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Study of the phosphorus functional magnetic resonance spectroscopy technique for application to metabolite changes in the brain during visual stimulation

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Abstract
The main objective of this work was to study the functional magnetic resonance spectroscopy (fMRS) technique using the phosphorus nucleus (31P), to later apply it for quantification of the variation of high energy phosphates during a experiment with visual stimulation with different frequencies, performed in normal individuals.

Key words:
fMRI, spectroscopy, brain.

Introduction.

Brain metabolic variations that underlie neuronal activation are still far from being well understood and quantified. One way to study these variations is using the technique of functional magnetic resonance spectroscopy (fMRS). MRS using the phosphorus nucleus (31P-MRS) is a non-invasive technique, which does not use ionizing radiation, and which allows the evaluation of some specific brain metabolites, in particular, the so-called high energy phosphates, such as phosphocreatine (PCr) and ATP [1]. The MRS data consist of a spectrum which is a mixture of signals from the different metabolites present in the sample. The quantification of these parameters is usually accomplished through computational techniques, so in this work we studied the use of the AMARES method (Advanced Method for Accurate, Robust and Efficient Spectral fitting of quantization MRS data) [2]. We used a database collected in a previous work [3], where healthy subjects were alternately subjected to rest and visual stimulation periods, while 31P-MRS data were acquired. Visual stimuli were presented in three periods, each with a different flickering frequency.

In this preliminary stage of the work, we studied the different preprocessing steps used in MRS and the AMARES quantification technique.

Results and Discussion

The paradigm used for data acquisition consisted of the application of a visual stimulus in a scheme of 7 blocks lasting 4 min each (total duration of 28 min), 4 of rest and 3 of stimulus [3].
The visual stimulus consisted of a radial checkered pattern flashing at 4, 8, and 16 Hz and the rest blocks consisted of a dark screen with a fixing point [3]. For the acquisition of fMRS the ISIS 3D sequence was used, with the voxel positioned in the center of the occipital cortex, over the calcarine fissure [3]. The steps to be performed in the present work are: the fMRS data must go through two stages: 1) pre-processing, for cleaning of the signal; and 2) quantification, which consists in relating the measured signal to the concentrations of the metabolites that generated it. Both steps will be performed using the jMRUI software [4]. Step 2 will be performed using the AMARES method [2], which is implemented in jMRUI.

Conclusions

The use of MRS using the phosphorus nucleus in functional experiments is a relatively new area, with controversial results on metabolic variations associated with neuronal activation. We expect this work will shed light on whether high phosphate levels in the visual cortex change according to visual stimulation and rest periods.

Acknowledgement

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