Radiobiological effect based treatment plan optimization with the linear quadratic model.

Abstract:
As an approach towards more biology-oriented treatment planning for external beam radiation therapy, we present the incorporation of local radiation damage models into three dimensional treatment planning. This allows effect based instead of dose based plan optimization which could potentially better match the biologically relevant tradeoff between target and normal tissues. In particular, our approach facilitates an effective comparison of different fractionation schemes. It is based on the linear quadratic model to describe the biological radiation effect. Effect based optimization was integrated into our inverse treatment planning software KonRad, and we demonstrate the resulting differences between conventional and biological treatment planning. Radiation damage can be analyzed both qualitatively and quantitatively in dependence of the fractionation scheme and tissue specific parameters in a three dimensional voxel based system. As an example the potential advantages as well as the associated risks of hypofractionation for prostate cancer are analyzed and visualized with the help of effective dose volume histograms. Our results suggest a very conservative view regarding alternative fractionation schemes since uncertainties in biological parameters are still too big to make reliable clinical predictions.