Purpose: To develop tailor-made utility functions based on each patient's pulmonary function distribution so that personalized organ-function-based treatment plan is obtained for locally advanced lung cancer patients.

Methods: Five locally advanced lung cancer patients were retrospectively evaluated in the study. Fractional regional ventilation was obtained by performing subtraction of spatially matched and corrected 4DCT images. Histogram of the fractional ventilation values was generated for each patient. The cumulative distribution function (CDF), which represented an inverse relationship with the desired dose to each voxel for function preservation, showed potential as personalized utility function. In order to spare the majority of the volume with pulmonary function, a more aggressive utility function was defined as a piece-wise linear function based on the most frequent fractional ventilation value (peak of the histogram). This utility function was used in the objective function during treatment planning. Conventional objectives and constraints were maintained during the planning process.

Results: Both conventional plan and personalized functional plan were classified as satisfactory plans by physician based on conventional dose and dose-volume metrics. However, functional plan successfully spared high ventilation volume based on each patient's unique condition. When spatial function information was included to collect function dose/dose-volume metrics, significant reduction of fV20, fV30 and mean lung dose was achieved by function-based personalized plan with p-value < 0.01.

Conclusions: Organ-function-based radiotherapy has been presented to incorporate patient's pulmonary function in hopes of reducing the risk of complications. Current methods utilize the function information in the same fashion across patients. We took one step further to not only incorporate heterogeneous pulmonary function during treatment planning but also generate personalized utility function based on the function distribution of each patient.

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