Purpose: To evaluate post-implant dosimetry of prostate implants by tracking edema-induced movements of implanted sources and tissue sub-volumes using deformable image registration on post-implant serial CT images.

Methods: Post-implant serial CT imaging was used to characterize the variations of prostate volume and movements of implanted sources during edema resolution. Seven post-implant time points, up to 42 days, were selected. Deformable image registrations performed between each consecutive pair of CT images were used to track the spatial movements and tissue deformation using the Yale BioImage Suite non-rigid image registration algorithm. The history of tissue movement was used in a 4D dose calculation approach to determine the dose actually received by each tissue sub-volume in presence of prostate edema.

Results: Tracking of tissue sub-volume was validated using simulated datasets with known tissue deformations. Post-implant dose rate distributions calculated at different post-implant times were accumulated to corresponding tissue sub-volumes. The dose distributions determined with full considerations of source migration and tissue deformation were compared to conventional approach using one static post-implant image set. We observed that the hot and cold spot positions were moving around with edema evolution. Overdose at the peripheral of prostate would cause problems to the adjacent organs. The edema-induced tissue and source movements caused overdose and deficit dose magnitudes were up to 1.12E04 cGy and -1.23E+04 cGy respectively, and overdose and deficit dose volumes were up to 10.37% and 10.26% respectively, and the percentage of hot or cold volume dynamically varied from 1.4% to 20.63% with post-implant timing.

Conclusions: Post-implant dosimetry based on actual source position and tissue deformation during edema resolution was obtained using serial post-implant CT imaging and deformable image registration. It provides a more realistic documentation of the actual dose delivered and could be used to compensate edema-induced dose deficits and assess the risk of overdose.

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