

## Correlation Features between Nitric Oxide (NO) Content and Erythrocyte Membrane Deformity in Erythrocytes of People of Different Ages

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Nitric oxide (NO) plays an important role in modulating the structure and permeability of erythrocyte membranes. It affects the lipid composition of the erythrocyte membrane, improves cell function and deformability. Membrane perfusion of erythrocytes significantly depends on the ability of the cell to deform, which contributes to long-term circulation and the normal functioning of red blood cells. The aim of the study was to determine the deformability of erythrocytes and NO indicators in different age groups and to establish the relationship between these two components. The positive correlation between erythrocyte deformation and NO content, found by us, may be associated with the development of age-related diseases. Study methods: 140 volunteers were selected, who were evenly distributed (28 volunteers one group) in 5 age groups: 1) 17-25, 2) 25-35, 3) 35-60, 4) 60-75, 5) 75-90. Free nitric peroxide (NO) was determined in patient's blood using electron paramagnetic resonance imaging (EPR) using spin traps (sodium diethyldithiocarbamate (DETC), (Sigma)) with radio spectrometer PPЭ-1307 (Russia). We examined the ability of erythrocyte membrane deformation using a computerized filtration-photometric method. The study results showed that the rate of deformation of peripheral blood erythrocytes in elderly volunteers is reduced compared to the rate of deformation of young volunteers. In particular, the deformability index in persons aged 17-25 is  $4.5.0 \pm 0.3$ , 25-35 s.; In volunteers -  $4.8 \pm 0.4$ ; In the elderly, this indicator decreases to  $-3.0 \pm 0.3$ , which may be due to changes in the composition of membrane lipids and proteins. We also detect changes in NO content in volunteers of different age groups. The statistically significant positive correlation between the deformation of erythrocytes and the content of NO, found by us, may be associated with age-related metabolic changes. As already mentioned, NO-dependent changes in the physical characteristics of erythrocyte membranes affect the rheological properties of blood, which in turn can cause age-related diseases. © 2022 Bull. Georg. Natl. Acad. Sci.

erythrocyte, deformity, membrane, nitrogen peroxide

As an organism ages, most of the tissues undergo control lifespan and age-related phenotypic morphofunctional changes. Mechanisms that changes remain the subject of research [1].

The aging process of a multicellular organism can be considered as a set of processes occurring in individual cells, and at the same time, the mechanism of death of individual cells can be generalized at the level of the whole organism. The erythrocyte provides the best opportunity to study the age-related changes in metabolism in these individual cells. The study of erythrocytes, life expectancy in the age aspect will allow drawing parallels with various clinical pathologies and suggesting expected results in order to be able to manage further processes to prevent unwanted cases [2].

The peculiarity of the structure of erythrocytes determines their certain physiological and physico-chemical properties. In addition to the transport of gases, they are involved in the regulation of the rheological properties of blood, the transport of drugs, biologically active substances and immune complexes [3]. Erythrocytes play an important role in the regulation of blood circulation, are involved in the regulation of vascular tone, arterial and venous blood pressure, and affect platelet function. Erythrocytes interact with the endothelium, have the ability to regulate a specific immune response and apoptosis in activated T cells [4].

**Table. Indicators of deformation ability and NO content in erythrocytes in people of different ages**

Groups	Quantity	Deformity (Seconds <sup>-1</sup> )	NO
17-25 years	28	4.5±0.3	16.0±7.1
25-35 years	28	4.8±0.4	15.2±8.9
35-60 years	28	4.0±0.7	16.8±7.9
60-75 years	28	3.0±0.3	13.0±5.2
75-90 years	28	3.0±0.3	12.0±6.3

Of particular importance is the erythrocyte membrane, which separates the cell from the environment and ensures the entry of substances necessary for life into it, and also regulates the

release of substances harmful to the body. The degree of membrane permeability determines the resistance and deformability of erythrocytes. The deformability of erythrocytes determines their viability during circulation [5].

The deformability of the erythrocyte membrane is considered as an integral indicator of the functional state of the erythrocyte. This ability is possessed only by a normal non-nuclear erythrocyte, which, as a result of a change in shape, is able to bind oxygen and release it from capillaries into tissues. The defeat of erythrocytes with low deformability (aged erythrocytes) in the finest sinuses of the spleen leads to their lysis [6].

NO plays an important role in modulating the structure and permeability of erythrocyte membranes, affects the lipid composition of erythrocyte membranes, which in turn greatly affects the physical properties of membrane-bound proteins and, possibly, the functioning of the entire cell [7]. The deformability of erythrocytes significantly depends on the density of the erythrocyte membrane. NO acts as an autocrine mediator in the regulation of erythrocyte deformation necessary for the movement of these cells through narrow capillaries [8].

**Objectives:** The aim of our study was to study the indicators of erythrocyte deformability and NO in practically healthy people in different age groups and to establish the relationship between these two components.

## Material and Methods

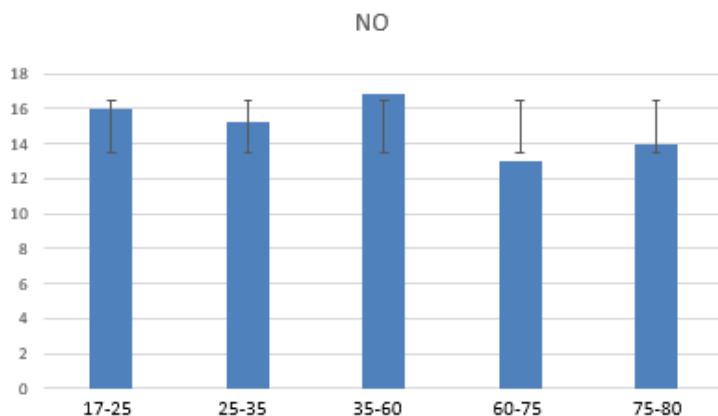
140 volunteers were selected, which were divided into 5 age groups: 1) 17-25 years old, 2) 25-35 years old, 3) 35-60 years old, 4) 60-75 years old, 5) 75-90 years old. The study excluded people with chronic diseases, pregnant women and smokers. Research has been done at TSMU, at the Department of Normal Human Anatomy and the Department of Medical Physics, Biophysics, Biomechanics and Information Technologies.

Free nitrogen oxide (NO) was determined by using electron paramagnetic resonance imaging (EPR) using spin traps (sodium diethyldithiocarbamate (DETC), (Sigma)) on the radio spectrometer PPЭ-1307 (Russia).

The ability of erythrocyte membrane deformation was examined by using a computerized filtration-photometric method.

physical characteristics of erythrocyte membranes (flow, deformation) modulate its signaling systems and thus affect the rheological properties of the blood.

The results of the studies showed that the rate of deformation of peripheral blood erythrocytes in elderly volunteers is reduced compared to the rate of deformation of young volunteers. In particular,



**Fig.** Indicators of erythrocyte NO content in people of different ages.

Statistical analysis was performed by using the Statistical Package for Social Sciences (SPSS) for Windows (SPSS version 11.0). The results were displayed as  $\pm$  SD values. A confidence limit of 0.05 ( $P < 0.05$ ) was selected for statistical reliability.

## Results and Discussion

We know that a change in the shape of an erythrocyte is important as it passes through its vascular capillaries. This amazing feature of it is due to its deformation ability. Nitrogen peroxide plays an important role in modulating the structure and flow of erythrocyte membranes, it affects the lipid composition of erythrocyte membranes, which in turn greatly affects the physical properties of membrane-bound proteins and possibly the function of the whole cell. The deformation of erythrocytes significantly depends on their membrane deformation. Therefore, it can be seen from the above that NO-dependent changes in the

the deformability index in persons aged 17-25 is  $4.5.0 \pm 0.3$ , 25-35 s.; In volunteers -  $4.8 \pm 0.4$ ; In the elderly, this indicator decreases to  $-3.0 \pm 0.3$ , which may be due to changes in the composition of membrane lipids and proteins.

The table and the figure show the indicators of the content of NO in the erythrocytes of people of different age groups. We find any significant changes in the content of NO in erythrocytes in volunteers of different age groups.

## Conclusion

The correlation analysis revealed a statistically significant positive relationship ( $r = 0.6470$ ;  $p = 0.168$ ) between the deformability of erythrocytes and the NO content. From the above, it is clear that, NO-dependent changes in the physical characteristics of erythrocyte membranes provide modulation of their signaling systems and thus affect the rheological properties of blood, which in turn can lead to the development of age-related diseases.

ციტოლოგია

## სხვადასხვა ასაკის ადამიანების ერითროციტებში აზოტის ჟანგის (NO) შემცველობასა და ერითროციტული მემბრანის დეფორმაბელობას შორის არსებული კორელაციური თავისებურებები

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\*\*თბილისის სახელმწიფო სამედიცინო უნივერსიტეტი, ადამიანის ნორმალური ანატომიის დეპარტამენტი, საქართველო  
§თბილისის სახელმწიფო სამედიცინო უნივერსიტეტი, ოფთალმოლოგიის დეპარტამენტი, საქართველო

ერითროციტების მემბრანების სტრუქტურასა და დენადობის მოდულაციაში მნიშვნელოვანი როლი ენიჭება აზოტის ზეჟანგს. ერითროციტების მემბრანის დენადობა ასევე მნიშვნელოვნად არის დამოკიდებული უჯრედის დეფორმაბელობის უნარზე, რაც ხელს უწყობს უჯრედის ხანგრძლივ ცირკულაციას და ნორმალურ ფუნქციონირებას. ჩვენი კვლევის მიზანს წარმოადგენდა შეგვესწავლა პრაქტიკულად ჯანმრთელ ადამიანებში ერითროციტების დეფორმაბელობის და NO-ს მაჩვენებელი სხვადასხვა ასაკობრივ ჯგუფში და განგვესაზღვრა კორელაციური კავშირი ამ ორ კომპონენტს შორის. კვლევის შედეგად გამოვლინდა ერითროციტების დეფორმაბელობის და NO-ს მაჩვენებლის ასაკდამოკიდებული ცვლილებები. NO ახდენს ზემოქმედებას ერითროციტული მემბრანის მექანიკურ თვისებებზე და იწვევს დეფორმაბელობის უნარის ასაკობრივ დაქვეითებას, რაც გამოიხატა სტატისტიკურად სარწმუნო დადებითი K კორელაციით ( $r = 0,6470$ ;  $p = 0,168$ ) ერითროციტების დეფორმაბელობასა და NO-ს მაჩვენებლებს შორის.

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*Received March, 2022*