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MATHEMATICAL MODELLING OF HEMODYNAMIC TRANSFORMATIONS IN THE MICROCIRCULATORY CHANNEL IN POST-COVID OCCLUSIVE MICROTHROMBOANGIOPATHY

МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ ГЕМОДИНАМІЧНИХ ПЕРЕБУДОВ МІКРОЦИРКУЛЯТОРНОГО РУСЛА ПРИ ПОСТКОВІДНІЙ ОКЛЮЗИВНІЙ МІКРОТРОМБОАНГІОПАТІЇ

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Recently, the medicine is often faced with consequences of the Covid pandemic, in particular, with seemingly causeless processes of thrombus formation at the level of microcirculation. There are important tasks of finding criteria for evaluating thrombosed capillaries and dissolving the corresponding blood clots at the level of microcirculation.

Vascular Screening Technology [1] enables to find places of localization of blood clots both in different segments of capillaries and in the lumen of main and peripheral blood vessels [2]. During 2020–2024, the visualization of the microthrombi has increased to 85-95% in the population during the screening study of in-vivo microcirculation in ordinary citizens

of Ukraine who contracted covid-19 of varying degrees of severity and/or were vaccinated with various Covid vaccines. Prior to 2020 the phenomena of microthromboangiopathy were practically not encountered during in-vivo microcirculation screening (maximum 1% of the population).

We have considered and modelled several variants of the micro-circulatory reconstruction in microthromboangiopathy, which has non-specific properties of a glomerular conglomerate of post-Covid protein and blood cells, which forms new models of cardiovascular lesions of infectious genesis (currently of post-Covid genesis) and is being formed in the 3rd week from the beginning of the Covid.

At the moment, we have differentiated among the pathological patterns of intravascular microthromboangiopathy the punctate and segmental (within 1-2 segments of the capillary – mainly the venular segment and the transition knee), the consistency of thrombotic masses in the capillaries – thick, solid and spongy, soft, dense, which leads to different approaches to mathematical modelling of each of these patterns in particular.

At the same time, we have simulated the situation when the capillary becomes gigantic and corresponds to the clinical picture of systemic scleroderma. The mathematical modelling of pathological hemodynamic rearrangements in giant capillaries enabled to reveal the phenomenon of massive aggregation and agglutination of erythrocytes with visualization of a grain-like mass of blood, which paradoxically moves with a trajectory similar to breakaway currents.

During the observation of blood movement in giant capillaries, it has been found that during the formation of blood clots in the transitional knees of capillaries there is a compensatory "effect of flow velocity" [3], which, in particular, can lead to the emergence of so-called "sponge blood clots" with quite hard internal and soft external structures. This structure of the thrombus enables erythrocytes and other blood elements to move near the wall in the capillary and partially perform their inherent metabolic functions. In this way, they partially preserve blood flow through the capillary and try to perform their main function – to maintain blood movement – blood flow even in damaged capillaries.

It is obvious that the movement of blood and metabolic processes slow down, because the erythrocyte rubs against the thrombus. Spongy thrombi often occur in the bends of capillaries, in particular, in transitional knees.

The Vascular Screening Technology [1] enables to observe blood circulation and the movement of erythrocytes in capillaries clogged with spongy thrombi and monitor the processes of thrombosis treatment (dissolution of spongy thrombi).

Depending on the internal conditions in the human body, hard blood clots that do not have a spongy structure can also form in the capillaries.

Then the internal space of the capillary can be completely covered by a thrombus – occlusion and the capillary ceases to function, and the process of treating thrombosis is complicated. This phenomenon is called occlusive microthromboangiopathy and can be presented in vivo in different variations, both total occlusion and partial with partially preserved blood flow in the capillaries.

The authors has developed an approach for studying the movement of erythrocytes with variable mass in capillaries to study the processes that occur during the movement of blood in capillaries clogged with spongy thrombi [4, 5].

*Conclusions***.** In vivo methods for visualization of hemodynamic processes in normal and pathological conditions are extremely important for the objectification of hemodynamic changes, differentiation of sanogenic and pathological transformations of capillary structure and functions and the microcirculatory bed in particular.

Mathematical modelling of hemodynamic changes enables to investigate the nature and vector of these changes in both the sanogenic and pathological directions, to identify key mechanisms and trigger zones for the formation of cardiovascular pathology.

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