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Proton Therapy Mediates Dose Reductions to Brain Structures Associated with Cognition in Children with Medulloblastoma

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Abstract

Background: Emerging evidence suggests proton radiotherapy may offer cognitive sparing advantages over photon radiotherapy, yet dosimetry has not been compared previously. The purpose of this study is to examine dosimetric correlates of cognitive outcomes in children with medulloblastoma treated with proton vs. photon radiotherapy.

Methods: In this retrospective, bi-institutional study, dosimetric and cognitive data from 75 patients (39 photon and 36 proton) were analyzed. Doses to brain structures were compared between treatment modalities. Linear mixed effects models were used to create models of global IQ and cognitive domain scores.

Results: The mean dose and dose to 40% of the brain (D40) were 2.7 and 4.1 Gy less among proton-treated patients as compared to photon-treated patients ($p = 0.03$ and 0.007, respectively). Mean doses to the left and right hippocampi were 11.2 Gy lower among proton-treated patients ($p < 0.001$ for both). Mean doses to the left and right temporal lobes were 6.9 and 7.1 Gy lower with proton treatment, respectively ($p < 0.001$ for both). Models of cognition found statistically significant associations between higher mean brain dose and reduced verbal comprehension, increased right temporal lobe D40 with reduced perceptual reasoning, and greater left temporal mean dose with reduced working memory. Higher brain D40 was associated with reduced processing speed and global IQ scores.

Conclusions: Proton therapy reduces doses to normal brain structures as compared with photon treatment. This leads to reduced cognitive decline post-RT across multiple intellectual endpoints. Proton therapy should be offered to children receiving radiation for medulloblastoma.

Keywords: cognition; medulloblastoma; proton therapy; radiotherapy.

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