Conversion of Pineal Germinoma to Sarcoma: A Case Report with Operative Video

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Abstract

Pineal tumors are rare, accounting for 1% of intracranial tumors in the United States. Germ cells tumors are the most common type of pineal tumors, but the differential also includes pineocytoma, pineoblastoma, and interstitial cells tumors. Here we report the case of a patient with a history of pineal germinoma status post resection, chemotherapy, and radiation that converted to a sarcoma.

Here we report a rare example of a pineal germ cell tumor treated with chemotherapy and radiation that converted to a sarcoma. This conversion is poorly understood, as is the treatment of this entity. Effective management will likely require a multidisciplinary approach, as is being applied to this patient.

Introduction

Pineal region tumors (PRT) are rare central nervous system (CNS) tumors that arise from the pineal gland. PRTs account for less than 1% CNS tumors in adults[1] and over 3% in children[2-4]. PRTs are most commonly germ-cell tumors (GCT), neuroepithelial tumors, and parenchymal lesions including pineoblastomas, pineocytomas, papillary tumors, and desmoplastic myxoid tumors[5,6]. Pineal germinomas (PG), a subtype of GCTs, are the most common PRTs[7,8].

PG presentation is due to mass effect on local structures. Involvement of the tectum can cause visual disturbances including an upward gaze palsy in the setting of Parinaud's syndrome[9,10]. PG mass effect can critically impair cerebrospinal fluid (CSF) outflow through the third ventricle or cerebral aqueduct causing obstructive hydrocephalus manifesting as headache, nausea, vomiting, and altered mental status[8]. Over 50% of PRT are associated with obstructive hydrocephalus, which is most frequently treated with endoscopic third ventriculostomy (ETV)[11]. While other PRT require surgical resection independent of CSF diversion, PG are exquisitely sensitive to chemoradiation with excellent survival rates[12]. While historical protocols pioneered in the 1990s involved craniospinal irradiation with 36 Gy with a boost of 50-54 Gy in 1.8 Gy fractions to the primary tumor site[13], the modern protocol utilizes lower doses of 24 Gy of whole ventricular irradiation and 16 Gy in 1.8 Gy fractions to the primary tumor, with even lower doses of 18 Gy and 12 Gy after chemotheraphy[12], in light of the morbidities associated with higher radiation doses[7,14,15].

Transformation of other pineal GCT into malignant lesions has been rarely reported in the literature, including transformation of a teratoma into a rhabdomyosarcoma after treatment with radiation[16,17]. To our knowledge, we present the first case of a PG transforming into a Ewing-like sarcoma.

Clinical Presentation

A 46-year-old male who originally presented with headache and altered mental status in 1999 at age 21 while studying in Berlin. CT and MRI revealed a 6 x 4 cm third ventricular contrast-enhancing PRT associated with marked hydrocephalus. He underwent an emergent ventriculostomy and transcallosal resection of the tumor. Pathology reported a mixed germ cell tumor with germinoma and immature teratoma components with a serum HCG and AFP of 5.2 and 31, respectively.

Upon returning to New York, he obtained an MRI which revealed residual pineal region tumor with compression of the aqueduct associated with marked enlargement of the lateral and third ventricles. ETV was performed resulting in improved hydrocephalus. Repeat CSF analysis revealed no malignant cells with an HCG of 23 and AFP of 12.6. That same year he completed 4 cycles of cisplatin 100 mg/m^2 and VP-16 100 mg/m^2 Over the next two years he received craniospinal irradiation of 54 Gy to tumor bed and 36 Gy to the craniospinal axis in accordance with the protocol prevalent at the time[13]. The tumor was then monitored via MRI which showed no interval change since completing radiation.

In 2024, an MRI of the brain demonstrated enlargement of the pineal region lesion when compared to surveillance imaging performed in 2023. He was otherwise asymptomatic. The patient agreed to an endoscopic intraventricular resection (Video 1). Gross total resection was achieved (Fig. 1). Pathology revealed a high-grade neoplasm most consistent with sarcoma, with Ki67 up to 60%. Notably, the methylation classifier was most consistent with a Ewing-like sarcoma with CIC alteration. The methylation signature was consistent with significant genomic instability, and overall similar to known sarcoma datasets. A PET CT did not show any evidence of systemic disease. He received stereotactic radiosurgery at a dose of 15 Gy to the ventricular resection bed with no complications

Procedure

After the patient was prepped and draped in the standard fashion, an introducing tube was passed into the right lateral ventricle using stereotactic navigation. We confirmed our location and followed the choroid plexus through the foramen of Monroe into the third ventricle.

Using grabbing forceps, we were able to take multiple bites from the lesion.

We advance the endoscope to obtain better access to the lesion. Any bleeding encountered is managed with irrigation.

As we resect tumor, we note that the lesion is increasingly mobile. We are able to use the grasping forceps to develop separation between the tumor and the margins of the third ventricle.

We note that the tumor is now only held in place at one point to the roof of the third ventricle. This attachment is cauterized using the bipolar, and cut with scissors.

The remainder of the tumor is then mobilized into the lateral ventricle. We attempted to manipulate it using a flexible suction. We proceed to grasp it using cup forceps. It is too large to be taken out through the introducing tube, so we elevate the camera, endoscope, introducing tube, and forceps in one motion to release the tumor from the ventricle.

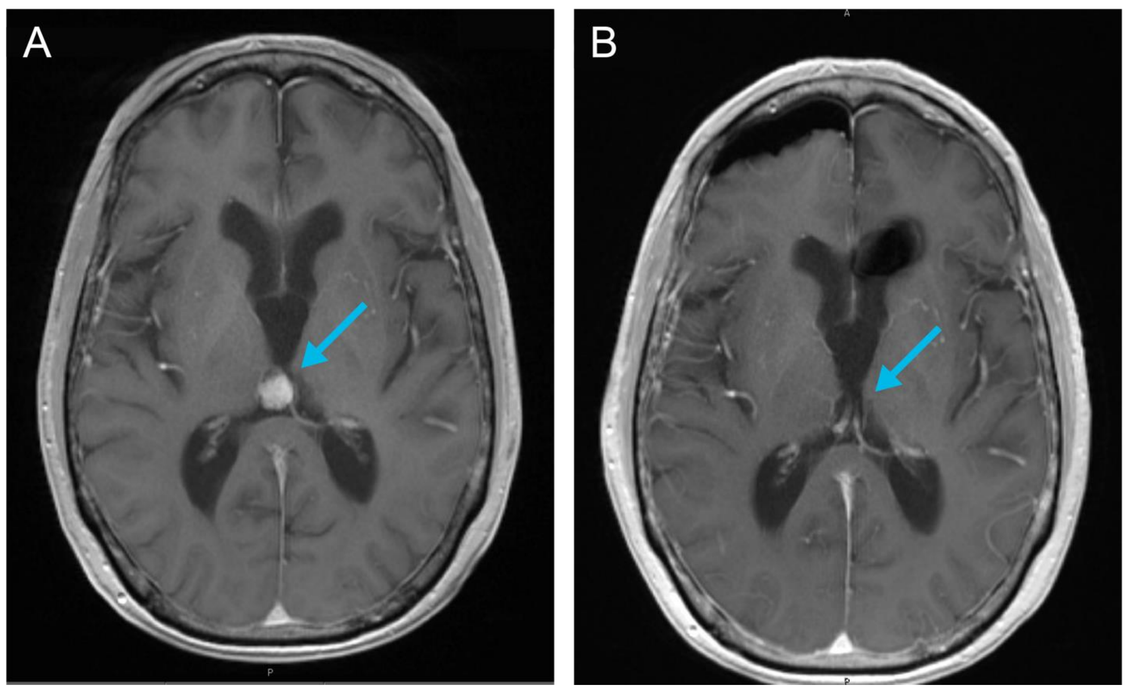

Figure 1: (A) Post-gadolinium contrast T1 MRI sequences pre- and (B) post-endoscopic resection of a pineal sarcoma transformed from a mixed germ cell tumor with germinoma and immature teratoma components originally managed with resection and RT in 1999. Tumor site indicated with blue arrow.

Discussion

While PG tend to have an excellent prognosis with current chemoradiotherapy regimens, this case highlights the risk of conversion to sarcoma. As part of his initial treatment for his PG, our patient received 54 Gy to the tumor bed, a dose high enough to be associated with the development of radiation-induced sarcomas (RIS), a rare but documented phenomenon observed after the use of radiation to treat a number of bony and soft-tissue cancers[18]. This is most commonly observed after treatment of breast cancer[19], but has been observed in brain tumors,[19,20] including germinomas[18], though to our knowledge never in the pineal region.

This case also highlights the importance of surveillance imaging. The patient presented here had no symptoms post resection in 1999 while his tumor enlarged. This was only seen due to his adherence to his management plan. The latency between radiation therapy and the development of RIS is often several years,[19,20] with cases of conversion over 20 years later documented.[18] Had our patient not been adherent to his surveillance plan, his lesion could have progressed to again cause obstructive hydrocephalus before being identified.
By documenting the transformation of this PG into a sarcoma, this case adds to the limited body of evidence suggesting that sarcomas can potentially result from radiation or natural transformation of this common pineal tumor.

Conclusions

Here we report a rare example of a pineal germ cell tumor treated with chemotherapy and radiation that converted to a sarcoma. This conversion is poorly understood, as is the treatment. Continued research into this rare transformation can provide future expansion in the effectiveness of proper diagnosis and management.

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