Abstract

Soft Tissue deformations during radiotherapy impact patient dosimetry and treatment accuracy. Systematic or patient-specific deformations may occur in any region of the body. This thesis focuses on three main anatomical sites that exhibit significant deformations over the course of treatment and explores potential solutions to improve patient dosimetry with a focus on therapeutic outcomes. Prostate brachytherapy involves the use of a Transrectal Ultrasound probe that externally deforms the prostate, Lung external beam radiotherapy is subject to patient breathing motion, and Head & Neck radiotherapy routinely results in interfraction weightloss and tumor debulking.

Influence of the TRUS probe on the prostate results in migration of implanted radioactive seeds post-implant with a change in target and organ doses. Shifts in seed positions showed that motion of prostate post-implant occurred in 3-dimensions, was non-uniform, and dependent on prostate region, tending in the superior and posterior directions. Comparisons between the in-vivo measured microMOSFET doses with the Variseed calculated doses yielded a mean and standard deviation of -5.0±25.2%. When considering the TRUS probe's effect on urethral dose, stratifying patients into those with and without periurethral seeds on the pre-plan resulted in mean and standard deviations of 12.8±10.0% and -13.8±12.9%, an increase and decrease in urethral dose respectively (p=0.0006).

The geometric accuracy of lung radiotherapy is affected by 4DCT image quality and requires quantification of the effect of AP motion artifacts on object reconstruction for various breathing patterns and to provide treatment planning recommendations for target sizes below a minimum threshold. Target reconstruction is most accurately represented on the exhale phase and was found to be the most reliable for target contouring when the range of motion exceeded 3x the tumor diameter. A 3d-printed patient-specific breathing phantom may aid in visualizing small SBRT targets to ensure a high degree of treatment accuracy.

Contour changes in head and neck radiotherapy results in gaps under bolus that is applied to ensure dosimetric coverage of superficial targets. Determining the acceptable gap before replanning a patient's treatment is subjective and patient-specific. Dosimetric VMAT measurements considering gap widths illustrate the point at which replanning should be considered to maintain treatment integrity.