Characterization of cortical activation patterns in action induced focal dystonia by 3.0 T fMRI

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Background and Purpose:
Recent studies about fMRI in focal dystonia usually refer to the registration of cortical activation patterns during provoked, or not consequentially eliminated, respectively, dystonic movements. Our goal was to describe functional cortical activation patterns in patients suffering from action induced focal dystonia (graphospasm) by fMRI without presentation of disease specific symptoms during task-specific stimulation. We focused on the primary motor (Brodman 4) and primary sensory (BA 1...3) areas, the supplementary motor area (SMA, BA 6), and secondary sensory areas (BA 40).

Material and Methods:
Seventeen patients with graphospasm and without medical or physiotherapeutical treatment, and 17 both age- and sex-matched healthy controls were included. All subjects were right-handed. Functional MRI was performed on a 3.0 T Scanner (GEMS, Milwaukee). Stimulation was performed by motor tasks (sequential finger tapping and index deflection), and above threshold electrical stimulation of the median nerve, each according to a block design. Any disease-specific dystonic movements were excluded by continuous electro-myographic recordings. Data postprocessing was carried out by SPM (statistical parametric mapping) software. Data of the statistical matrix were converted by non-linear transformation from MNI (Montreal Neurological Institute) coordinates into Talairach coordinates to visualize the SPM clusters. For the data conversion procedure we used a modified Matlab routine, the MSU-MNI Space Utility. Clusters sized at minimum 29.5 voxels were included into further postprocessing. We estimated the number of voxels per cluster, the Talairach coordinates of the primary maxima of each cluster, and the ratio of intersection volume to the regional volume for Brodman areas (BA) 4, 1…3, 6, and 40. Statistical evaluation included multi-variance analysis (Brunner) and Wilcoxon test by means of SPSS and SAS.

Results:
Interhemispherical predominance
Within the patient group we found no significant difference between left and right cortical activation during all stimulation modes neither considering the ipsilateral nor the contralateral hemisphere. In controls we registered a significantly increased contralateral (left) cortical activation in BA 4, 1…3, and 40 with right median nerve stimulation, and significantly increased ipsilateral (left) BA 4 activation with all stimulations.

Patients vs. control subjects
Significant results of group analysis: In patients we found a decreased activation of the left BA 4 with both ipsi- and contralateral motor tasks, a decreased activation of left BA 1...3 with contralateral finger tapping, left BA 3 with contralateral index deflection and ipsilateral tapping, right BA 2 with contralateral tapping. Decreased cortical activations were registered in patients in bilateral BA 6 with all motor tasks of the left hand and in the left BA 6 with contralateral tapping. Both ipsi- and contralateral BA 40 showed reduced activation with tapping of the right as well as the left hand.

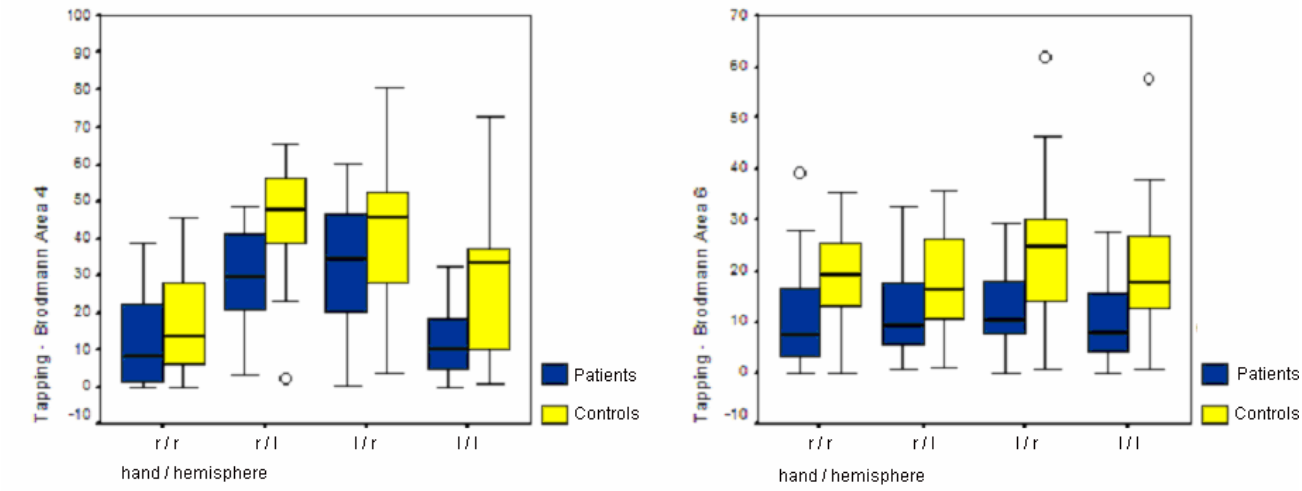

Figure: Ratios of intersection volumes to regional volumes in patients and controls for tapping in selected Brodman areas 4 and 6

Conclusion:
Our results suggest a pathologically reduced baseline activity as well as an impaired reactivity to motor tasks and somatosensory inputs in primary motor (BA 4) and sensory (BA 1...3) cortical areas, in supplementary motor areas (BA 6), and in somato-sensory associative areas (BA 40) in patients suffering from action induced focal dystonia.
This is a previously unreleased finding to our knowledge sine in thematically related studies dystonic movements during motor tasks were triggered with the complementary result of increased cortical activation patterns in corresponding areas.