Prospective Outcome Study of Proton Therapy for Chordomas and Chondrosarcomas of the Spine

Daniel J. Indelicato, MD, Ronny L. Rotondo, MD, Mark T. Scarborough MD,
C. Parker Gibbs MD, Christopher G. Morris, MS and William M. Mendenhall, MD

From the Department of Radiation Oncology, University of Florida, Gainesville, FL

Background: Curative non-morbid resection of spinal chordomas and chondrosarcomas is rarely achieved.
Questions/Purposes: High-dose radiotherapy may be used in either the adjuvant or definitive setting to obtain local control. The purpose of this study is to present our outcomes following proton therapy (PT) for spinal chordomas and chondrosarcomas for patients enrolled on our prospective study.
Patients and Methods: Fifty-one adult patients with non-metastatic chordomas (n=34) and chondrosarcomas (n=17) of the cervical spine (n=20), thoracolumbar spine (n=10), and sacrum (n=21) were treated with PT between March 2007 and May 2013 on a prospective outcome study. Patients with a minimum potential followup of < 1 year and those with low-grade and mesenchymal chondroscarcomas were not included. Median age was 58 years (range, 22 to 83) and 37 patients (73%) were male. The distribution of maximum diameter was as follows: <5 cm, 23 (45%); 5 to 10 cm, 22 (43%); and >10 cm, 6 (12%). Twelve patients (24%) had tumors that were recurrent after prior management with surgery alone and 24 patients (47%) had stabilization hardware at the time of radiation. Twenty-seven patients (66%) had unresectable gross disease at the time of radiation. Median total dose was 70.2 Gy (range, 64.2 to 75.6 Gy). Thirty-four patients (67%) were treated once daily and the remainder with hyperfractionated twice-daily fractionation. Twenty-three patients (45%) received some photon radiotherapy to mitigate the dosimetric impact of hardware. Median followup was 3.7 years (range, 0.3 to 7.7 years). The following factors were analyzed in a univariate analysis to determine their potential impact on the 4-year disease control rates: sex, ethnicity (white vs other), site (pelvis vs spine), histology (chordoma vs chordrosarcoma), modality (protons vs protons and photons), recurrence after prior surgery, prior intralesional procedure, presence of hardware, maximum tumor diameter (<5 cm vs >5 cm), extent of surgery (gross total resection vs other), fractionation schedule (once daily vs altered fractionation), and number of prior surgical procedures (1 vs >2).
Results: The 4-year actuarial outcomes were as follows: local control (LC), 58%; freedom from distant metastases, 86%; disease-free survival, 57%; and cause-specific survival and overall survival, 72%.Younger age (38% vs 74% LC if older versus younger than 58 years old, respectively; $p < 0.05$) and recurrent presentation (19% versus 71% if recurrent versus primary presentation, respectively; $p < 0.01$) were significantly associated with local progression. No risk factor was statistically associated with 4-year cause-specific or overall survival. Serious adverse events were rare and often multifactorial, including chronic skin toxicity and hardware failure. Despite high doses delivered near the spinal cord, no patients experienced radiation myelopathy.

Conclusion: High-dose PT is a safe and relatively effective treatment for these challenging malignancies. Local progression is the dominant mode of treatment failure and may be reduced by treating patients with PT at the time of initial surgery.