Abstract

Introduction: The most frequently diagnosed cancer and type of leukemia in children is acute lymphoblastic leukemia (ALL), which accounts for almost one third of all childhood cancer cases. The peak incidence in this group of patients is observed between the ages of 1 and 4, with boys being slightly more often diagnosed with ALL. Achieving survival rates of up to 90% is the result of multicenter studies and developing therapeutic regimens based on the assessment of prognostic factors, which are especially meaningful for improving the effectiveness of treatment of the problematic refractory and relapsed ALL, as well as minimizing long-term side effects of chemotherapy. It is crucial to diagnose ALL at the earliest possible time and implement an appropriate form of chemotherapy adapted to the molecular profile of neoplastic lymphoid precursor cells to achieve adequate treatment outcome. Both cytological evaluation of bone marrow, immunophenotype and genetic changes testing require a large expenditure of time, resources and experience of the people performing the test, and the biopsy itself, as an invasive procedure, performed under deep sedation or general anesthesia, carries a risk of complications. Vibrational spectroscopy techniques – Fourier transform infrared spectroscopy (FT-IR) and Raman spectroscopy (RS) allow for obtaining information on the structure and biochemical composition of the analyzed material, which may include cells, tissues and biological fluids, examining the interaction of electromagnetic radiation with the particles and atoms which they are composed of. As a rapid and non-invasive techniques they have been receiving increasing attention as new potential tools in medicine, which, by tracking changes occurring in the course of metabolic, neurodegenerative and neoplastic diseases, can be used to its diagnosis and to monitor the effectiveness of therapy.

Aim of the study: Fourier transform infrared spectroscopy and Raman spectroscopy were used for spectral analysis of peripheral blood serum and bone marrow cell lysate to identify molecular changes in the course of ALL in chidlren, which could potentially be used in medical diagnostics as diagnostic and prognostic markers. Investigated diffreneces in FT-IR spectra and Raman spectra of serum and bone marrow cell lysate of paediatric ALL patients and healthy patients or patients with haematological disorders other than cancer. The obtained spectral data were also analyzed with regards to clinical data available for patients with ALL associated with assessment of risk group, molecular profile and the result of minimal residual disease, as well as the occurrence of recurrence or death of the patient.

Results: In terms of the presence and position of bands and peaks, no significant differences were observed for FT-IR spectra and RS spectra of serum and bone marrow cell lysate for patients with ALL and patients from other groups, similarly to the comparison of spectra of patients from the high-risk group and patients from the standard and intermediate risk groups. However, statistically significant differences were shown in the absorption value for the peaks of the original FT-IR spectra, the percentage share of individual secondary structures evaluated by integration in the amide I range of the second derivative of the FT-IR spectrum and the peak intensity values of RS spectra, but the sensitivity and specificity of distinguishing patients with ALL from other groups as well as patients from the HR and non-HR groups were not satisfactory in most cases, which was confirmed by PCA and HCA analyses.

Conclusions: FTIR and Raman spectroscopy have shown limited utility in identifying specific molecular alterations in the course of ALL in children, but have revealed significant differences between controls and patients with haematological disorders, including ALL Among other things, differences were observed in the contribution of structures α-helix and beta-sheet proteins, which may serve as potential diagnostic markers, especially in differentiating ALL as a cause of peripheral blood anaemia or pancytopenia in children and for initial stratification into risk groups. Raman spectroscopy also made it possible to distinguish pancytopenia in ALL from other causes on the basis of serum testing, suggesting the potential possibility of developing non-invasive screening tests. The results need to be validated on larger patient groups due to the limited sample size.