T1/FLAIR as a surrogate for T1/T2 in the assessment of myelination

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Introduction

- It has been suggested that the ratio T1/T2 can be used as a surrogate measure for the amount of myelin (Glasser et al, 2011).
- FLAIR scans offer a similar type of T2-weighted contrast, with an additional inversion pulse aimed at suppression of water signal.
- Myelin has a substantial hydrophobic component, the signal from which may be little affected by that inversion.
- Here we investigate whether the ratio T1/FLAIR could provide a similar contrast as T1/T2, and therefore, serve as another potential marker for myelination.
- If T1/FLAIR could provide such an informative image contrast, then many studies in which high quality FLAIR images (but not T2-weighted) have been collected, could be revisited for the analysis of this new marker.

Research Question

Could T1/FLAIR be used in lieu of T1/T2 as a surrogate measure for myelination?

Methods

- 7 healthy adults completed the following scans, all on the same GE 3T scanner:
  - T2-weighted (TE: 65 ms , TR: 3202 ms, FA: 90, voxel size: 1 mm x 1 mm x 1 mm)
  - T1-weighted (TE: 2.94 ms, TI: 1060 ms, TR: 2500 ms, FA: 8, voxel size: 1 mm x 1 mm x 1 mm)
  - 3D FLAIR (TE: 117 ms, TI: 1442 ms, TR: 4802 ms, FA: 90, voxel size: 1 mm x 1 mm x 1 mm)
- Two separate processing streams in FreeSurfer 6.0.0's recon-all were run for each participant, both using the T1 scan and either T2 or FLAIR to improve the placement of pial surfaces.
- Same seed for the random number generator was used, to ensure identical surfaces before T2 or FLAIR entered into the stream.
- The T1 / T2 and T1 / FLAIR ratios were computed using intermediate (conformed) files, before bias field intensity correction.

Results

- Visual inspection revealed a striking similar pattern between T1/T2 and T1/FLAIR, that could be noted in both volumetric and surface-based reconstructions (Figures 1 and 2).
- The spatial correlation across the whole brain between the two metrics was high, ranging between 0.82 and 0.88 among the 7 subjects. However, these indices varied for different subcortical structures.
- For example, 0.75 for the thalamus, 0.70 for the amygdala, 0.81 for the nucleus accumbens, 0.79 for the putamen, although just 0.54 for the caudate. Variability across different cortical parcellations was narrower, for example, 0.72 for the inferior parietal lobe, 0.73 for the precentral gyrus, and 0.84 for the banks of the superior temporal sulcus.
- Correlation also varied consistently, albeit narrowly, across the cortical layers for each of the parcellations.
- Within each subject there appears to be a strongly symmetric correspondence between the two metrics, and a broadly linear relationship between them, that is somewhat stronger in the gray matter, particularly for primary areas, such as those near the pericalcarine sulcus, and pre and postcentral gyrus.

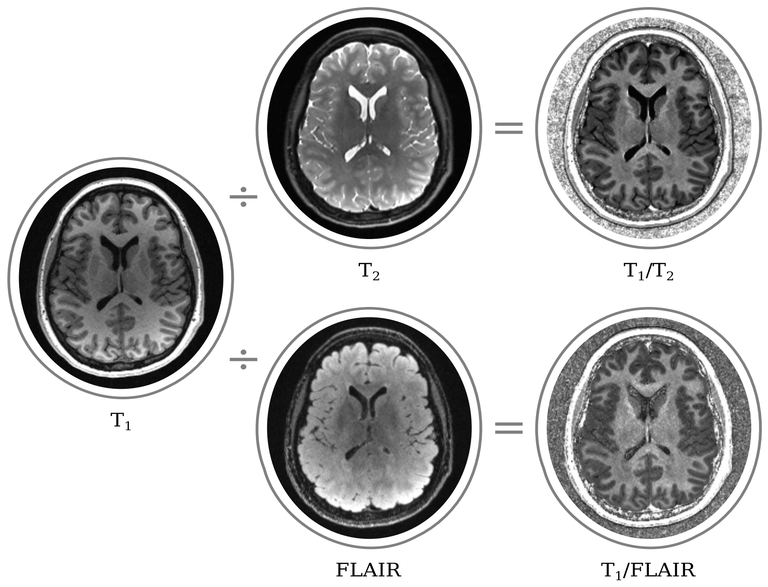

Figure 1: The original T1, T2, and FLAIR for a single, representative participant, and the ratios T1/T2 and T1/FLAIR. The contrast is very similar, yet with a few unique differences.

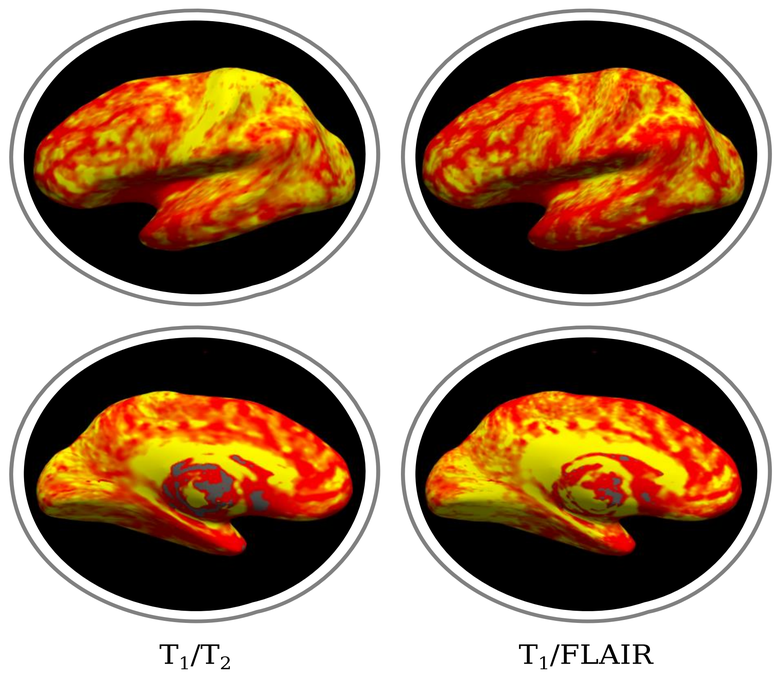

Figure 2: Surface reconstruction (inflated) of the left hemisphere of the same subject from Figure 1. Here too the similar contrast can be observed, albeit with a few regional differences.

Conclusions

- These results suggest that the T1/FLAIR ratio is similar to the T1/T2 ratio, and could be used as a measure of myelination in studies where the T1/T2 ratio cannot be computed.
- There are, however, some differences between the two ratios, particularly in regions with a higher proportion of CSF.

References

Glasser, M. F., & Van Essen, D. C. (2011). Mapping human cortical areas in vivo based on myelin content as revealed by T1-and T2-weighted MRI. *Journal of Neuroscience*, *31*(32), 11597-11616.

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