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Doctoral thesis: "Spectroscopic diagnosis of low-differentiated small round cell tumors in children"

Abstract

Cancers in children are relatively rare (approx. 1% of all cancer cases), and their pathogenesis and histopathology are different from cancers in the elderly. In Europe, approximately 15,000 new cases of cancer are diagnosed each year among children from 0 to 14 years of age and 20,000 cases among adolescents and young people aged 15-24. In Poland, there are about 1200-1300 cases of cancer among children per year.

A characteristic feature of most childhood cancers, in contrast to adults, is their rapid growth and short time to the point when they are able to metastasize. Delayed diagnosis of cancer may be associated with a worse prognosis and even life-threatening. That is why it is so important to search for new effective, objective, cheap and quick diagnostic methods.

Fourier transform infrared spectroscopy (FTIR) and Raman spectroscopy are physicochemical, non-invasive, sensitive and reproducible methods that provide important information on changes in molecular structure. The obtained spectra are the sum of the frequencies of many present biomolecules, which reveals, among others, significant biochemical changes that have occurred in neoplastic tissue and body fluids as a result of altered metabolism of healthy and cancerous cells. Of particular importance in tissue diagnostics is the spectral region in the so-called in the fingerprint range of the wavenumber (the so-called "fingerprint region"), which most often concerns the range of 800-1800 cm^{-1}, which corresponds to, among others, signal from important biomolecules assigned to proteins and nucleic acids. This gives a potential opportunity to distinguish between healthy and cancerous tissues and to detect cancer early, even before the changes appear in the light microscope. The obtained spectrum and its changes can also be potentially used to monitor the course of the disease and as a prognostic marker for the stratification of oncological treatment.

The aim of this study was an attempt to use the obtained spectroscopic spectra as a potential diagnostic tool and as a prognostic marker for: Ewing's sarcoma (ES) and medulloblastoma (MB) in children.

In the first chapters of the work, the scientific literature on the current application of infrared spectroscopy and Raman spectroscopy in oncology was reviewed, and the

characteristics of small round cell tumors in children were given. Then, the research methodology and the characteristics of the study population together with medical data were discussed. In the following chapters, the results of spectral measurements of Ewing's flesh and medulloblastoma spectra were presented, an analysis of the component bands of the region of vibration of functional groups belonging to the primary amide was performed, and the secondary structure of the protein was determined. In addition, for the obtained MB spectra and the control group, an analysis of absorbance dynamics and machine learning (ML) were performed. The next part of the paper presents a discussion and conclusions from the obtained research.

Summing up, on the basis of the results obtained in this work, the usefulness of vibrational spectroscopy as a diagnostic test in both MB and ES was confirmed. Additionally, the high prognostic value of FTIR spectroscopy in ES has been demonstrated. This justifies the continuation of further research in this area, especially since the analyzed groups of patients were not numerous. Therefore, it is necessary to confirm the obtained results in larger groups of patients. In the case of positive verification, FTIR and Raman spectroscopy could become recognized diagnostic methods in these cancers.