Gray Matter Volume Changes Following Training in Hemispherectomy Patients

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Introduction

Cerebral hemispherectomy surgery is used for patients with treatment resistant epilepsy in the most severe cases. The surgery is often successful, but the loss of a cerebral hemisphere typically results in severe motor deficits. Only one previous study has investigated neural correlates of training in children who have undergone hemispherectomy surgery, but showed no behavioral improvement (de Bode et al., 2007).

Here, in a preliminary study with five children who underwent hemispherectomy surgery, we investigated gray matter volume changes following two weeks of daily motor training.

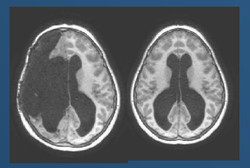
Methods

Subjects and Training

This preliminary study included five hemispherectomy subjects (all female; average age 11.2 years) before and after motor training. The motor training lasted two weeks and involved both upper and lower body training, weighted toward the subjects individual needs.
Subjects each had different amounts of their right hemisphere removed during surgery (see right). In order to process images with the analysis software, the whole hemisphere was duplicated and flipped and final analyses were run focusing on the intact left hemisphere.

	Pre-Training	Post-Training	Difference
Subject JW	21	23	+2
Subject AM	31	38	+7
Subject HW	22	22	0
Subject JH	21	24	+3
Subject SS	20	21	+1

Fugl-Meyer Score Changes Following Training.



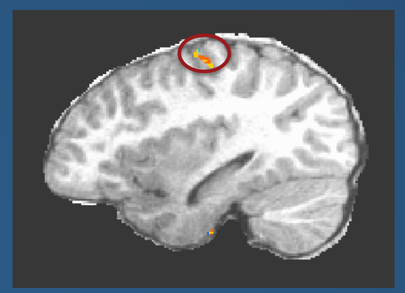
Example subject before and after hemisphere duplication.

FSL - SIENA

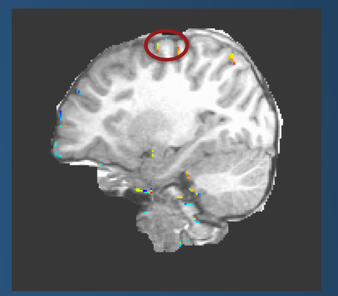
Tool used to estimate a two-timepoint percentage brain volume by aligning the two brain images and performing tissue-type segmentation to find brain/non-brain edge points. Next, perpendicular edge displacement between the two timepoints is calculated and the mean displacement is converted into an estimated percentage brain volume change.

Results

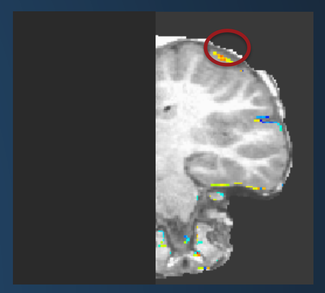
An increase in thickness in the gray matter of primary motor cortex in the non-affected hemisphere was detected in 3 of the 5 subjects. This increase in gray matter was detected near the “hand knob” area of the primary motor cortex. 2 of the 3 subjects with an increase in gray matter also had improved Fugl-Meyer Scores.



Patient AM
Size of Cluster: 31 Voxels
FM Score: Improved from 31 to 38



Patient HW
Size of Cluster: 20 Voxels
FM Score: No Change



Patient JH
Size of Cluster: 27 Voxels
FM Score: Increased from 21 to 24

Discussion

We found that after intensive task-specific therapy to the paretic extremity, behavioral improvements (shown with Fugl-Meyer Score) is associated with an increase in gray matter volume in appropriate areas of primary motor cortex. Increases in gray matter volume could reflect: synaptogensis, increase in cell size, variance in dendritic spine density and/or changes in insterstitial fluid or blood flow.

References

1. de Bode S, Mathern GW, Bookheimer S & Dobkin B 2007 Locomotor training remodels fMRI sensorimotor cortical activations in children after cerebral hemispherectomy. Neurorehabil Neural Repair, 21(6):497-508.

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