment break. Follow-up cranial CT scan 3 months after completion of radiation therapy showed no evidence of tumor recurrence. He was followed periodically for 7 months with no neurologic deficit.

Discussion

The meninges contain primitive multipotential mesenchymal cells [3–6]. All layers of the meninges, blood vessels, and the membranous portion of the skull are derivatives of the primitive multipotential mesenchyme [7]. Sarcomas account for 3% of all primary intracranial tumors [8], and may arise from any of the cellular elements of the meninges [9]. Most of these tumors are found over the frontoparietal convexity and in the posterior fossa. Among the intracranial sarcomas, fibrosarcoma is the most common pathologic type; hemangiopericytoma, reticulum cell sarcoma, myxofibrosarcoma, chondrosarcoma, and osteosarcoma are less common.

Primary osteosarcoma of the meninges is extremely rare. To our knowledge, only two cases have been reported in the literature [1, 2]. This tumor has been reported for patients who received radiation therapy [8–13]. Osteosarcoma may occur as a complication of Paget’s disease in the skull [14].

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Brain metastasis from osteosarcoma of bone has also been reported [15].

The major blood supply for the anterior falx is provided by the middle meningeal artery and the anterior falx artery (one branch of the ophthalmic artery) [16]. The preoperative diagnosis of falx meningioma was made in this patient because of both the CT findings (a partially calcified, enhanced mass in the bifrontal region without bone destruction) and the cerebral angiographic findings (a vascular mass with blood supply from both anterior falx and middle meningeal arteries). However, none of these findings are specific. Sarcomas of the falx should be included in the differential diagnosis. The
Fig. 1.—A, Plain cranial CT scan shows large, partially calcified mass in bifrontal region with surrounding brain edema. Frontal horns are compressed and posteriorly displaced, more severely on right side. Calcifications are located in region of falx and in right frontal region. B, Cranial CT scan after intravenous administration of contrast shows dense but slightly inhomogeneous enhancement in bifrontal mass with irregular margins. C, Bone settings of plain cranial CT scan show skull to be intact. Calcification along falx measures 300–400 H. Lateral views of left internal carotid angiogram, early (D) and late (E) arterial phase show enlarged anterior falx artery (arrows in D) from dilated ophthalmic artery. Tumor vessels, seen in left frontal region, were fed by anterior falx artery and callosomarginal arteries. Tumor blush appeared in arterial phase and persisted through capillary phase. Lateral views of right internal carotid angiogram, arterial phase (F) and venous phase (G) show tumor vessels in right frontal high convexity fed by callosomarginal arteries. There is a gap between inner table of frontal bone and cortical branches of callosomarginal arteries, which represents mass in the falx. There is occlusion of anterior half of superior sagittal sinus.

presence of CT appearances of the irregularity of the margins of the lesion, which has been described as a CT sign of potentially malignant behavior of meningioma [17, 18], the severe surrounding brain edema, and the inhomogeneity of enhancement and density in the lesion, raises the possibility of a malignant meningioma. Another differential diagnosis that should be included is meningeal hemangiopericytoma, which is a rare and aggressive tumor from the meninges; however, lack of lytic cranial bony destruction and the presence of tumor calcification in this case are very unusual for hemangiopericytoma [19]. This case should serve as a reminder to radiologists that osteosarcoma is one of the rare possibilities in the differential diagnosis of falx meningioma.

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Fig. 2.—Photomicrograph of resected tumor shows pleomorphic malignant cells with hyperchromatic nuclei (left) and malignant osteoid (right). Preserved dural fibroconnective tissue is present (upper left) (H and E x 20)

REFERENCES