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 possible marker for the amount of myelin (Glasser et al, 2011). FLAIR offers a similar type of T2-weighted contrast, yet it includes an 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. The reason for this investigation is that, 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 of possibly interesting underlying biological and/or pathological processes.

Methods:

T1-weighted, T2-weighted, and FLAIR images were collected from 7 healthy adults. Imaging protocols for T1 and T2 used the ABCD acquisition protocols, whereas FLAIR used the ADNI3 protocol, modified to ensure the same voxel size and field of view as the T1- and T2-weighted sequences (1x1x1mm). Images were processed using FreeSurfer 6.0.0, with two separate streams for each participant, each using either T2 or FLAIR to improve the placement of the pial surfaces. We took intermediate (conformed) files, before bias field intensity correction, and computed the ratios from these files. Comparisons were performed by visual inspection of volume and surface files, scatter and Bland-Altman plots. Comparisons were done for the whole brain, as well as by tissue type, and by cortical and subcortical parcellations, and further, repeated at 9 intermediate layers across the cortex, equally spaced between pial and white surfaces.

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.

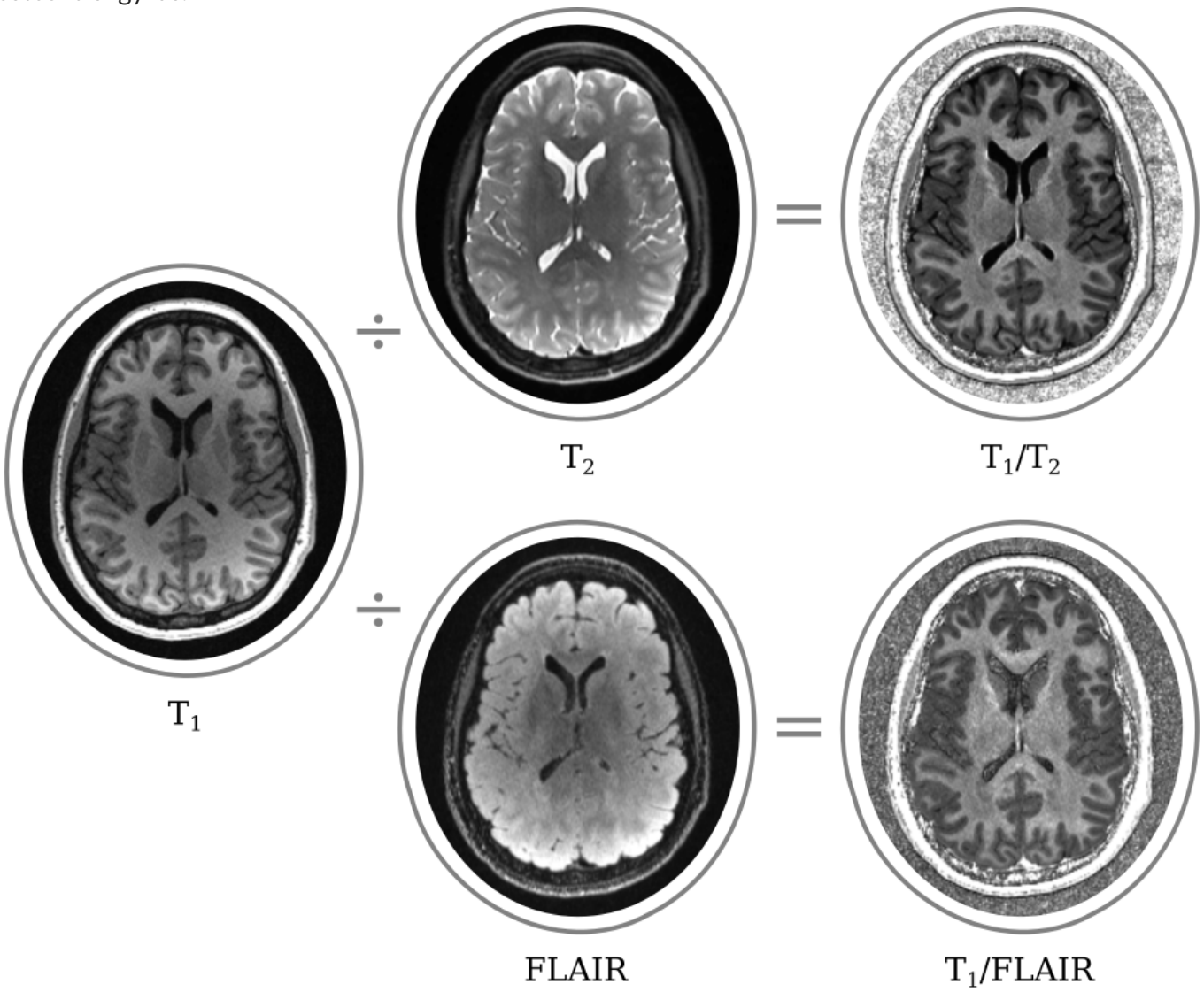

Figure 1: *The original T1, T2, and FLAIR for a single, representative participant, and the ratios T1/T2 and T1/FLAIR. The contrast is very similar, yet with a few unique differences.*

·Figure 1

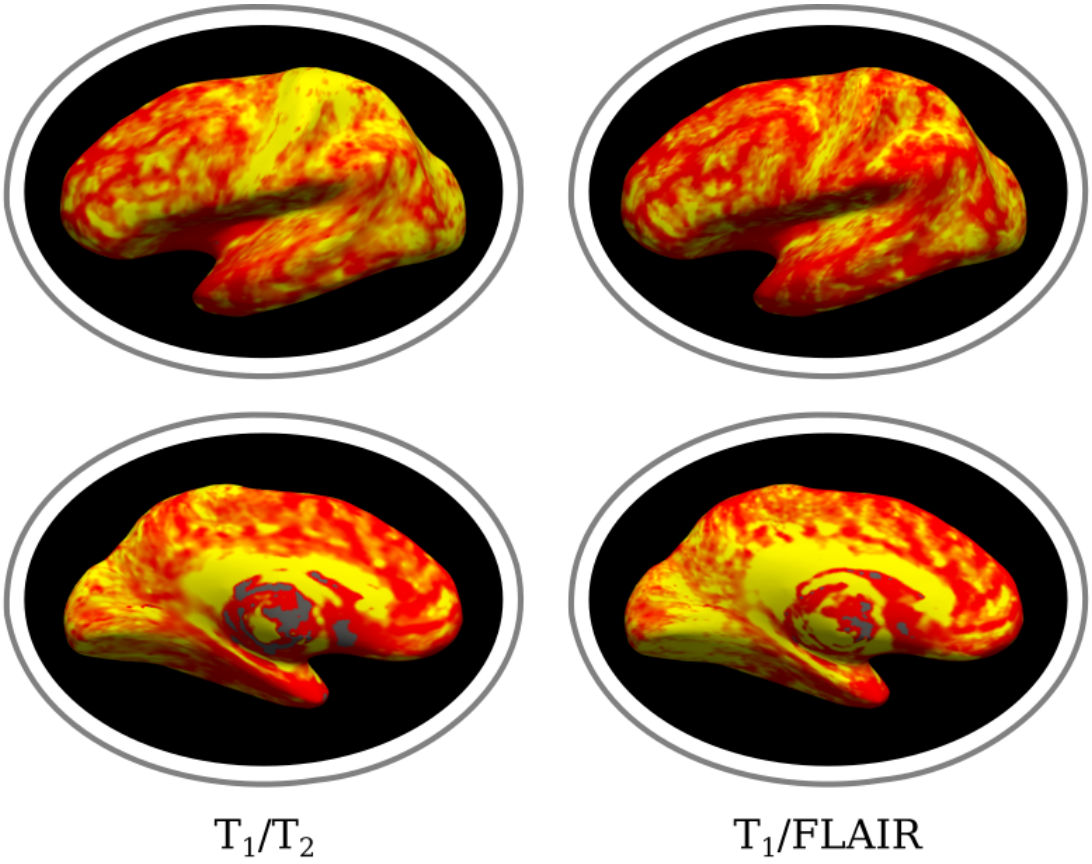

Figure 2: *Surface reconstruction (inflated) of the left hemisphere of the same subject from Figure 1. Here too the similar contrast can be observed, albeit with a few regional differences.*

·Figure 2

Conclusions:

These results appear to indicate that the contrast in the ratio T1/FLAIR is remarkably similar to the contrast observed in T1/T2, such that it could be a potential replacement for the latter in studies of myelination in cohorts in which only T1 and FLAIR are available. Moreover, T1/FLAIR appear to possess some particularities that may render it useful on its own right.

Imaging Methods:

Anatomical MRI [1]

Neuroanatomy:

Cortical Cyto- and Myeloarchitecture [2]

Keywords:

MRI

Myelin

[1|2]Indicates the priority used for review