CHARACTERISTIC FEATURES OF IR SPECTRA OF SERUM FROM PATIENTS WITH MULTIPLE MYELOMA

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Introduction

Currently, the diagnosis of cancer is one of the most important tasks of medicine. Multiple myeloma (MM) is one of the most difficult diseases for diagnosis. MM is characterized by the formation of malignant plasma cells clusters in the bone marrow that produce monoclonal immunoglobulins (M-proteins) or their fragments. Due to the increased formation of immunoglobulins by malignant cells in blood vessel, the ratio of immunoglobulins to other protein structures changes. These changes can be recorded using infrared spectroscopy, which has been proven as very promising method for cancer diagnosing.

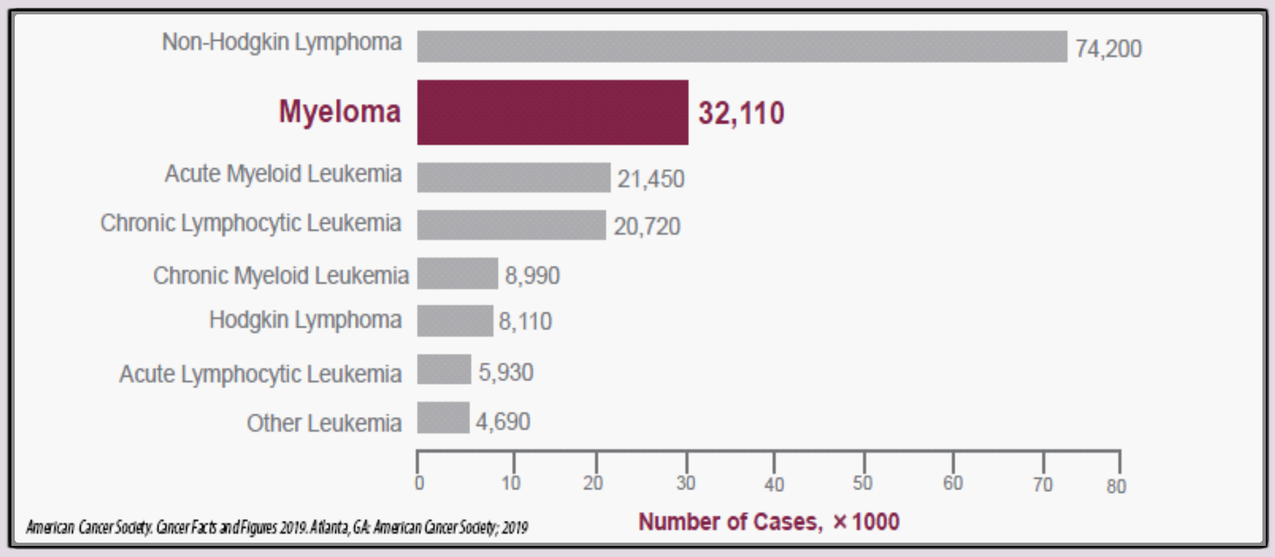

Figure 1. Statistics based on diagnosed oncohematological pathologies in America in 2019.

Materials and methods

In this research was analyzed the blood serum from patients with multiple myeloma under the supervision of the hematology clinic of the Russian Research Institute of Hematology and Transfusiology (St. Petersburg, Russia), where the primary analysis of these samples was performed. Serum samples from 25 healthy donors and 13 patients with multiple myeloma were analyzed in this study. The patients included 6 men and 7 women in the age of 50-70 years. Absorption spectra in the mid-infrared range (4000–400 cm-1) were obtained using a Tensor 27 FTIR spectrometer (Bruker). The samples were studied in D2O solutions using collapsible BaF2 cells with an optical path length of 50 μm. Primary processing and analysis of the spectra were carried out using the software supplied with the spectrometer. The spectra of each sample were recorded with a resolution of 2 cm-1 and averaged over 128 accumulations. An example of the studied spectrum is shown in Figure 2.

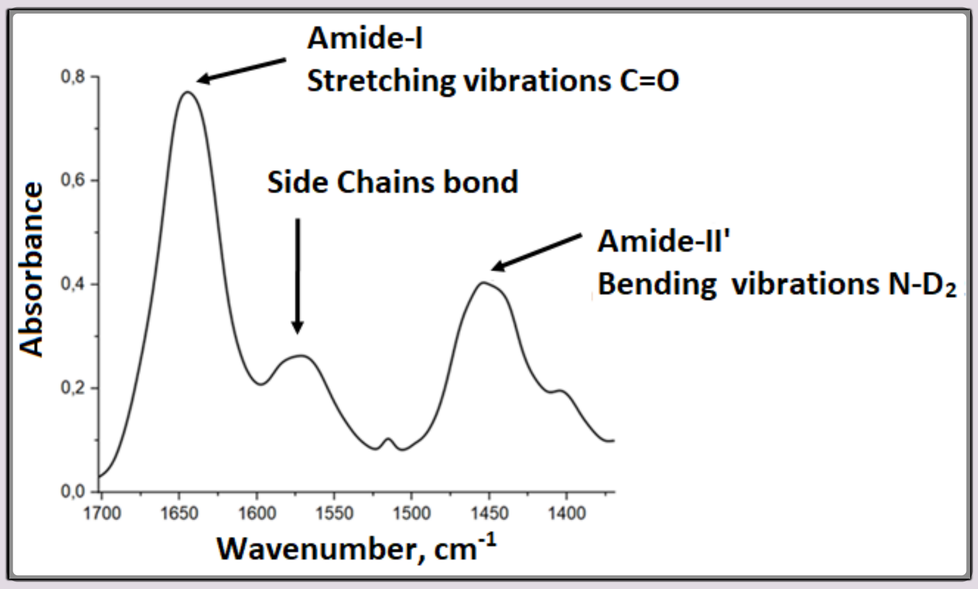

Figure 2. An example of the absorption spectrum of blood serum in the range of wave numbers 1700-1350 cm-1, as well as the absorption bands for which the spectra were compared.

Results and discussion

The range of wavenumbers from 1700 to 1350 cm-1 was analyzed corresponding to the vibrations of groups in the peptide bond. As result of the analysis, a number of criteria according to which these groups of spectra differed were found. Such criteria are the ratios of the absorption band maxima of Amide-I to Amide-II', Amide-I to the maximum of the side groups vibration band, Amide-II' to the maximum of the side groups vibration band, as well as the positions of the maxima of Amide-I, Amide-II', b ands of side groups vibrations and minima between these bands. The average value for these parameters were found for the spectra of donors after which they were compared separately with each MM patient sample. In Fig. 3, the radial diagram shows the most characteristic differences that were found during the analysis of the spectra in terms of absorptions. Figure 4 shows a comparison of the positions of extremums in the studied range of wavenumbers in the spectra of patients and healthy donors. Table 1 compares the average values for patients with MM patients and healthy donors according to the most characteristic features. Thus, as a result of the comparison, it was possible to find a number of parameters in which MM patients and healthy donors differ from each other.

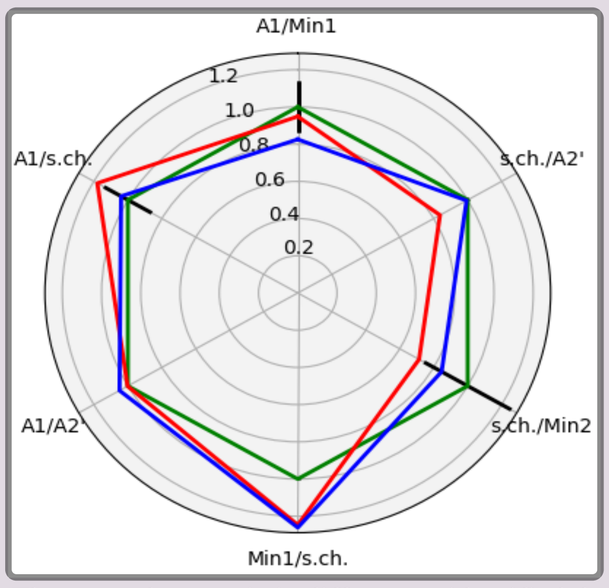

Figure 3. The most characteristic differences identified during the analysis of the spectra, presented in the form of a radial diagram.

Table 1. Average values of absorption bands ratios to each other, the most strongly differing in two groups of patients.

	Amide-I/side chains	Amide-II'/s. chains	Amide-I/Amide-II'
Av. val. for donors	2,94 ± 0,05	1,58 ± 0,03	1,86 ± 0,08
Av. val. patients	3,65 ± 0,05	2,06 ± 0,03	1,77 ± 0,08

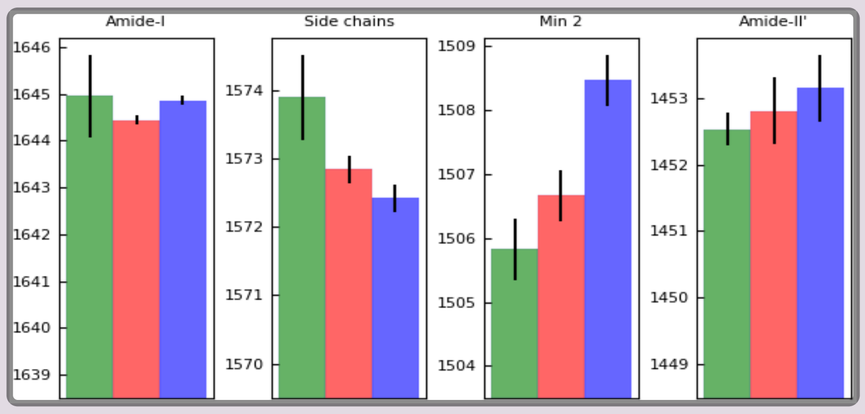

Figure 4. Average values of the wavenumbers, on which the maxima of the absorption bands or the minima between them were located.

Conclusion

As a result of the study, several spectral parameters that differ between the spectra of blood serum of people suffering from multiple myeloma and the spectra of healthy donors were identified. It was shown that blood spectra of patients with myeloma pathology differ from those of healthy people in a number of parameters. This suggests that this approach may be promising for identifying patients in the early stages of the disease. In this situation, further treatment could be facilitated

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