Glioblastoma Mimicking Meningioma: Report of 2 Cases
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INTRODUCTION
Glioblastoma is the most common malignant primary tumor of the central nervous system. It can mimic various pathologies, including arteriovenous malformation, hemorrhage from ischemic stroke, cerebral contusion, metastatic disease, lymphoma, and infection. The literature is limited regarding diagnostic confusion with meningioma. Herein, we present 2 patients that exhibited imaging, including cerebral angiography during preoperative embolization, which was consistent with meningioma, but where final surgical diagnosis revealed glioblastoma.

CASE DESCRIPTION: Case 1 was a 57-year-old woman presenting with headache, ataxia, and memory lapses for the past month. Brain magnetic resonance imaging (MRI) demonstrated a heterogeneous-enhancing right temporoparietal mass abutting the falx with a dural tail sign—consistent with meningioma. Patient underwent angiography with successful polyvinyl alcohol foam (PVA) particle embolization of the left middle meningeal artery (MMA) and meningeal branch of the right occipital artery, resulting in significant devascularization of the tumor blush. Subsequently, the patient underwent tumor resection, where pathology revealed glioblastoma.

CASE 2
A 60-year-old man presenting with right hemiparesis. Brain MRI demonstrated a left parasagittal, heterogeneous-enhancing mass abutting the falx with a dural tail sign—consistent with meningioma. Patient underwent angiography with successful PVA particle embolization of the left MMA, resulting in significant devascularization of the tumor blush. Patient underwent a tumor resection where pathology revealed glioblastoma.

CONCLUSIONS: Glioblastoma can mimic meningioma on MRI with dural tail sign, CSF cleft sign, and broad dural contact. Moreover, cerebral angiography can reveal tumor feeders commonly associated with meningioma. These features can contribute to diagnostic confusion. Based on these 2 cases, preoperative embolization of tumor feeders is possible with glioblastoma.
polyvinyl alcohol particle embolization of the left MMA, resulting in significant devascularization of the tumor blush (Figure 5). The following day, the patient underwent a left parasagittal craniotomy for mass resection, where necrotic tumor was noted. Estimated blood loss was 200 mL. The final pathology revealed a diagnosis of glioblastoma. The patient underwent concurrent whole brain radiation and temozolomide, followed by 12 months of adjuvant temozolomide. At 22 months after the initial diagnosis, the patient exhibited recurrent disease with right hemiparesis and aphasia. He underwent bevacizumab infusion and pulsed low-dose radiation therapy. His condition progressed and he passed away 6 months after recurrence.

DISCUSSION

On magnetic resonance imaging, glioblastoma appears as a sizeable, intra-axial mass with ill-defined margins. The pathology can exhibit irregular, peripheral, and/or nodular enhancement with a central heterogeneous signal (caused by necrosis or intratumoral hemorrhage). Profound vasogenic edema is typically present. Common differential diagnoses include cerebral abscess, metastases, lymphoma, and tumefactive demyelination. On the other hand, meningioma presents as a lobular, extra-axial mass with well-defined boundaries and intense enhancement. The pathology frequently exhibits broad-based dural contact. With a large mass, there is inward displacement of the cortical gray matter. Common locations include the cerebral convexity, parasagittal, and sphenoid wing regions. Classic magnetic resonance imaging features include the CSF cleft sign (a perimeter of CSF...
between the tumor and brain parenchyma), sunburst or spoke wheel pattern (radial divergence of feeder arterial branches), and dural tail sign (thickening and enhancement of the adjacent dura).\textsuperscript{3}

Both of the patients exhibited magnetic resonance imaging features consistent with meningioma: the first patient exhibited well-defined margins, displacement of cortical gray matter, CSF cleft sign, dural tail sign, relatively profound enhancement, and mild vasogenic edema given the size of the mass; the second patient exhibited well-defined margins, a superficial parasagittal location, and dural tail sign. Several prior cases stress the potential confusion between meningioma and glioblastoma on magnetic resonance imaging: the dural tail sign has been reported in 9 prior cases\textsuperscript{4-8} and the CSF cleft sign in 1 case.\textsuperscript{7}

On cerebral angiography, Yoshikawa et al.\textsuperscript{9} demonstrated that AV shunting was present in 72% of patients with perisylvian glioblastomas and 13% of patients with nonperisylvian glioblastomas. Glioblastomas are often hypervascular tumors associated with oversecretion of growth factors, such as vascular endothelial growth factors, that may induce angiogenesis and alter flow dynamics. With AV shunting, low-resistance vessels may develop, leading to more regional blood flow and hemodynamic stress to vessel walls that could promote formation of aneurysms.\textsuperscript{10-14} Moreover, invasion of tumor cells into blood vessel walls may lead to formation of aneurysms as well.\textsuperscript{10,11,15} Instances of AV malformation within glioblastoma have also been described.\textsuperscript{16,17} Preoperative embolization is not commonplace. Imai et al.\textsuperscript{1} described a case that involved embolization of AV shunting in a glioblastoma where the neurosurgical team deemed it beneficial to decrease intraoperative bleeding. For intratumoral aneurysms, Nguyen et al.\textsuperscript{13} and Ene et al.\textsuperscript{18} used coil embolization of the aneurysm prior to tumor resection, given

Figure 3. Case 1: right occipital artery injection before (A) and after (B) embolization. Notice decrease in tumor blush (arrows).

Figure 4. Case 2: coronal magnetic resonance T1 image with contrast demonstrates left parasagittal mass with dural tail sign (arrow).
concerns for potential subarachnoid hemorrhage\textsuperscript{13} and goals to reduce the risk for intraoperative hemorrhage.\textsuperscript{13,18}

Endovascular embolization has steadily gained prominence for the management of meningioma.\textsuperscript{19} Up to 44\% of intracranial meningiomas undergo embolization prior to resection.\textsuperscript{20} For cranial vault locations, primary blood feeders may stem from the superficial temporal, occipital, middle meningeal, and/or posterior meningeal arteries; for skull base locations, feeders may emanate from the internal carotid artery or vertebrobasilar system.\textsuperscript{13} Feeders appear as a tumor blush; the finding is generally associated with meningioma but is present in other pathologies, such as hemangiopericytoma, hemangioblastoma, and paraganglioma.\textsuperscript{19} Large series have reported salient advantages, including reduced operative blood loss, shortened operative duration, and increased tumor necrosis and softening.\textsuperscript{1,20,21}

With magnetic resonance imaging consistent for meningioma, both of the patients underwent preoperative embolization. Angiography demonstrated a characteristic tumor blush for both patients. Moreover, the feeders were typical vessels associated with meningioma, such as branches from the MMA and occipital artery. Chance enabled the realization that tumor feeders commonly associated with meningioma can exist for glioblastoma. This feature has been reported in 4 prior cases of glioma\textsuperscript{4,22-24}; preoperative embolization was not an option as the cases predated this technique.

These 2 cases reveal that preoperative embolization of tumor feeders can be done for glioblastoma. Retrospectively, given the final pathology and that preoperative embolization is not standard treatment for glioblastoma, the patients may have undergone unnecessary risks associated with embolization. The complication rate for embolization is 4.6\%–6.8\%,\textsuperscript{21} including risks for stroke and blood vessel rupture.\textsuperscript{25} Moreover, with only 2 cases, we cannot say with certainty that preoperative embolization effectively reduced blood loss or facilitated tumor resection with increased tumor necrosis or tumor softening. Operative findings regarding tumor necrosis may be related to glioblastoma pathology, rather than effects from preoperative embolization.

**CONCLUSIONS**

Glioblastoma can mimic meningioma on magnetic resonance imaging with dural tail sign, CSF cleft sign, and broad dural contact. Moreover, cerebral angiography can reveal tumor feeders commonly associated with meningioma. These features can contribute to diagnostic confusion. Based on these 2 cases, preoperative embolization of tumor feeders is possible with glioblastoma. Further research on preoperative embolization of glioblastoma needs to be conducted to evaluate potential benefits in treatment of glioblastoma and the embolization effects on intraoperative bleeding, resection site, and overall prognosis.

**REFERENCES**


