J. M. Favreau, S. Hemm, C. Nuti, J. Coste, V. Barra and J. J. Lemaire, "A Tool for Topographic Analysis of Electrode Contacts in Human Cortical Stimulation," *2007 IEEE 11th International Conference on Computer Vision*, Rio de Janeiro, 2007, pp. 1-6.

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Abstract: Electric chronic stimulation of the human motor cortex (ECSM) has been reported to alleviate chronic severe pain. However the mechanism of action of ECSM is still hypothetical. This is due mainly to the poor knowledge of 1) the electric diffusion through the multiple structures beneath the epidural contacts (i.e. dura matter, cerebrospinal fluid space, arachnoid membrane, grey and white matter layers, pie mere and vascular tree), 2) the absence of consensus concerning the stimulation parameters (mono versus bipolar stimulation, cathodic or anodic current) and 3) the detailed cortical topography of the contacts. In this study we focused on the precise identification of the cortical areas covered by the electric contacts in a series of twelve patients operated on for ECSM. We propose a new automatic tool for topographic analysis able to compute 2D maps from the 3D anatomic MRI with bijective transformation (point- to-point correspondance). Anatomical regions of interest (AROIs) were visually identified, manually outlined and extracted (Iplan, BrainLab, Germany) for further analysis: 1) for the anatomic structures, on pre operative Tl-weigthed magnetic resonance imaging (MRI), the frontal (superior or Fl, intermediate or F2 and inferior or F3), the pre central and the post central gyrus; 2) for the electrode contacts (Resume, Medtronic, USA), on post operative computerized tomography (CT). After getting white and gray matter membership maps by automatic segmentation, we produced a cortical mask to build a triangular mesh. We defined a homeomorphism between the 3D mesh and a subset of R2 and could apply in consequence the circle packing algorithm. We built depth maps (distance to the skull), distance- to-contact maps (distance to a given electrode contact) and anatomic structure maps. Results showed that it was easier to accurately define the location of the contact projection on the cortex allowing physicians to correlate the benefit with the topography. In particular,- because of the unfolding, it was easier to integrate the cytoarchitectonics (i.e. the manually identified AROIs) knowledge in the analysis. Beyond the better understanding of ECSM and indirectly of the pathophysiologic process of chronic pain, this new tool might be used in the future for image guided electrode positioning.

keywords: {bioelectric phenomena;biomedical MRI;biomedical electrodes;brain;computerised tomography;image segmentation;medical image processing;neurophysiology;patient treatment;automatic segmentation;computerized tomography;electric chronic stimulation;electrode contacts;human cortical stimulation;human motor cortex;topographic analysis;Biomembranes;Computed tomography;Electrodes;Humans;Image analysis;MONOS devices;Magnetic analysis;Magnetic resonance imaging;Pain;Surfaces},

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