MEASUREMENT AND CALCULATION OF 4D DOSE

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This presentation is a review of the various methods to determine radiation dose being delivered to a moving target (e.g., 4D dosimetry), particularly in the presence of modulated fluence patterns in the inhomogeneous datasets. These include calculations, measurements, and hybrid approaches. Experimental undertakings vary from simple point dose measurements to full 3D dose measurements in a phantom loaded with radiochromic polymers and mounted on a motion platform. Calculations are based on convolution of dose or fluence with the motion kernel, full 4D reconstruction with deformable registration between 4DCT phases, or isocenter shifts opposite to motion. Hybrid methods use a great variety of approaches, including information from tracking devices, in-room 4DCT, accelerator delivery log files, and cine EPID images. One method treats motion as perturbation of the original treatment plan that can be reconstructed in 4D from a static dosimeter measurement and a known motion kernel.

Review of the literature shows that point dose measurements tend to over-emphasize the importance of the interplay between target motion and radiation fluence modulated in space and time, while full 3D reconstruction indicates that the important target DVH parameters are not significantly affected.

Overall, 4D dose reconstruction is paractical terms may be a self-limiting proposition for established treatment techniques, at least for the target. Even in lung, the difference between the full 4D dose and a 3D approximation using average density or density overrides is marginal. Furthermore, interplay is not a clinical issue in terms of near-minimum and mean tumor dose. However, developed 4D reconstruction techniques will likely flourish in emerging technologies, such as dynamic tracking techniques, including cine MR-based, and intrafraction motion-adaptive planning.

Some of the relevant references are summarized below. 1-14

References:


