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Prolonged survival in pediatric diffuse intrinsic pontine glioma following intensity-modulated radiation therapy: a case report

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Abstract

Background The aggressive WHO grade IV brainstem tumors known as diffuse intrinsic pontine gliomas (DIPGs) primarily strike children between the ages of 5 and 10. Because they are incurable, their median survival is less than a year. While traditional radiation provides short-term discomfort alleviation, more sophisticated methods like as intensity-modulated radiation therapy (IMRT) have demonstrated potential for enhancing tumor targeting and lowering treatment-related side effects**.**

Case presentation A 9-year-old Indian male with persistent headaches and vomiting was diagnosed with diffuse intrinsic pontine glioma (DIPG) after a large, non-enhancing, altered signal intensity lesion was found in his brain. The lesion was hyperintense on T2WI/fluid-attenuated inversion recovery (FLAIR) and hypointense on T1WI, causing significant mass effect and resulting in obstructive hydrocephalus. The patient underwent ventriculoperitoneal shunting to relieve hydrocephalus, but a postoperative computed tomography (CT) showed a hypodense lesion extending from the thalami to the pons. The patient was scheduled for definitive intensity-modulated radiation therapy (IMRT) to a total dose of 54 Gy in 30 fractions, initiated on December 20, 2022, and completed by January 30, 2023. Supportive medications were continued post-treatment.

Conclusion The case report highlights prolonged survival in a pediatric DIPG patient following IMRT, highlighting the potential for improved outcomes with modern radiation techniques. Future research should focus on therapy predictors and treatment integration.

Keywords Pontine glioma, DIPG, Pediatric oncology, Radiotherapy, IMRT, Prolonged survival

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Introduction

Diffuse intrinsic pontine gliomas (DIPGs) are highly aggressive pediatric brain tumors classified as World Health Organization (WHO) grade IV astrocytomas. These malignancies arise within the pons of the brainstem and primarily affect children between the ages of 5 and 10 years. Due to their critical anatomical location and diffusely infiltrative growth pattern, DIPGs are deemed inoperable and historically associated with dismal prognoses [1]. Despite numerous investigative efforts over the past several decades, the median overall survival for patients diagnosed with DIPG has remained under one year, with long-term survivors representing a rare exception. The centrality of the pons and its proximity to vital neurological structures preclude safe surgical resection, rendering radiation therapy the cornerstone of treatment [2]. Conventional external beam radiotherapy (EBRT), which delivers uniform doses across large anatomical volumes, has long served as the standard palliative intervention. Although EBRT may transiently alleviate neurological symptoms and slow tumor progression, it has not significantly altered the natural course of the disease, and meaningful improvements in survival have remained elusive [3].

In recent years, advances in radiation delivery technologies have catalyzed renewed interest in optimizing therapeutic strategies for DIPG. Among these, intensity-modulated radiation therapy (IMRT) represents a significant evolution in precision radiotherapy [4]. IMRT employs inverse treatment planning and computer-controlled linear accelerators to modulate the intensity of radiation beams in real time, facilitating the delivery of highly conformal dose distributions. This technique enables clinicians to maximize tumor coverage while sparing adjacent organs at risk (OARs) notably the brainstem, cranial nerves, and surrounding eloquent brain regions [5]. The resulting reduction in normal tissue toxicity not only improves tolerability but also opens the door for dose escalation protocols that may enhance local tumor control. Although the role of IMRT in the management of DIPG is still being elucidated, early clinical experiences suggest that its use may confer survival benefits in select patient cohorts. The integration of IMRT into multidisciplinary treatment frameworks is also being explored alongside emerging therapeutic modalities, including molecularly targeted agents, immune checkpoint inhibitors, and genetically engineered oncolytic viruses [6].

This report presents the clinical case of a 9-year-old male diagnosed with DIPG who underwent definitive IMRT and subsequently experienced a survival duration exceeding typical historical benchmarks. Through detailed documentation of the patient's diagnostic workup, radiotherapeutic planning, treatment course, and longitudinal outcomes, we aim to illustrate the potential advantages of IMRT in this context. Additionally, we provide a comprehensive review of the current literature to contextualize this case within broader treatment paradigms and ongoing research efforts. While DIPG remains one of the most formidable challenges in pediatric neuro-oncology, case reports such as this contribute to the growing body of evidence that suggests meaningful survival extension is possible. By highlighting a case of prolonged disease control, we seek to underscore the clinical value of advanced radiation techniques and encourage continued investigation into innovative therapeutic avenues. Our ultimate objective is to inform clinical practice, support the development of evidence-based protocols, and foster hope for affected patients and their families.

Case presentation

Patient history and physical examination

A 9-year-old Indian male in September 2022 presented to our care with a one-month history of progressive headache and vomiting. The patient also had a past medical history of intentional tremors since the age of 8. There was no significant family history of neurological disorders or cancer.

Upon physical examination, the patient was alert and oriented, although responsive to commands at a slower pace. Neurological exam revealed right eye squint and gait ataxia. Other cranial nerve function was intact. General physical examination was unremarkable, except for a fair nutritional state.

Diagnostic investigations

- **MRI brain (21.09.2022)**: Initial magnetic resonance imaging (MRI) revealed a large, infiltrative lesion centered in the pons, extending into the midbrain, medulla, and bilateral thalamus. The lesion measured approximately $69 \times 68 \times 45$ mm. Signal characteristics were consistent with DIPG, demonstrating hyperintensity on T2-weighted and FLAIR sequences, and hypointensity on T1-weighted sequences. There was no contrast enhancement, diffusion restriction, or evidence of hemorrhage. The mass effect resulted in displacement of the third and fourth ventricles, leading to obstructive hydrocephalus.

Significant increase in size of a large, well-defined altered signal intensity lesion in the midbrain, pons, and bilateral thalamus, suggestive of low-grade glioma, compared to the previous scan (Fig. 1).

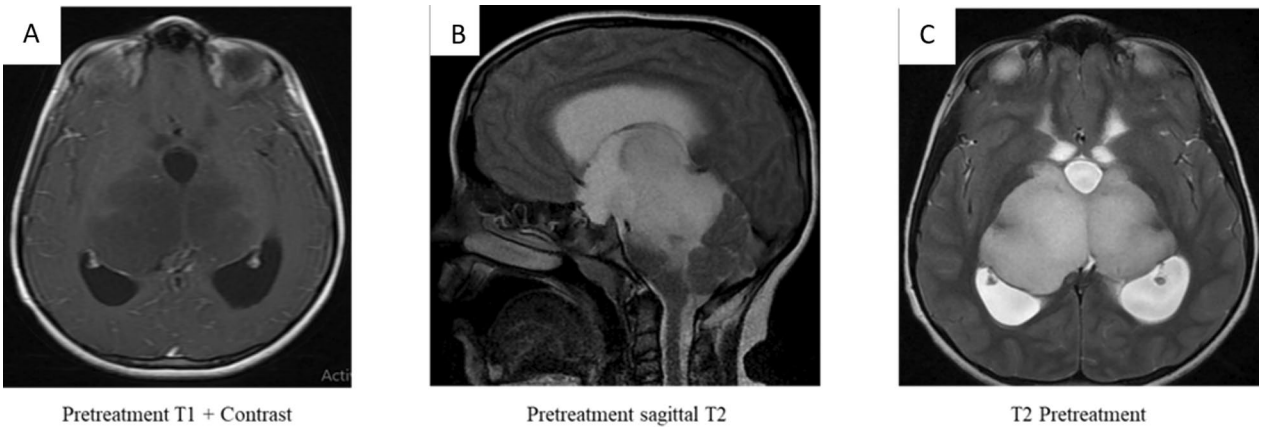

Fig. 1 Pre-treatment MRI of the brain showing diffuse intrinsic pontine glioma

- **MRI brain (03.10.2022)**: Follow-up MRI showed a slightly increased lesion size of 8.3 × 6.9 × 5.7 cm.
- **CT brain (07.10.2022)**: Post-VP shunt CT showed a hypodense mass lesion within bilateral thalamus, extending to include the midbrain and pons. Evidence of pneumocephalus was also observed.

Diagnosis

Based on the clinical presentation, imaging characteristics, and lack of contrast enhancement, a diagnosis of diffuse intrinsic pontine glioma (DIPG) was established. Due to the risks of biopsy in this location and the highly characteristic imaging appearance, a biopsy was not pursued.

Treatment and management

- **Ventriculoperitoneal (VP) shunt placement (04.10.2022)**: VP shunt placement was performed to relieve obstructive hydrocephalus.

Radiotherapy (20.12.2022–30.01.2023): The patient underwent definitive radiotherapy with IMRT to a total dose of 54 Gy in 30 fractions over six weeks.

Supportive care

The patient received supportive care throughout treatment, including antiemetic's (Ondem), nutritional support (Ensure protein powder), and medication to manage potential seizures (Levipil). Topical treatment (Fucibet cream) was prescribed for skin reactions.

Treatment outcomes

There is removal of ill-defined altered signal intensity lesion involving bilateral thalami and midbrain appearing hypointense on T1WI, hyperintense on T2/FLAIR sequences showing no diffusion on DWI and no blooming on SWI. External CSF drainage catheter noted in situ with its tip in right lateral ventricle. T2/FLAIR hyperintense area noted along the course of shunt in right frontal region-edema. Both gangliocapsular region appears normal. In the infratentorium, the cerebellum and the basal cisterns appear normal. Sella and parasellar region appear normal. Mucosal thickening noted in bilateral ethmoid and maxillary sinuses. Left inferior turbinate hypertrophy noted. Mild deviation of nasal septum toward right side noted.

During radiotherapy, the patient exhibited Grade 1 skin reactions and mild alopecia. His neurological status post-treatment included the pre-existing right eye squint and ataxia, with no new deficits (Fig. 2).

Follow-up

The most recent follow-up was conducted on [date of last follow-up]. At that time, the patient's Karnofsky Performance Status (KPS) was [Report KPS score]. Repeat MRI imaging demonstrated [Description of imaging findings, tumor stability, reduction, or progression]. The patient's neurological examination revealed [Current neurological status, comparing to baseline, any improvements, or new deficits]. The patient continued to require supportive medications, including [List all medications the patient is currently taking].

*As of [***Date of last follow-up***], the patient is alive and continues to be followed clinically and radiographically every three months.*

Discussion

In pediatric neuro-oncology, diffuse midline gliomas (DMGs), notably the form called diffuse intrinsic pontine glioma (DIPG), remain a major treatment challenge

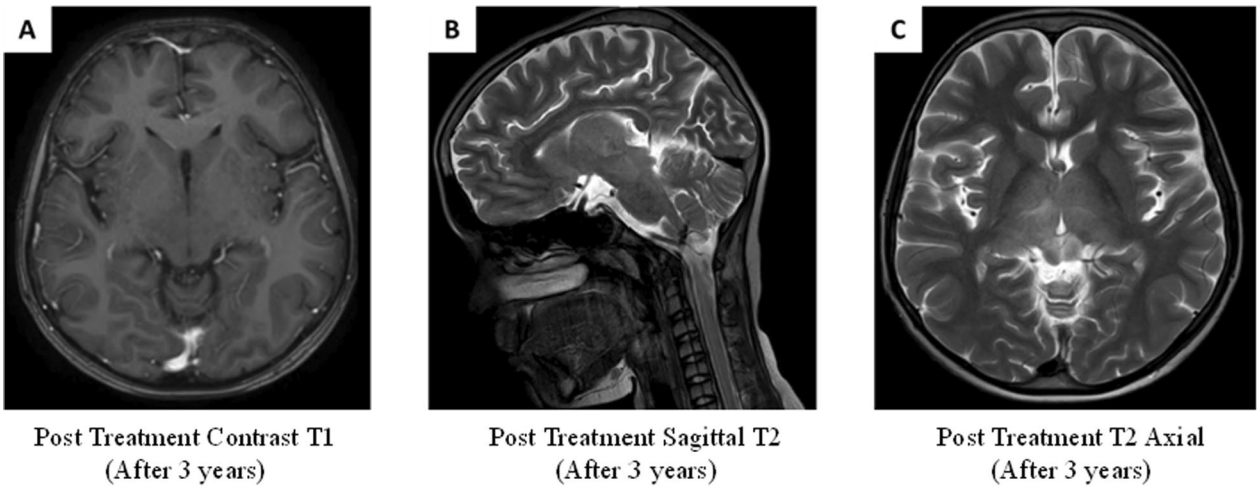

Fig. 2 Post-treatment MRI of the brain showing diffuse intrinsic pontine glioma

[7]. These tumors are characterized by their high-grade histology, midline anatomical placement, and common H3K27M mutations [8]. They are also often aggressive and resistant to existing therapeutic approaches. With the discovery of the H3K27-altered phenotype, which has allowed for more precise prognostication and stratification for treatment approaches [9], the new 2021 WHO classification emphasizes the clinical significance of molecular diagnostics in DMG [10]. Although radiation is still the primary therapeutic option, its palliative effects and the short-term durability of tumor control highlight the urgent need for more potent approaches [11]. In DIPG, biomarkers are essential for enhancing therapy targeting, diagnosis, and prognosis. Histone H3K27M mutations, namely in the H3F3A and HIST1H3B genes, have been shown in recent research to be important molecular indicators. These mutations occur in around 80% of instances and are linked to epigenetic dysregulation [12]. Amplification of PDGFRA, mutations in ACVR1, and changes in TP53 and PIK3CA are further indicators [13]. In addition to improving our knowledge of DIPG etiology, these molecular markers provide promising paths for personalized medicine and targeted therapeutics. In this instance, a 9-year-old boy with DIPG had a noteworthy clinical result after receiving definitive intensity-modulated radiation therapy (IMRT), achieving a survival rate above the usual median. By delivering highly conformal radiation doses to intricate anatomical areas like the brainstem while limiting exposure to nearby healthy tissue, IMRT is a technical leap over traditional radiotherapy [14]. By improving tolerance to concurrent and sequential therapies and maintaining neurological function and quality of life two important factors for young patients this enhanced precision may lessen acute and long-term harm. The use of IMRT in DIPG is supported by recent research, both as a salvage strategy using re-irradiation and as a main therapeutic method [15]. Re-irradiated patients in a retrospective cohort had a median overall survival of 19.5 months and better symptom management [16]. The potential importance of IMRT in multimodal therapy regimens has also been highlighted by trials that combine it with systemic medicines like temozolomide and have demonstrated small survival advantages without severe toxicity [17]. Additionally, the accuracy of IMRT makes it easier to spare important structures like the hypothalamic–pituitary axis and optic pathways, which may lower the risk of endocrine and neurocognitive side effects that might result from cranial irradiation [18]. There are a number of reasonable reasons for the extended survival in this instance, even though the precise causes are still up for debate [19]. It is possible that the patient's tumor has improved radiosensitivity or more latent biological activities. Furthermore, more efficient tumor management while maintaining vital brain function would have been possible because to the advantageous anatomical targeting that IMRT was able to achieve [14]. One should also not undervalue the importance of supportive care in preserving the patient's general health and compliance to therapy. However, the prognosis for DIPG is still dismal, and IMRT by itself has not shown a significant effect on long-term survival in larger clinical investigations, despite these positive findings. Access to IMRT necessitates certain tools and knowledge that might not be available to everyone, which could lead to inequities in treatment. Moreover, although IMRT can improve local control, it ignores infiltrative spread

outside of the primary target volume and the underlying tumor biology [20].

In summary, this case adds to the increasing amount of data indicating that IMRT may improve quality of life and survival in a subset of DIPG patients. It emphasizes the value of customized treatment planning and the necessity of continuing research into combinatorial approaches that combine precision radiotherapy with immunotherapies, molecularly targeted agents, and innovative drug delivery methods like focused ultrasound and disruption of the blood–brain barrier (BBB) [21]. In order to improve therapy results for this debilitating condition, multi-institutional collaboration and clinical trial enrollment will be essential as the field shifts toward molecularly directed, patient-specific treatment paradigms.

Conclusion

In this case report, a young child with DIPG provides a convincing illustration of prolonged life after IMRT. Although there is still uncertainty regarding the prognosis for DIPG, this instance highlights how contemporary radiation treatments may improve results for a small number of patients. For children with DIPG, future research should concentrate on determining variables that predict response to therapy, creating innovative therapeutic approaches, and maximizing the integration of IMRT with other treatment modalities in order to significantly enhance survival and quality of life.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13256-026-06026-7.

Additional file1 (DOCX 91 kb)

Additional file2 (PDF 224 kb)

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None.

Author contributions
Dr. Tejshri Telkhade was responsible for conception and drafting of this paper. Tanushree Budhbaware: conceptualization, methodology and writing of original draft, editing and reviewing it critically and Dr. Jaishriram Rathored was also involved in conception and drafting of this paper. Kidus Mulugeta and Sandeep Iratwar, all authors agree to be accountable for all aspects of this study.

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Data Availability
All data generated or analyzed during this study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Name of the Ethics Committee—Institutional Ethics Committee of 'Datta Meghe Institute of Higher Education and Research' approved the present medical case report.
Committee's Reference Number—Not applicable.

Consent for publication
Written informed consent was obtained from the patient's legal guardian for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests
Not applicable.
Data supporting the findings of this case are available from the corresponding author Dr. Jaishriram Rathored upon reasonable request.

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