AbstractID: 4419 Title: Functional Imaging for Radiotherapy Guidance - Quantitative Biological Imaging and the Oncologic Target

Purpose: Biological imaging modalities are reviewed for their quantitative applications, contributions, and limitations in radiation treatment. Concepts are presented for biologically-matched dose distributions.

Method and Materials: Quantitative use and assessment of anatomical and biological oncology images shows promise for identification and evaluation of targets for radiation treatment. Biological images, combined with anatomical images, contain digital information on the spatial distribution and intensity level of biological character representative for both cancerous and normal tissues. Quantitative aspects of "bioanatomic" images, for instance, from FDG PET-CT or MR spectroscopy, enable software processing and manipulation for target localization and delineation, assessment during treatment phase, and post-treatment evaluation. IMRT provides a method for selective targeting based on biology.

Results: Bioanatomic imaging modalities include FDG PET, non-FDG PET-CT, MR spectroscopy, diffusion-weighted MR, MR perfusion, functional MR, magneto-encephalography (MEG), and others. Each modality/technique has finite spatial resolution, contrast (signal-noise-ratio), range of voxel intensity values, and sensitivity/specificity. Limitations for quantitative uses include spatial resolution, and "calibration" for validation of voxel intensities and image interpretation. Image digital file formats may be a challenge for certain images. Research opportunities include biology, physics, and imaging science work, and image-based clinical trials that combine bioanatomic images with advanced dose delivery.

Conclusion: Contributions and limitations for quantitative uses of bioanatomical images in radiation treatment are reviewed, including digital characteristics of biological images. Potential benefits include a better understanding of tumor and normal tissue biology and treatment response, and radiation targeting that matches biological conditions.

Educational Objectives

1. Review characteristics of digital images and the task of image interpretation
2. Review signal origins relevant to tumor biology for selected imaging modalities
3. Describe the use of threshold parameters for biological radiation target delineation
4. Discuss concepts for biologically-matched radiation dose distributions
5. List research opportunities for basic science and image-based clinical trials

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