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BLOOD FLOW MECHANICS IN THE MICROCIRCULATION IS A SPECIFIC SCIENTIFIC FIELD

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Abstract. Actually, blood is not a true fluid in the narrowest microvessels, up to 15-20 μm in diameter, since up to half of its volume compose the red cells whose size is commensurable with the microvessels' lumens. For a better understanding of the physical backgrounds of the blood flow inside this latter we propose to make an analysis of the blood flow structure (structuring) and its disturbances inside the living microvessels.

Key words: blood flow mechanics, microcirculation, microvessels

In the narrowest microvessels – capillaries, adjacent arterioles and venules, up to 15-20 μm in diameter, the blood is actually not a fluid and the word "flow" might be, therefore, even not quite adequate. This is because almost half of the blood's volume is occupied with cells whose sizes are commensurable with the vessel’s lumen, and, therefore traditional biorheological approaches are actually helpless to find the fundamentals determining the normal blood flow and its disturbances in such microvessels. Biorheologists, who are considering mechanical basis of the non-Newtonian fluid flow, unequivocally certify that advancement of the blood in channels with the lumen’s diameter of 5-25 μm is not a subject of the presently known biorheological regularities [1]. Nevertheless, nobody can doubt that the normal blood flow in the living microvessels is a biomechanical phenomenon.

Importance of the blood flow mechanical regularities in the microvessels is tremendous. Solution of these problems is necessary for a better understanding of the microcirculation under the normal conditions and even more when blood rheological properties become disturbed during various pathologies. It is difficult to overestimate significance of this scientific field, which could be identified as microhemorheology or microhemomechanics, since it is well known that hemorheological disorders play an essential (often even determining) role in development of various important pathologies, such as inflammatory processes and development of such diseases, as arterial hypertension, cerebral and cardiac infarcts, and many others.

But the present-day biomedical workers have no sufficient knowledge to carry out a thorough analysis of the non-Newtonian fluid mechanical regularities of the blood flow in the narrowest microvessels. To overcome these difficulties the biomedical microcirculationists need to collaborate with specialists of the non-Newtonian fluid mechanics in order to investigate these problems, which are highly important for the modern biomedical science.

For the specialists investigating the microcirculation these problems are not new, since they were in focus of scientific interests in course of a century or so. During the recent decade there is certain advancement in a better understanding of the biomechanical nature of blood flow in the microvessels. Proceeding from the perennial research and thorough consideration of the normal blood flow and its disturbances in the capillaries under conditions of unchanged arterial-venous pressure difference along their course and of their unaltered diameters, we arrived at the conclusion that it is the normal blood flow structure that might be the principal factor determining the rheological properties of the flowing blood and its disturbances in the microvessels. Now the phenomena of the blood flow structuring in the microvessels are to be analyzed from the biomechanical point of view in more details.

Proceeding from the results of our perennial animal experiments, the blood flow "structure" (or "structuring") in the most narrow microvessel's lumen becomes disordered by any cause, e.g., when the red blood cells become aggregated (pasted in-between in form of rouleaux or clumps) the blood "fluidity" decreases dramatically in the microvessel's lumen. This immediately results in a considerable slowing-down of the blood cell advancement in the microvessels till its full stasis. This occurs despite the fact that the arterial-venous pressure gradient remains preserved and that the microvessels' lumens do not narrow in any points along their course. These phenomena were repeatedly analyzed in our scientific articles [2-6].

I would like to pay attention of the appropriate specialists in biomechanics to the phenomena that are of a paramount significance for the theoretical biomedicine and for the medical practice. I am thoroughly convinced that without close collaboration of specialists in the microcirculation and the experts in the non-Newtonian fluid mechanics, these problems cannot be solved appropriately and therefore cannot become useful for the medical practice. It is to be specially mentioned that the phenomena of blood "fluidity" in the narrowest microvessels are complex for direct investigation, and special experience of the specialists is necessary to carry out such research successfully. The Microcirculation Research Center, Tbilisi, Georgia has a perennial experience and is ready to start collaboration with specialists in this field. We are convinced that this research will be essential for both biomechanics and medical practice.

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МЕХАНИКА КРОВОТОКА В МИКРОКАПИЛЛЯРАХ КАК ОТДЕЛЬНОЕ НАУЧНОЕ НАПРАВЛЕНИЕ

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В микрососудах с просветом до 15-20 μm в диаметре кровь фактически не является жидкостью, т.к. до половины ее объема составляют эритроциты, величина которых сопоставима с сосудистым просветом. Для выяснения физических основ кровотока в таких микрососудах мы предлагаем анализировать в совместных биомедицинских и биомеханических исследованиях структуру (структурирование) кровотока и ее нарушения внутри живых микрососудов.

Ключевые слова: механика кровотока, микроциркуляция, микрососуды

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