Light scattered by thrombocytes can improve the treatment of cardiovascular diseases

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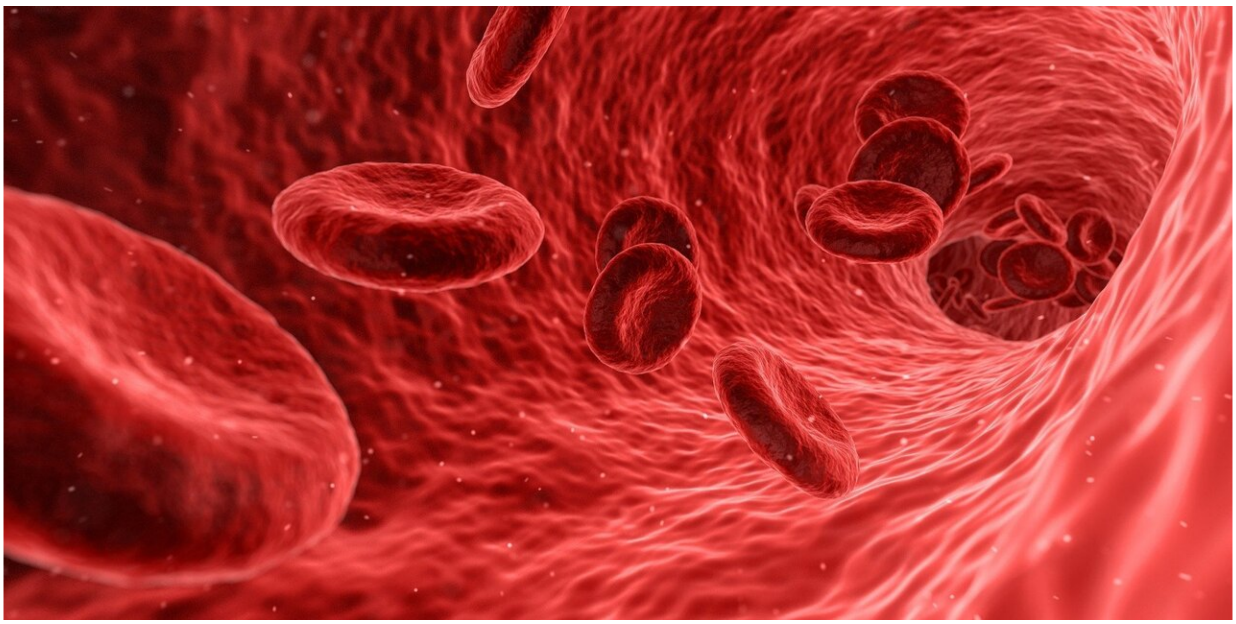

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A team of scientists from Immanuel Kant Baltic Federal University used Raman spectroscopy to study the thrombocytes of patients with cardiovascular diseases and compared their spectra with those of healthy people. The researchers identified informative areas of the spectra and confirmed that Raman spectroscopy was a promising method allowing one to diagnose the diseases associated with changes in thrombocyte activity and also to forecast the efficiency of antithrombotic therapy.

A grant for the research was provided by the Russian Science Foundation, and its results were presented at several conferences on medicine and optics: Optics in Health Care and Biomedical Optics IX, 20-23 October 2019, Hangzhou, China, and the 6th Annual European Congress on Clinical and Translational Medicine. 18-20 October, 2019 Vienna, Austria. The results were also published in SPIE Digital Library, *European Journal of Molecular & Clinical Medicine*.

Blood consists of a liquid medium called plasma with blood cells suspended in it and performing different functions. Thrombocytes protect our bodies from blood loss in case of an injury. They look like colourless oblate spheroids 2-4 microns in diameter and are produced by red bone marrow. As a rule, thrombocytes remain deactivated; however, when vascular walls are damaged, and cell disintegration products and special molecular "distress signals" are released in the blood, they react with the proteins on the surface of thrombocytes and activate them. When a thrombocyte is activated, it quickly and almost always irreversibly changes its state and shape, increasing its surface area. As a result thrombocytes acquire the ability to stick to each other (this process is called aggregation) and to vascular walls (adhesion). A clot is formed, and serious blood loss is prevented. Moreover, thrombocytes release the so-called growth factor into body tissues surrounding the injury site, making them divide faster.

But blood properties can change in the course of some cardiovascular diseases causing clots (thrombs) to form without any damage to vascular walls. Thrombs can circulate along blood vessels and stick to their walls thus contracting their lumen and making other elements stick to them. This leads to the clotting of vessels, prevents blood flow to tissues and organs, damages their functions, and in case of long oxygen and nutrient deficiency might even cause necrosis. If an artery is clotted in the heart (heart attack) or the brain (stroke), it causes serious health issues and may even be lethal. To diagnose diseases of this type, doctors pay attention to several blood indicators including the quantity and state of thrombocytes. Current evaluation methods are quite complex and take a lot of time to carry out all reactions. However, as it turns out, to diagnose the state of a patient, one may use the characteristics of thrombocytes.

A team of scientists from Immanuel Kant Baltic Federal University suggested using Raman spectroscopy to diagnose the state of thrombocytes. In the course of Raman spectroscopy a laser beam goes through the studied substance, and then the characteristics of scattered light are compared to its initial indicators. The substance absorbs a segment of the light, and the frequency of such absorption depends on the composition and structure of the sample. The intensity of the beam in all frequencies is visualized as a chart, and scattering peaks are identified on it. Then the spectral structure of the thrombocyte in question is evaluated.

"Raman spectroscopy is currently being actively studied as a new diagnostic method in many areas of medicine. For example, it can be used to identify the known markers of cardiovascular diseases or to search for new ones. The analysis of thrombocytes and their aggregation ability might become a new, efficient and minimally invasive diagnostics method in modern cardiology," said Ekaterina Moiseeva, a postgraduate of the Institute of Medicine, Immanuel Kant Baltic Federal University.

The team suggested that the state of thrombocytes in the blood of patients with cardiovascular diseases could be quickly evaluated using Raman spectroscopy. The participants of the study were volunteers; some of them had healthy hearts and blood vessels, and some suffered from high blood pressure or had survived a heart attack and took anti-aggregants (blood thinners). Samples of venous blood were taken from both groups. After that, thrombocytes were extracted from them and placed on a base plate. Then the scientists registered the spectra of single suspended cells and studied their characteristics. The comparison of samples taken from healthy people and cardiovascular patients showed differences in several areas of the spectra. Namely, the intensity of the signal changed in the latter which may indicate changes in the physical characteristics of the lipidic base of thrombocyte membranes

"It is too early to say that the spectra change according to a certain set of rules. We need further studies to classify them and link to specific cell processes. To confirm the results, we plan to collect more research statistics and to identify spectral patterns that might be brought into correlation with the thrombocyte state indicators," said Andrei Zyubin, a senior researcher at the Research and Educational Center "Fundamental and Applied Photonics: Nanophotonics," Immanuel Kant Baltic Federal University.

The results of the study confirmed that Raman spectroscopy could be used to study the changes in the properties of thrombocytes in patients undergoing antiaggregant therapy. This would help doctors not only control the progress of the therapy, but also identify possible risks of cardiovascular diseases.

More information: Andrey Y. Zyubin et al, Single human platelet study using surface-enhanced Raman spectroscopy as a perspective tool for antiplatelet therapy effectiveness prediction, *Optics in Health Care and Biomedical Optics IX* (2019). DOI: 10.1117/12.2536384

Provided by Immanuel Kant Baltic Federal University

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