The dosimetric impact of respiratory motion for lung cancer treatment in boron neutron capture therapy

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Abstract

Lung cancer has been the leading cause of cancer mortality, and its incidence is growing worldwide. Boron neutron capture therapy (BNCT) technology has some unique advantages in the treatment of lung cancer, such as the binary and high LET characteristics. In recent years, researchers have proposed the treatment of BNCT for lung cancer, the feasibility and the effectiveness has been verified by dosimetry calculation and clinical trials. The effect of respiratory motion on dosimetry during radiotherapy has always been a concern of medical physicists. However, changes in dose distribution due to respiratory motion have not been studied in BNCT. In this study, four-dimensional Computed Tomography (4D CT) images of real lung cancer patients were used to construct patient geometry. Six phases (e.g. 10%, 20%, 50%, 60%, 80%, 90%) were selected to represent the anatomy of patients at different moments throughout the respiratory cycle. A virtual respiratory patient model with moving tumor was constructed in this work. Tumor-related Dose Volume Histograms (DVH) indices at different phases were calculated using Monte Carlo toolkit. The tumor mean dose, tumor $D_{95\%}$, mean lung dose and V_5 as the main dosimetric indicators was compared among different phases. The results showed that the dosimetric indicator differences of different phases increased with the increase of respiratory amplitude; the dose differences caused by respiratory motion in the anterior–posterior direction were significantly under the treatment planning configurations we studied , and in the motion range of 5~21 mm, and the dose difference range of different phases was - 11.99% ~ 13.03%. According to the results of the study, patients with a large range of tumor movements should take some respiratory motion inhibition measures to reduce the dose changes during treatment, or introduce 4D CT into the treatment plan to make more accurate calculations and assessments for patients in clinic.

Keywords：BNCT; Respiratory motion; Monte Carlo; 4D CT