

Purpose: To compare dose distributions for plans optimized by using the Monte Carlo algorithm (MC) and the Ray-Tracing algorithm (effective path length method, EPL) for CyberKnife treatments of lung tumors.

Methods: In the CyberKnife Multiple planning system, a treatment plan can be created by using the Ray-Tracing algorithm or by using the Ray-Tracing algorithm in the first run and switch to the Monte Carlo algorithm for further optimizations. In this study, treatment plans were created using Multiplan 4.0 in both ways with exactly the same planning parameters. Dose was prescribed to the isodose line encompassing 99% of the planning target volume (PTV). The difference in dose distributions was studied by analyzing the dose-volume histograms (DVHs), isodose distributions and the conformity indexes (CIs). 10 patient plans with different tumor shape, size and locations have been investigated in this preliminary study.

Results: The maximum doses and mean doses to target and critical structures between plans generated by the Ray-tracing (RT plan) and the Monte Carlo (MC plan) shows small differences with no obvious advantages from either one. However, the largest differences were observed in the target dose conformity. In average, conformity index from the RT plan is about 17% larger than the MC plan. In general, the more irregular shaped target, CI ratio between the RT plan and MC plan becomes the larger.

Conclusions: Both plans generated using the Ray-tracing and re-calculated, re-normalized using Monte Carlo and plans optimized using the Monte Carlo directly are clinically acceptable. But the MC plan delivers better target dose conformity. Therefore MC-based treatment planning is recommended for SBRT of pulmonary targets.