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 research[1], 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 density[2]. However, several confounds hamper the specificity of T2* measures such as iron content and blood vessels[3]. 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 content[4] 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 surface[5]. 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 (e.g., B4, B1). 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, issue 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.

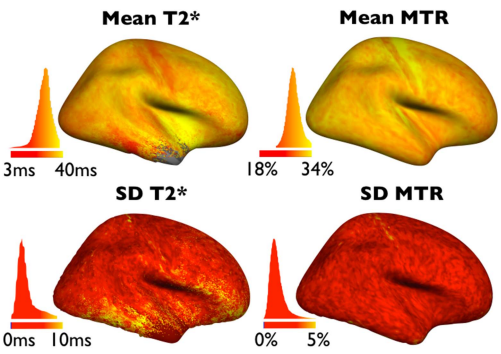

Fig. 1. *Mean and SD maps between the six controls for the T2* metric (left) and the MTR values (right). Mean maps (top) shows an increase in MTR and a decrease in T2* in the central sulcus.*

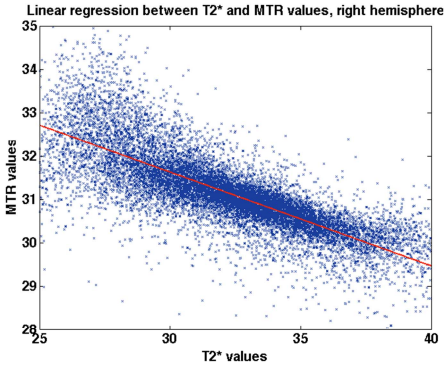

Fig. 2. *Linear regression between T2* and MTR vertices values. The Pearson's correlation coefficient for this regression is r=-0.77.*

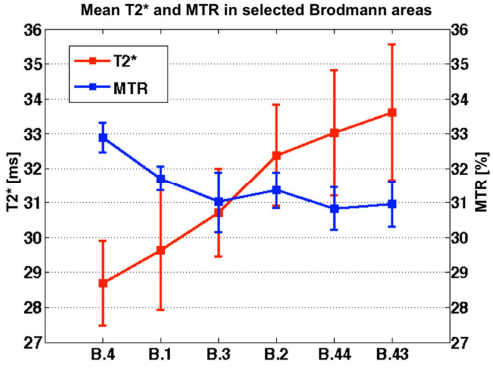

Fig. 3. *Mean values of T2* and MTR across Brodmann regions with different myelin content. Data are averaged between the six controls. Error bars represent SD across subjects.*

References:

1. J. Lee, et al. The contribution of myelin to magnetic susceptibility-weighted contrasts in high-field MRI of the brain. Neuroimage. *2012;* vol. 59, pp. 3967-75.
2. J. Cohen-Adad, et al. T2* mapping and B0 orientation-dependence at 7 T reveal cyto- and myeloarchitecture organization of the human cortex. NeuroImage. 2012. 1006-1014.
3. M. Fukunaga et al. Layer Aspecific variation of iron content in cerebral cortex as a source of MRI contrast. PNAS. 2010; USA 107, 3834A3839
4. I.R. Levesque and G.B. Pike, Characterizing healthy and diseased white matter using quantitative magnetization transfer and multicomponent T(2) relaxometry: A unified view via a four-pool model. *Magn Reson Med.* 2009; vol. 62, pp. 1487-96.
5. J. Cohen-Adad, What can we learn from T2* maps of the cortex? NeuroImage. 2013.

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