Resting State Motor Network Changes Associated with Motor Task Performance in Multiple Sclerosis: A Pilot Study

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Introduction

While motor weakness is presented in patients with Multiple Sclerosis (MS) [1], how motor-related functional connectivity (FC) in the resting-state is related to motor performance in patients with MS is unknown. A clear description of this relationship can improve our understanding of mechanisms underlying the performance of motor tasks in patients with MS and might guide future treatments to preserve functional ability through induction of neuroplastic changes.

We hypothesized that motor performance deficits could be reflected in altered resting-state FC with diverse cortical regions in the motor network in patients with MS. This study aimed to:

(1) identify the motor-related resting-state FC networks for the dominant and non-dominant hemispheres,

(2) estimate the association between these FC networks and motor task performance among patients with relapsing-remitting MS.

Methods

Subjects and Data Collection

Six right-handed MS patients (age: 46.8 ± 12.17y) during remission underwent T1-weighted MRI and resting-state functional MRI scans with their eyes closed. The Nine-hole peg test (NHPT) was performed as a measure of hand motor performance. The completion time of the test was standardized to age-matched controls, with higher scores indicating worse motor performance.

Statistical Analyses

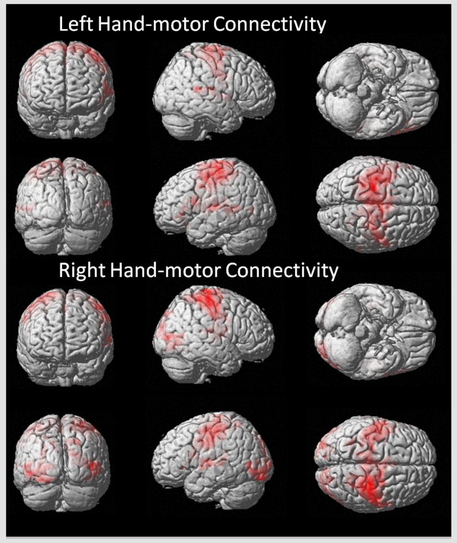
- Seed-based correlation performed for each subject with the left and right hand-knob motor regions as seeds
- The group FC generated using one sample t-test ($p< 0.05$, corrected for cluster level of significance with $p< 0.05$)
- Based on obtained group FC, identifying connections significantly correlated with performance on NHPT with linear regression ($p< 0.05$, cluster size> 60 voxels)

Results

1. Motor related FC (see the figure on the right)

Multimodal "nonmotor" cortical regions [2] (e.g. Insula/STG and posterior cortical regions) are involved in the motor networks in patients with MS.

Five out of the six subjects show white matter lesions near Insula/temporal regions as well as parietal regions, and three of them shows white matter lesions near primary motor regions, suggesting that the functional reorganization may be related to these structural changes.



Seed location	Cluster Name	Cluster size (x8mm^3)	Peak t-value	Peak Coordinates (MNI)		
Dominant Hand						
Left hand-motor	Left SMA	78	12.39	-12	-4	70
	Right SMA	114	10.35	-2	2	54
	Left Insula/STG	80	-21.77	-48	-18	6
	Left Insula	61	-7.88	-44	-34	16
	Right Insula/STG	319	-22.18	54	-20	6
	Right Insula/STG	212	-7.92	44	-16	-2
	Left posterior cingulate	67	-10.18	-6	-20	46
	Left somatosensory cortex	129	-6.55	-4	-20	74
Non-Dominant Hand						
Left hand-motor	Left SMA	84	10.36	-14	2	64
	Left Insula/STG	164	-11.63	-50	-16	4
	Right Insula/STG	379	-14.65	58	-22	6
	Right Insula	266	-7.37	40	-16	-4
	Left posterior cingulate	75	-11.10	-6	-16	46
	Left primary motor cortex	179	-10.37	-16	-14	62
	Right primary motor cortex	84	-8.79	4	-6	66
	Left superior parietal lobule	87	-5.18	-30	-42	50
	Left somatosensory cortex	97	-4.88	-16	-30	78
Right hand-motor	Left Insula/STG	160	-9.49	-52	-8	2
	Right Insula	116	-5.80	36	-28	20
	Right superior parietal lobule	80	-4.91	26	-48	62
	Right somatosensory cortex	154	-5.56	30	-28	68
	Right somatosensory cortex	71	-4.44	60	-10	42

Table 1. The MNI coordinates of peak functional connection-motor performance relationships.

Results

2. Association between FC networks and motor task performance (Table 1)

Worse motor performance is related to:

(1) higher FC between left hand motor seed and SMA,

(2) lower FC between bilateral motor seeds and regions not typically involved in the motor network.

Conclusions

1. Regions involved in the motor networks in the brains of the patients with RRMS may be more widespread than the typical motor networks in healthy subjects from literature [2].

2. It suggests that the traditional common motor FC may be more in need when motor performance is worse, whereas the multimodal "nonmotor" FC may be recruited to compensate for motor performance.

3. The impact of the structural lesions on the motor related FC is now being explored with a larger sample.

References

1.Provinciali et al., Acta Neurologica Scandinavica 1999 (100): 156-162.

2.Yaou Liu et al., Journal of the Neurological Sciences 2011 (304): 127–131.

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