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EFFECT OF ION BALANCE CHANGE ON ERYTHROCYTE DIAMETER

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იონური ბალანსის ცვლილებების გავლენა ერითროციტების დიამეტრზე
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რეზიუმე

ჩვენი კვლევის მიზანს წარმოადგენდა შეგვესწავლა ერითროციტებში Na + და K + იონების შემცველობა სხვადასხვა ჯგუფის მოხალისეებში და გავვეგო მიღებული მაჩვენებლები რა გავლენას ახდენდა უჯრედის ფორმის (დიამეტრის) ცვალებადობაზე. კვლევებმა აჩვენა, რომ ასაკოვანი პირების ერითროციტებში იზრდება შიგაუჯრედული Na+ შემცველობა და მცირდება K-ის იონების შემცველობა. შესაბამისად ასაკის მატებასთან ერთად იზრდება ერითროციტის დიამეტრიც, ეს კი თავის მხრივ განაპირობებს უჯრედის დეფორმაბელობის დაქვეითებას, რამაც შესაძლოა არასასურველ კლინიკურ მდგომარეობამდე მიიყვანოს პაციენტი.

The normal erythrocyte membrane is known to be insoluble with respect to monovalent and divalent cations and, therefore, contains high concentrations of potassium, low sodium and very low concentrations of calcium. Anion exchange takes place through anionic transport proteins. The content of intracellular Na⁺ and Ca⁺ ions is under metabolic control and is regulated by an ATP-dependent Na / K and Ca active pump.

With human aging, the ATP / ADP ratio decreases throughout the body, as well as in each cell [1,2] leading to a decrease in the activity of ion active pumps and disruption of intracellular electrolyte balance.

Our goal was to observe the ionic balance and cell variability of red blood cells on the example of Na⁺ and K⁺ ion content in volunteers of different age groups.

Materials and methods. We studied the ionic balance of erythrocytes in the blood of a practically healthy person and determined the cell diameter. 140 volunteers participated in the study and we divided them into 5 groups. The results of the study are processed using the student t criterion and are reliable. Determination of ion balance (Na⁺, K⁺) in erythrocytes was performed by means of an alloy photometer. The erythrocyte diameter was studied under a standard light microscope.

Results and discussion. Our studies have shown that the intracellular Na content in the erythrocytes of the elderly increases and the content of K ions decreases. It is known that the content of intracellular Na⁺ and Ca⁺ ions is under metabolic control and is regulated by an ATP-dependent Na / K and Ca active pump. Reduction of the ATP / ADP ratio in the cell (this parameter decreases with cell age) leads to disturbance of intracellular electrolyte balance [4].

At the same time, it is noteworthy that under conditions of decreasing ATP in the cell and, consequently, increasing the content of Ca ions, the permeability of Ca-dependent K channels increases [3], which leads to the departure of K ions from the cell and, consequently, causes the accumulation of Na⁺ ions, which contributes to the disruption of the osmotic balance (Na-K) in the cells and the increase in cell size.

Table 1. Indications of K + and Na + ion content in erythrocytes in people of different ages

Groups		Member (n)	K ⁺	Na ⁺	K ⁺ /Na ⁺
17-25 y.	male	14	152,6±0,8	5,3±0,3	28,7
	female	14	150,2±0,8	4,9±0,7	30,7
25-35 y.	male	14	152,8±0,3	5,4±0,6	28,3
	female	14	156,5±0,4	5,0±0,8	31,3
35-60 y.	male	14	153,8±0,4	5,3±0,3	28,5
	female	14	141,5±0,7	5,4±0,4	24,0
60-75 y.	male	14	144,0±1,5	6,4±0,2	22,5
	female	14	142,0±1,0	6,7±0,4	21,2
75-90 y.	male	14	143,6±1,2	6,5±0,3	22,1
	female	14	140,6±1,5	6,7±0,5	21,0

Diagram 1. Changes in K + / Na + ion balance in erythrocytes in people of different ages (a - 17-60 years, b - 60-90 years)

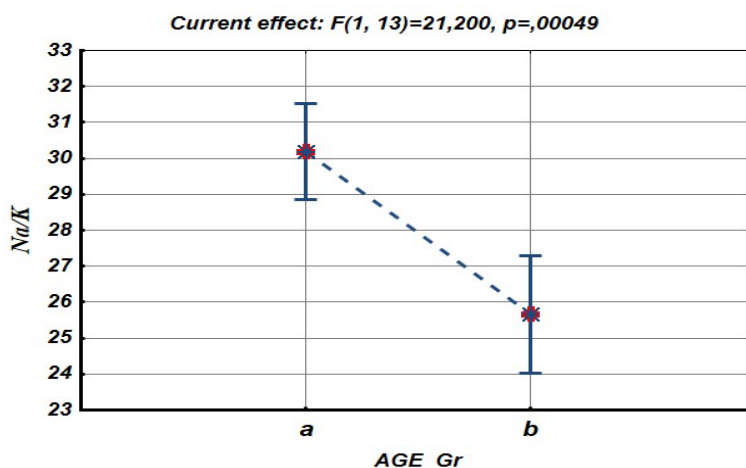


Table 1 and Diagram 1 show the content of K + and Na + ions in different age groups. The data in the table show that the content of intracellular Na in erythrocytes of the elderly increases and the content of K ions decreases.

Table 2. Erythrocyte diameter readings in people of different ages

Groups	Member (n)	diameter of erythrocytes (µm)
17-25 y.	28	5,7±0,4
25-35 y.	28	5,8±0,4
35-60 y.	28	6,5±0,4
60-75 y.	28	7,1±0,4
75-90 y.	28	7,1±0,4

Table 2 shows the mean diameter of erythrocytes in people of different age groups. Studies have shown that the diameter of peripheral blood erythrocytes in the blood of young volunteers increases compared to the rate of erythrocytes in the elderly. In particular, 17-25 years. In individuals the diameter is equal to $5.7 \pm 0.4 \mu\text{m}$, 25-35 s. In volunteers - $5,8 \pm 0,4 \mu\text{K}$, in 35-60 years - equal to $6,5 \pm 0,4 \mu\text{K}$, while in the elderly (60-90 years) this figure increases to $7.1 \pm 0.4 \mu\text{K}$, indicating an increase in erythrocyte size.

Disruption of membrane permeability in erythrocytes is possible as a result of various types of damage to these cells, development of lipid bilayer changes, and activation of a complex

with cationic channel properties. Occupation of cation channels by calcium ions causes the opening of mainly Ca-dependent K channels (Gardo channels). Activation of these channels leads to intensive excretion of potassium ions from erythrocytes (such passive transfer of ions conditionally exceeds the intensity of transport of Na⁺ and K⁺ by sodium pump), accompanied by the accumulation of Cl and water in the cell to maintain its electrolyte swelling and hemolysis. This leads to an increase in the size (diameter) of erythrocytes, which in turn reduces the deformity of erythrocytes. This leads to an undesirable clinical picture.

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ВЛИЯНИЕ ИЗМЕНЕНИЯ ИОННОГО БАЛАНСА НА ДИАМЕТР ЭРИТРОЦИТОВ

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РЕЗЮМЕ

Целью нашего исследования было определение содержания ионов Na⁺ и K⁺ в эритроцитах у добровольцев разных возрастных групп и понимание результатов, полученных при влиянии на вариабельность формы (диаметра) клеток. Исследования показали, что внутриклеточное содержание Na⁻ в эритроцитах пожилых людей увеличивается, а содержание K-ионов снижается. Следовательно, диаметр эритроцитов увеличивается с возрастом, что, в свою очередь, приводит к уменьшению деформации клеток, что может привести к неблагоприятному клиническому состоянию пациента.

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SUMMARY

The aim of our study was to determine the content of Na⁺ and K⁺ ions in erythrocytes in volunteers of different age groups and to understand the results obtained by influencing the variability of cell shape (diameter). Studies have shown that the intracellular Na⁻ content in the erythrocytes of the elderly increases and the K⁻ ion content decreases. Consequently, the diameter of erythrocytes increases with age, which in turn leads to a decrease in cell deformity, which may lead to an unfavorable clinical condition of the patient.

Key words: Erythrocyte. Na⁺ and Ca⁺ ions. erythrocyte diameter.