Method to Preserve Post-radiotherapy Ventilation by Mitigating Radiation-Induced Airway Injury

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Field
Radiation Oncology

Technology
Treatment Planning

Advantages
Functional Airway Mapping Approach

Risk-based avoidance planning of specific critical airways

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UMB Docket Reference
AS-2019-095

External References
Vicente et al. (2020)
PMID: 32575096
Kazemzadeh et al. (2018)
PMID: 29891202

Summary

Preserving post-radiotherapy respiratory function is an important consideration in thoracic radiation therapy. A common limitation of current clinical and investigational approaches that attempt to achieve this objective is that they ignore radiation injury to the elements of the bronchial tree, which are critical to the gas exchange process. There is currently very little knowledge on the dose-response of and radiation damage to these anatomical structures. While some methods for radiation therapy are known, which map functional regions of the lungs and generate avoidance radiation therapy (RT) plans for high-functioning lung regions, these known methods do not account for branching structures of the anatomy that are especially vulnerable to radiation damage. To address the limitation of current models, UMB researchers have designed a novel functional avoidance approach that uses virtual bronchoscopy to spatially map and incorporate central as well as peripheral airway segments in the treatment planning process. This functionally weighted airway sparing (FWAS) method estimates the radiosensitivities of critical airway segments to develop a risk-based approach to incorporate and avoid excessive dose to specific airways in the treatment planning process. By reducing the probability of post-RT airway toxicity combined with improved modeling of lung anatomy and function, such methods may lead to reduced toxicity in conventional lung RT as well as safer use of high-potency regimens and modalities such as stereotactic body radiotherapy (SBRT) and particle therapy.

Technology

UMB investigators have developed a novel image-guided treatment planning paradigm that quantifies dose thresholds for and achieves dose-sparing of bronchial segments, thereby reducing radiation-induced lung toxicity and loss of pulmonary function. The FWAS method (i) maps the bronchial pathways to each functional sub-lobar lung volume using a virtual bronchoscopy system; (ii) assigns a weighting factor to each airway based on the relative contribution of the sub-volume to overall lung function; and (iii) creates a treatment plan that aims to preserve these functional pathways. **Comparison of prescribed clinical plans of SBRT patients with the FWAS plans showed that FWAS preferentially spared airways that supported high-functioning lung regions for improved ventilation preservation after treatment. Ventilation preservation improvements ranged between 3% and 23% depending on the size and location of the tumor (see Figure 1)**.

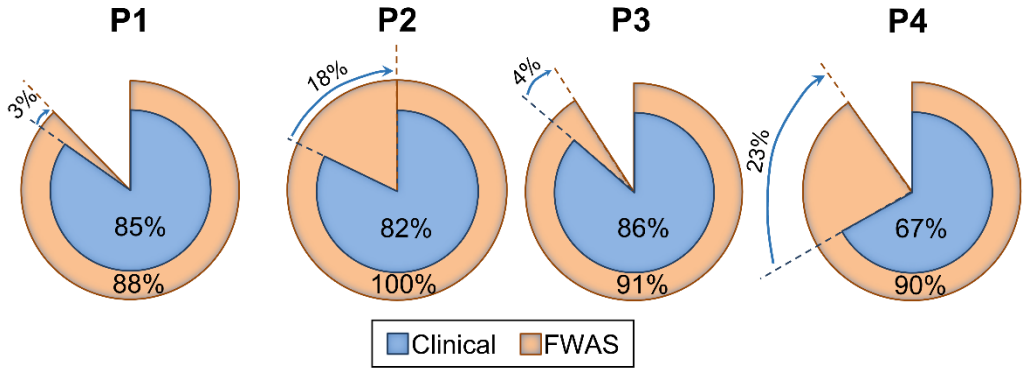

Figure 1. Ventilation preservation for clinical plans (blue sectors) and FWAS plans (orange sectors) for four patients (P1–P4). Blue arrows indicate the improvement values achieved when using the FWAS method with respect to the clinical plan (FWAS minus clinical [%]).

Market

Lung cancer is the leading cause of cancer-related deaths in the US (~235K new cases and ~132K deaths in 2021). Radiotherapy concurrent with chemotherapy is the established standard-of-care for inoperable local, and locally-advanced non-small-cell lung cancer. Driven by mounting clinical evidence and recent changes to reimbursement models, the RT community is increasingly adopting highly potent treatment modalities such as SBRT and proton therapy. Minimizing toxicity and preserving post-RT respiratory function (and, therefore, quality of life) are ever more critical considerations in modern lung cancer RT.

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