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MAIN TRENDS IN EXPERIMENTAL MORPHOLOGICAL RESEARCH  
IN ANGIOLOGY AND OUTLOOK FOR ITS DEVELOPMENT<sup>1</sup>

by

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In our country there are a number of authoritative morphological centers where urgent questions of experimental angiology are being successfully solved. The majority of them have a direct or indirect relationship to the largest Soviet school of angiologists created by V. N. Tonkov.

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The direction selected by V. N. Tonkov (a study of the experimental morphology of circulatory compensation) was further developed in the works of B. A. Dolgo-Saburov and his colleagues. In addition to a clarification of the plasticity of the near-vascular bed, venous system and vascular-neural bonds they focused a lot of attention on the use of functional criteria to judge the effect of disrupted circulation on the working state of the organs.

The monograph of B. A. Doglo-Saburov Ocherki funktsional'noy anatomii krovenosnykh sosudov ["Essays in Functional Anatomy of the Blood Vessels"]

<sup>1</sup>Report at symposium of VNOAGE [All-Union Scientific Society of Anatomists, Histologists and Embryologists] on experimental angiology in Dnepropetrovsk, 1972.

\*Numbers in margin indicate pagination in original foreign text.

published over 10 years ago, was the result of a large number of observations on experimental angiology. It contains many valuable conclusions and ideas from a methodological viewpoint whose realization promises further progressive development of angiology as applied to modern needs of the theory and practice of medical science.

The problem of collateral circulation is being fruitfully worked on in a number of laboratories in the country. Purposeful and productive searches in this respect have been promoted by the topical conferences regularly set up in Ivano-Frankovsk. The main promising trends in the problem of collateral circulation are the following: 1) study of the laws governing the reconstruction of blood and lymphatic vessels in model experiments with a change in circulation and with the corresponding pathological states in man; 2) study of the species plasticity of vessels at stages of phylo- and ontogenesis; 3) study of the morphology of macro-microcirculation in organs during ischemia, disruption in the venous outflow, reduced circulation; 4) creation of new models to study indirect blood flow under conditions close to practical medicine (vascular occlusion, gunshot and dull trauma of vessels, etc.) with the clarification of peculiarities in the formation of collaterals; 5) study of the mechanism for opening of the collaterals and search for methods of stimulating the collateral blood flow; 6) study of the process of reduction in the indirect paths after restoration of the passability of the main vessels; 7) substantiation of the extant and working out in experiment of new and effective approaches to revascularization of organs; 8) combination of morphofunctional methods to take into account the compensatory-adaptive changes in the ischemic organs during their transplantation, etc. /22

Fundamental stereo-morphological studies on different aspects of functional angiology were made by D. A. Zhdanov and his colleagues. Extensive factual material in this direction has been accumulated in the Institute of Experimental Morphology of the Georgian SSR Academy of Sciences. Studies on the organ-specificity of blood vessels, especially capillaries, are being made with regard for clinical needs. It has been established that despite the restoration of circulation on indirect paths, the inter-relationship of capillaries with the tissue elements is disrupted. These

disorders are more significant in the highly differentiated tissues, which was confirmed in experiments with ligation of the common carotid arteries and study of the capillary network of the cortex of the large hemispheres, with the deletion of the coronary arteries of the heart, pulmonary, intestinal, hepatic and uterine arteries, and vessels of the endocrine glands.

In recent years advances have been made in studying the finest structure of capillaries with the help of methods of electron microscopic analysis and cytochemical analysis (D. A. Zhdanov, V. A. Shakhlamov, A. M. Chernukh, Ya. L. Karaganov, et al.).

Work on experimental revascularization and innervation of internal organs and the participation in this of the vessels and nerves of the commissure has practical directivity (D. M. Golub, et al).

A broad front of studies is underway on the adaptation of the microvessels, their plasticity under conditions of altered hemodynamics, and in the simulation of pathological situations. The leading morphological center on the problem of microcirculation is the laboratory headed by V. V. Kupriyanov.

An investigation of the structural polymorphism and dynamics of the paths of microcirculation under a light and electron microscope is necessary first of all to reveal the actual mechanism of microcirculation and a deeper understanding of the details of the structure of the histohematic barrier that guarantees tissue metabolism. Determination in acute and chronic experiments, on living and nonliving objects of the potential properties of the microcirculatory system, functional mobility of its links, their successive adaptive changes remains the task of micro-angiology in the immediate future.

A new trend in experimental angiology to study the effect of gravity loads, hypodynamia and hypokinesia on the vascular bed and readaptation of the organism to these factors that has been greatly developed in the laboratory of M .G. Prives has great importance for cosmology and clinical medicine. Diverse links in the vascular bed of the same object and wall

of the vessels are subject to study. Based on the findings patterns are worked out for special trainings for gravity loads and the laws are revealed that govern their effect on the organism in order to prevent pathological shifts caused by hypergravitation. Work on this topic is also underway in the departments of anatomy of the S. M. Kirov Military Medical Academy, the Second Moscow Medical Institute, and other institutions. Studies on the effect of G-forces on the neural instruments of the heart and major vessels have a direct relationship to this trend (S. S. Mikhaylov, et al.). All of this work contributes to the development of a new trend, space anatomy of the vascular system.

The adaptation changes in the cardiovascular system under the influence of extreme and climate-geographical factors are being successfully studied in experiment by the angiologists of Central Asia (Ya. A. Rakhimov, R. I. Khudayberdiyev, L. Ye. Etingen, A. L. Leytes, et al.). The obtained morphological data must be considered in an analysis of the mechanisms for the disorders that emerge during the effect on the human organism of these factors, as well as to substantiate the permissible physiological parameters, 123

A large series of work on investigation of the plasticity of the paths of circulation on the background of simulation of the pathological states has been fulfilled at the department of anatomy of the Kirgiz Medical Institute under the leadership of A. L. Leytes.

The experimental methods in angiology are successfully used in studies of an ecological and comparative-anatomical nature (V. G. Kas'yanenko, S. N. Kasatkin, et al.), and in the biological simulation of different cardiovascular diseases (K. I. Kul'chitskiy et al.).

Experimental and morphological studies in angiology are planned and executed without centralized correction on the part of the VNOAGE. Often the themes therefore are duplicated, are brought up to date by modifications of experiments which are set up at times on an unjustified large number of animals. It is inexpedient to artificially reproduce such situations that are not characteristic for clinical pathology. At the same time one should focus attention on the need to conduct experiments not on healthy animals,

but on models that are close to the human pathology.

Of course, all questions that disturb modern biology and medicine, in particular on the problem of diseases of the heart and vessels cannot be solved only by experimental approaches.

Not to mention the defective background from previously endured diseases which is usually not reproduced in the process of biological simulation we are deprived of the possibility of specifically considering the chief importance of social factors, manifestations of the characterological features of the psychic sphere, the action of different stress factors in their interaction, all that characterizes man as a social being.

Here combined experimental and clinical-anatomical studies are needed, a complex and multilateral approach to the solution of particular problems and their correct methodological evaluation.

Because of method difficulties there are still few works covering the venous system. Thanks to the fact that the extant methods have not succeeded in overcoming the valve barrier, the veins of certain internal organs, extremities and other parts of the body have still been revealed and studied to an insufficient extent.

It is necessary to improve the methods of precise distinction of the finest arteries, veins, arteriovenous anastomoses, capillaries on total preparations and sections of organs by combining the injection and injection-less techniques. This will make it possible under experimental conditions to make a combined analysis of the changes in different links of the unified blood channel.

Morphological studies on angiology are still being made primarily by qualitative methods of evaluation. A conclusion on the state of the blood supply to the organ, and the nature of vascularization is often made based on the presence on the preparations of a rich or poor vascular network, roughly greater or smaller quantity of vessels, and their sufficient or weak filling with the contrast mass. Corresponding quantitative methods

for considering the capacity of the vessels and micrometric studies of their parameters (density per unit of area, ratio of the width of the lumen to the thickness of the medium, indices of vessels, etc.) with subsequent processing of the numerical data by methods of variational statistics are used little.

Discussions on the capacity of the vascular bed, the volumetric rate of circulating blood, intensity of blood flow and change in the hemodynamics are valid only with the use of the extant functional methods for studying the circulatory system.

It is impossible to run to other extremes by fetishizing mathematical computations to derive innumerable variants of the vascular picture into simplified plans that are far from real life.

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The morphologists studying the blood vessels give little attention to the vascular wall. Often they speak of the reconstruction of vessels, changes in the architectonics of the latter, transformations, etc., actually implying by these terms only the general redistribution, recalibration, and change in the customary relationships of the elements in the vascular network, and the plan of its branching. By reconstruction of the vessel one should understand the histological changes in the endothelial lining, elastic framework and muscular membrane. They produce a secondary disorder in the linear orientation, shape of the vascular lumen and its contours. In this respect in the general plan of experimental and morphological studies by analogy one should focus considerably more attention on the vascular wall, viewing its changes as a mobile and reliable indicator of reactivity by means of circulation in hemodynamic shifts.

Until now not enough attention has been given to a study of those disorders on the part of the organs and parts of the body that can emerge during limited vascular supply at the stages of prenatal and post-natal ontogenesis; as yet there are no convincing data on the effect on the vascular system of ultrasonic, super-frequency impulse magnetic fields and many other powerful physical factors that affect the human organism in the

production situation. The circle of questions concerning the effect of intensified and reduced physical load of static and dynamic nature of unequal duration on the state of the circulatory paths of the support-motor apparatus and internal organs has far from been exhausted. Such studies are necessary to substantiate the corresponding complexes of therapeutic-physical culture exercises. There is little information about the morphological expression of the functional angiospasm, the effect of experimental ischemia on the organism in different periods both before and after their transplanting. The morphogenesis of experimental acute and chronic occlusion disease of the veins, in particular of the lower extremities, and post-thrombophlebitic syndrome still has not been studied.

Of great importance are the combined experimental and clinical-anatomical studies on the state of adaptation and de-adaptation of the macro-microcirculatory bed during progressive disruption in the hemodynamic pattern (hypertonia, hypotonia, etc.), atherosclerosis, different forms of coronary insufficiency, cardiac failures, etc. We consider it urgent to further work out the experimental morphology of the vascular-neural bonds, clarify the laws governing the intimate relationships and organ specificity of the capillaries and neural fibers, capillaries and nerve cells, capillaries and nerve endings in the dynamics of modeling different functional shifts and diseases. The results of these observations can cast light on the importance of the local vascular-neural component in the pathogenesis of the neural-vascular and neural-dystrophic disorders.

The problem of the structural dynamics of the blood channel of different levels of the central nervous system during simulation of the pathology of cerebral circulation, a frequent cause of serious neurological diseases in man remains a current one.

There are still many other urgent problems and trends in whose development great importance is attached to the methods the experimenters-angiologists are armed with.

The modern angiologists must strive for a favorable combination in their

studies of macro-, macro-micro, micro- and submicroscopic methods and resources. In order to study vessels there is still insufficient practice of methods of intra vitam arterio- and vengraphy, vital microscopy, histo-autoradiography, luminescent and electron microscopic analysis with parallel study of the substrate of the vascular and histoemetic permeability. /25

This is explained by the lack of a material and technical base of the angiological laboratories, as well as the insufficient unification of the scientific efforts of the angiologists with the physiologists, pathophysiologicalists, pathomorphologists and clinical physicians.

Perfection of the old methods that have been accepted for a long time in angiology, and continuous search for new methods for the optimal detection of the structural nature of the vessels, this is our important duty.

Not satisfied with the advances made in investigating the structural mechanisms of the circulatory system in experiment, the morphologists of the Soviet Union, undoubtedly, will do everything possible so that, by using the advantages of modern scientific and technical progress they will make by new basic discoveries and research the optimal contribution to the realization of the decisions of the 24th CPSU Congress on preventing and treating cardiovascular diseases.