Optimization of treatment planning using a fuzzy weight function

Development of a clinical feasible inverse-planning algorithm involves several important aspects such as the selection of objective function, iteration approach, prescription and dose calculation methods, etc. In this study, we developed a fully analytical solution for optimizing beam intensities and a fuzzy inverse solution for optimizing uncertain prescription in normal tissue. Based on the classical minimum theory, parameters used in this new iteration scheme are analytically derived. Therefore, the algorithm guarantees a fast and monotonic convergence to the global minimum of a constrained-quadratic objective function. The importance of matching the prescribed dose and the calculated dose in the normal tissue is represented by a fuzzy weight function. The task of giving full dose to the target volume while minimizing dose to the normal tissue is achieved by dynamically modifying weights of the normal tissue prescription using a fuzzy weight function. The effectiveness of the new approach has been evaluated using DVH data for several clinical treatment sites. Results indicated that the performance of the algorithm is substantially improved with the introduction of a fuzzy weight function. Typically, acceptable results can be obtained with less than 10 iterations and no dose calculation is required during iteration for fixed beam configuration. It has been shown that the technique is capable of finding a solution that achieves the optimal balance between the objective of matching the calculated dose and the prescribed dose for the target volume and the objective of minimizing the dose in normal tissues.