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Abstract

Dosimetric Comparison of Protons Versus Photons for Treatment of Vestibular Schwannoma

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Objectives: To evaluate the dosimetric advantages and limitations of protons (PSRS) compared to photons (XSRS) in stereotactic radiosurgery for vestibular schwannoma.

Methods: Nine patients with vestibular schwannoma were selected among those receiving single-fraction stereotactic proton radiation therapy (PSRS) at a single institution between 2015 and 2018. These cases were re-planned with XSRS volumetric-modulated arc therapy (VMAT) with 2.5mm and 5mm multileaf collimators (2.5XSRS and 5XSRS, respectively). PSRS was delivered via three equally or unequally weighted isocentric fields using a dedicated passive scattering stereotactic proton unit with collimated and range compensated ports. XSRS VMAT plans were generated with up to 3 partial arcs to avoid direct irradiation or exit dose through the eyes and minimize dose to organs at risk (OAR). Plans were constructed using the original total treatment dose of 12Gy(RBE) delivered in one fraction.

Results: Plans for this benign neoplasm were evaluated for gross target volume (GTV), planning target volume (PTV) dosimetry and estimated clinical toxicity. Average target volume was 0.73ml (range 0.2 - 1.8). There was no statistically significant difference in the PTV V100% (97.7%, 97.9%, 98.5%), GTV V100% (98.9%, 99.3%, 99.6%) or Homogeneity index (1.13, 1.11, 1.13) between PSRS, 5XSRS, 2.5XSRS, respectively. 5XSRS offered equal (within 1 percentage point) or superior PTV V100% compared to PSRS in 8 of 9 cases. 2.5XSRS offered equal or superior PTV 100% in 9 of 9 cases compared to PSRS. The Conformity index was significantly higher for PSRS (2.08) than 5XSRS (1.70, $p = 0.004$) and 2.5XSRS (1.50, $p<0.001$). The Dmax, highest dose to a 0.1ml volume of PTV, was not significantly different between PSRS, 5XSRS and 2.5XSRS (13.5, 13.4, 13.5), $p>0.05$. The maximum dose to OAR, highest dose in Gy delivered to a 0.1ml volume, was significantly lower with PSRS compared to 5XSRS and 2.5XSRS for optic nerves (0, 0.08, 0.05), chiasm (0, 0.10, 0.08) and eyes (0, 0.02, 0.02), $p<0.001$. Maximum dose to cochlea was significantly lower with PSRS than 5XSRS (5.90, 6.22, $p=0.001$) but not 2.5XSRS (5.92, $p = 0.86$). The maximum dose to OAR did not significantly differ for the brainstem. The average whole brain volume receiving 8Gy, 10Gy was higher for PSRS than 2.5XSRS (2.92ml versus 2.02 and 1.80 versus 1.33, $p<0.01$).

Conclusions: Target volume dosimetry is comparable between PSRS, 5XSRS and 2.5XSRS. The maximum dose to OAR including critical proximal structures such as the optic nerves, chiasm

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and eyes was significantly lower with PSRS. 2.5XSRS and PSRS have similar dose to cochlea. In treatment of vestibular schwannoma, dosimetric advantages are similar between PSRS and XSRS but in clinical scenarios where hearing preservation is important, PSRS may offer better sparing.