Purpose: Robust optimization leads to IMPT plans that are more robust than and superior in optimality compared to PTV-based optimized plans. Robust optimization incorporates setup and range uncertainties, which implicitly adds margins to targets and organs-at-risk (OARs); whereas PTV-based optimization only considers setup uncertainties and adds margins only to targets in practice. The purpose of this work is to determine if the superiority of robustly optimized plans is due to not assigning margins to OARs during PTV-based optimization.

Methods: Plan robustness and optimality of the PTV plus Planning organs-at-Risk Volume (PRVs)-based plans and robustly optimized plans were compared for 5 head and neck cancer cases and one rhabdomyosarcoma case. The PRVs were generated by expansion from OARs by 3 mm. 9 different dose distributions were computed - one each for Â± setup uncertainties along three spatial directions, for Â± range uncertainty, and the nominal dose distribution. The worst-case dose distribution was obtained by assigning the lowest dose among the 9 doses to each voxel in the target and the highest dose to each voxel outside the target. The DVHs from the worst-case dose were used to assess the plan optimality and robustness. D1cc doses for spinal cord and brainstem, mean doses Dmean for oral cavity and parotids, and D1% doses for other organs were also used to assess plan optimality. D5% and D95% doses are used to assess target dose coverage and homogeneity.

Results: For H&N cases, PTV+PRV-based optimization was inferior to robust optimization. However, PTV+PRV-based optimization yielded plans that spared OARs better than PTV-based optimization, although the target dose robustness and homogeneity were comparable to the PTV-based optimization. The same conclusions are also valid in the rhabdomyosarcoma case.

Conclusions: We find that the PTV+PRV method can partly improve plan optimality, but it is still inferior to robust optimization method.

Funding Support, Disclosures, and Conflict of Interest:

This research is supported by National Cancer Institute (NCI) grant P01CA021239, the University Cancer Foundation via the Institutional Research Grant program at the University of Texas MD Anderson Cancer Center, and MD Andersonâ€™s cancer center support grant CA016672.