DTI of white matter microstructural differences in migraine with aura

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Abstract – We used diffusion tensor imaging (DTI) to test for white matter (WM) microstructural differences in the brains of patients suffering from migraine with aura (MWA). In MWA, the migraine headache is commonly preceded by impressions of flickering lights followed by blind spots progressing through the visual field. DTI of MWA patients revealed significant differences in fractional anisotropy (FA), a putative marker of WM microstructural integrity, in specific WM pathways. The FA values along the bilateral optic radiations (OR) of MWA patients were lower compared to those from healthy control subjects. The etiology of these changes could be repetitive ischemic episodes, or neuronal damage following repetitive episodes of cortical spreading depression (CSD) – the cortical event that underlies the visual aura [1]. The functional organization of the observed FA differences supports the role of CSD in microscopic brain white matter lesions. The functional and structural significance of these WM differences needs to be further investigated for a better understanding of the pathophysiology of migraine.

Population, Clinical Data and Methods – Two groups of subjects were selected: the first consisted of twelve MWA patients (8F/4M; mean age: 33.5yrs; std. dev.: 9.8) following the International Headache Society guidelines [2]. The second group consisted of fifteen age- and sex-matched healthy subjects (11F/4M; mean age: 33.1yrs; std. dev.: 8.8). Migraine patients had migraine for the past 20.7 years on average. Their mean level of pain intensity during the attacks was of 7.6 on a scale of 0-10 (0-no pain/10-worst pain imaginable). These patients had a mean frequency of 4.2 migraine attacks per month, and almost half of them (1.9 per month) were preceded by a visual aura. **Image Acquisition** – DTI scans were obtained on all 27 participants. The scans were performed on a Siemens Allegra 3T MRI scanner. The imaging parameters were TR/TE: 8300/89ms - 9200/91ms, b=700s/mm^2, 60 directions of encoding, 2mm isotropic resolution, 60-64 slices. **Analysis** – Each participant's FA volume was produced using motion correction of the raw data, calculation of FA maps from the corrected volume, spatial transformation in MNI/Talairach space, and resampling and smoothing of the FA map.

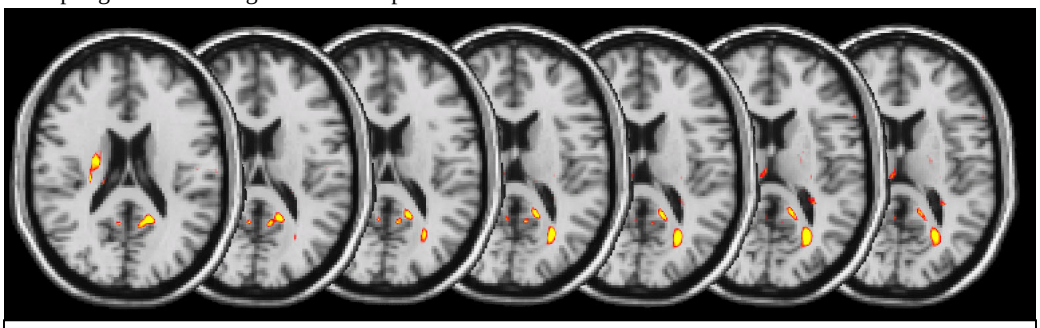

Fig 1. Group difference significance map comparing FA in MWA to matched controls. The FA values were significantly lower in MWA patients along the optic radiation.

Results – Significantly lower FA values were noted along the visual pathway of MWA patients compared to age- and sex-matched healthy controls. These differences were located in the forceps major of the corpus callosum, and particularly concentrated in the OR. Fig1 shows the result of group analysis of the data in multiple horizontal slices. The FA difference significance values were superimposed on a map with T1 contrast and color-coded tensor orientation data for more detailed localization of the changes (Fig. 2).

Discussion - There have been previous reports of MRI differences in the WM of migraine patients [3]. Whether these changes have any clinical significance is not known. Using DTI we observed significantly lower FA values along the optic radiation in MWA patients than in healthy, matched controls. The observed WM differences could be interpreted as axonal damage due to repetitive episodes of CSD, which underlies the symptoms of visual aura. The localization of the WM differences specifically to the OR more directly implicates CSD than global ischemia. This neuroimaging study provides the first *in vivo* evidence of possible WM microstructural changes in MWA.

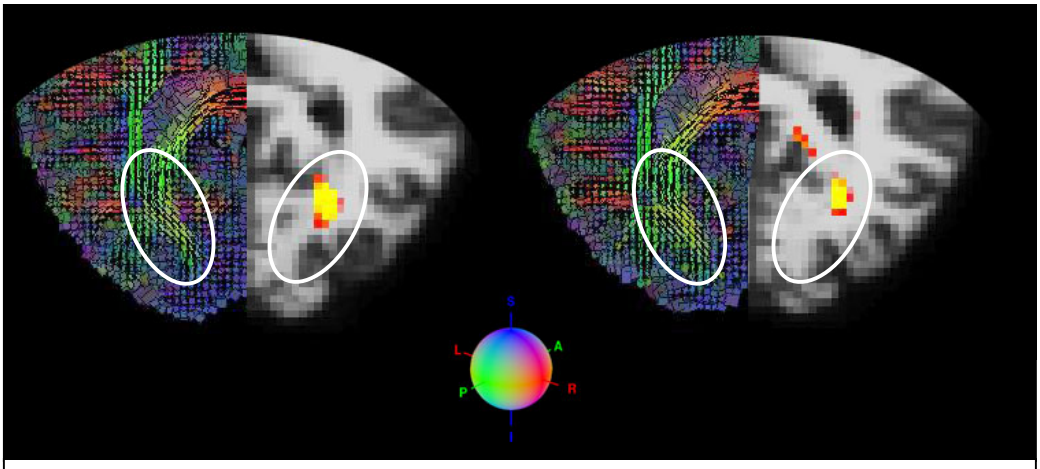

Fig 2. Magnified view of the group significance and diffusion tensor maps in occipital cortex. On the left half of each image are presented the diffusion tensor maps for occipital cortex. The color coding depicts the local principal eigenvector orientation. The optic radiation is seen as a green bundle. The right half of each image shows the FA group significance.

References

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Supported by NIH P01 NS35611-09