A Comparison of T_2- and T_2^*-weighted Imaging at 7T

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Background: MRI at higher field strengths is expected to lead to improved anatomical scanning. Such improvement is not just through the raw SNR available, but also through changes in contrast mechanisms such as T_2^*. As a first step in examining this, we compared TSE [1] (i.e. T2-weighted) and FLASH [2] (i.e. T_2^*-weighted) images taken at the same slice position and resolution.

Methods: Data were acquired on a 7T scanner based on Siemens Avanto hardware. An 8 channel phased array coil [3] was used in combination with a detuneable birdcage transmit coil [4]. The slice position, number and resolution for each method was kept as similar as possible: Read FOV and resolution 200mm/576 voxels, and 10 slices slice with thickness 2mm and gap 2mm. TSE details: phase FOV 86.1%, TR 5770ms, TE 54ms, Turbo factor 11, Averages 2, Bandwidth 197Hz/pixel. T2star details: phase FOV 83.3%, TR 500ms, TE 25ms, Average 1, Bandwidth 30Hz/pixel. The TSE acquisition took approximately 9 minutes, compared to 4 minutes for the T2* acquisition.

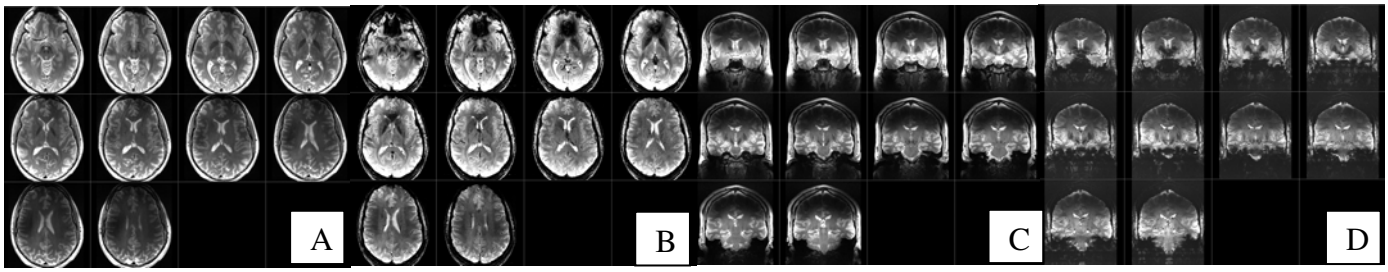

Figure 1: Sets of transverse T_2- (A), transverse T_2^*- (B), coronal T_2- (C) and coronal T_2^*–weighted (D) images. Slices are 2mm thick with 0.347mm in-plane resolution.

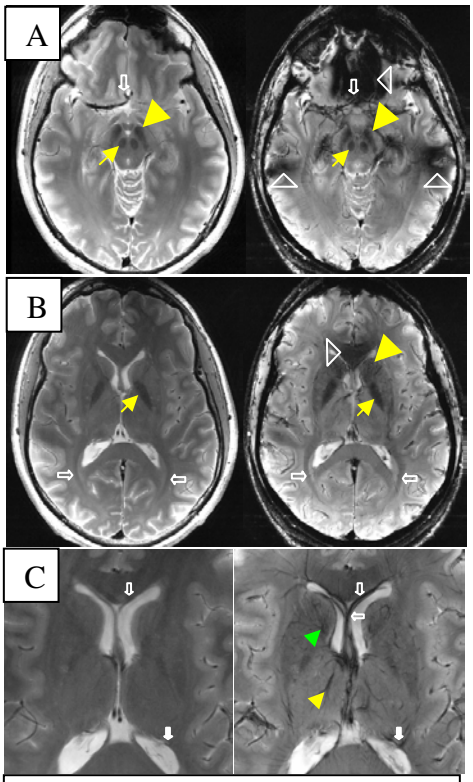

Figure 2: Comparison of features in T_2- (left) and T_2^*- (right) weighted images. See text for details.

Results: Figure 1 shows sets of transaxial and coronal TSE and FLASH images with acquired on a single subject. The coronal images show intensity variations in the superior-inferior direction that are a result of the limited axial coverage of the 8 channel receive array.

Discussion: In Figure 2a, the red nucleus is seen well in both approaches (yellow small arrow) as is the pars reticularis in the midbrain (yellow arrowhead). However, the anterior cerebral arteries are better seen on the T_2 images (open white arrow) and there is a lack of susceptibility artifact from the ethmoid sinuses or temporal bones on the T_2 that is present on the T_2^* images (open white arrowheads).

Looking at a more superior slice (Figure 2b), while the vessels in the head of the caudate nucleus are highlighted on the T_2^* images (yellow arrowhead), the contrast between the globus pallidus (small yellow arrow) and the adjacent putamen is more clearly defined on the TSE. Note the persistence of the ethmoid sinus susceptibility artifact (open white arrowhead). Both images demonstrate dark signal in a bundle of white matter in the expected location of the optic radiation bilaterally (open white arrows), a structure not typically seen at lower field strengths.

A more zoomed view (Figure 2c) shows how the T_2^* images demonstrate substantially more vascular structures than the TSE images. This differential signal between the paired images allows definitive assignment of certain tubular structures as vessels. This is true not only of vessels that are slightly seen on the TSE vessels, such as the vessels along the septum pellucidum (open white arrows) and periventricular space (closed white arrow), but also of other vessels as well, including those in the parenchyma. Note the branching vascular patterns clearly evident in the caudate head (green arrow) and thalamus (yellow arrow). These are not minimum intensity projection images but 2mm slice thickness T_2^* images. The complementary nature of TSE and T_2^* images at 7T is readily apparent.

Conclusions: T_2- and T_2^*-weighted imaging are both suitable for anatomical imaging at high field. Structures that are not readily seen at lower field strength are more clearly distinguished. In addition, the different contrast mechanisms allow these two methods to give complementary information, especially about vessels. T_2^* imaging is slightly more prone to artifacts, especially around interfaces between tissue and bone. However TSEs at high field are often limited by SAR considerations, which can make achieveing higher resolution difficult. As an example, Figure 3 shows T_2^*-images with yet higher resolution (0.22mm x 0.22mm with 1mm slice thickness) acquired in slightly less time (7 minutes) than the TSE protocol used here.

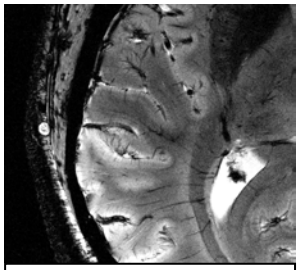

Figure 3: Zoomed detail of a 0.22x0.22x1mm T_2^* image.

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References:

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