Purpose:
To retrospectively calculate three dimensional dose distributions in the lung and surrounding tissues using Monte Carlo (MC) simulations to evaluate the effect of including media heterogeneities for patients treated with I-125 brachytherapy for resected non-small cell lung cancer.
Methods:
The EGSnrc user-code BrachyDose is used to perform simulations including media heterogeneities for patients treated with intraoperative I-125 mesh brachytherapy for stage I non-small cell lung cancer at Mayo Clinic. Heterogeneous simulation phantoms are generated using patient CT data: voxel medium (air, lung, soft tissue, bone) and density assignment is based on the densities in the CT images. Seeds are fully modeled. Three-dimensional dose distributions in the lung are calculated and are compared with the TG-43 formalism via DVHs and dose metrics for normal tissue volumes and volumes consisting of various margins (5-20 mm) surrounding the surgical suture (PTV10 for 10 mm margin).
Results:
Differences in dose metrics for TG-43 and heterogeneous MC calculations vary dramatically between patients; differences of up to 17% in V100, 26% in D90, and 20% in the mean dose are observed within PTV10. MC doses to voxels within PTV10 can differ by up to 20 Gy (20% of prescription dose) from TG-43 doses. Correspondingly, large differences are observed in isodose contours for the two calculation methods, particularly in lung tissues; differences are smaller for soft tissue regions. Dose differences are highly sensitive to source positioning within the lung and on lung composition (i.e. media heterogeneities).
Conclusions:
Doses computed using full MC simulations differ considerably from TG-43 calculated doses for I-125 mesh brachytherapy. Accurate treatment planning and evaluation requires the inclusion of non-water media based on imaging data in dose calculations. BrachyDose calculation times are sufficiently fast for clinical use.