New tool for early detection of hypertension

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In the lab. Credit: Sergey Gnuskov/NUST MISIS

Russian scientists have come up with a new tool for early detection of hypertension. They applied surface-enhanced Raman spectroscopy powered by silver nanoparticles to detect hypertension-induced molecular changes in blood cells at early stages of the disease. The study was published in *Biosensors*.

Cardiovascular diseases are the leading cause of death globally. High blood pressure, or hypertension, is one of the most important risk factors for cardiovascular diseases, leading to organ hypoxia and consequent damage, such as heart failure, stroke, vasculopathy, and nephropathy.

Hypoxic conditions can develop as the result of hypertension-induced alterations in vessel structure or abnormal changes in hemoglobin's affinity for oxygen, leading to the decreased ability of hemoglobin to transport and release oxygen in peripheral tissues.

Identification and monitoring of such changes occurring at the cellular level could help develop new tools for early diagnostics and personalized targeted treatment.

A group of scientists from NUST MISIS, Moscow State University, Moscow Institute of Physics and Technology and University of Copenhagen have proposed a new approach for the selective study of the hemoglobin in erythrocytes with SERS using a colloidal solution of silver nanoparticles and silver nanostructured surfaces.

"The nanostructured surfaces were obtained by dissolving 0.3 g of silver nitrate in 40 mL of water, followed by the addition of 30 mL of 20% sodium hydroxide solution. The resulting substance was then washed, followed by the addition of 5 mL of 25% aqueous ammonia and 25 mL of water. The obtained solution was then sprayed onto the surface of coverslips and subjected to heat treatment. These nanostructures allowed us to achieve the enhancement of the Raman scattering from molecules near the nanostructure surface," noted Georgi Maksimov, Professor at the Materials Physics Department in University MISIS.

The researchers applied plasmonic SERS nanosensors to assess changes in the properties of erythrocytes in normotensive and hypertensive rats. They were able to detect changes in erythrocyte properties in

hypertensive rats, such as a decrease in the erythrocyte plasma membrane fluidity. One of the explanations of this phenomenon is the increased level of cholesterol. Increasing cholesterol leads to a decrease in membrane fluidity and changes in the erythrocyte function.

For the first time, the scientists observed a decrease in the in-plane mobility of heme in hemoglobin in hypertensive rats, which is impossible to detect by other methods. The researchers believe that this can be explained by the increasing stiffness of the membrane, which may reduce the ability of a heme to adapt to changing oxygen concentrations and affect the affinity of hemoglobin to oxygen. That in turn can impair oxygen supply to tissues in hypertensive conditions.

The proposed SERS-based approach may be used to develop novel diagnostic tools to detect early pathologies and to assess treatment outcomes in CVD and beyond, the researchers believe.

More information: Evelina I. Nikelshparg et al, Detection of Hypertension-Induced Changes in Erythrocytes by SERS Nanosensors, *Biosensors* (2022). DOI: 10.3390/bios12010032

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