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On the Benefits and Risks of Proton Therapy in Pediatric Craniopharyngioma.

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Abstract

PURPOSE: Craniopharyngioma is a pediatric brain tumor whose volume is prone to change during radiation therapy. We compared photon- and proton-based irradiation methods to determine the effect of tumor volume change on target coverage and normal tissue irradiation in these patients.

METHODS AND MATERIALS: For this retrospective study, we acquired imaging and treatment-planning data from 14 children with craniopharyngioma (mean age, 5.1 years) irradiated with photons (54 Gy) and monitored by weekly magnetic resonance imaging (MRI) examinations during radiation therapy. Photon intensity-modulated radiation therapy (IMRT), double-scatter proton (DSP) therapy, and intensity-modulated proton therapy (IMPT) plans were created for each patient based on his or her pre-irradiation MRI. Target volumes were contoured on each weekly MRI scan for adaptive modeling. The measured differences in conformity index (CI) and normal tissue doses, including functional sub-volumes of the brain, were compared across the planning methods, as was target coverage based on changes in target volumes during treatment.

RESULTS: CI and normal tissue dose values of IMPT plans were significantly better than those of the IMRT and DSP plans ($p < 0.01$). Although IMRT plans had a higher CI and lower optic nerve doses ($p < 0.01$) than did DSP plans, DSP plans had lower cochlear, optic chiasm, brain, and scanned body doses ($p < 0.01$). The mean planning target volume (PTV) at baseline was 54.8 cm(3), and the mean increase in PTV was 11.3% over the course of treatment. The dose to 95% of the PTV was correlated with a change in the PTV; the R(2) values for all models, 0.73 (IMRT), 0.38 (DSP), and 0.62 (IMPT), were significant ($p < 0.01$).

CONCLUSIONS: Compared with photon IMRT, proton therapy has the potential to significantly reduce whole-brain and -body irradiation in pediatric patients with craniopharyngioma. IMPT is the most conformal method and spares the most normal tissue; however, it is highly sensitive to target volume changes, whereas the DSP method is not.

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