

As can be seen from other presentations and scientific sessions at this meeting, the predominant modes of radiation delivery in modern radiation oncology are the three dimensional conformal radiation therapy (3DCRT) and intensity modulated radiation therapy (IMRT). One of the foundation blocks of 3DCRT and IMRT process is a volumetric patient scan. This scan is the bases for the treatment plan and the main guide for design of treatment portals and dose distributions. The quality of the study and the data contained in the study have a direct impact on the patient treatment and potentially on the outcomes and complications.

The 3DCRT process based on x-ray computed tomography (CT) imaging was first described in 1980s (Goitein and Abrams 1983, Goitein et al 1983, Sherouse et al 1990). Ever since, the CT has remained the primary imaging modality in radiation therapy. X-ray computed tomography offers excellent spatial integrity, which is important for accurate patient treatments, it provides radiation interaction properties of the imaged tissues for heterogeneity based dose calculations, and digitally reconstructed radiographs (DRRs) can be calculated from a volumetric CT data. The three main limitation of CT are the relatively poor soft tissue contrast, the limitations to record functional properties of the imaged tissues, and the fact that motion information is generally not appreciated as CT images are acquired as snapshots in time. Magnetic resonance imaging (MRI) has a much better soft tissue contrast than CT and can provide often more useful anatomic information.

The second limitation relates to the fact that CT primarily records anatomic information and does not convey functional properties of imaged tissues. Knowledge of functional properties of imaged tumors and surrounding critical structures can be very important in design of dose distributions within target volumes and in guidance for sparing of critical structures. Ling at al (2000) have proposed a concept of biological target volumes (BTVs). In addition to conventionally defined CTV, GTV, and PTV targets, portions of target volumes would be identified as having increased growth activity or radioresistance. Identification of these volumes would be performed with functional imaging and these volumes would be labeled as BTVs. Biological target volumes would then have a special consideration during the treatment planning process and would be subject to dose escalation. Magnetic resonance imaging (proton spectroscopy, diffusion, perfusion, functional) and nuclear medicine imaging (single photon emission tomography (SPECT) and positron emission tomography (PET)) can be used to identify BTVs. This presentation addresses the use of PET imaging in planning of radiotherapy treatments. The main emphasis is on the use of images and not on the image acquisition and PET tracers.

PET has a potential to play an important role in the overall goal of imaging in RT, which is to accurately delineate and biologically characterize an individual tumor, select an appropriate course of therapy, and to predict the response at the earliest possible time. The requirement to biologically characterize an individual tumor means that an imaging modality must be capable of imagining beyond gross anatomy and recording information about physiology, metabolism, and molecular makeup of a tumor. Biological information contained in PET can be used for disease detection, staging, therapy selection, target design, outcome prognosis and follow-up. These individual points are reviewed along with PET based treatment planning process and a limited review current status of PET/CT technology

EDUCATIONAL OBJECTIVES LIST

This refresher course:

- 1) reviews the current status of CT-simulation technology, tools, and processes
- 2) discusses the use of PET imaging for treatment planning in radiation oncology
- 3) discusses clinical implementation of PET based treatment planning