QUANTITATIVE ASSESSMENT OF RADIOTHERAPY RESPONSE FOR LUNG CANCER PATIENTS

Lung cancer is the most common cause of death among all other cancer types, accounting for about 12% of all cancer cases. For inoperable lung cancer patients, radiation therapy (RT), usually combined with chemotherapy, is the primary treatment of choice. Since the current prognosis of lung cancer patients treated with RT is low, several studies have reported that dose escalation improves the overall survival. Dose escalation can however cause increased dose to normal lung tissue and other organs at risk and may lead to radiation induced lung complications. Therefore, there have been attempts to limit the toxicity to the normal lung tissue while increasing the dose to the tumor.

Tumor response to RT can be evaluated from changes in metabolic activity between two positron emission tomography (PET) images. Activity changes at individual voxels in pre-treatment PET images, however, cannot be derived until their associated images are appropriately registered to during-treatment images. Due to tumor shrinkage, cells in individual image voxels could be replaced, and objectively monitoring metabolic activity changes in each voxel is not an easy task. We investigated the feasibility of using different deformable image registration (DIR) techniques to quantify radiation-induced metabolic changes on PET images and found that the hybrid- DIR methods were beneficial in evaluating tumor response in the case of regressing tumors. For the purpose of sparing normal lung tissue during RT, functional image guided radiotherapy allows for the delivery of an equivalent dose to tumor targets while sparing highly ventilated lung tissues. We investigated how radiation dose to different functional lung tissues is associated with clinical outcome for patients treated with stereotactic body radiation therapy (SBRT). Using two different 4-dimensional computed tomography (4DCT) based ventilation imaging techniques we found that low dose delivered to high ventilation areas may also increase the risk of compromised pulmonary function. Even though 4DCT ventilation imaging is a promising technique for evaluating pulmonary function, lung elasticity and mechanics are usually not part of the ventilation image analysis. We therefore demonstrated a 4DCT based imaging technique that can be used to calculate regional lung compliance changes after RT. Ventilation and CT density changes were also investigated. We found that a combination of ventilation and compliance information with CT density should be beneficial for understanding radiation induced lung damage and is valuable for function-guided treatment planning for lung cancer patients.