# Comparison of ViSTa myelin water imaging with DTI and MT

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**Target audience:** Researchers/Clinicians interested in quantitative white matter imaging.

INTRODUCTION: Direct Visualization of Short Transverse Relaxation Time Component (ViSTa)[1] is a newly proposed myelin water imaging (MWI) method that produces a high quality myelin image. In a previous study[2], ViSTa myelin water fraction (MWF) showed a high spatial correlation (R=0.75±0.04) with that of conventional spin-echo MWI using a modified GRASE sequence[3]. In the same study, intra-session reproducibility was tested for both methods, and ViSTa showed higher reproducibility (R=0.97±0.01) than SE-MWI (R=0.88±0.03) demonstrating the reliability of ViSTa. In addition to MWI, diffusion tensor imaging (DTI) and magnetization transfer (MT) imaging have been suggested as a surrogate biomarker of myelin[4-6]. In this study, we compared the spatial distribution of a MWF map (or apparent MWF; aMWF) from ViSTa with those of fractional anisotropy (FA) and radial diffusivity (RD)[5] maps from DTI and also that of a magnetization transfer ratio (MTR) map from MT. Additionally, inter-session reproducibility of ViSTa was tested to evaluate the reliability of the method.

**METHODS:** Data were collected at a 3T MRI scanner (Siemens). For the comparison of the three myelin surrogate images (i.e. ViSTa, DTI, and MT), three subjects were scanned. For the inter-session test-retest study, four subjects were scanned. Both studies were approved by IRB. **ViSTa:** A 3D ViSTa sequence using a 3D segmented EPI readout was acquired[7]. The scan parameters were as follows: resolution = 1.5 x 1.5 x 4 $mm^3$, TR/TE = 1160/6.4 ms, TI1/TI2/TD = 560/220/300 ms, 28 slices, and total scan time = 4.6 min (including a reference scan for aMWF calculation). **DTI**: The same resolution as ViSTa was used. Other parameters were TR/TE = 4500/89 ms, b-value = 1000s/$mm^2$, gradient directions = 30, # averages = 2, and scan time = 4.7 min. After data acquisition, FA and RD maps were calculated using FSL[8]. Since higher RD means more rapid radial diffusion, it may be negatively correlated with myelin concentration. Hence we used 1-RD instead of RD as a parameter to correlate with aMWF. **MT**: A GRE sequence was acquired twice: with and without MT pulses. The scan protocol was as follows: The same resolution as ViSTa , TR/TE = 32/3.6 ms, flip angle = 14º, and total scan time of the two scans = 3.6 min. **Data analysis:** A white matter mask of an individual map was generated by a threshold. Then a common white matter mask was obtained by combing the four individual masks. A correlation coefficient was calculated between an aMWF map and another map in this mask. **Reproducibility:** Two ViSTa scans were acquired on average 10 ± 8 days apart. The scan parameters were the same as above except the slice number (= 32) and scan time (= 6.8 min). Data were registered[8]. A correlation coefficient was calculated.

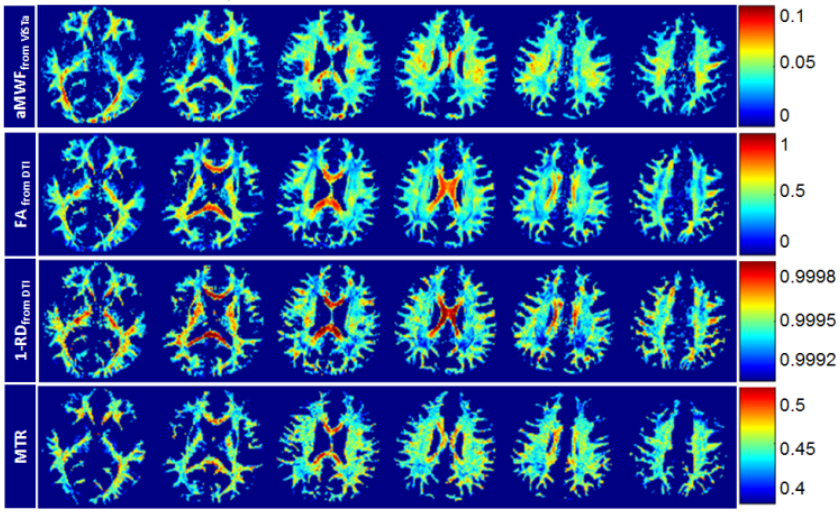


*Figure 1. aMWF from ViSTa (first row), FA (second row) and RD (third row) from DTI, and MTR from MT (fourth row)*

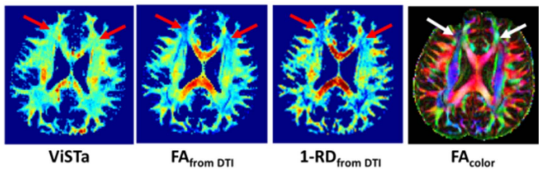


*Figure 2. ViSTa vs. DTI*

**RESULTS:** Figure 1 shows the surrogate myelin maps from each method. The display range of each map was adjusted to have similar color patterns. In a few areas, the aMWF map from ViSTa and the other maps show similar spatial distributions. However, substantial differences are observed in other areas. When quantitatively analyzed, the correlation coefficients (R) between the aMWF map and the other maps were less than 0.54 (see Table 1) reflecting disagreements in the spatial distribution. These correlation coefficient values are substantially lower than the result observed in the previous study[2] when SE-MWF was correlated with ViSTa-aMWF (R = 0.75±0.04). In Figure 2, the areas of large differences are indicated by red arrows. The color-FA map suggests that these are the areas of crossing fibers. In corpus callosum, FA and 1-RD present much higher values than aMWF. These observations and the low correlation results suggest that DTI parameters are not a good surrogate biomarker of myelin[9]. When the aMWF and MTR maps are compared, a low correlation coefficient (R = 0.54±0.02) suggests limited similarity[10] (Figure 3). The inter-session reproducibility resulted in a high correlation coefficient (0.91 ± 0.02) suggesting the robustness of ViSTa.

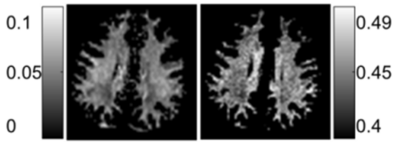


*Figure 3. ViSTa (left) vs. MT (right)*

**DISCUSSION & CONCLUSION:** In this study, ViSTa aMWF was compared with FA and RD of DTI and MTR of MT. Overall, the aMWF map showed limited correlation with the other maps suggesting that DTI and MT parameters are not well-correlated with myelin water. ViSTa MWI has shown a good intra-[2] and inter-scan reproducibility. Hence, the method may provide a reliable biomarker for myelin.

| R-value | FA | RD | MTR |
|---|---|---|---|
| ViSTa | 0.5 ± 0.04 | 0.43 ± 0.03 | 0.54 ± 0.02 |

*Table 1. Correlation coefficients*

**REFERENCES**: [1]Oh,Neuroimage,2013,83,485 [2]Oh,ISMRM,2014,#4875 [3]Prasloski,Neuroimage,2013,63,533 [4]Stainisz, MRM,1999,42,1228 [5]Song,Neuroimage, 2005,26,132 [6]Song,Neuroimage,2003,20,1714 [7]Oh,ISMRM,2014,#4280 [8]http://fsl.fmrib.ox.ac.uk/ [9]Beaulieu, NMR in Biomedicine [10]Vavasour, J Magn Reson Imaging,2004,20,555