Plasticity changes as reorganization of pre-motor cortex in lower limb amputees: a VBM study.

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Introduction

Motor cortex contributes to sensory experience, particularly in perceiving objects and locating body parts in space [1]. Limb amputation leads to functional reorganization of sensory [2], and motor cortex [3]. Patients phantom limb sensation (PLS) and phantom limb conscious awareness (PLCA) are the result of the dynamic changes depending on the task requirements and context [4]. These structural reorganizational changes are part of the functional changes initially reported through MEG. Voxel Based Morphometry (VBM) [5] has allowed to identify gray matter regional differences between our two groups of subjects, amputee patients and controls, particularly in the pre-motor area.

Methods

Fourteen healthy control subjects and five below-knee right lower limb amputees with no history of neurological or psychiatric disorders and right handed participated in the study after informed written consent. All MRI volumetric studies were acquired using a 1.0 T Intera System (Philips, Best, Netherlands) using a T1-weighted fast field echo (FFE) pulse sequence with 1x1x1.1 mm^3 voxel resolution TR=25ms, TE=6.9ms, flip angle=30°, on a 256 x 256 matrix with FOV = 25cm and RFOV 80% in 160 axial slices, thickness of 0.8 mm and zero gap. Voxel-based morphometry analysis was performed with SPM2 (Wellcome Department of Imaging Neuroscience, London, United Kingdom), executed in Matlab 7.1 (Mathworks, Sherborn, Massachusetts). First the images were spatially normalized to a template based on 152 healthy subjects from the Montreal Neurological Institute (MNI), which is the SPM standard T1-weighted MRI template (Mazziotta et al 1995). The program Talairach Deamon Client (Research Imaging Center, University of Texas Health Science Center, San Antonio) was used to translate each of the Talariach coordinates into the specific Brodmann area/brain region it is was associated with.

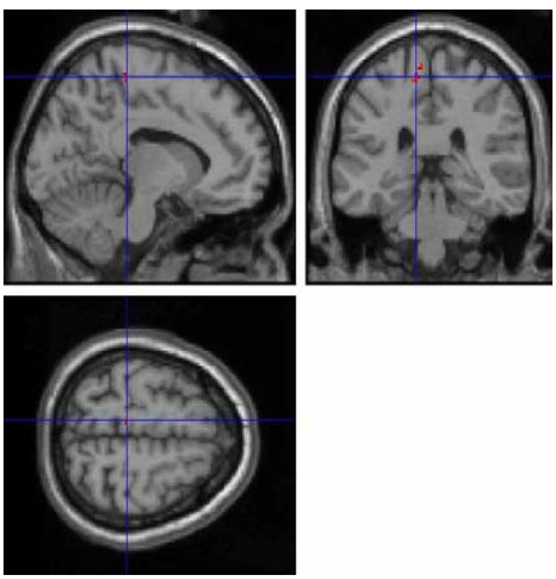

Figure 1. The red colored area in this image mark a cluster of pixels that differs between amputee patient and control subjects. It is localized mainly in the left Brodmann area number 6 with a statistically significant difference.

Results

All the amputees had differences in the gray matter of the somatosensory and/or motor cortex. However, although there were differences as to other areas, they all shared the same in Brodmann area 6, the supplementary motor area (SMA).

Conclusions

SMA is part of the circuitry of structures that functionally participate in the PLS/PLCA. This finding through VBM provides for a better understanding of how the brain continues to reorganize itself in response to changes in sensory input and how it reorganizes itself at the motor cortex. This helps us to depict how the brain dynamically constructs and maintains the body image and to understand how the phantom limb sensation and conscious awareness are produced. VBM help to explains how the structural changes that took place as part of the dynamic reorganization at the sensorymotor cortices, were first reflected through MEG [2] in the initial studies both in animals and in humans 10 years ago.

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