Whole-body applications of isotropic high-resolution T2-weighted MRI with a single slab 3D-TSE based sequence optimized for high sampling efficiency, called SPACE – initial clinical experiences.

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Purpose

To evaluate the clinical benefit of T2-weighted (T2w) body imaging with high isotropic resolution with a sequence based on single-slab 3D turbo spin echo (TSE) with variable-flip-angle refocusing RF pulses and high sampling efficiency, called SPACE.

Materials and Methods

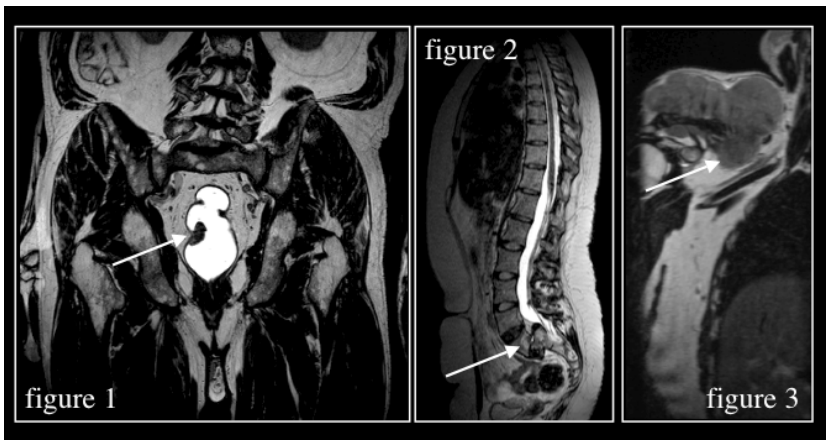
All examinations were performed on a 1.5 T whole-body MR scanner (Magnetom Avanto, Siemens Medical Solutions), equipped with 32 independent rf-channels. In all cases a combination of body- and spine-matrix coils were used for signal reception (Total Imaging Matrix). The 3D T2w SPACE pulse sequence was specifically designed to permit spatially-selective imaging with a high-quality slab profile while using short non-selective, variable-flip-angle refocusing RF pulses to achieve very short echo spacings and thus a very high sampling efficiency [1,2,3,4]. In addition parallel imaging (acceleration factor 3) was used along the in-plane phase encoding direction to reduce the required number of phase encoding views. Sequence parameters were: TR/TE=1500/124ms, 2 averages, FoV = 380mm, 144 slices per slab, base matrix = 384, iPAT factor = 3 (GRAPPA), bandwidth 407 Hz/Px, turbo factor = 71, echospacing = 4,2 ms, resulting isotropic voxel size $(1.0\ mm)^3$, resulting measurement time 10 min 32 sec. Slab orientation was coronal or sagittal. In case of a small volume of interest, the number of slices was reduced to minimize measurement time (minimum approximate 7 min). All examinations were performed while the patients were breathing freely. For imaging of rectal cancer, a dilution of water und ultrasound gel was used additionally. To reduce disturbing bowl motion in these cases, n-butyl-scopolamine (Buscopan®) was applied intravenously. In total, three healthy volunteers and 36 patients were examined. Areas of interests were: pelvis n= 21 (7 patients with rectal cancer, 2 with cervix carcinoma), spine n=10, extremities n=4 and the chest n=1. For volunteer examinations, signal-to-noise (SNR) and contrast-to-noise (CNR) ratios were evaluated using a region-by-region analysis. Examinations with the SPACE sequence were compared with conventional T2w 2D TSE (512 base matrix, slice thickness 3mm). Multiplanar reconstructions of 3D data were also performed according to the angulation of the conventional 2D T2w images. Image quality and visualisation of lesions for all sequences were rated by two experienced radiologists.

Results

The 3D T2w SPACE sequence provided sufficient SNR and high isotropic resolution of $1mm^3$ in all patients. No reinforcement of artefacts was obvious (e.g. caused by vessel pulsation or bowel motion). CNR was sufficient for all kinds of clinical diagnosis and all lesions were clearly visualised by the 3D data sets. However, contrast behaviour was rated slightly inferior compared to that for the conventional 2D T2w TSE, but without affection of the lesion detection. In all cases, the possibility of oblique data reconstruction of the data acquired with SPACE was of clinical relevance and improved diagnostic quality of the MR examination.

Conclusion

The combination of parallel imaging techniques and the T2-weighted single-slab 3D SPACE method with variable-flip-angle refocusing RF pulses will allow conventional multiplanar 2D T2w TSE imaging to be replaced for all relevant clinical examinations of the body trunk. The achievement of 3D image data with high, isotropic spatial resolution and the usage of interactive 3D visualisation software for image reading essentially improve the diagnostic potential of MRI. In cases with complex anatomical relationships, e.g. the spine, this technique allows access to all relevant structures and improves not only the diagnosis but also therapy planning.



Figures

Examples for the applied 3D T2w SPACE sequence with high isotropic resolution used for therapy planning: Figure 1) Male patient with a T2 staged rectal cancer (bowel filled with dilution of water and ultrasound gel), Figure 2) Female patient with spondylolisthesis, and Figure 3) coronal MPR for better visualisation of the plexus and vessels in a case of an Ewing sarcoma of the right shoulder.

References

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