Evaluation of fractional anisotropy and apparent diffusion coefficient of Broca's area in Parkinson's disease using diffusion tensor imaging

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INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disease caused by progressive loss of the dopaminergic neurons in the substantia nigra. Eighty nine percent of patients with PD have problems with speech and voice production, which is caused by damage to the central nervous system. However, the neurological mechanism associated with the language problems of patients with PD has not been determined. The areas of the brain responsible for language in humans are Broca's and Wernicke's areas. Broca's area is connected to Wernicke's area by the arcuate fasciculus (AF), which is a pathway made of neurons. The purpose of this study was to reconstruct the connection of nerve fibers in Broca's and Wernicke's areas by diffusion tensor imaging (DTI) in patients with PD and determine the presence of neurodegenerative changes based on the fractional anisotropy (FA) and apparent diffusion coefficient (ADC) values.

MATERIALS AND METHODS

Subjects

Twenty-two patients 60 years of age or older participated in this study. Eleven patients with Parkinson's disease (6 women and 5 men; mean age, 70 ± 4.65 years) and 11 gender- and age-matched control subjects (6 women and 5 men; mean age, 67 ± 3.80 years) were enrolled.

MR Imaging Acquisition Protocol

MR imaging was performed with a 3.0T scanner (Intera Achiva; Philips Medical Systems, Netherlands) equipped with a 16-channel neurovascular phased array coil. All patients were examined by single-shot spin echo EPI sequences for DTI using a 3D T1 turbo field echo sequence for anatomical information.

Data analysis

All images were post-processed on a console using a DTI program provided for the Philips 3.0T MRI system. A virtual dissection of the arcuate fasciculus, of the left hemisphere, was performed using two regions of interest (ROIs).

RESULTS

The fiber bundles were confirmed to be connected to Broca's and Wernicke's areas by fiber-tractography (Fig.1-2). Fig. 1 shows the pathway of nerve fibers connected by the AF in Broca's and Wernicke's areas in four subjects. In Fig.2, fiber-tractography image and 3D T1-weighted image are fused to identify the anatomical location of AF. The mean and the p-value for the FA and ADC of Broca's and Wernicke's areas of patients with PD and controls are shown in Table 1. The nonparametric Mann-Whitney U-test showed that the FA value in Broca's area was statistically significant for the patients with PD compared to the controls (p=0.001). In addition, the FA value for Wernicke's area was statistically significant for the patients with PD compared to the controls (p=0.045). However, ADC value for Broca's and Wernicke's areas was not statistically significant. The distribution of the FA and ADC values measured in controls and patients with PD is illustrated in a scatter plot (Fig.3).

DISCUSSION AND CONCLUSION

In this study, there were two important findings. First, we found that the FA values in Broca's and Wernicke's areas of patients with PD were significantly decreased compared to controls. Second, fiber-tractography helped to visualize the connection of nerve fibers in language area of left hemisphere. In conclusion, the results of this study showed the visualization of the pathway of nerve bundles between Broca's and Wernicke's areas using fiber-tractography. The findings showed that the FA values were significantly decreased in patients with PD compared to the controls. These results suggest that neurodegenerative changes occur in the language areas of patients with PD.

ACKNOWLEDGEMENT

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REFERENCES


Table 1. Mean FA and ADC values for Broca's and Wernicke's areas in controls and patients with PD.

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<tr>
<th></th>
<th>Control</th>
<th>Parkinson</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Broca FA</td>
<td>0.337 ± 0.037</td>
<td>0.257 ± 0.029</td>
<td>0.001</td>
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<tr>
<td>ADC</td>
<td>0.774 ± 0.120</td>
<td>0.863 ± 0.119</td>
<td>0.115</td>
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<tr>
<td>Wernicke FA</td>
<td>0.426 ± 0.106</td>
<td>0.350 ± 0.111</td>
<td>0.045</td>
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<tr>
<td>ADC</td>
<td>0.741 ± 0.074</td>
<td>0.794 ± 0.122</td>
<td>0.224</td>
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