CBCT for Stereotactic Body Radiation Therapy of Lung

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Abstract

Objectives: The objective of the study is to validate the strategy to find the smallest margins to be safely added the gross tumor volumes (GTVs) of the thorax without any breath control system during Stereotactic Body Radiation Therapy (SBRT). In our experience the measure of inter-fractional tumour motion was determined among the daily pretreatment CBCTs, the simulation CT “slow” and the diagnostic 4D PET/CT.

Methods: Thirty-nine patients (p) with primary non-small cell lung cancer (NSCLC) and forty two with lung metastases were treated on this study from June 2012–June 2015. All patients were simulated and treated in a stereotactic immobilization system with BodyFIX® 14 BlueBAG HIP and Total Body with Diaphragm Control and Mechanical Pressure System with compression arch. All CT images (3-mm thickness) were registered and transferred in the treatment planning system (Xio). Plans were generated with variable (> seven) non-coplanar beams of 6-MV X-rays. The GTV was contoured as the identifiable tumor on planning CT in the lung window. The clinical target volume (CTV) , enclosed the respiration-correlated GTV position from different phases of respiration (ITV), is generated from maximum intensity projection (MIP) of 4D-CT/PET image. For the planning target volume (PTV), another 2-mm margin was added isotropically to CTV. Different doses, based on the targets location was prescribed at the p with NSCLC: a) 54Gy/3 fractions to the 80% isodose lines for parenchymal GTV (n18) b) 60Gy/5 fx to the 95% isodose for sub costal GTV (n8) c) 60Gy/8 fx to the 95% for GTV next to the mainstem bronchus (n12). For the lung metastatic patients: a) 45 Gy/3 fractions fractions to the 80% isodose lines for parenchymal GTV (n18) b) 50 Gy/5 fractions to the 95% for GTV close to critical structures. All fractions were scheduled as three times per week. To verify patient positioning and inter-fractional tumour motion, CBCTs were acquired daily and checked on line at each treatment session, the change of mean tumour position relative is investigated, first to bony structures between (measured by software between the planning CT and CBCT scans) and then looking at tumor in the lung window. Patient position was adjusted if the setup error was > 0.2 cm in any direction. To verify that the correction was accurate, an additional CBCT was acquired immediately following the correction, prior to treatment and checked again.

Results: In our study of 81 patients, 490 cbct were taken. The mean three-dimensional tumor motion for patients with upper lesions (n = 43) and mid-lobe or lower lobe lesions (n = 37) was 1.2 and 5.5 mm, respectively. The mean residual error after target localization using CBCT imaging was 1.9 mm (range from 1 to 4 with the SI larger than AP (1,4 range 1-2) and LR (1,2 range 1-2). The mean intrafractional tumor deviation at CBCT imaging after treatment was always < 1 mm.
Conclusions: In-room volumetric imaging, such as CBCT, is essential for target localization accuracy in lung SBRT, with online match on soft tissue in order to be able to reduce treatment margins. This study shows that it is possible to reduce the uncertainties induced by respiratory motion for patients suitable for SBRT using a CBCT generated from 4D-CT/PET. These results demonstrate that our setup technique was successful at reducing the setup error to a reasonable level where patients are positioned with customized immobilization.