Comparison of Chemical Exchange Saturation Transfer MR Imaging and Diffusion Tensor Imaging in Parkinson's Disease at 3 Tesla

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TARGET AUDIENCE

Neurologists and radiologists who pay attention to functional and molecular MR imaging of Parkinson's Disease (PD).

PURPOSE

To compare the diagnostic efficiency of chemical-exchange-saturation-transfer (CEST) imaging and diffusion tensor imaging (DTI) in PD.

METHODS

Twenty-three PD patients with a mean age of 65.5 years (range 46-77 years) and twenty-three age-match normal controls (mean age 64.3 years) were recruited in this study. All patients and controls were imaged on a 3 Tesla Philips MR system, using an 8-channel head coil. APT-MR imaging was based on single-slice, single-shot TSE (saturation time = 800 ms; saturation power = 2 μT). Magnetization transfer spectra with 31 different frequency offsets (-6 to 6 ppm, interval 0.25~0.5 ppm) were acquired in two transverse slices of the head, including basal ganglia and midbrain. MTR_{asym} at 3.5 ppm was calculated according to: MTR_{asym} = MTR(+offset) - MTR(-offset). Meanwhile, DTI (b value= 1000 s/mm^2, with 31 directions) was acquired for all the patients and normal controls. FLAIR imaging was used as anatomical reference to draw ROIs (caudate, globus pallidus, putamen, substantia nigra, and red nucleus). Analysis of variance post-hoc tests were used to compare the differences in CEST imaging signals and DTI parameters between PD patients and normal controls.

RESULTS

Fig. 1 quantitatively compares the average APT-weighted signal intensities of the five regions for all PD patients and normal controls. The MTR_{asym}(3.5ppm) values of the putamen, and caudate were significantly higher in PD patients than in normal controls (P = 0.010 and P = 0.009, respectively). In contrast, the MTR_{asym}(3.5ppm) value of the substantia nigra and red nucleus was significantly lower in PD patients than in normal controls (P = 0.003 and P = 0.017, respectively). Meanwhile, the total CEST signal intensity of the substantia nigra was significantly lower in PD patients than in normal controls (P = 0.004). For DTI, no significant differences were found for the mean diffusivity (MD) in the five regions between PD patients and normal controls. Decreased fractional anisotropy (FA) was observed in the substantia nigra in PD patients (P < 0.001) (Fig. 2).

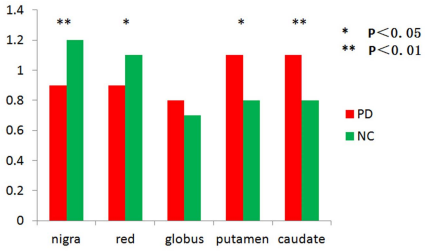

Fig. 1. Average APT-weighted signal intensities of the five regions for all PD patients and normal controls.

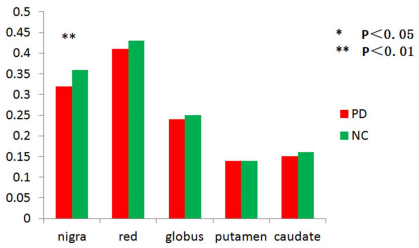

Fig. 2. FA values of the five regions for all PD patients and normal controls.

DISCUSSION

Multiple regions we focused on in this study have shown significant changes with CEST imaging. The fact that the MTR_{asym}(3.5ppm) signal intensities of the putamen and the caudate were higher in PD patients than in normal controls (Fig. 1) may be associated with increased cytosolic proteins and peptides, as expected [1, 2]. In contrast, the substantia nigra showed significantly lower MTR_{asym}(3.5ppm) signal intensities and lower total CEST signal intensities in PD patients than in normal controls (Figs. 1 and 2), which may suggest that the changes could be attributed to the loss of dopaminergic neurons [3] or to the depletion of some chemicals with fast exchange protons, such as dopamine. For DTI, only FA of the substantia nigra showed significant difference in PD patients, which may be resulted from the loss of dopaminergic neurons and injury of axons. Meanwhile, MD values seemed to be not helpful in the diagnosis of PD for they were similar in PD and normal controls in all the regions we focused on.

CONCLUSION

Multiple CEST imaging signals could potentially serve as imaging biomarkers to aid in the non-invasive molecular diagnosis of PD and it may apply more information than DTI.

REFERENCES

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