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## 学位論文の内容の要旨

Dissertation Abstract

( 李 洋 ) Name 印

(学位論文のタイトル) Title

Dose assessment for patients with stage I non-small cell lung cancer receiving passive scattering carbon-ion radiotherapy using daily computed tomographic images: A prospective study

(非小細胞肺癌 I 期の炭素イオン線治療における日々のCTを用いた線量評価：前向き研究)

(学位論文の要旨)

Carbon-ion radiotherapy (CIRT) has been considered as a more effective treatment for early-stage non-small cell lung cancer (NSCLC) than conventional radiotherapy due to its fine dose distribution. However, inter-fractional anatomical changes such as tumor displacement and soft tissues deformation have great impacts on the dose distribution, even in hypofractionated CIRT. These deviations between fractions may cause a severe dose reduction in target. Therefore, detecting and quantifying these uncertainties is important to ensure the robustness of the treatment. This study aimed to assess dose distributions for NSCLC with passive scattering CIRT using daily computed tomography (CT) images. We enrolled 10 patients with stage I NSCLC and acquired a total of 40 daily CT image series under the same settings as the treatment planning CT images. The daily CT images were used to evaluate the reproducibility of tumor positions and dose distributions. The daily dose distributions were calculated on the daily CT images using the irradiated beam parameters for both bone matching (BM) and tumor matching (TM) positions, and accumulated dose distributions were calculated using a deformable image registration for both positions. Moreover, the dose volume parameters were compared in terms of tumor coverage and lung exposure, and statistical analyses were performed. The prescribed dose was 60 Gy (RBE) in 4 fractions. The case with CTV V95 < 95% was defined as unacceptable. In addition, required margins were proposed to improve the dose distribution in BM and TM.

Large inter-fractional tumor displacements were observed, especially in superior-inferior direction. A moderate negative correlation was obtained between dose coverage and tumor displacement. 32.5% of tumor displacements were greater than 5 mm, which caused that 25% of 40 fractional dose distributions were unacceptable with BM, compared with 2.5% with TM. Using BM, three patients' accumulated dose distributions were unacceptable; however, all were satisfactory with TM. The required margins in patients with poor dose distribution were 5.9 and 4.4 mm for BM and TM, respectively.

This study establishes that CT image-based TM is robust compared with conventional BM for both daily and accumulated dose distributions. Hence, daily CT alignment is recommended for patients with stage I NSCLC receiving CIRT.