

## Analysis of intrathoracic tumor mobility during the whole breathing cycle by dynamic MRI and application for an individualized safety-margin concept in radiotherapy planning

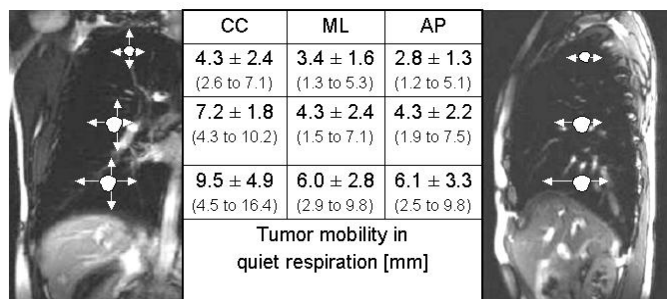
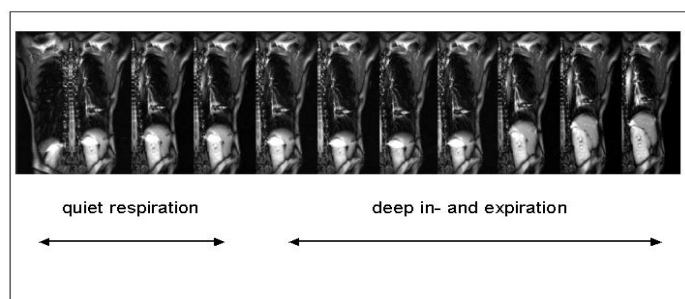
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**Purpose** To assess diaphragm, lung region and tumor mobility during the whole breathing cycle using dynamic MRI. A generalized safety-margin concept for radiotherapy planning is calculated and compared with an individualized concept.

**Methods and Materials** Breathing cycles of twenty patients with solitary lung tumors (15 stage I non-small-cell lung carcinoma, 5 small solitary metastases) were examined with dynamic MRI (trueFISP; TE/TR: 1.7/37.3 ms; flip angle: 65°; receiver bandwidth: 977 Hz/pixel; field of view (FOV): 375x400; matrix 149x256; slab thickness: 10mm; voxel size: 2.5x1.6x10 mm<sup>3</sup>; three images per second). Deep in- and expiratory positions of the diaphragm, upper, middle, lower lung regions and the tumor were measured in three dimensions. Mobility of tumor-bearing and corresponding tumor-free regions was compared. Tumor mobility in quiet respiration served as a MRI-based safety-margin concept.

**Results** Dynamic MRI using a trueFisp sequence during the whole breathing cycle consistently resulted in diagnostic image quality. The motion of lung regions was significantly higher in the lower regions than in the upper regions ( $5 \pm 2$  cm vs  $0.9 \pm 0.4$  cm,  $p < 0.05$ ). Tumor-bearing lung regions showed a significantly lower mobility than corresponding non-involved regions ( $p < 0.05$ ). In quiet respiration tumor mobility showed a high variability, a safety-margin of 3.4 mm in the upper, 4.5 mm in the middle and 7.2 mm in the lower region was calculated.



**Figure 1** MRI of tumor mobility during the breathing cycle in the coronal plane. After quiet respiration patients were instructed to perform a vital capacity maneuver (deep inspiration followed by deep expiration). Note a little metal artifact from a metal clip in the tumor region.

**Figure 2** Mobility vectors (mm) and range of mobility (in brackets) for tumors in different lung regions (upper, middle, lower) during quiet respiration (CC, craniocaudal; ML, mediolateral; AP, anteroposterior).

**Conclusion** Dynamic MRI is a simple non-invasive method to evaluate intrathoracic tumor mobility for radiotherapy planning. Because of the high variability of tumor mobility an individualized safety-margin concept is recommended.

### References

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