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Effects of gait training on the brain white matter in patients with Parkinson's disease

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Introduction

In order to mitigate impaired ambulation of individuals with Parkinson's disease (PD), gait training has been widely accepted in rehabilitation (Morris et al., 2010). We hypothesized that there should be accompanied brain reorganization by significantly improved walking ability of the patients after a certain period of training. To examine our hypothesis, diffusion tensor imaging was acquired in the individuals with PD before and after 4 weeks of gait training.

Methods

Twenty-eight individuals with PD were participated in this study (7 Male, mean age: 67.8 ± 8.8 years), registered at Clinical Trials on March 2018 (Kang et al., 2019). They were the idiopathic PD with Hoehn-Yahr stage of 2.5 or 3. A total of 12 sessions of training was given to the participants by randomly assigned two types of training; robot-assisted gait training and treadmill training. The actual training time was 30 min for each session. Diffusion tensor imaging (DTI) was acquired before and after the training using a 3T scanner (Magnetom Triotim; Siemens, Erlangen, Germany). All scans have 45 slices with 30 distributed orientations at a b-value of 100 s/mm2 and with one b=0 image. The DTI data were preprocessed using the FSL (v. 6.0.1), including correction of eddy current distortion and motion artifacts. To investigate longitudinal changes of the white matter, we generated fractional anisotropy (FA), axial diffusivity (AD), and radial diffusivity (RD) maps at each time point, and subtracted the follow-up images from the baseline one. Mean response of the subtraction images of each map was tested by one-sample t-test with PD duration, age, and gender as nuisance variables to examine FA, AD, or RD values were changed after training. Statistical significance was set at threshold free cluster-enhancement uncorrected $P < 0.005$ with cluster > 10 voxels, using a non-parametric random permutation test with 5000 iterations.

Results

After 4 weeks of gait training, individuals with PD showed increased FA in the left precentral area and left pallidum and showed decreased FA in the right posterior cingulum

(Fig. 1). Decreased AD was observed in the several brain areas including the cerebellar areas, brainstem, midbrain and limbic-cortical areas (Fig. 2). There was no significantly increased AD after training. Increased RD was observed in the left anterior cingulum while decreased RD was observed in the right middle cingulum and left pallidum (Fig. 3).

Conclusion

A consistent finding of this study was the white matter change of the left pallidum, particularly in the posterior sensorimotor region, in the manner of increased FA in combination with decreased AD and RD, after 4 weeks of gait training. It suggests brain reorganization of the individuals with PD, having elevated neural branching and myelination, reflecting positive effects of gait training on the basal ganglia sensorimotor circuit susceptible to degeneration in PD.

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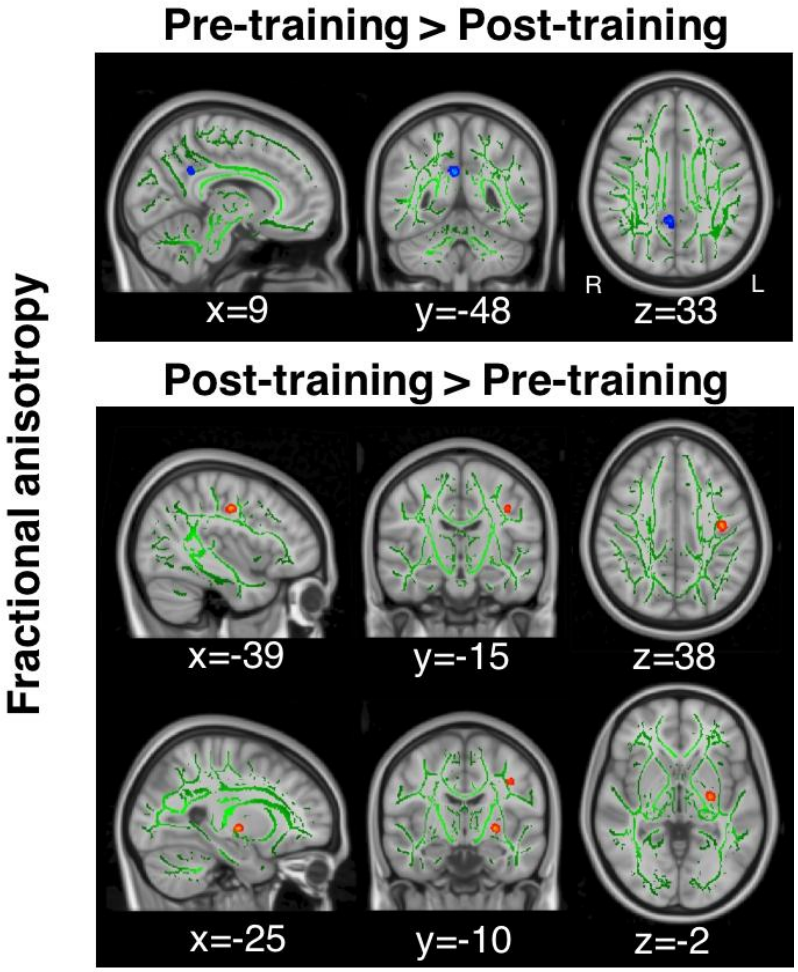

Figure. 1

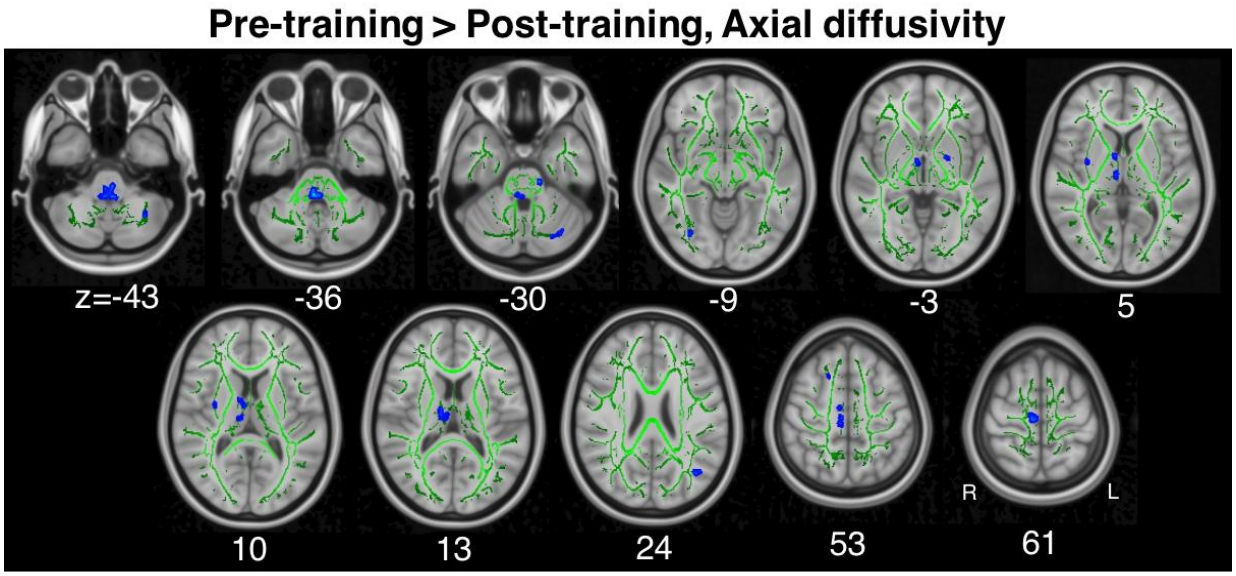

Figure. 2

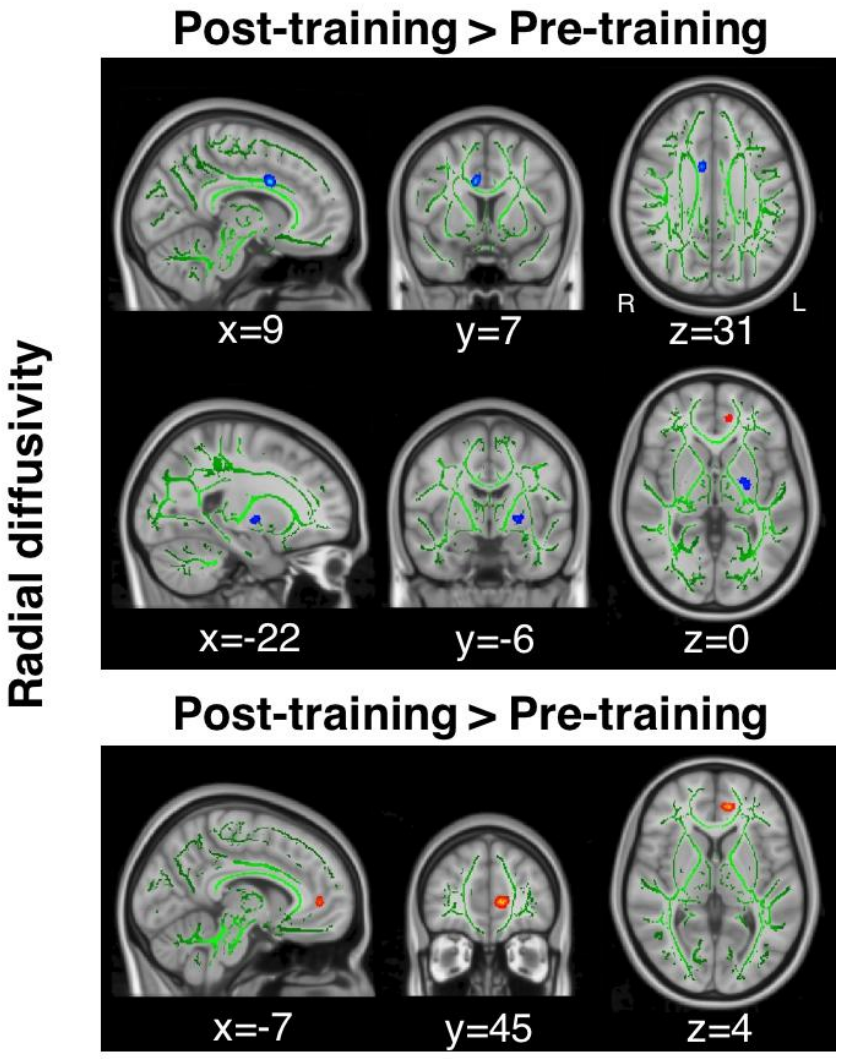

Figure. 3