Purpose: Radiation induced pulmonary diseases can change the tissue material properties of lung parenchyma and the regional ventilation. 4DCT can be used to measure regional ventilation when combined with non-linear 3D image registration. The purpose of this study is to analyze the effects of the B-Spline grid spacing and the weighting of linear elasticity in 4DCT and image registration based measurement of ventilation by comparing the result to hyperpolarized helium-3 MR (HP He-3 MR).

Methods: 4DCT data set and HP He-3 MR before RT were acquired from one patient. The regularized tissue volume and vesselness preserving image registration algorithm was applied to register the maximum inhalation image to the maximum exhalation image for the measurement of regional ventilation. The HP He-3 MR ventilation map was rigidly registered to the maximum exhalation image for direct comparison to the 4DCT derived ventilation map. Relative overlap (RO) was used to quantify the similarity between the two measurements. Ventilation maps derived from different B-Spline grid spacing and Laplacian weighting in the image registration were compared.

Results:The similarity between the two measurements increases as the increase of the B-Spline grid spacing and Laplacian weighting which result a smoother ventilation map. In this study, the best similarity with the RO value 0.75 is found with Laplacian weighting of 0.5 and B-Spline grid spacing of 32 mm. The Laplacian weighting of 0.01 with B-Spline grid spacing of 8 mm shows the lowest OR value of 0.68. Visual inspection indicates the two measurements have similar anterior/posterior and superior/inferior gradients.

Conclusions: We have compared the 4DCT based ventilation measurement with the results from hyperpolarized helium-3 MR. This result will be valuable for improving the lung CT image registration algorithm toward accuracy not only in the measure of landmark error but also the underlying physiological changes.

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