New Non-linear Color Look-up Table for Fractional Anisotropy Demonstrated on Multiple System Atrophy

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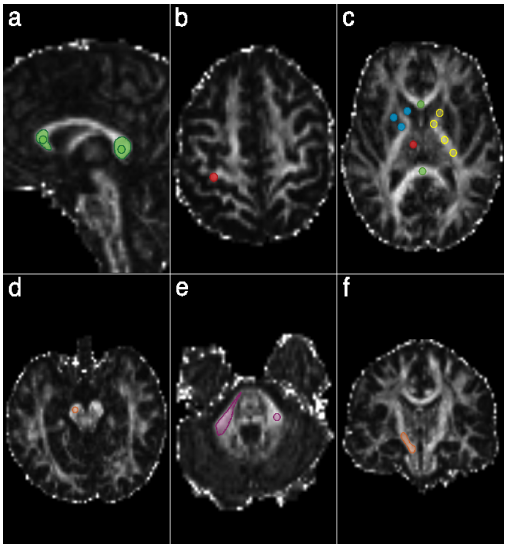
Introduction: A clinical radiologist primarily makes decisions based on the qualitative assessment of images. Changes of fractional anisotropy (FA), a quantitative measure of diffusion parameters in tissue, have been reported in many neurological disorders. These changes are often quite small and difficult to distinguish (e.g., complete demyelinization would decrease FA by 10% [1]). Despite many reports of statistically significant results, difficulties remain in incorporating these findings into clinical practice and a new approach is needed to provide an easy tool for FA image evaluation. We propose a new colour look-up table (LUT) based on normative data as a tool for screening FA decline, making the quantitative assessment of FA easier to access for the clinical radiologist. Clinical use is demonstrated on a cohort of multiple system atrophy (MSA) patients compared to patients with Parkinson disease (PD) and healthy subjects.

Methods and Materials: FA was calculated for 76 healthy volunteers (age 44.4 years ± 18 SD, range 15-80, 1.5T, 2.2 mm isotropic voxel, 12 motion probing gradients (MPG)). A subset of 59 subjects was additionally scanned using 30 MPG. FA in the corpus callosum, frontal gray matter, thalamus, and in the basal ganglia was measured (Figure 1) and analyzed using the random intercept linear mixed model to calculate the population means and 95% prediction intervals, which were used to create a non-linear color LUT. Unique colors were assigned to inflection points and continuous ramps were generated to create a color transition between them. The LUT was applied to groups of 17 patients with MSA (Figure 2b), 13 patients with PD and 17 healthy volunteers (Figure 2a), age and sex matched to MSA subjects. Three blinded radiologists classified subjects as MSA/non-MSA.

Results: The LUT generated from 12 MPG data is comparable with that from 30 MPG (Figure 2c). Three blinded radiologists achieved an average sensitivity of 88% (65-100%) and a specificity of 93%(80-100%) in differentiating MSA from other groups by solely using this method.

Discussion: The new non-linear LUT based on normative data can accentuate abnormal FA values as well as anatomy. The radiologist can differentiate between MSA and norms/PD subjects just using LUT information. The new LUT can be potentially useful as a screening method for other neurological disorders.

Figures:



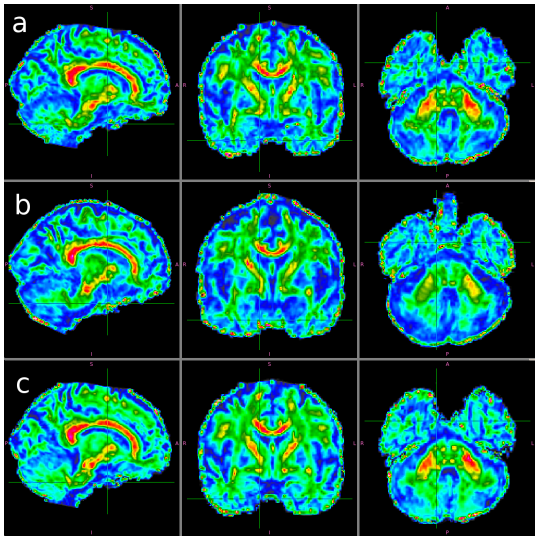


Fig 1 (left): regions of interest used for the generation of the non-linear colour LUT

Fig 2 (right): LUT applied to 12 MPG (a, top row) and 30 MPG (c, bottom row) data of a healthy volunteer and one MSA subject (b, middle row).

Reference:

[1]. Nair G, Tanahashi Y, Low HP, et al. Myelination and long diffusion times alter diffusion-tensor-imaging contrast in myelin-deficient shiverer mice. Neuroimage 2005, 28:165–174.

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