Inner-volume 3D Turbo-spin-echo (SPACE) Imaging of the Prostate: Preliminary Experience

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Introduction: Optimized versions of single-slab, 3D fast/turbo spin-echo (FSE/TSE) imaging (e.g., SPACE [Siemens], CUBE [GE], VISTA [Philips]) have recently gained popularity for clinical MR imaging. Although the high sampling efficiency of these methods combined with parallel imaging yield sufficiently short acquisition times to permit high-resolution 3D imaging for a variety of applications, there nonetheless remain applications for which additional acceleration is needed. One such application involves the prostate (for which some components have relatively long T1 values), wherein fairly long repetition times may be desirable to provide contrast comparable to that for established 2D-TSE protocols. To address this need, we implemented an "inner-volume" [1,2] version of 3D TSE, which employs orthogonal spatially-selective RF pulses to reduce the imaging volume with a concomitant decrease in acquisition time [1], and explored the contrast properties for the prostate compared to those for conventional 2D TSE.

Methods: An extended first echo spacing [2,3] has been used in single-slab 3D TSE to accommodate the relatively long excitation RF pulse required to achieve slab-selection [4]. Since, with an extended first-echo-spacing pulse-sequence structure, relatively long pulse durations can be used for the excitation and/or first refocusing RF pulses without sacrificing short echo spacings for the remaining echoes, this structure offers the opportunity to implement inner-volume 3D TSE without compromising the efficiency of the technique, as demonstrated previously by Mitsouras et al [2].

Inner-volume 3D TSE was implemented by modifying a commercial version of single-slab 3D TSE (SPACE) to include a spatially-selective first refocusing RF pulse. To obtain good spatial selectivity for the first refocusing RF pulse over a several centimeter slab thickness, while limiting the peak RF-amplitude requirement, a root-reflected design was used [5,6]. Basic operation of the technique was verified in phantoms, and protocol optimization was performed in 4 healthy male volunteers at 1.5T (2 subjects, Aera, Siemens) and 3T (2 subjects, Skyra, Siemens). Based on these initial tests in healthy subjects, a protocol with TR/TE ~4500/100 ms was selected for preliminary assessment of contrast and image quality at 3T in subjects with prostate disease. Inner-volume SPACE was compared to conventional 2D TSE (TR/TE ~8000/100 ms) and standard single-slab SPACE (TR/TE 1600-1700/90-100 ms) in three male patients being evaluated for suspected prostate cancer. Informed consent was obtained prior to imaging.

Results: The increase in TR from 1600-1700 ms for standard SPACE to 4500 ms for inner-volume SPACE visibly improved contrast among structures in the healthy prostate. Inner-volume SPACE (acquisition time 8-9 min.) exhibited contrast similar to that for 2D TSE (TR 8000 ms, acquisition time 4.6 min. for a single orientation), but provided the advantage of 3D multiplanar reconstructions (**Fig. 1**). Overall, results for inner-volume SPACE were analogous in the 3 patients (**Fig. 2**), although tissue contrast properties differed slightly among techniques. In general, structural detail was better depicted by inner-volume SPACE, but in one subject a suspected carcinoma appeared a bit less conspicuous with both standard and inner-volume SPACE than with 2D TSE. One possible explanation for this contrast difference is a stronger magnetization-transfer (MT) effect for 2D TSE than for SPACE. Nonetheless, if this is the case, stronger MT-dependent contrast can be implemented for the SPACE pulse sequence by adding appropriate preparation RF pulses.

Conclusions: For prostate imaging, inner-volume SPACE permits the TR to be substantially extended compared to standard slab-selective SPACE, while maintaining an acceptable acquisition time and the ability to obtain high-quality multi-planar reconstructions. Thus a particular advantage for clinical prostate imaging would be a time savings compared to more time-consuming 2D-TSE protocols in demonstrating the prostate in multiple planes. Initial evaluation in patients with prostate disease yielded promising results compared to conventional 2D TSE, although additional optimization to further improve the contrast properties for disease may be warranted.

References: **1.** Feinberg DA et al. Radiology 1985;156:743. **2.** Mitsouras D et al. Med Phys 2006; 33:173. **3.** Kanazawa H et al. Proc SMR 2 (1994); 474. **4.** Mugler JP et al. Proc ISMRM 12 (2004); 695. **5.** Murdoch JB. Proc SMR 3 (1995); 552. **6.** MATPULSE 5.1, Matson GB.

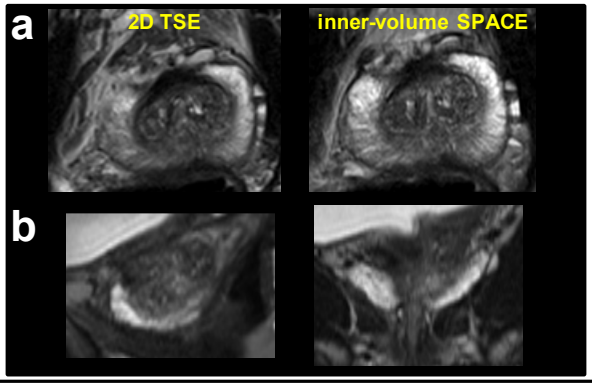

Fig. 1. (**a**) Comparison of 2D TSE (TR/TE 8000/101) and inner-volume SPACE (TR/TE 4510/103) in a healthy subject. (**b**) Sagittal (left) and coronal (right) reconstructions from the inner-volume SPACE acquisition.

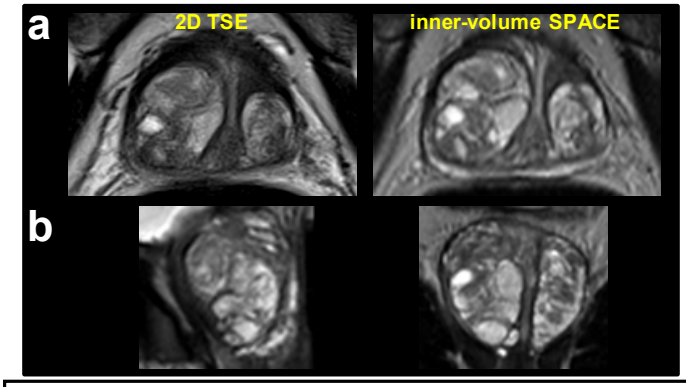

Fig. 2. (**a**) Comparison of 2D TSE (TR/TE 8000/101) and inner-volume SPACE (TR/TE 4500/100) in one of three patients. (**b**) Sagittal (left) and coronal (right) reconstructions from the inner-volume SPACE acquisition.