Water/Fat Selective Whole Body Continuous Moving Table Imaging

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Introduction

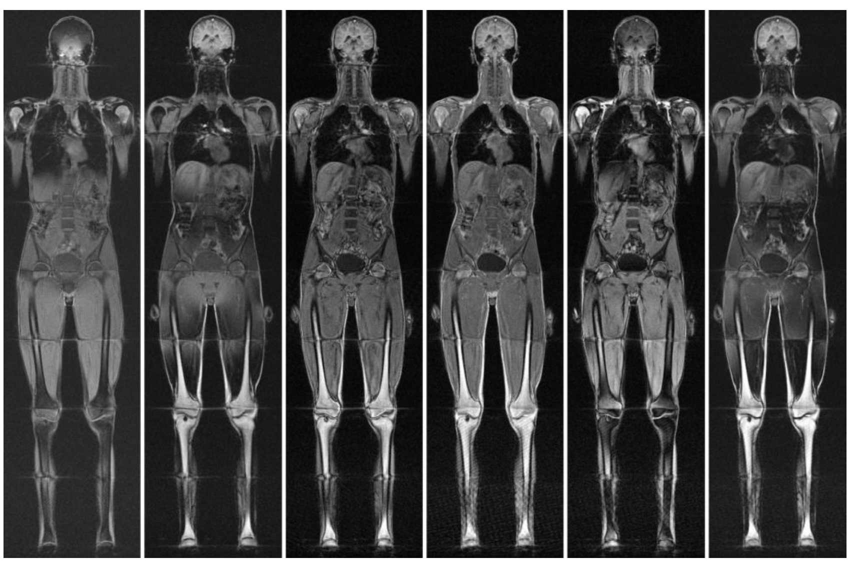
The degree of body fat content shows a relationship with a number of diseases, for example, the perilesional fat sparing, which is often an indicator for tumors or their metastases. MRI as a non-invasive diagnostic tool is able to measure the fat distribution and could thus become part of future whole body screening procedures. Continuous moving table imaging [1], currently mainly used for contrast enhanced peripheral angiography, has the potential to be used in water/fat selective whole body imaging. For water/fat tissue signal measurements, two different methodological approaches can be employed, i.e. chemical shift selective or chemical shift encoding techniques. Thus, spectral spatial RF excitation [2] and 2-point-Dixon [3] encoding was considered in the present work to study the basic feasibility of water/fat selective continuous moving table imaging in healthy volunteers.

Methods

In-vivo experiments were performed on young healthy adults, using a 1.5T whole body scanner (Gyroscan Intera, Philips Medical Systems) employing the body coil for both RF transmission and signal reception. The patient support was moved during data acquisition at constant table velocity. In these initial experiments, a 3D gradient echo acquisition using a linear phase encoding scheme was employed. Two basic water/fat selective approaches were studied. In the first one, a 1-2-1 spectral spatial excitation RF pulse tuned either to the fat or the water resonance was used. This limited the shortest possible echo time (TE), and consequently prolonged the repetition time (TR). In the second approach, a 2-point-Dixon double echo sampling was employed in which the first TE was set to the shortest possible out-of phase TE (180°) and the second one to the next possible in-phase TE (0°) for the water and fat components. To allow the comparison of both approaches, the same TR and sampling bandwidth was used. In all measurements, the same virtual field of view of $460 \times 1840 \times 64$ mm³, voxel size of $1.8 \times 1.8 \times 8$ mm³, TR of 8.8 ms, flip angle of 12° and patient table velocity of 12.8 mm/s was used, with TE set to 5 and to 2.1/4.2 ms, respectively, for the two different approaches. Flip angle optimization, shimming and resonance frequency determination were performed in the abdominal region prior to whole body scanning. During reconstruction, all data were corrected for the table motion [1] and Fourier transformed. For the 2-point-Dixon data, additional sum and difference images were calculated to allow water/fat signal separation.

Results and Discussion

Figure 1 shows a comparison between the two imaging methods studied for one of the volunteers. All images show slight artifacts at the boundaries of the individual sub-FoVs. These artifacts, which are well known to moving table imaging, are caused mainly by B_0- and B_1-field inhomogeneities, gradient non-linearity and errors in table velocity. Image quality will benefit from future corrections to reduce these adverse effects. However, a new kind of artifact appears in the fat images and is especially pronounced in the lower thighs. Local variations of the main field homogeneity caused by the presence of the patient and corresponding variations in the resonance frequency (f_0) result in an incomplete separation of water and fat signals. A possible correction method would be a repeated update of f_0 and corresponding shims, according to the anatomy scanned in the iso-center during continuous table motion. For the Dixon approach, this difficulty could probably be circumvented using a 3-point-Dixon approach [4], which intrinsically measures a B_0-map.



water (121) fat (121) Dixon (180°) Dixon (0°) water (sum) fat (diff)

Fig. 1. Water/fat selective images of a 3D data set of a healthy volunteer. Left two: water/fat selective excitation, central two: 2-point Dixon data and right two: corresponding water/fat reconstructions based on Dixon data.

Conclusion

Whole body water/fat sensitive screening could be performed using continuous moving table imaging, but further improvements are necessary. Due to the intrinsic sensitivity of continuous moving table imaging to system imperfections (as e.g. B_0- and B_1-field inhomogeneity), which may even change during scanning, the applicability of the method is currently limited. Corrections for the adverse effects have to be developed to improve image quality in the future.

References

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