Diffusion changes in patients with systemic lupus erythematosus

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Introduction

Systemic lupus erythematosus (SLE) is an autoimmune disease in which the central nervous system is often involved. The clinical diagnosis is presumptive in some patients. Routine MRI is often nonspecific or negative. Diffusion imaging is expected to be useful in characterizing the disease and assisting the diagnosis.

Methods

Data from 15 SLE patients (age range 18-73 year) and 18 age matched volunteers (age range 29-59years) were analyzed. The MR imaging was performed on a 1.5T clinical MR scanner with a quadrature head coil: a) axial T1WI: TR/TE 500/min; axial T2WI: TR/TE 4000/102; FLAIR: TR/TE/TI 10000/162/2200, matrix size 256x192; b) DWI: TR/TE 10500/min, matrix 128x128, slice thickness 5 mm, FOV 220 mm. Diffusion was measured in three orthogonal directions with b value of 1000s/mm^2. A set of images (S_o) were obtained with b=0. An orientation-independent diffusion image related to trace of diffusion tensor is obtained as: $DWI_{trace} = \sqrt[3]{DWI_x \, DWI_y \, DWI_z}$. The D_{av} maps were calculated using the DWI_{trace} and S_o image utilizing the equation: $D_{av} = (1/b) \log (S_o/DWI_{trace})$. A computer C program was used to calculate the diffusion distribution histograms by distributing the pixels into 250 bins with a bin width of 0.02×10^{-5} cm^2/s. This histogram was fitted to a triple Gaussian curve using commercial software. This curve ($C_1e\text{-}[(D_{av}\text{-}BDav)/\sigma]^2 + C_2e\text{-}[(D_{av}\text{-}D_2)/\sigma_2]^2 + C_3e\text{-}[(D_{av}\text{-}D_3)/\sigma_3]^2$) represents a three-compartment model [1]: 1) brain tissue compartment, 2) brain tissue mixed with CSF, 3) the high diffusion compartment of CSF. The mean of the brain tissue distribution is recognized as a mean diffusion constant for the whole brain (BD_{av}). Regional diffusion measurements (D_{av}) were performed by region of interest (ROI) in the frontal lobe and the thalamus. Student *t*-test was used to analyze the diffusion difference between SLE patients and the normal controls. SLE patients were separated into two groups according to whether there was abnormal signal intensity in the FLAIR images. P<0.05 was considered to be statistically significant.

Results

10 of the SLE patients showed ventricle dilatation and non-specific high signal intensity in the brain white matter while the remaining patients had normal MRIs (Figure 1). Quantitative diffusion analysis showed, BD_{av} and frontal lobe D_{av} were significantly higher (3% and 5% increase respectively) in all SLE patients when compared to normal controls (p<0.005 and <0.01 respectively). Even the SLE patients with normal MRI showed higher BD_{av} and D_{av} of the frontal lobe than those of the normal controls (p<0.05) (Figure 2). There was no significant difference in the D_{av} of the thalamus between the SLE patients and normal controls (p>0.05).

Discussion

This work indicated that quantitative diffusion imaging shows early changes in the brains of the SLE patients. Increased BD_{av} and D_{av} of the frontal lobe may represent preclinical signs of central nervous system involvement of SLE even when the routine MRI findings are negative or non-specific [2-3]. The diffusion the deep grey matter like the thalamus remained unchanged. Quantitative diffusion imaging [4] may prove useful in detecting the initial brain involvement of SLE and enable monitoring of early disease progression and treatment efficacy.

References

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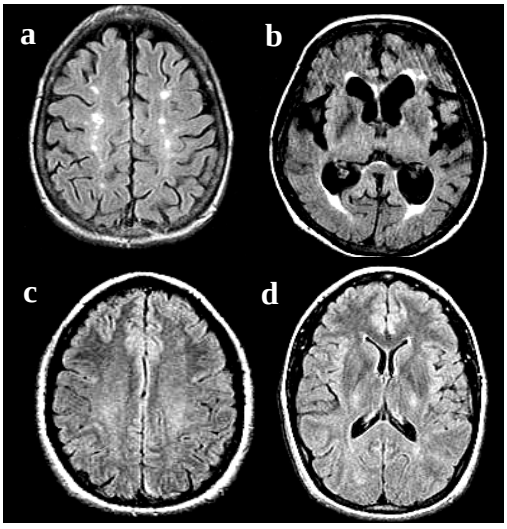

Figure 1. FLAIR images of an SLE patient with abnormal high signal intensity in the area of subcortical white matter (a), periventricular white matter (b) and an SLE patient with negative MRI (c, d).

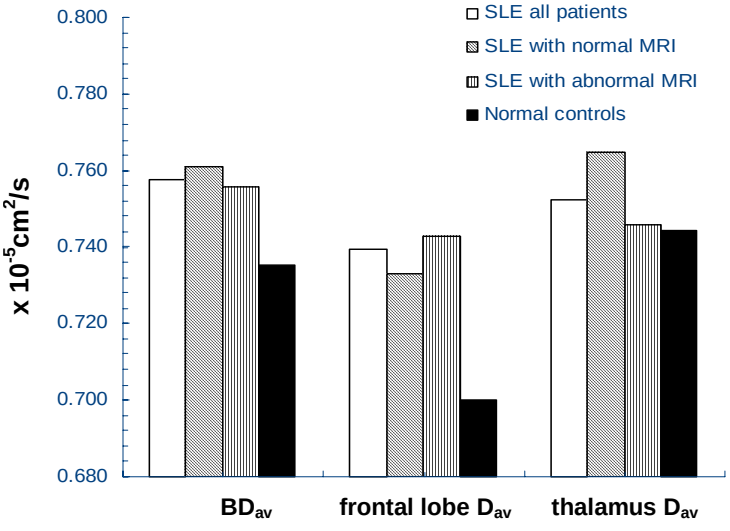

Figure 2. SLE patients have higher BD_{av} and D_{av} in the frontal lobe (p<0.01 and <0.05 respectively) even in the group of negative MRI (p<0.01 and <0.05 respectively). There is no difference in D_{av} of the thalamus between SLE group and normal controls.