

Brain plasticity after myelitis

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Introduction

Myelitis is a disorder of the spinal cord which produces sensory and motor deficits, and is often inflammatory in nature. Resolution of inflammation may be associated with a wide range in degree of clinical recovery. While some return of function is likely due to the reduction of abnormalities at the level of the spinal cord, reorganization of cerebral cortex may also contribute. In the current study, brain activation patterns were studied using functional MRI (fMRI) in patients with improved hand motor function after myelitis involving the cervical cord.

Methods

Personal and hospital case records were reviewed to identify patients with a diagnosis of myelitis; age-matched controls were identified. Entry criteria for patients were involvement of the cervical cord, motor abnormalities in one or both hands in association with the myelitis, improvement in these motor abnormalities by the time of imaging, and no additional or supervening neurologic diagnoses. Pre-scanning neurologic assessment was followed by anatomic studies of cervical cord and brain, as well as two BOLD fMRI studies (12 axial 7 mm slices, in-plane resolution 3.1 mm, 128 images/slice): one for right index finger tapping and one for left (each consisting of 15 second epochs, rest alternating with 2 Hz tap guided by a metronome beep). Activated pixels in left and in right sensorimotor cortex (SMC), supplementary motor area (SMA), and premotor cortex (PMC) were counted using a t-test (threshold $p < .001$) to contrast images obtained during tapping with images obtained at rest. Controls and patients were compared in 2 ways, each sensitive to variations in brain region size. First, for each of the 6 brain regions, total activation was summed in the controls and in the patients. For each region, a t-test (2-tailed, $\alpha < .01$) was used to compare the relative proportion of all activity in each of the two groups. Second, for each of the 6 regions, a Poisson parameter calculated from control data expressed the 99% upper limit for the fraction of pixels activated. For each subject and each region, the fraction of activated pixels was compared with this parameter.

Results

Seven patients (median age 33 y) and 9 controls (median age 32 y) were evaluated. Both methods of analysis identified examples of increased activity in patients. Comparing the groups as a whole, an excess proportion of the total amount of significant activation was distributed in the patient group, compared to the control group, in left SMC and right PMC during right finger tapping; and in bilateral SMC and right PMC during left finger tapping. Comparing all individuals against the 99% cutoff for the fraction of pixels activated within each region, an increased volume of activation was found in 8 instances for the patients and 3 instances for the controls. Most of these were in SMC contralateral to the tapping finger. When tapping the finger on the side more severely affected by myelitis, contralateral SMC activation exceeded all control values for 4 of the 7 patients. When comparing these 4 patients with the 3 who did not have increased contralateral SMC activation, no significant

differences were found in any of the clinical parameters of disease severity. SMC activations in these 4 patients were on pre-central gyrus, with extension to post-central gyrus in 1/2 of the cases.

Conclusions

The principal finding in this study is that most myelitis patients with improved hand motor and sensory function activated an enlarged volume of contralateral SMC when tapping on (what had been) the more severely affected side. There are several possible interpretations. The tapping performance of the patients with this finding may have been different from other participants, although tapping was closely monitored during imaging. The finger representation site on contralateral primary motor cortex may have enlarged as a mechanism of recovery. This contrasts with prior findings in stroke patients, in which *ipsilateral* SMC activation was enlarged. Moreover, no linear relationship was found between expansion of this site and clinical status. Enlarged SMC activation could be an effect of sensory deafferentation. Several studies have documented shifts in cortical representational maps in relation to interruption of sensory input. Patients with improvement after myelitis show differences in brain activation compared to controls. Further studies may clarify the role of cerebral cortex reorganization in recovery from spinal cord disease.

Presenter's Biography
Steven C. Cramer, MD

Dr. Cramer earned a BA with Highest Honors from U.C. Berkeley. He attended University of Southern California School of Medicine, earning his MD. After that, he trained for three years in Internal Medicine at UCLA. After one year in private practice, Dr. Cramer trained in Neurology at Massachusetts General Hospital. This was followed by a 2 year fellowship during which he trained in cerebrovascular disease, earned a Masters of Medical Science at Harvard Medical School, and studied functional brain imaging. After this, he was hired as an Assistant Professor at the University of Washington.

His research has focused on functional brain imaging. The brain is a plastic organ, constantly restructuring itself in response to environmental stressors, experience, and disease. Dr. Cramer's research examines patterns of brain adaptation to neurological disease, particularly stroke and myelitis. He is a member of the American Academy of Neurology, the National Stroke Association, and the Stroke Council of the American Heart Association.

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