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Motion Control Consistency with Abdominal Compression Device from Daily 4D CBCT

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Purpose

To investigate the effectiveness of abdominal compression in tumor motion control for lung cancer radiotherapy. To study the motion control consistency during radiation treatment course through 4D reconstruction of daily cone beam computed tomography (CBCT) images.

Method and Materials

Patients with lung tumors were scanned with 4D helical CT and the tumor motion was evaluated in left-right (LR), superior-inferior (SI), and anterior-posterior (AP) directions. Patients with tumor motion greater than 1cm in any of the three directions and who could not tolerate the active breathing control (ABC) were treated with abdominal compression. Kilovoltage(kV) CBCT image was acquired for each treatment fraction to correct patient setup. The CBCT imaging data were then reconstructed using a respiratory-correlated technique to derive 4D CBCT images with 10 different phases of breathing cycle. Daily tumor motion with abdominal compression was evaluated from the 4D CBCT by recording the tumor center position relative to the treatment isocenter in each phase. Three patient data (1 upper lobe tumor and 2 middle lobe tumors) were included in this study and 4 consecutive treatment fractions for each patient were studied. The extent of tumor motion was compared between different treatment fractions to assess the daily variation of motion control with abdominal compression.

Results

Mean value and standard deviation (SD) of tumor motions from all patients and treatment fractions studied were $3.1\text{mm} \pm 0.9\text{mm}$ (mean \pm SD), $6.8\text{mm} \pm 1.7\text{mm}$, and $5.3\text{mm} \pm 1.8\text{mm}$ in LR, SI, and AP directions respectively. The variation of tumor motion extent of the same patient between different fractions was $1.1\text{mm} \pm 0.7\text{mm}$, $2.0\text{mm} \pm 1.9\text{mm}$, and $2.3\text{mm} \pm 2.0\text{mm}$, in LR, SI, and AP directions respectively.

Conclusion

Tumor motions which were greater than 1cm with free-breathing were reduced to less than 1cm with abdominal compression. Variation of motion control during treatment course was significant relative to the tumor motion in the patients and treatment fractions studied.