STRESZCZENIE ROZPRAWY W JĘZYKU ANGIELSKIM

This work is a record of activities aimed at conducting MR studies in the field of spectroscopy and relaxation times of cell cultures. The research was conducted using the OPTIMA 360MR clinical magnetic resonance imaging system by GEHC with a magnetic field strength of 1.5T. Due to the limitations of the MR system, it became necessary from the very beginning to develop a number of coils - receiving circuits that could work with the system used and at the same time ensure that the sensitivity and resolution of the diagnostics were increased.

During the work, many prototype receiving coils were designed and made, some of which were used in the work. Each of these structures was adjusted in size and shape to the tested structures. The development of each was associated with its research in the context of the band and imaging. The constructed coils were single-channel constructions with surface and volume coil characteristics. For spectroscopic measurements, a solenoidal structure was prepared to ensure the greatest homogeneity inside the coil. These activities allowed to obtain images whose resolution reached the upper limit of MR microscopy. The articles that are part of the work contain descriptions of both the construction and show the characteristics obtained as a result of testing with a spectrum analyzer.

An integral part of the work was the development of an application whose task was to create maps of the distribution of T1 and T2 relaxation times in the tested objects. For this purpose, a high-level programming language was used, which is MATLAB prod. The MathWorks. This software package is one of the standard tools in the engineering arsenal. Due to its capabilities, it is used in the vast majority of sciences, not only technical but also biological and chemical or even economic. The developed application downloads data directly in DICOM3.0 files, which are records of medical data images. It performs imaging for the SR (saturation recovery) and IR (inversion recovery) methods to determine the times T1 and T2. It allows you to generate maps showing the distribution of longitudinal and transverse relaxation times together with maps of the distribution of the R2 coefficient to determine the quality of fitting of approximating curves. In addition, it is possible to display data as histograms of T1 and T2 values in given areas. The application allows you to obtain, in addition to maps of coefficients, also charts that are cross-sections of the examined areas. Artificial intelligence (AI) analysis has also been incorporated into the software. The use of an artificial neural

network to remove noise allowed for a significant optimization of the calculations and significantly accelerated the work of the application. An important functionality of this application is the ability to export data to many graphic formats, both raster and vector.

The work includes 10 publications on cancer cells - MCF-7, lung cancer - A549, and kidney cancer - ACHN. The selection of journals was closely matched to the researched and analyzed aspects of work.

Each of the works describes the results of activities in a specific range of topics related to the times T1 and T2. The first 3 of them are a description of relaxation time measurements and results related to spectroscopic measurements.

The remaining 7 publications contain the results of work related to potential sources of errors and the possibilities of optimizing the analysis time. During the work, the influence of partial volume on the measurement result was focused on. An experiment was designed which showed unequivocally that the effect of partial volume on the measurement result is very large. Another parameter whose relationship was plotted was viscosity. In this case, it was shown that the relaxation time T1 decreases with increasing viscosity. The scope of these changes is of little importance for the analyzes due to the relatively low value of this parameter, and it does not change significantly during the measurements.

As it was written earlier, several prototype coils were created during the research, the construction of which took into account the parameters of the tested objects. These aspects were also taken into account during the research. These constructions have undoubtedly contributed to the improvement of the quality of the MRS spectra. It should be added that the spectra obtained in a system with a magnetic field induction of 1.5T are very complex. This is due to the characteristics of the magnetic resonance phenomenon itself. Nevertheless, it has been shown that it is possible to analyze metabolites in cell cultures. An example here is lactate, which tells about glucose metabolism in the tested culture.

In addition, attention was paid to the influence of the temperature itself on the possible measurement results and signal quality. The influence of the temperature of the tested object was presented on the basis of literature and available numerical data, which were transformed into a graphical form. In everyday clinical practice, changes in this parameter do not significantly affect the imaging results (except in selected cases) due to the relative constancy of temperature in the human body. However, in vitro studies show considerable variability in this parameter. This is particularly important for in vitro MRS studies, where the lack of temperature correction may lead to incorrect identification of the signal. Deterioration of the signal quality as a consequence of, for example, the distance of the tested object from the

receiving elements of the coil results in a significant increase in noise on the acquisition plane, which also translates into an increase in noise in the images that are maps of relaxation times. It has been unquestionably shown that this can falsify the result of the assessment of these parameters.

The paper presents the study of selected cell cultures and an extensive study of the influence of various factors on the determination of relaxation times. Many of the factors included in the list of interfering factors are not present in everyday MR practice and clinical trials and therefore may be underestimated or omitted, which is of particular importance in the in vitro mode.

Clinical MR systems allow the study of cell cultures. However, when working with them, it is necessary to take into account the specificity and limitations of these systems in connection with the characteristics of the studied phenomena.