FEATURES OF THE ANGIOARCHITECTONICS OF THE TERMINAL VASCULAR BED IN DIFFERENT SKELETAL MUSCLES

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Abstract. This article presents the results of a study of the terminal vascular architecture of various human skeletal muscles using a macromicroscopic method. The investigation was performed after preliminary injection of the blood vessels with transcapillary injection masses, followed by fixation, clarification, and meticulous dissection of the specimens. Although the structural organization of the microcirculatory bed in human skeletal muscles is characterized by many common features, each muscle and even each of its individual regions exhibits distinctive angioarchitectural characteristics. These differences should be interpreted in relation to the specific functional role and physiological demands of each muscle.

Keywords: human, skeletal muscles, blood vessels, capillaries, vascular injection, transcapillary injection masses, arterioles, venules.

ОСОБЕННОСТИ АНГИОАРХИТЕКТОНИКИ ТЕРМИНАЛЬНОГО КРОВЕНОСНОГО РУСЛА В РАЗЛИЧНЫХ СКЕЛЕТНЫХ МЫЩЦАХ

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Аннотация. В данной статье изучено терминальные кровеносные конструкции различных мышц человека макромикроскопическим методом после предварительной инъекции сосудов транскапиллярными массами, с последующей фиксацией объектов, просветлением и препарированием. строение микроциркуляторного отдела кровеносной на многие системы схожие скелетной мускулатуры человека, несмотря черты, в каждой мышце, в

каждой ее части каждое отличается своеобразием, которое нужно рассматривать с точки зрения их функциональной предназначенности.

Ключевые слова: человек, мышцы, сосуды, капилляры, инъекции сосудов, транскапиллярными массами, артериоы, венулы,

Introduction. The microcirculatory component of the vascular system has recently become the focus of extensive scientific research [1,2]. It has been established that terminal vascular structures possess a remarkable capacity for adaptation and structural remodeling depending on the functional state of the organ. Despite the considerable number of studies devoted to microcirculation, not all organs and systems have been investigated to the same extent [3,4]. In particular, insufficient attention has been paid to the terminal vascular bed of skeletal muscles, although the organization of the capillary network plays a crucial role in the functional activity of the locomotor system.

Objective. To investigate the angioarchitectural features of the terminal vascular bed in various human skeletal muscles.

Materials and Methods. The terminal vascular networks of different human skeletal muscles were examined using the macromicroscopic method following preliminary vascular injection with transcapillary contrast masses. The specimens were subsequently fixed, cleared, and carefully dissected. The components of the microcirculatory system were characterized according to their branching pattern and the structural features of the vascular wall.

Results. Our findings confirm the existence of a common pattern of vascular branching in all skeletal muscles examined. Intramuscular arteries form numerous anastomoses with one another, creating vascular plexuses with meshes of various sizes and shapes. Precapillaries arise from arterioles forming the boundaries of large vascular meshes and are most commonly oriented transversely or obliquely to the muscle fiber bundles. These precapillaries give rise to capillaries extending in different directions; however, their course generally corresponds to the longitudinal axis of the muscle fibers.

The arterial segment of the capillary gradually or abruptly increases in diameter and transitions into the venous segment. Venous capillary segments merge to form postcapillaries, which run in the opposite direction to the precapillaries and drain into venules. Capillaries are interconnected by transverse anastomoses, forming characteristic capillary networks occupying the space between the pre- and postcapillaries, thereby providing the capillary bed with a segmented organization.

Examination of the vascular beds of the extraocular muscles, masticatory muscles, diaphragm, lower limb muscles, tongue muscles, and other skeletal muscles demonstrated considerable variability in vascular arrangement. In some muscles (extraocular muscles, pectoralis major, gastrocnemius), arterioles and accompanying venules are located within the connective tissue between muscle bundles and run parallel to the muscle fibers. In others (gluteus maximus, quadriceps femoris), they are predominantly oriented transversely to the muscle fibers. In certain muscles, including the masticatory muscles, diaphragm, and tongue muscles, the orientation of arterioles varies considerably relative to the direction of muscle fibers. The smallest distance between the capillary bed and the main vessels was observed in the extraocular muscles, facilitating efficient blood inflow and venous drainage. Pronounced differences were also found in the architecture of the capillary network among different muscles. The shape of capillary meshes ranged from long and narrow in the diaphragm and pectoralis major to small oval meshes in the extraocular muscles. The architecture of the terminal vascular bed differs not only among individual muscles but also between different regions of the same muscle. At the musculotendinous junction, blood vessels gradually increase in diameter toward the muscle belly while maintaining predominantly longitudinal orientation.

The vascular bed of the external and internal intercostal muscles is morphologically continuous. Each intercostal space contains two constant arterial trunks running along the superior and inferior margins of the ribs, connecting the vascular systems of the internal thoracic artery and the posterior intercostal arteries. Considerable variability was observed in the transverse and oblique

orientation of arterioles relative to muscle fibers. Such vascular organization appears to maintain optimal blood flow during contractions of the intercostal muscles accompanying respiratory movements of the thoracic cage. In broad, flat muscle bundles, a characteristic arteriole crosses the muscle fibers transversely and gives rise to precapillaries branching predominantly at acute angles. The length of the precapillaries generally corresponds to the width of the muscle bundle because they extend from one margin of the bundle to the other. Capillary branching, abundant anastomoses, transitions of capillaries from one muscle fiber to another, and their distribution in different planes create a highly developed three-dimensional capillary network. Long, non-anastomosing arterioles running parallel to the longitudinal axis of the muscle bundle divide at acute angles into two precapillaries extending in opposite directions. These vessels either branch into two or three capillaries or gradually taper into single capillaries. In these cases, the course of the precapillaries coincides with the longitudinal axis of the muscle bundle. When an arteriole approaches a muscle bundle from one side at an acute angle, the architecture of the precapillary network does not differ substantially from that described above.

Conclusion. The formation of postcapillaries and venules within the intrinsic muscles of the tongue also demonstrates considerable variability. Postcapillaries are formed by the confluence of one to four capillaries, while the relationship between precapillaries and muscle bundles depends on the topographical arrangement of these vessels.Thus, although the microcirculatory bed of human skeletal muscles exhibits many common structural characteristics, each muscle and even each of its regions possesses distinctive angioarchitectural features that should be interpreted in relation to their specific functional roles.

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