Comparison between 7T T2* and 3T MTR in the in vivo human cortex.

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Purpose. Characterization of cortical myelo-architecture with MRI is an active field of research1, which can give insights on the structural and functional organization of the brain. It is however challenging to image the cortex due to its convoluted and thin geometry (2-4mm). Recently, ultra-high field MRI (7T) combined with T2* was shown to reveal features of myelin density2. However, several confounds hamper the specificity of T2* measures such as iron content and blood vessels3. An independent measure with different contrast mechanisms would increase the specificity to myelin. Magnetization Transfer Ratio (MTR) imaging at 3T was shown to be sensitive to myelin content4 and thus would be an excellent complementary measure. The goal of this study was to evaluate the relationship between T2* at 7T and MTR at 3T, and show their respective sensitivity and specificity to myelin content.

Methods. Data acquisition. Healthy subjects (N=6, age = 36 +/- 5 years) were recruited and scanned with a 7T whole-body scanner (Siemens Healthcare, Erlangen, Germany) to measure T2* and with a 3T scanner (Siemens TIM Trio) to measure MTR. Both scanners were equipped with a 32-channel coil. Parameters at 7T were: TR = 2020ms, TE = 6.34+3.2n [n=1...12], resolution = 0.33x0.33x1mm3. Parameters at 3T were: 3D FLASH, TR/TE = 30/2.49ms, matrix = 192x192, resolution=1.2x1.2x1.2 mm3, with and without Gaussian MT pulse (7:45min each). Data processing. T2* and MTR data were registered to individual cortical surfaces, sampled at the mid-cortical distance and registered to a common template surface5. Data were first averaged in the common space and SD maps were computed to assess inter-subject variability. A linear regression between the mean T2* and MTR maps was performed for each hemisphere, as well as within Brodmann regions with different myelin content.

Results. Average and SD maps of T2* and MTR are shown in Fig. 1. SD map of T2* show high variability in the lower brain, likely due to poor shimming in this region. Conversely, SD of MTR shows fairly good reproducibility (mean SD = 1.59%). Fig. 2 shows the relationship between T2* and MTR. Strong correlations in the right (r=-0.77) and left (r=-0.75) hemispheres were detected. To verify if partial volume effect affected our measures, cortical thickness was correlated with these measures and showed low effect (r=0.14 and r=-0.09 for T2* and MTR, respectively). Fig. 3 shows the mean values of T2* and MTR for the Brodmann regions (B1, B2, B3, B4, B43 and B44), sorted by T2* values. Once again, T2* and MTR are highly anti-correlated.

Discussions: Our results show within the same subjects an increase of T2* and a decrease of MTR, in regions that are known to be heavily myelinated (mean SD = 1.59%). These trends were expected given the sensitivity of T2* and MTR to myelin content. However, this is the first time these two metrics are combined within the same subjects, providing a framework to isolate confounding parameters affecting T2* (iron, orientation, poor shimming) and MTR (B1 inhomogeneities, T1). Combining other metrics (quantitative T1, diffusion, T2w/T1w) within the same methodological framework could potentially bring more insight into cyto- and myeloarchitecture than if these metrics were studies separately.

References:
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