Purpose: The effectiveness of IMPT may be significantly diminished by range and patient setup uncertainties. The purpose of this presentation is to evaluate the ability of robust optimization methods to desensitize H&N IMPT plans to uncertainties and their impact on plan optimality.

Methods: We use a robust optimization method, in which the objective function value for a given iteration is computed using the 'worst case' dose distribution. The conventionally optimized PTV-based IMPT plans and robustly optimized plans were generated for 14 head and neck cancer cases. The dose standard deviation was calculated for every voxel and used to compute 'standard-deviation volume histograms' (SVHs). The area under SVH curves was used to quantify the plan robustness. In addition, D1cc doses for spinal cord and brainstem, mean doses Dmean for oral cavity and parotids, and D1% doses for other organs were used to assess plan optimality. D5% and D95% doses are used to assess target dose coverage and homogeneity. The plan optimality and robustness are then compared statistically by the pair t-tests using SPSS 19.0 software.

Results: Compared with PTV-based optimization, robust optimization provides significantly more robust dose distribution for both targets and organs without sacrificing, and possibly even improving, the sparing of normal tissues. In addition, our robust optimization method also leads to more homogeneous dose distribution in targets with better prescription dose coverage. Improvements are statistically significant with p-value smaller than 0.05 for almost all end points compared.

Conclusion: Robust optimization results in patient-specific, optimizer-determined, and effectively reduced margins compared to a predefined and fixed margin used in the PTV approach. The optimizer can find a desired beamlet weight solution from the degenerate solution space so that the dose distribution follows the changes in anatomical geometry and is minimally perturbed by uncertainties. Our results demonstrate the importance of robust optimization.

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.