AbstractID: 5082 Title: A simple method to reconstruct a representative mid-ventilation CT scan from 4D respiration correlated CT scans for radiotherapy treatment planning of lung cancer patients

Purpose: Four-dimensional (4D) imaging techniques can be used to obtain (respiration) artifact-free CT images of the thorax. However, its use in radiotherapy is limited since clinical treatment planning systems are currently not able to use the full 4D data. The purpose of this study was to reconstruct a representative single 3D CT scan from the 4D data set (with tumor closest to the mean position) for use in radiotherapy planning of lung tumors to enable reduction of treatment error margins.

Method and Materials: After acquisition of the 4D CT scan (10 frames), the tumor is manually segmented (roughly) in the first frame and automatically (gray-value) registered to the tumor in the subsequent frames. This gives the motion of the tumor during the respiratory cycle in 3D. Subsequently, from the cranio-caudal (CC) tumor motion curve, the mean tumor position and its corresponding mid-ventilation (MV) time-percentage are calculated. The CT scan for planning is reconstructed at this time-percentage. As indication of the merit of this concept, its effect on margins from CTV to PTV and on the PTV volume was calculated covering respiratory motion, respiratory baseline variation and setup errors (systematic and random).

Results: Based on 13 patients, the worst tumor position accuracy (with respect to the mean tumor position) in the mid-ventilation CT scan occurred in the anterior-posterior direction: -0.7±0.8 mm (due to hysteresis). For these patients, the errors in conventional free-breathing CT were estimated to be 0±3.4 mm (CC) and 0±1.4 mm (AP). The mid-ventilation concept resulted in margin reduction up to 45% and a PTV volume reduction up to 35%.

Conclusion: The mid-ventilation concept, based on tumor motion, is a simple method to obtain an artifact-free CT scan with smaller systematic errors compared to conventional CT scans. Significant reduction of the PTV volume can be achieved.