Public Abstract

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Title:THE EFFECT OF UNCERTAINTY IN FIELD OF THE DAY TREATMENT REGIMES IN PROTON THERAPY

Purpose: A common practice in proton therapy is to plan a treatment using multiple fields, but only deliver a subset of those fields for each fraction. This practice could lead to increased uncertainty in the treatment. The aim of this study is to analyze how uncertainties impact the quality of proton therapy treatment when a rotating subset of the planned fields is delivered for each fraction rather than delivering all planned fields for every fraction.
Methods and Materials: Uncertainties were separated into two categories, physical and biological. Physical uncertainties were defined to be those that impact the location of the physical dose. Uncertainty in patient positioning is a primary example of physical uncertainty. These uncertainties were analyzed by introducing a physical uncertainty into a treatment plan and comparing resulting dose calculated for different treatment regimes. Uncertainties related to the manner in which tissue respond to radiation were considered biological uncertainties. For example, fractionation differences and the LET-dependence of proton RBE were considered biological uncertainties. These uncertainties were analyzed using models that have been proposed in the literature. Comparisons were made for different treatment regimes.
Results: Physical errors primarily impact the taget and OAR’s located very near the target. Errors in a single field of a plan are partially mitigated when multiple fields are delivered for each fraction. The effects of biological uncertainties due to differences in fractionation are very similar to the effects of hypofractionation used in radiosurgery. The caveat being that in this situation the tissue receiving hypofractionated dose is normal tissue far from the target. This results in increased biological effect in normal tissue for the same dose when fewer fields were delivered for each fraction. The LET-dependence of the proton RBE primarily impacts the target region of the patient. For parallel opposed fields the increased uniformity of the two-field per fraction treatment resulted in a RBE advantage compared to the one field per fraction treatment. The caveat being that the RBE is also dependant on tissue type. Above an alpha/beta ratio of 4 Gy the one field per fraction treatment would result in a greater RBE advantage.
Conclusion: Uncertainty due to fractionation differences for different delivery regimes had the greatest impact on the overall treatment. Whenever possible, it is best to deliver all fields from the treatment plan in order to minimize this effect.