AbstractID: 7156 Title: Degeneracy and robustness of IMPT plans in the treatment of skull-base chordomas

Purpose: Intensity modulated proton therapy (IMPT) allows the delivery of highly conformal dose distributions through the application of multiple, simultaneously optimized fields. Bragg peaks are distributed for each field in 3D, therefore a large number of degrees of freedom are available in the optimization process (degeneracy of the solution). We tested the response of the clinically used optimization engine to changes in various parameters, in order to better understand the sensitivity of IMPT to such choices and particularly to find solutions less sensitive to range uncertainties.
Method and Materials: For 4 patients with skull base chordomas, different plans were calculated by varying: i) number and angular configuration of fields; ii) planning parameters (i.e. dose-volume constraints) and iii) philosophy of treatment (e.g. IMPT for whole treatment or as boost). All plans were optimized to maximize target coverage while adhering to dose-limits of OARs. Robustness analysis was performed by modeling a systematic error of 3% in proton range. Comparisons were performed through visual and quantitative DVH analysis for targets and OARs.
Results: 4-fields IMPT plans supply the best target coverage, with no improvement being observed using 6-fields. Changes in planning parameters inflence somewhat target coverages (differences in V95 of up to 10% in GTV). A treatment consisting of a homogeneus plan followed by a second series IMPT boost provides a higher D98 (up to 5% in the CTV) and, furthermore, provides a treatment less sensitive to range uncertainties.
Conclusion: The quality of IMPT plans is relatively independent on the number of fields. V95 or D98 (but not both) can be optimised depending on whether IMPT is used for the whole treatment or as a boost and depending on the choice of planning parameters. However, a more robust treatment is achieved when IMPT plan is used as a boost only.