Quantification of lung tumor volume and rotation during respiration using 3D dynamic parallel MRI with view sharing – preliminary results

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Purpose To evaluate a technique using 3D dynamic MRI (dMRI) combining parallel imaging with view sharing and dedicated postprocessing techniques to quantify lung nodule volumes and rotations during respiration.

Materials and Methods DMRI of pulmonary nodules was performed in phantoms using a 3D FLASH sequence with parallel imaging and view sharing (TR/TE: 1.5/ 0.6 msec; 3.8x3.8x3.8 mm^3; scan time per 3D data sets: 1 sec). Phantoms (meat balls: 130 ml, 40 ml, 12 ml, Fig. 1) were semi-automatically segmented; 21different algorithms to correct for partial volume effects were evaluated and calculated volumes were compared with real phantom volumes. The technique was applied in five patients (4 m/1 f) with stage I NSCLC and verified by CT and histology. MRI nodule rotation during respiration was quantified using oriented bounding box techniques (Fig. 2).

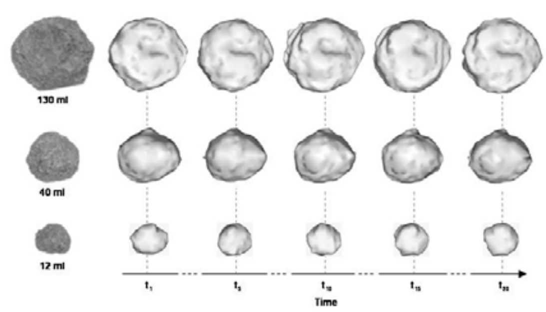

Fig. 1 Photographs of the tumor phantoms (left) and surface renderings of every fifth image.

Results The most precise algorithm ($r > 0.9$, $p < 0.01$) to correct for partial volume effects yielded a root mean square error (RMSE) of 14% (calculated phantom volumes 120.8 ± 4.1 ml, 36.1 ± 3.98 ml and 13.1 ± 1.5 ml). In patients there was no significant difference between MRI, CT and histologic volumetry. There were substantial respiratory changes of volumes and rotations of the nodules (Fig. 3).

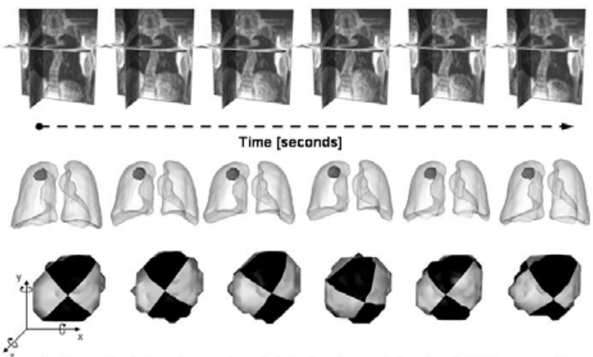

Fig. 2 Respiratory cycle from maximum inspiration to maximum expiration using a FLASH 3D sequence with a time resolution of 1 image per second and segmented tumor and lung volumes. Rotation of the tumors principal axes during respiration from maximum inspiration to maximum expiration and back. The surface of the tumor was subdivided into 8 segments to facilitate detection of rotation.

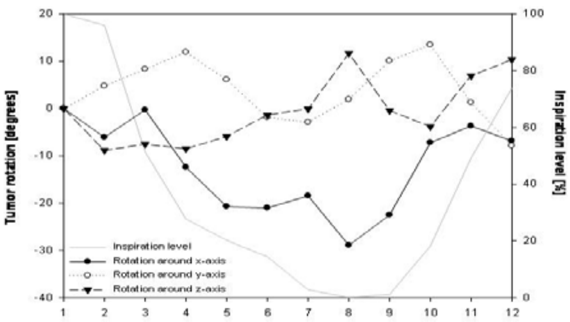

Fig. 3 Rotation of the tumors principal axes during respiration from maximum inspiration to maximum expiration and back.

Conclusion 3D dMRI techniques make it possible to non-invasively quantify volume and rotation of pulmonary nodules during respiration.

References: Plathow et al. 2004 & 2005, Invest Radiol; Plathow et al. 2005, JMRI; Suga et al. 2001, JMRI