AbstractID: 8345 Title: CE-IMRT 3: Role of Imaging for IMRT

The evolving roles of imaging for mega-voltage (MV) photon-beam intensity modulated radiation therapy (IMRT) treatment planning, delivery, and verification will be presented. Methodologies to assess the capabilities of imaging systems and apply them to quantitative applications in IMRT will be discussed.

The discipline of radiation therapy has continued to rapidly advance over the last decade with continued technological improvements in conformal radiotherapy. The introduction of MV photon-beam IMRT achieved through multileaf collimator (MLC) delivery has allowed the wide-spread clinical implementation of very complex non-convex dose distributions. In principle, these complex dose distributions will allow escalation of the ionizing radiation dose that can be delivered while lowering or maintaining iatrogenic toxicities caused by radiotherapy. Indeed, advantageous employment of this IMRT MLC delivery to reduce treatment related toxicity has already been reported by several institutions in the treatment of head-and-neck and prostate cancers.

However, these advances do not come without a risk. Accurate IMRT delivery relies on precise mechanical delivery, dose calculational accuracy, and patient positioning and immobilization accuracy at an unprecedented level. Experimental techniques employed to commission and validate IMRT treatment planning and delivery systems must call upon advanced imaging science. The complex nature of the beam fluence maps and dose distributions delivery in IMRT make high resolution fluence and dose imaging a necessary component of commissioning and validating these systems. Applications of imaging science to radiotherapy are often unique due to the requirement for quantitative results. Performing dosimetry and radiotherapy targeting through imaging places the highest requirements on both the spatial integrity and signal content of the data imaged. IMRT delivery verification requires accurate high spatial resolution imaging of IMRT fluence maps and dose distributions using electronic portal imaging devices, film, or gel dosimetry media.

Combining IMRT delivery with registered multimodality imaging promises to revolutionize conformal radiotherapy. While computed tomography (CT) image studies remain the primary imaging modality used for conformal radiotherapy treatment planning due to their inherent spatial integrity, other imaging modalities are proving very useful in delineating tumor volumes and critical structures. Magnetic resonance imaging (MRI), magnetic resonance spectroscopy (MRS), single photon emission computed tomography (SPECT), and positron emission tomography (PET) are imaging modalities which can provide unique target related information and may improve overall radiation therapy patient management. Fast CT and MR imaging techniques can provide data for the modeling of intrafraction organ motion, which can significantly impact on IMRT delivery accuracy. All of these imaging modalities can provide valuable complimentary forms of treatment planning information that should allow the efficacious employment of the very complex non-convex dose distributions produced by IMRT delivery. At the same time, these imaging modalities can be prone to artifacts that without proper handling can result in treatment errors.

Educational Objectives:

1) Describe the roles of quantitative imaging in IMRT
2) Discuss the theory of quantitative imaging
3) Present methods of validation for quantitative imaging dosimetry
4) Present examples of multimodality imaging employed with IMRT delivery
5) Discuss the current state of radiotherapy imaging

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