Summary

"Comparison of activity studies of brain with functional magnetic resonance imaging task-based fMRI and no-task rsfMRI for healthy and diseased people."

The field of investigation for this doctoral dissertation: "Comparison of activity studies of brain with functional magnetic resonance imaging task- based fMRI and no-task rsfMRI for healthy and diseased people" two issues have become: the first is fMRI, non-invasive method of mapping brain function in pre- and postoperative patients, based on patient-physicist cooperation and the rsfMRI method, which is the latest approach in better understanding of the brain, not requiring direct cooperation of the patient. These two areas of interest require broader and more in-depth research, especially in terms of quality and quantitative, however, the focus of the research was primarily on all on their analysis, visualization and subsequent optimization. Until now, little attention has been paid to selected parameters and software used for both methods and especially in research carried out in Poland.

The main purpose of the research was to analyze the results of research, i.e. fMRI, rsfMRI, and to try to isolate the best research method for better diagnostics. In addition, an effective attempt was made to optimize brain research using the fMRI and rsfMRI methods, which should be the starting base for both non-task and task-based methods.

Great emphasis was put so that research could contribute to the improvement of diagnostics in this area, and the analyzes and parameters used can form the basis in this area. Data - BOLD fMRI and rsfMRI was acquired with a Siemens Magnetom Skyra 3-Tesla scanner using a whole – brain in Helimed Diagnostic Imaging in Katowice. We used data from 24 patients (5 preoperative, 5 postoperative and 14 patients with multiple sclerosis). As part of the ERASMUS + internship program, rsfMRI studies were conducted only for a group of healthy people at the Diagnostics and Neuroradiology Department at the hospital in Tuebingen in Germany. All measurements for 20 healthy people (13 women and 7 men) were performed with a Siemens Magnetom Skyra 3-Tesla. Various software was used for the analysis, but in particular the focus was on Statystical Parametric Mapping (SPM), Data Processing Assistant for Resting-State fMRI (DPARSF) and Group ICA of fMRI Toolbox (GIFT). The Seed Corelation Analysis (SCA) and ICA methods were used in the rsfMRI analysis and parameters were optimized in the DPARSF toolbox.

The possibilities of individual software and disease entities were taken into account. In some analyzes, the patient is perceived as an individual due to the cases analyzed (patients both before and after surgery), where it would be wrong to focus on group analysis due to e.g. different locations of tumor lesions. The obtained fMRI results allow to explain the neurological symptoms of patients' diseases (paresis) and to properly plan the surgery so as to limit the damage to speech centers as much as possible. In addition, results in the form of "activation maps" allowed to estimate to what extent the removal of cancerous tissues may affect brain functionality and whether the right areas have taken action. As our research shows, fMRI can be a tool supporting the diagnosis of both pre- and postoperative patients and it should be noted that with the change of the kernel and the level of significance, the activation areas change - hence the need to optimize the methodology. SPM12 was used for analysis while for observing the results in real time you can use the application Neuro3D, which allows you to save time in the event of e.g. failure of the experiment. Using DPARSF software to analyze rsfMRI research, the focus was on 3 main values, i.e. smoothing (kernel), amplitude of low frequency of fluctuation (ALFF) and the spherical radius of the selected area

of interest. The analysis allowed to find the best set of parameters, although each area, (2 different point of the brain) characterized different correlation values. Studies have shown that the highest correlation values were obtained for spherical areas of interest (ROIs) with a radius of 8, with the same values observed for r = 3 and r = 4. Higher correlation values for the ROI pair were obtained for ALLF in the range 0.01-0.04 than for 0.01-0.08.

Using the GIFT software, a comparison was made between healthy and multiple sclerosis patients using ICA analysis and the selected Infomax algorithm. The results obtained allowed locating active areas in the sensory-motor region in both healthy and sick people, where the highest values of spectral parameters (kurtosis) with a large predominance were obtained for healthy people. ICA method can be successfully treated as a screening test for MS patients.

Keywords: rsfMRI, fMRI, ICA, SCA, DPARSF, GIFT, SPM, MS, brain, MATLAB, ROI, BOLD