Unleashing the Mystery of a Treated Case of Medulloblastoma

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Abstract

Medulloblastoma (MB) is the most common malignant brain tumor in children. Despite advancement in treatment modalities, recurrence remains common, even among those treated with a combination of neurosurgery, craniospinal irradiation, and chemotherapy. The diagnosis of recurrence is usually not difficult in these cases. However, it may pose a challenge in cases with unusual clinical presentation and imaging. Imaging findings on magnetic resonance imaging, with application of perfusion, in conjunction with positron emission tomography-computed tomography can help in clinching the diagnosis in such cases. MB subgroups show consistent patterns even in cases of recurrence, and sonic hedgehog group MB may present as local recurrence showing enhancement with no diffusion restriction, as demonstrated in this case.

Keywords

- recurrent medulloblastoma
- radiation-induced demyelination
- radiation-induced glioma
- MR perfusion

Introduction

Medulloblastoma (MB) is a small-cell embryonal brain cancer located in the posterior fossa and the most common malignant brain tumor in children.1 We present a case of treated MB that was a diagnostic challenge, given the history of treatment and atypical imaging findings at the time of presentation. It serves as a valuable learning experience and highlights the role of imaging, particularly magnetic resonance imaging (MRI) along with application of perfusion, in reaching the right diagnosis.

Case Report

A 13-year-old male child, known case of nonmetastatic MB (sonic hedgehog [SHH]-subtype with N-Myc over-expression), presented with complaints of diplopia, ataxia, and severe headaches. He was diagnosed 4 years earlier and was operated for the same. He subsequently received craniospinal radiation therapy and chemotherapy (radiation therapy planning figure demonstrating dose received [►Fig. 1]), and was followed up with routine MRIs that showed no residual disease or spinal metastasis (►Fig. 2). Baseline MRI was not available for review.

The presenting MRI (done outside) showed T2/fluid-attenuated inversion recovery hyperintensities in the pons, medulla, and left cerebellar peduncle that were reported as diffuse intrinsic pontine glioma (DIPG) versus a radiation-induced high grade glioma (►Fig. 3). On reviewing these films in our department, as the lesions in the pons showed intense homogeneous enhancement with low MR perfusion values...
provisional diagnoses of lymphoma versus secondary demyelination following radiation (in view of significant latency period, disease free interval of 4 years) was considered.

Meanwhile, the patient was started on pulse methylprednisolone. However, after initial improvement, patient deteriorated, likely due to rapid tapering of steroid therapy, and presented to casualty after 2 weeks with right-sided hemiparesis, increase in diplopia, and new onset dysarthria and dysphagia. Repeat MRI and cerebrospinal fluid (CSF) studies were ordered. CSF revealed no malignant cells. MRI revealed

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**Fig. 1** Craniospinal irradiation therapy planning image demonstrating color map showing dose distribution of 95% of 11.6 Gy.

**Fig. 2** Axial T2-weighted (A) and postcontrast images (B) demonstrating no evidence of residual disease postadjuvant craniospinal radiation therapy and chemotherapy.
mild reduction in edema (portion in the superior part of ventral pons, right middle cerebellar peduncle, and lower part of midbrain), likely secondary to steroid therapy. However, the intensely enhancing component in the pons remained stable with low perfusion score and no significant spectroscopy findings (\textit{\textcircled{Figs. 4 and 5}}).

Demyelination usually regresses following steroid therapy and as lymphoma can show a rebound increases following

\textbf{Fig. 3} Axial T2-weighted (A), T2/FLAIR (fluid-attenuated inversion recovery) (B), and postcontrast images (C) reveal T2/FLAIR hyperintensities with corresponding postcontrast enhancement in pons, medulla, and left cerebellar peduncle (arrowheads).

\textbf{Fig. 4} Axial T2-weighted (A), T2-fluid-attenuated inversion recovery (B), and postcontrast images (C) showing altered signal intensity (arrowheads) involving inferior colliculus, pons, and left cerebellar peduncle with mild decrease in edema but persistent postcontrast enhancement.

\textbf{Fig. 5} Perfusion images reveal that the lesions show hypoperfusion.
stoppage of steroid therapy; a positron emission tomog- 
raphy-computed tomography (PET-CT) was advised. PET-CT 
revealed the lesion to have a standardized uptake value 
(SUV)-max of 14 with heterogenous (fluorodeoxyglucose) 
FDG-PET avidity (► Fig. 6). This, with the finding of T2 
hyperintensity went against the diagnosis of lymphoma. 
However, the lesion was hyperattenuating on plain CT scans 
(► Fig. 7).

The presence of persistent intense contrast enhancement 
on MRI and hyperattenuation on plain CT suggested the 
possibility of recurrence/atypical metastasis (in the absence 
of baseline scan location of primary disease was uncertain). 
This was further strengthened when PET-CT ruled out lym-
phoma. However, our case did not show any restricted 
diffusion, which prevented us from diagnosing recurrence/atypical metastasis initially (► Fig. 8).

The case was discussed in a multidisciplinary meeting. 
Decision to biopsy the lesion was taken to guide further 
treatment. The left cerebellar lesion was biopsied under 
 intraoperative ultrasound guidance that revealed recurrent 
MB (► Fig. 9). It was decided to proceed with palliative 
chemotherapy (COMBAT regimen).

Discussion

MB is a small-cell embryonal brain cancer arising in the 
posterior fossa. MB represents 9.2% of pediatric brain tumors 
in children aged between 0 and 14 years, with a higher 
incidence in children between 3 and 4 years of age and 
between 8 and 10 years of age.3

The CT appearance of MB is a hyperattenuated, well-
defined cerebellar mass with homogeneous enhancement 
and surrounding vasogenic edema. The tumor is radiosensi-
tive and a combination of surgery and radiation therapy is 
most commonly used.4

However, radiation therapy is not without substantial 
side effects. Subacute effects are typically transitory that 
affect the white matter, whereas late effects affect the 
periventricular region.5,6 Histologically proven white matter 
changes, gliosis, and inflammation presenting as new, en-
hancing lesions on MRI can be mistaken for recurrent 
tumor.6,7 As seen in this case, the significant latency period 
combined with the imaging findings favored the possibility 
of delayed effects of radiation. However, the location of the 
lesions was atypical.6

Radiation-induced secondary gliomas and lymphomas 
can occur after a latency period of 5 to 10 years.8 Radiation-
associated DIPGs may present as a poorly prognostic 
distinct molecular subgroup of H3 wild-type DIPG.9 Our case 
showed lesions in areas typical for DIPG in the background of

![Fig. 6](image-url) Fluorodeoxyglucose-positron emission tomography images reveal avidly enhancing soft tissue lesion noted in medulla extending into left cerebellum and superiorly involving pons (standardized uptake value-max 14.6).

![Fig. 7](image-url) Axial noncontrast computed tomography image showing a hyperattenuating mass in the pons and left cerebellar peduncle (arrowhead).
irradiation; however, presence of intense homogeneous postcontrast enhancement involving almost the entire lesion and hypoperfusion went against the diagnosis of DIPG.

Central nervous system lymphomas often enhance homogeneously but sometimes may show no enhancement or only a thin rim of enhancement in immunocompromised patients. They may show a rebound increase or worsening after cessation of steroid therapy. Moreover, areas of restricted diffusion were observed in lymphomas in 90% cases on pretreatment scans with variable diffusion restriction on posttreatment scans. Homogenous FDG-PET avidity and SUV value greater than 15 are in favor of lymphoma and values lesser than this cutoff along with a heterogenous FDG avidity are more in favor of other brain tumors like metastasis or glioblastoma.

Recurrence of MB is unfortunately very common and usually manifests as leptomeningeal enhancement or focal parenchymal nodular enhancement within the brain. Recurrent disease develops most frequently in the posterior fossa followed by the subfrontal region.

Significant differences exist across subgroups with respect to the anatomical and temporal patterns of recurrence: specifically SHH tumors mostly recur in the local tumor bed and group 3 and 4 tumors recur almost exclusively with metastases. Also, MB does not change subgroup at recurrence.

**Fig. 8** Axial diffusion-weighted images showing no diffusion restriction within the areas of altered signal intensity seen in ► Fig. 2.

**Fig. 9** Photomicrographs showing a cellular tumor of primitive embryonal cell morphology (A) with marked anaplasia seen in the form of cellular wrapping (B).
Diffusion-weighted imaging is more sensitive (100% sensitivity) than contrast enhancement (76% sensitivity) for the detection of recurrent MB, particularly in leptomeningeal nonenhancing disease and distal nonenhancing focal disease.\(^{15}\) As such, recurrent MB can present as a lesion with diffusion restriction in a patient with normal postcontrast MRI (“mismatching” pattern).\(^{16,17}\) However, our case did not demonstrate any areas of diffusion restriction contrary to existing literature. Only one prior study had four patients with leptomeningeal disease showing contrast mismatching.\(^{4}\) However, SHH subgroup. One case series reviewed 10 cases of MB of which two demonstrated no significant restricted diffusion. Pathologic review revealed that both of these nonrestricting cases displayed a lack of reticulin deposition by light microscopy.\(^{18}\) We propose that a detailed radiopathologic review of mismatching findings in further cases such as these is needed to corroborate these atypical MRI features.

This case demonstrates that good clinicoradiological correlation can guide in establishing the diagnosis of recurrence at unusual sites with unusual presentation. Further, SHH group MB may present as local recurrence showing enhancement with no diffusion restriction.

**Key Messages**

Magnetic resonance imaging, and its applications such as perfusion, in conjunction with other imaging findings, can help differentiate recurrent medulloblastoma from other differentials such as radiation-induced demyelination or radiation induced secondary central nervous system neoplasms in posttreatment cases.

**Presentation at a Meeting**

Nil.

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Nil.

**Conflict of Interest**

None.

**References**