Comparison of Motor Function and Cortical Activation in Parkinson's Disease

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Introduction: Recently, we have shown that a long-term lower extremity forced-exercise intervention resulted in significant improvements in clinical ratings of Parkinsonian symptoms and upper extremity motor function.[1] Interestingly, symptomatically produced by forced exercise is similar to that seen by standard medical levodopa therapy for Parkinson's disease. Symptomatic changes suggest that the two interventions may produce similar changes in underlying motor pathway network function. Previous studies have demonstrated increased fMRI activation in the SMA and M1 region in response to levodopa therapy.[2,3] The present study will utilize functional MRI to study changes in the motor pathway in response to both forced exercise and levodopa therapy in patients with Parkinson's disease. We hypothesize that both treatment interventions will have similar pathway related changes in functional brain activation.

Methods: Six subjects with Parkinson's disease a program of forced exercise using a tandem exercise bike with a trainer maintaining the speed and cadence of exercise. Subjects underwent one 1-hour training session consisting of a 10 minute warm-up, 40 minute main set, and 10 minute cool down. During the main exercise set subjects maintained a pedaling rate of 80-90 rpm with the aid of the trainer. This produced maximal heart rates in the 60 to 80% range. Imaging and behavioral data collection was performed in three conditions, off medication, on medication and off medication after forced exercise. Gradient echo EPI FMRI was performed on at 3T during performance of a bimanual finger tapping and force-tracking task utilizing a standard block design. The data were Tailarach transformed and activation maps were generated for each task. Region of interest analysis was performed using the Human Motor Area Template (HMAT). Comparisons of the activation pattern in the off medicine state, on medicine state, and post-forced exercise states were made.

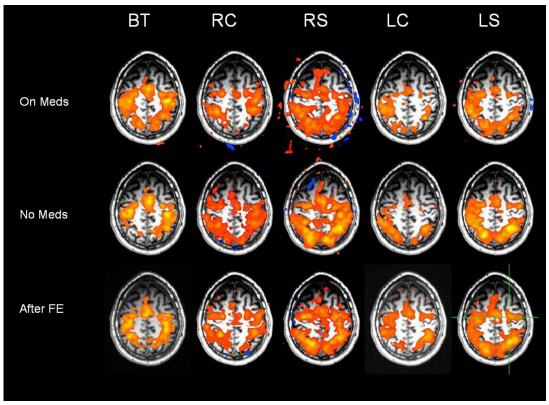

Figure 1. Activated regions in M1 and SMA during bilateral tapping (BT), right hand constant force (RT), right hand sinusoidal force tracking (RS), left hand constant force (LC), left hand sinusoidal force tracking (LS). Results shown are combined across subjects with threshold p<10-5

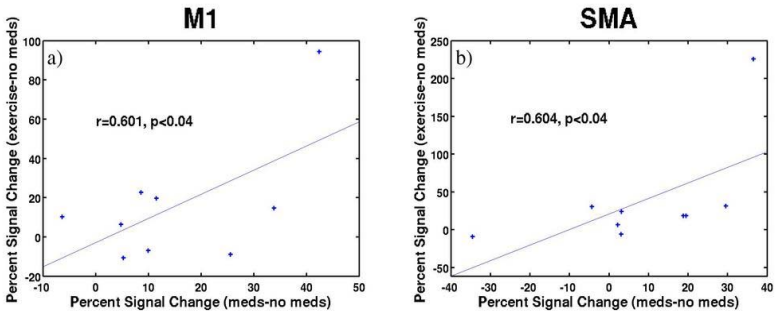

Figure 2. Difference in mean percent signal change between on medication and no medication and after exercise and no medication. Mean difference for each subject is plotted for an ROI in primary sensorimotor region (M1) and supplementary motor region (SMA).

Results: Forced exercise and medication produced similar significant reductions in the UPDRS motor score, 35% and 38% respectively. **Figure 1** demonstrates the activation patterns during bilateral finger tapping in each of the testing conditions. FMRI data demonstrates increased activation in the SMA and M1 regions in response to both exercise and medication. Quantitative analysis of fMRI (**Figure 2** above) data shows significant correlation between percentage activation increase following forced exercise and medication.

Discussion and Conclusion: Forced exercise and levodopa therapy produced a similar pattern of fMRI activation and therapeutic response. Findings suggest that same underlying mechanisms may provide symptomatic relief from Parkinson's disease in both levodopa therapy and forced exercise.

References: 1. Ridgel et al., J Journal of Neurorehabilitation and Neural Repair, In Press. 2. Buhmann et al., Brain, 2003 3. Haslinger et al., Brain, 2001