Target Intrafraction Motion Dosimetric Impact on 5-Fraction Proton Prostate SBRT

Using an in-house MATLAB based proton treatment simulation program, we simulated 5 fraction proton prostate SBRT treatments of 14 patients with clinical treatment plan and intrafraction motion traces (Figure 1) from an electromagnetic transponder system. A patient CT dataset, RT structures and treatment plan were imported into the program from the Eclipse proton treatment planning system. Prostate intrafraction motion traces were also imported into the program.

For double scattering treatment simulation, prostate CTV was rigidly moved through the 3D dose matrix (SOBP in Figure 2) according the prostate motion traces. For uniform scanning, 3D dose matrix of each energy layer was obtained and was assigned a fraction of total irradiation time based on its weight in SOBP(energy layers in Figure 2). Prostate CTV was rigidly moved through this spatiotemporal (4D) matrix. The final CTV dose of the whole treatment fraction was the sum of CTV dose from each energy layer. Realistic pretreatment beam tuning time and beam-on time with about 2Gy/min dose rate were all simulated.

This treatment simulation evaluated the potential target dose uncertainty if we treat 5 fraction prostate SBRT with proton therapy. Figure 3 showed that CTV can be severely underdosed with significant prostate intrafraction motion. Even though the 5 fraction cumulative DVH improved (Figure 4), the single fraction underdose may not be as forgiven in regular fractionated prostate proton treatment.