

Correlation between clinical outcome, morphometric and functional MR findings in patients with periventricular leucencephalopathy. Does size really matter?

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Abstract

Periventricular leucencephalopathy (PVL) is a prenatal disorder of the early last trimester of gestation causing motor disabilities of various degree. Using fMRI we correlated the extent of clinical disability with functional imaging findings and morphometric correlates and elucidated mechanisms of cortical reorganization. There was a good correlation between lesion size and testing scores with small lesions demonstrating significantly better clinical outcome. Good clinical outcome was associated with additional recruitment of premotor areas in mapping of the affected hand. There seems to be a need for this activation beside M1 to compensate for motor abilities in these patients.

Introduction

Functional magnetic resonance imaging (fMRI) is widely used in neuropsychological studies, preoperative or in stroke. It offers a non-invasive mapping tool to study mechanisms of cortical reorganization. Periventricular leucencephalopathy (PVL) is a rare lesion of the periventricular white matter caused during the early third trimester of gestation. Clinically, patients may be disabled in their motor abilities to various degrees. In this study we investigated whether the size of the lesion is reflected in clinical testing scores and whether mechanisms of cortical reorganization after brain damage at this early state can be elucidated in fMRI in relation to their clinical outcome.

Material and methods

Patients: Functional magnetic resonance imaging (fMRI) was performed in 8 patients with PVL of various size (between the age of 13-41 years) after reference data was achieved in age-matched controls. Written informed consent was obtained prior to the examination.

MRI: fMRI was performed on a 1.5 Tesla scanner (Siemens, Magnetom Vision, Erlangen Germany) using a standard head coil. A multislice T2*-weighted EPI-sequence (TR / TE = 0.96 / 66 ms, FOV 240cm matrix 128x128, slice thickness 3mm, 35 slices) was used for BOLD-imaging. The patients were instructed to open and close one hand in one session at an external given pace at 1/s. For morphometric analyzes a three dimensional MPRage data set was acquired prior to functional imaging.

Data analysis: SPM99 (1) was used for analyzes of functional data. According to Staudt et al. (2), the size of the periventricular lesion was graded by an asymmetry index in semicoronal slices parallel to a line between the omega shaped hand area and the ventral portion of the internal capsule. Clinical outcome was scored by the Wolf Motor Function Test (WMFT). Handedness was determined according to Milner et al. (3).

Results

In all patients the non-affected hemisphere was found to be the dominant for handedness. Small periventricular lesions with a laterality index below 1.3 had a better clinical ability in the WMFT (above 95% of all possible tasks). There was a significant correlation between the index and WMFT-scores ($R^2=0.63$, $p<0.019$). In contrast to the healthy subjects, 7 of 8 patients demonstrated additional ipsilateral activation in fMRI of the affected hand. The size of the activated areas in fMRI seemed to be increased in the dominant hand in healthy subjects, in patients the "laterality" differed between subjects. Beside activation in M1, premotor areas were additionally activated in patients during fMRI of the affected hand. In 3 of these patients WMFT-scores were above 95% of all possible tasks.

Conclusion

As expected, the non-affected hand was found to be the dominant hand. Even though cases have been reported, in which patients had an excellent clinical outcome even with large periventricular lesions, our data suggest, that bigger lesions in PVL represent a worsened clinical outcome. The laterality index (2) was found to be a reliable predictor for clinical abilities. Furthermore we found a close correlation between lesion size and motor tasks in the WMFT. Beside the size of the lesion, cortical reorganization mechanisms occur that improve clinical skills. Patients with additional activated premotor areas were found to have WMFT-scores above 95%. The size of the activated fMRI area was no predictor for outcome. Lesion size did not correlate with the size of the activated fMRI areas. We therefore conclude that there is a need for activation of additional premotor areas beside the primary motor area M1 to compensate for motor abilities in patients with PVL to achieve a good clinical outcome (WMFT-scores > 95%).

References:

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