Improved T2-weighted Imaging of the Pelvis using T2-prepared Single-slab 3D TSE (SPACE)

J. P. Mugler, III[1], T. A. Altes[1], W. Horger[2], and B. Kiefer[2]
[1]Radiology, University of Virginia, Charlottesville, VA, United States, [2]Siemens Healthcare, Erlangen, Germany

Introduction: It is well known that the echo spacing for spin-echo-based acquisitions, such as fast/turbo spin echo (FSE/TSE), affects the apparent rate of decay of the transverse magnetization [1]. As a result, the contrast in T2-weighted (T2W) FSE/TSE images is somewhat different than that in conventional T2W spin-echo images, with certain structures and pathologies (e.g., hemorrhage) demonstrating lower contrast with T2W FSE/TSE techniques. Nonetheless, the speed advantage of FSE/TSE imaging has made it the method of choice for clinical MRI. Recently, optimized versions of single-slab, three-dimensional FSE/TSE imaging (e.g., SPACE [Siemens] or 3D FSE CUBE [GE]) have been introduced. With these methods, it is possible to use robust, non-spatially-selective contrast preparations without compromising the fundamental structure or efficiency of single-slab 3D TSE. In this work, we implemented a T2-contrast preparation for T2W 3D-TSE [2,3] imaging of the pelvis, and explored the resulting contrast properties compared to those for the standard 3D-TSE method and conventional 2D TSE.

Methods: A commercial version of single-slab 3D TSE (SPACE) was modified to include an adiabatic T2 preparation [4,5], applied just before the excitation RF pulse of each spin-echo train as illustrated in **Fig. 1a**. Between approximately one-third and one-half of the total echo time was allocated to the adiabatic T2 preparation **(Fig. 1b**). Thus, the echo spacing for the adiabatic preparation (30-40 ms) was approximately ten times longer than that for the spin-echo train (~4 ms). Partial Fourier acquisition was used for the encoding direction associated with the echo train to maintain efficient sampling when using a relatively short effective TE.

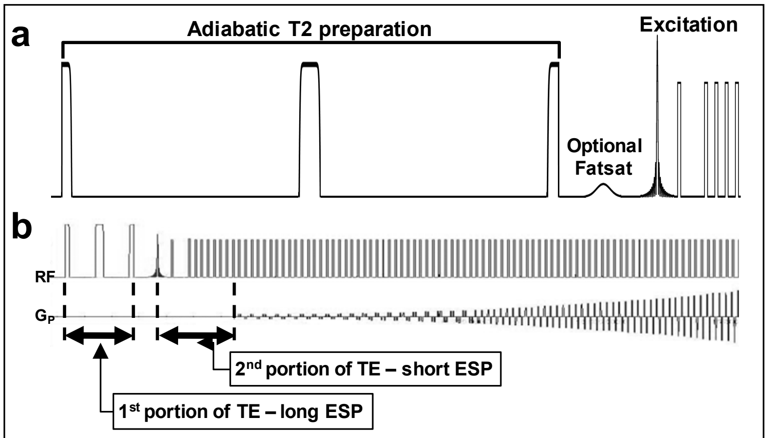

Fig. 1. (**a**) RF-pulse configuration for the T2-weighted SPACE pulse sequence using an adiabatic T2 preparation before each excitation RF pulse. (**b**) Allocation of the echo time between the preparation (long echo spacing [ESP]) and echo train (short ESP).

The T2-prepared SPACE method was compared to standard T2W SPACE and conventional 2D TSE in five healthy volunteers for imaging the prostate (2 subjects) or uterus (3 subjects). Imaging was performed at 1.5 T (1 prostate subject, 2 uterus subjects; Siemens Aera) and 3 T (1 prostate subject, 1 uterus subject; Siemens Skyra). Contrast-relevant parameters for the 3D acquisitions included TR 1600-1700 ms, effective TE 87-100 ms (standard SPACE) or 82-95 ms (T2-prepared SPACE, with 30 or 40 ms allocated to the adiabatic preparation), restore pulse, and constant-flip-angle refocusing RF pulses. The 3D acquisitions used approximately isotropic spatial resolution to permit high-quality multi-planar reconstructions. Two-dimensional TSE was performed using standard protocols available on the respective scanners (TR 4000-4700 ms, effective TE 82-101 ms). Informed consent was obtained from all subjects prior to imaging.

Results: The contrast among structures in the rectal wall, and in the prostate or uterus, was visibly different among the three techniques (2D TSE, standard SPACE, T2-prepared SPACE). In both male subjects, T2-prepared SPACE provided improved contrast of structures within the prostate as compared with standard SPACE and axial 2D-TSE acquisitions. For example, the 3T prostate images shown in **Fig. 2** compare separate coronal and axial 2D-TSE acquisitions (left) with coronal and axial reconstructions from standard SPACE (center) and T2-prepared SPACE (right) 3D acquisitions. In addition to the improved contrast within the prostate, there was improved contrast of rectal wall structures for both SPACE acquisitions compared to 2D TSE. With all three female subjects, the endometrium was relatively brighter and more structural detail was apparent in the myometrium with the two SPACE acquisitions. In the one subject with fibroids, the contrast of fibroids differed between the standard and T2-prepared SPACE acquisitions.

Conclusions: The use of a T2 preparation for T2W single-slab 3D-TSE imaging provides image contrast in the pelvis that is different than that for either conventional T2W 2D-TSE or standard T2W single-slab 3D-TSE imaging. In healthy subjects, these preliminary studies indicate that certain structures are depicted with higher contrast using T2-prepared single-slab 3D TSE. This observation, coupled with the ability to reconstruct multiple image planes from the high-resolution 3D acquisitions, suggests that T2-prepared single-slab 3D-TSE warrants evaluation in subjects with disease.

References: **1.** Constable RT et al. Magn Reson Imaging 1992; 10:497. **2.** Busse RF et al. Proc ISMRM 14 (2006); 392. **3.** Mugler JP et al. Proc ISMRM 18 (2010); 2612. **4.** Epstein FH et al. J Magn Reson Imaging 1995; 5:463. **5.** Staewen RS et al. Invest Radiol 1990; 25:559.

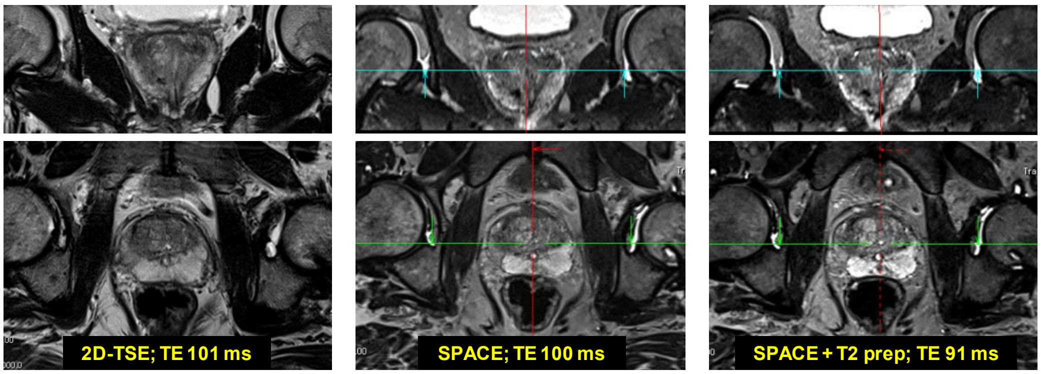

Fig. 2. Separate coronal and axial 2D-TSE acquisitions (left) of the prostate in a healthy volunteer at 3T compared with coronal and axial reconstructions from standard SPACE (center) and T2-prepared SPACE (right) 3D acquisitions. For T2-prepared SPACE, 30 ms was allocated to the adiabatic preparation.