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Proton Therapy for Skull Base Chondrosarcoma

Dennis M. Tang[1] Raffaello M. Cutri[1] Arthur W. Wu[1] Chirag Patil[2] Zachary S. Zumsteg[3]

[1] Department of Otolaryngology, Cedars-Sinai Medical Center, Los Angeles, California, United States
[2] Department of Neurosurgery, Cedars-Sinai Medical Center, Los Angeles, California, United States
[3] Department of Radiation Oncology, Cedars-Sinai Medical Center, Los Angeles, California, United States

Address for correspondence Dennis M. Tang, MD, Division of Otolaryngology, Cedars-Sinai Medical Center, 8631 W 3rd St, Suite 915E, Los Angeles, CA 90048, United States (e-mail: Dennis.tang2@cshs.org).

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Abstract

Chondrosarcoma is a type of an endochondral bone malignancy that is primarily treated surgically with radiation therapy used in the adjuvant setting or in cases of unresectable disease. Proton therapy has potential advantages compared with traditional photon therapy for the treatment of tumors in close proximity to critical structures due to the theoretic lower exit dose. Studies have shown improved survival in patients with skull base chondrosarcoma who undergo proton therapy. However, there is a lack of randomized data. Further studies are needed to define the role of proton therapy in the treatment of skull base chondrosarcoma.

Keywords
- skull base
- chondrosarcoma
- radiation therapy
- proton therapy

A 69-year-old gentleman presented with sudden vision loss in his left eye. Imaging revealed a large sinonasal mass involving the left sinuses, pterygopalatine fossa, orbit, and middle cranial fossa. Biopsy was consistent with a grade II chondrosarcoma. The multidisciplinary tumor board recommended proton beam radiotherapy, but there were concerns that the tumor's proximity to the optic chiasm would limit the ability to deliver therapeutic doses. Therefore, the patient underwent an endoscopic endonasal debulking of the tumor to decompress the optic chiasm. He subsequently underwent proton radiotherapy to a total dose of 7000cGy over 8 weeks. Twelve months post-treatment, his imaging demonstrated no progression of his cancer.

Chondrosarcomas are a heterogeneous group of endochondral bone neoplasms comprising approximately 6% of skull base tumors.[1] Chondrosarcomas are classified based on histology, with conventional/classic being the most common (80%).[2] Other subtypes include clear cell, mesenchymal, and dedifferentiated. Chondrosarcomas are graded from I to III based on histopathologic differentiation.[1,3,4]

The recommended primary treatment modality is complete surgical resection when possible.[5] However, gross total resection cannot be achieved in approximately 60 to 80% of chondrosarcomas given frequent involvement of critical neurovascular structures.[6,7] Radiation therapy can be used as primary treatment for unresectable cases or adjuvantly for positive margins in high-grade tumors. Chondrosarcomas are historically considered radioresistant due to low mitotic activity and poor vascularity.[8,9] Given this, relatively high radiation doses are recommended. However, proximity to critical structures can limit the ability to deliver doses in this range for photon-based radiotherapy.

Proton radiotherapy (PT) was developed as an alternative to photon-based radiotherapy. Photon radiotherapy beams have significant exit doses due to the massless, chargeless nature of X-rays.[10] PT has markedly decreased exit dose due to its Bragg peak, a physical property of proton beams that results in the radiation dose being deposited at a specific depth, with rapid fall-off beyond the target. This lack of exit dose can help minimizing damage to adjacent critical

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structures.[10] Doses can also be escalated while maintaining similar doses to normal organs at risk.[11–13]

There is little randomized data available for PT for chondrosarcoma. Local control rates at 5 years after PT are between 75 and 99%.[14–17] A recent analysis of the National Cancer Database demonstrated that patients receiving surgery with adjuvant PT had significantly better overall survival at 5 years (95.4 vs. 82.3%) and 10 years (85.1 vs. 72.8%) compared with surgery with adjuvant photon-based radiotherapy.[18] In a systematic review of proton versus photon radiotherapy for paranasal sinus cancers, PT was associated with superior 5 years disease-free survival and locoregional control.[19] Complications after PT are similar to traditional radiotherapy including fatigue, pituitary insufficiency, hearing impairment, and visual disorders; however, they potentially may occur less frequently or with less severity.[16,17,20,21] Although there is strong rationale for PT in the treatment of radioresistant skull base tumors like chondrosarcoma, optimal treatment regimen remains controversial. A systematic review of 33 studies demonstrated variations in radiotherapy-protocols did not yield differences between post-treatment symptom improvement or tumor volumes.[5] Moreover, widespread utilization is limited by the relative scarcity of centers offering PT.

Conflict of Interest

D.M.T. is a consultant for Acclarent, Inc. and 3-D Matrix.
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