

Functional Imaging of the Lung for Radiotherapy Treatment Planning

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Delivery of radiotherapy through hypoperfused pulmonary regions for lung cancer treatment has been shown to result in less pulmonary injury in a single prospective trial. This finding suggests a strategy for image-guided radiotherapy utilizing physiological images in radiotherapy treatment planning for image guidance to avoid the irradiation of highly functional regions and minimize the injury and/or function loss following thoracic radiotherapy. Patients may have inhomogeneous lung function distribution due to tumor invasion of the airway and vascular structures and/or preexisting pulmonary diseases. Imaging studies have found the prevalence of these hypoperfused regions adjacent to the primary tumor from 43 to 74% in non-small cell lung cancer cases. However, the current thoracic treatment planning practice has been primarily based on using anatomical information from the treatment planning computed tomography (CT). Therefore, the non-uniform distribution of regional function of normal lung tissue has not been considered in the process of treatment planning. Imaging modalities that have been reported in treatment planning studies to provide image guidance to identify the highly functional regions include single photon emission computed tomography perfusion, ³He hyperpolarized gas magnetic resonance ventilation, and 4D CT derived ventilation imaging. No prospective studies demonstrating improvement in outcome using these modalities for functional image-guided radiotherapy have yet been reported. Strategies to incorporate functional image guidance include identification of highly functional regions by an expert for avoidance, automated segmentation of pulmonary regions with the highest function for avoidance, and optimization of functional metrics including the dose function histogram.

This lecture will provide an overview of the physiologic origins of the functional imaging methods, post-acquisition processing, and strategies to integrated functional imaging into thoracic treatment planning.

Educational Objectives:

1. Understand clinical basis for the use of functional imaging for treatment planning
2. Survey the functional imaging modalities which may be utilized for image-guidance.
3. Review strategies to integrated functional imaging into thoracic treatment planning.