ACHIEVEMENTS OF THE MEDICAL FACULTY — Varna
IN THE FUNDAMENTAL STUDIES
OF CARDIOVASCULAR SYSTEM

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Fundamental studies conducted in the Medical Faculty — Varna are morphological and physiological in character, and deal with normal, as well as with experimentally and pathologically altered vessels. Systematic researches into venous, arterial and terminal blood vessels are carried out in the Chair of Anatomy and Histology. Their morphological manifestations are investigated at different levels — from ultrastructural to macroscopic — both in humans and laboratory animals of varying age, with quantitative analysis invariably extensively used.

The study of venous vessels covers their structure, vascularization and valve apparatus. The fine relationships between ground structural components of the venous wall (endothelium, smooth muscle cells, elastic and collagen fibers) are studied with electron microscope, and a number of new aspects of its build-up, developmental mechanism and permeability are elucidated (5, 45). A dense contact is established between smooth muscle cells and elastic and collagen fibers, as well as disappearing of the basement membrane in the junction zones. Data are obtained concerning the participation of smooth cells in the formation of elastic substance, and endothelial cells — in the formation of the subendothelial intima. The abundant pinocytosis in the thinned endothelial cells’ areas, and the lacking occlusion zone in the intercellular contacts points to an intense transendothelial transport in the venous wall, which in turn proves the participation of venous blood in its nutrition. The structure of major veins in man is studied under age-related aspect, and the results obtained contribute to the solution of a variety of controversial problems, clarification of some new items in the venous wall structure, and to the outlining of new regularities as well (4, 5, 15, 16, 19, 20, 44). Proceeding from the latter achievements, a new classification of veins is proposed (4, 5).

For the first time, the intramural vessels of veins are studied under conditions of complete capillary bed demonstration, enabling us to obtain reliable evidence of the penetration of capillaries into the venous wall, capillary network density and structure of the microcirculatory system. All major veins, and some small-caliber venous vessels in man are investigated in a similar fashion (2, 3, 4, 5, 8, 9, 10, 15, 16, 19, 20, 24, 25, 37, 38, 44). A critical thickness for the vascularization of the true venous wall is established, and its parameters are defined (4, 5). Age-related changes in the degree of vascularization are elucidated, pointing out that with the growth of the individual, an inner avascular layer is formed in the venous wall, with the capillary network within the latter displaying a strong rarefaction (2, 3, 4, 5, 16, 19). On the basis of morphological peculiarities of the valve cusps and venous wall in the region of valves, the character of incomplete venous valves
Achievements of the medical faculty...

is described (2, 4, 5, 6). Against the background outlined, and after studies on a vast material from practically all valvular veins, the issue of age-related changes in the valvular apparatus is solved, with a valve regression being proved during the growth period of the individual up to middle age (4, 5, 16, 19). For the first time, on the ground of objective data, it is established that the irregular form of valves, and their insufficient loading promote the process of involution (4, 5, 40). The achievements of the venous wall study may have an important impact on venous diseases, where various problems relating to pathogenesis, prophylaxis and clinical course are still awaiting solution. Researches into the structure, vascularization and valvular apparatus in most of the human major veins yield a complete characteristic of the venous wall, both qualitative and quantitative, and define its qualities as a transplant in the reconstructive surgery of vessels. It becomes possible to assay which of the veins, and which of their segments are most feasible for utilization as grafting material.

Researches into the arterial wall deal with vascularization, presence of acid mucopolysaccharides, fine structure of the components, and endothelium permeability. The basic regularities of the arterial wall vascularization are clarified in experiments on dogs (7, 42, 47), and thereupon corroborated and further specified on human main arteries (10, 36, 43). It is demonstrated that the depth of intramural vessels’ penetration into the arterial wall is directly dependent on the latter’s thickness and blood pressure (penetration is deepest in the pulmonary trunk because it has the lowest blood pressure); in the systemic circulation arteries, the vessels penetrate deepest into the wall of the aortic arch, and thereafter along with thinning of the wall, they are gradually withdrawn towards the adventitia; in the arteries of muscle type, as a rule, the adventitia alone is vascularized, whilst in the thickened media — its outer parts as well. Acid mucopolysaccharides are mainly concentrated in the avascular zone of the arterial wall (7, 28). The microcirculatory bed structure in the arterial wall is also clarified. In the arteries of elastic type the terminal vascular bed displays a loop-like pattern with a varying degree complexity of the formations, dependent on the depth of their penetration into the media, whereas in the muscle type arteries the intramural vessels form a reticulum. Based on a biophysical analysis of the data concerning vascularization of the arterial wall, an original concept about a pumping mechanism effect on blood circulation within the intramural vessels is substantiated — the pulse wave causes rhythmic squeezing of the vessels which in turn facilitates the blood flow through them (39). Aortic wall structure and innervation are studied under comparative anatomy aspects in different vertebrate classes (17, 27).

Systematic data are obtained concerning age-related changes in the ultrastructure of cellular and acellular components of the arterial wall (11, 12, 31, 45). It is established that prior to birth and in the neonatal period, the endothelial cells have a strongly developed apparatus, characterized by secretory activity, attributable to the elastogenesis in the subendothelial intima. In the later stages of ontogenesis, they usually stand out through the abundance of micropinocytotic vesicles, complicated junction relationships, and clearcut luminal and basal formations, pointing to differentiation in terms of transendothelial transport (45). To clarify the dynamics of such transport, researches are conducted using tracer macromolecules. Also original data are
obtained concerning age, related differentiation of the subendothelial intima which appears to be the morphological target of arterial lesions (11, 45) Two basic types of smooth muscle cells, whose quantitative ratio and intramural topography display dynamic changes depending on age, are described (12, 45). In fetuses and in the early postnatal ontogenesis, virtually all smooth muscle cells are differentiated as cells with secretory activity, attesting their participation in the formation of the extracellular matrix and fibrillary elements. Using the antimicrotubular agent colchicine, the role of microtubules in the secretory process of these cells is elucidated. The morphology and origin of lysosome formation within them are also studied. Characteristic arterial wall structures, coined in the literature with the term "ghost bodies", are described and followed is dynamics with due clarification of their morphology, origin and significance. The fine relations between cellular and fibrillary elements in the aorta and pulmonary trunk are also studied (31).

The microcirculatory bed structure in various organs is investigated, and an overall idea about the pathways of blood and terminal vascular formation in these organs is obtained. Systematic data are also available concerning the microvascularization in all parts of the cardiac wall and pericardium (14, 23). Of particular interest are the vascular formations with functional-adaptational character observed in the heart; they have an essential bearing on the prevention of tissue lesions in mechanical stress conditions, occurring subsequent to atrio-ventricular valves' occlusion. Blood routes in the lymph node are elucidated, as well as the relations of blood vessels to lymph sinuses and lymphoid formations in view of the direct exchange of lymphocytes between blood and lymph node, which is essential for immunity induction (1, 21, 22, 41). A description is made of the microcirculation system structure in the components of the lymph node parenchyma, secondary follicles inclusive, where a central vascular plexus is found within the germinative centers, providing for continuous contact between blood and cell elements. New findings are reported concerning the structure and functional activity of capillary bed and specific vascular formations in the large salivary glands of man and animals (18, 29, 30). The results of studies on thymus microvascularization (13), and regional peculiarities of the terminal vascular bed in the lower limb skin represent contributions to the literature on this particular issue (26).

In the course of investigating age-related changes in the ultrastructure of terminal blood vessels in rat adrenal gland, using tracers, some new aspects in the fine structure manifestations of transendothelial permeability are outlined. Also special structural appliances for glandular cells to blood approximation are detected, promoting the intensification of transendothelial transport, the passage of hormones from glandular cells into blood inclusive (32, 33, 46).

In the Chair of Pathophysiology, making use of up-to-date methods of examination, a substantial progress is made in the study of blood supply of organs and tissues in various experimental set-ups — atherosclerosis, brain edema and burns (34, 35). It is established that protein hydrolysate introduction into animals with experimental atherosclerosis, at parallel cholesterol nutrition, secures a better blood supply of internal organs and improvement of the rheological properties of erythrocytes. The functional studies performed show less pronounced pathological changes in the heart. In animals with brain edema, subjected to beforehand protein hydrolysate protection, the blood
supply of the brain is improved. After burns and protein hydrolysate treatment, a normalization of the volume of circulating blood and plasma, lower hematocrit values and shortened semiactivity period are established, pointing to an improved permeability and tone of the microcirculatory bed. It is furthermore demonstrated that the favourable effect of protein hydrolysate on the blood supply is to be attributed to the trophic effect of amino acids on the endothelial cells of vessels, and on the normalization of their permeability, as well as to the improved rheology of formed elements. The obtained results give us sufficient reason to recommend for clinical trial a variety of methods and schemes for prophylaxis and treatment of the above mentioned pathological conditions.

REFERENCES

ДОСТИЖЕНИЯ В ФУНДАМЕНТАЛЬНЫХ ИССЛЕДОВАНИЯХ
СЕРДЕЧНО-СОСУДИСТОЙ СИСТЕМЫ В МЕДИЦИНСКОМ
ФАКУЛЬТЕТЕ — ВАРНА

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РЕЗЮМЕ

Сообщаются обобщенные результаты морфологических и физиологических исследований сердечно-сосудистой системы у людей и экспериментальных животных, касающихся ультраструктуры, тканевого строения, васкуляризации и клапанного аппарата вен. Исследованы тонкое строение, проницаемость эндотелия, наличие кислых мукополисахаридов и липидов, а также и васкуляризация артериальной стенки в возрастном аспекте. Сообщаются результатом исследований микроциркуляционного русла в надпочечнике, сердце, слюнных железах, лимфатических узлах, вилочковой железе и др. Отражены достижения в изучении орошения органов и тканей при экспериментальных постановках — атеросклерозе, отеке мозга, ожогах и др.