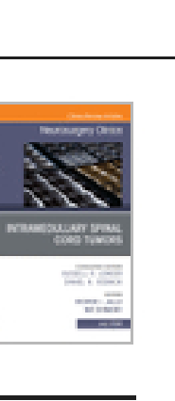
Neurosurgery Clinics of North America
Volume 37, Issue 3, July 2026, Pages 427-437



# Radiation Therapy for Spinal Cord Tumors

Aahan Arif MBBS, Thomas E. Merchant DO, PhD

Department of Radiation Oncology, St. Jude Children's Research Hospital, Memphis, TN 38105, USA

Available online 27 April 2026, Version of Record 8 June 2026.

What do these dates mean?

Check for updates

Show less

Add to Mendeley Share Cite

https://doi.org/10.1016/j.nec.2026.03.005

Get rights and content

Access through your organization

Check access to the full text by signing in through your organization.

Access through your organization

## Section snippets

## Key points

- Indications for radiotherapy vary by tumor subtype, grade, and surgical outcome. …
- Proton therapy can reduce long-term skeletal complications in children. …
- Radiation may weaken bone and increase risk of spinal deformity. …
- Multidisciplinary management and careful consent are essential. …
- Case-based approaches guide individualized treatment. …

…

…

…

Abbreviations …

| | |
|---|---|
| CRT | conformal radiation therapy |
| CSI | craniospinal irradiation |
| CTV | clinical target volume |
| DMG | diffuse midline glioma |
| GTR | gross total resection |
| LGG | low-grade glioma |
| MPE | |

…

…

…

…

…

…

## Radiotherapy for spinal tumors

When patients are referred for RT, the radiation oncologist must first evaluate whether additional surgery to achieve complete resection is warranted, as this decision can significantly influence the subsequent need for RT. A thorough assessment of disease extent is also critical; the curative potential of RT may be compromised if patients with equivocal or subclinical microscopic disease receive only focal irradiation and later develop tumor seeding. This principle applies to low-grade glial …

## Low-grade tumors

Low-grade gliomas (LGGs), classified as World Health Organization (WHO) grade 1 or 2 tumors, are among the most common spinal cord tumors in children while ependymomas (often grade 2) are most common in adults.[3] LGGs typically include pilocytic and diffuse astrocytomas, as well as rare glioneuronal tumors composed of both neural and glial components, such as gangliogliomas and dysembryoplastic neuroepithelial tumors.[3] The primary therapeutic approach is surgery with gross total resection (GTR), …

## Clinics care points

Indications for RT in Low-Grade Spinal Cord Tumors

- After GTR:
    - Observation is preferred. …
    - RT reserved for documented progression if further surgery is not possible. …

  …
- After Near-Total or Uncertain GTR:
    - Close observation recommended. …
    - RT considered only with unequivocal evidence of progression. …

  …
- After STR:
    - RT indicated if further surgery is not feasible and risk of progression threatens functional outcome. …

  …
- If Pathology Reveals a More Aggressive Variant:
    - Early RT may be considered, even if resection is …

  …

…

…

…

…

…

## Case presentation—low-grade astrocytoma

A 3 year old male patient was diagnosed with a pilocytic astrocytoma of the spinal cord after presenting with back and lower abdominal pain, decreased mobility, and scoliosis. MRI revealed a large tumor extending from T9 to L1, involving the conus. He underwent attempted surgical resection, which was limited by intra-operative neurophysiological changes, and pathology confirmed a WHO grade I pilocytic astrocytoma. Post-operatively, he experienced left lower extremity weakness requiring …

## Spinal Cord Ependymomas

Spinal cord ependymomas account for approximately 20% of primary spinal tumors, with a median age at diagnosis between 25 and 45 years.[13] In adults, the spinal canal is the most common site for ependymomas, while in children, spinal ependymomas represent only 8% of all ependymomas.[14] According to the WHO, these tumors are classified as subependymomas (WHO grade I), MPEs (now WHO grade II), spinal ependymomas (WHO grade II or III, when molecular analysis is unavailable), and spinal ependymomas …

## Myxopapillary ependymomas

MPEs are a distinct subtype of ependymal tumors, typically arising in the lumbosacral spine.[26] Complete surgical resection is the primary treatment, largely due to the risk of tumor seeding.[26] Adjuvant RT may be considered, especially when GTR is not achieved. GTR generally provides better long-term tumor control compared with STR (STR) and RT, with some authors suggesting that radiation therapy is unnecessary following successful GTR.[27] Large-scale studies using the SEER database in pediatric …

## Case presentation—myxopapillary ependymoma

A 23 year old man was diagnosed with a MPE of the lumbar spine 7 years earlier, for which he underwent surgical resection (L2–L5 laminotomy) followed by adjuvant radiation therapy (50.4 Gy in 28 fractions) to the lumbar spine (Fig. 3). Over the subsequent years, serial MRIs showed slowly progressive, enhancing lesions in the thoracic spine and a new leptomeningeal focus in the left ambient cistern, but the patient has remained asymptomatic and fully active with no neurological deficits.

The …

## Case presentation—myxopapillary ependymoma

A previously healthy 7 year old girl presented with severe low back pain radiating to her right leg, which progressed over several weeks and prompted imaging. MRI revealed a large, contrast-enhancing intradural extramedullary lesion spanning L1 to L3. She underwent surgical resection with bilateral laminectomies and laminoplasty, achieving near total removal of the tumor, which was confirmed by pathology as MPE (WHO grade II). The tumor was intimately associated with nerve roots, and a thin …

## High-grade tumors (473)

Pediatric high-grade spinal gliomas (HGSGs) are a rare subset of spinal cord tumors, classified as WHO grade 3 and 4, and include entities such as diffuse midline glioma (DMG) H3 K27-altered, diffuse hemispheric glioma H3 K34 mutant, and diffuse pediatric-type high-grade glioma H3- and IDH-wildtype.[35] Although uncommon, these tumors carry an extremely poor prognosis due to their aggressive nature and tendency for both local and distant leptomeningeal spread.[36] A systematic review by Gong and …

## Case study/presentation

A previously healthy 20 year old man presented with 3 months of progressive neck and upper back pain, followed by ascending numbness and weakness in his extremities. MRI revealed an intramedullary spinal cord tumor extending from C4 to T1 (Fig. 8), with no evidence of metastatic disease. Initial management included dexamethasone for symptomatic relief, but a second opinion and subsequent imaging showed interval tumor growth and new canal dilation, raising concern for an aggressive lesion. The …

## Complications and controversies

Consenting patients for RT requires careful consideration of both short-term and long-term side effects. When photon RT was standard, side effects such as nausea, vomiting, loss of appetite, diarrhea, and pancytopenia were possible, depending on the treatment site, volume (number of vertebral segments), and factors such as pre-existing conditions. One of the most concerning acute complications during or immediately after RT is pseudoprogression, which can range from mild pain or sensory …

## Clinics care points

- Radiotherapeutic Management of Spinal Cord Tumors General Principles: Radiotherapy decisions depend on tumor histology, grade, extent of resection, and patient age. …
- Maximal safe resection is preferred; radiotherapy complements surgery in selected cases. …
- Early multidisciplinary involvement is essential for optimal outcomes. …
- Indications for Radiotherapy: Residual, recurrent, or high-grade disease. …
- When further surgery is not feasible or risks neurologic compromise. …
- Observation is appropriate for …

…

…

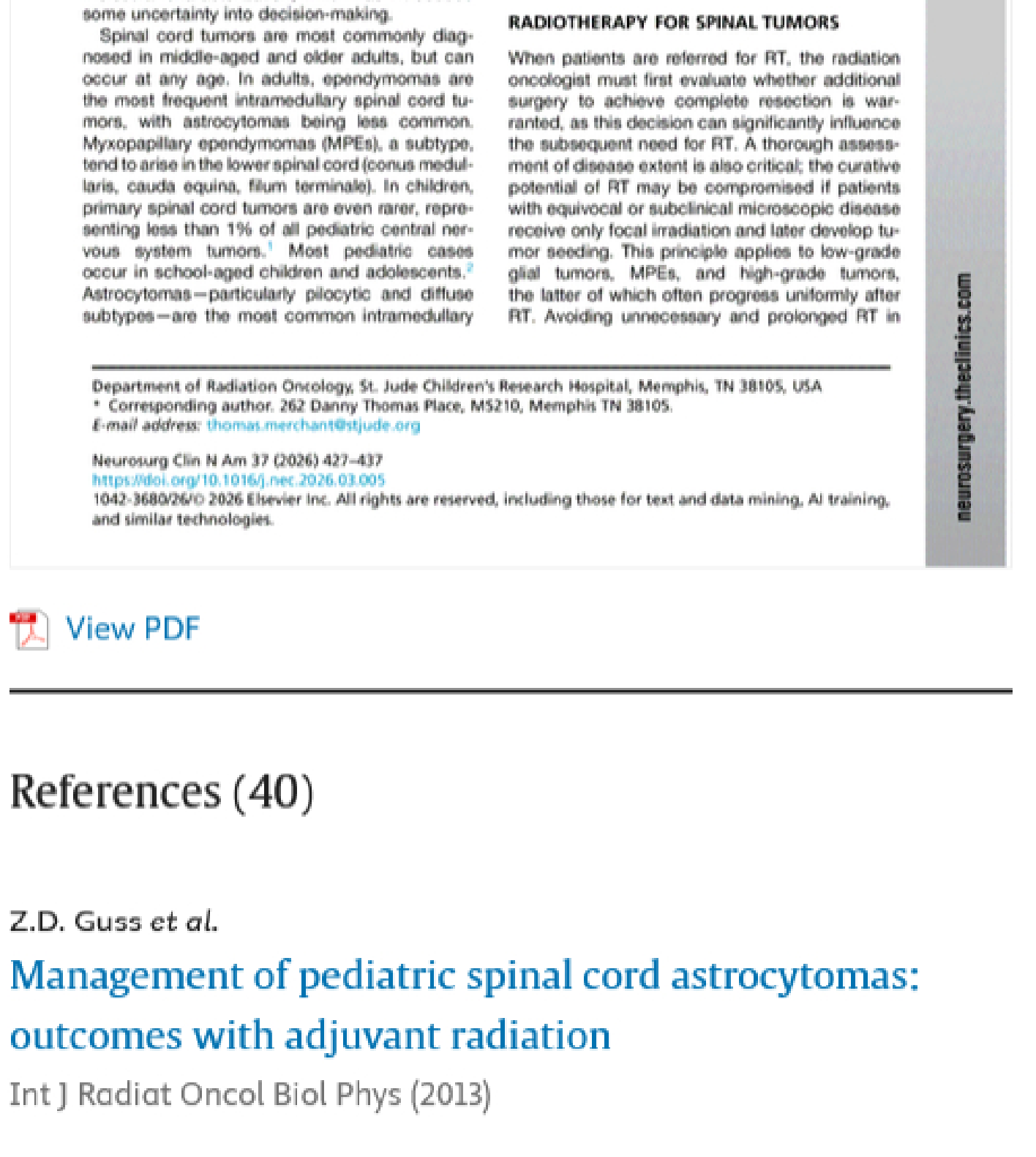
…

…

## Disclosure

There are no disclosures. …

## First page preview



Radiation Therapy for Spinal Cord Tumors

Aahan Arif, MBBS, Thomas E. Merchant, DO, PhD*

KEYWORDS

- Spinal cord tumor • Pediatric • Radiotherapy • Proton therapy • Ependymoma • Astrocytoma • Complications

KEY POINTS

- Indications for radiotherapy vary by tumor subtype, grade, and surgical outcome.
- Proton therapy can reduce long-term skeletal complications in children.
- Radiation may weaken bone and increase risk of spinal deformity.
- Multidisciplinary management and careful consent are essential.
- Case-based approaches guide individualized treatment.

INTRODUCTION

Spinal cord tumors, including intramedullary and intradural extramedullary types, are rare in both children and adults and present unique challenges for radiotherapeutic management. Variations in histologic subtype, propensity for metastasis, tumor location, and extent of disease significantly influence the ability of radiotherapy (RT) to achieve a cure while minimizing complications. When planning treatment, radiation oncologists consider patient age, histologic subtype, and increasingly, molecular characterization, which has introduced some uncertainty into decision-making.

Spinal cord tumors are most commonly diagnosed in middle-aged and older adults, but can occur at any age. In adults, ependymomas are the most frequent intramedullary spinal cord tumors, with astrocytomas being less common. Myxopapillary ependymomas (MPEs), a subtype, tend to arise in the lower spinal cord (conus medullaris, cauda equina, filum terminale). In children, primary spinal cord tumors are even rarer, representing less than 1% of all pediatric central nervous system tumors.[1] Most pediatric cases occur in school-aged children and adolescents.[2] Astrocytomas—particularly pilocytic and diffuse subtypes—are the most common intramedullary tumors in this group, followed by ependymomas.[1] The myxopapillary variant of ependymoma is the most frequent intradural, extramedullary spinal cord tumor in children, while glioneuronal tumors are rare but may occasionally occur.

For clinical categorization, spinal cord tumors are generally divided into MPE and glioneuronal subtypes, which include both high-grade and low-grade tumors. In this article, astrocytomas will be discussed by grade (low vs high), and ependymomas will be divided into classic and myxopapillary subtypes.

RADIOTHERAPY FOR SPINAL TUMORS

When patients are referred for RT, the radiation oncologist must first evaluate whether additional surgery to achieve complete resection is warranted, as this decision can significantly influence the subsequent need for RT. A thorough assessment of disease extent is also critical; the curative potential of RT may be compromised if patients with equivocal or subclinical microscopic disease receive only focal irradiation and later develop tumor seeding. This principle applies to low-grade glial tumors, MPEs, and high-grade tumors, the latter of which often progress uniformly after RT. Avoiding unnecessary and prolonged RT in

Department of Radiation Oncology, St. Jude Children's Research Hospital, Memphis, TN 38105, USA
* Corresponding author. 262 Danny Thomas Place, MS210, Memphis TN 38105.
E-mail address: thomas.merchant@stjude.org

Neurosurg Clin N Am 37 (2026) 427–437
https://doi.org/10.1016/j.nec.2026.03.005
1042-3680/26/© 2026 Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

View PDF

## References (40)

Z.D. Guss *et al.*
Management of pediatric spinal cord astrocytomas: outcomes with adjuvant radiation
Int J Radiat Oncol Biol Phys (2013)

C.G. Robinson *et al.*
Long-term survival and functional status of patients with low-grade astrocytoma of spinal cord
Int J Radiat Oncol Biol Phys (2005)

K.R. Hamilton *et al.*
A systematic review of outcome in intramedullary ependymoma and astrocytoma
J Clin Neurosci (2019)

H.C. Agbahiwe *et al.*
Management of pediatric myxopapillary ependymoma: the role of adjuvant radiation
Int J Radiat Oncol Biol Phys (2013)

A. Rubio-San-Simón *et al.*
European standard clinical practice recommendations for newly diagnosed ependymoma of childhood and adolescence
EJC Paediatric Oncology (2025)

A. Casper *et al.*
Radiation therapy target volume definition for myxopapillary ependymoma of the Lumbosacral spine without indication for craniospinal irradiation: the question of extending the target inferiorly to include the proximal nerve roots and thecal sac
Pract Radiat Oncol (2025)

M.J. Amsbaugh *et al.*
Proton therapy for spinal ependymomas: planning, acute toxicities, and preliminary outcomes
Int J Radiat Oncol Biol Phys (2012)

R.D. Tendulkar *et al.*
Irradiation of pediatric high-grade spinal cord tumors
Int J Radiat Oncol Biol Phys (2010)

T.A. Huisman
Pediatric tumors of the spine
Cancer Imaging (2009)

M. Price *et al.*
CBTRUS statistical report: pediatric brain tumor foundation childhood and adolescent primary brain and other central nervous system tumors diagnosed in the United States in 2017-2021
Neuro Oncol (2025)

View more references

## Cited by (0)

View full text

© 2026 Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

All content on this site: Copyright © 2026 Elsevier B.V., its licensors, and contributors. All rights are reserved, including those for text and data mining, AI training, and similar technologies. For all open access content, the relevant licensing terms apply.