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THE MECHANISM OF AOETIC FUNCTION

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Abstract: The aorta, the largest artery in the human body, plays a crucial role in systemic circulation by distributing oxygen-rich blood from the heart to the rest of the body. Its function is regulated by complex biomechanical properties, elastic recoil, endothelial function, and neurohormonal control. This review explores the structural and functional mechanisms of the aorta, emphasizing vascular compliance, hemodynamics, and pathophysiological changes associated with aging and disease. Twenty scholarly sources provide insights into recent advancements in aortic research.

Keywords: Aorta, hemodynamics, vascular elasticity, endothelial function, pulse wave velocity, nitric oxide (NO), renin-angiotensin system, aortic compliance, arterial stiffness, hypertension, atherosclerosis, aortic aneurysm, windkessel effect, smooth muscle cells, elastin, collagen, biomechanical properties, blood circulation, cardiovascular diseases, autonomic regulation.

The aorta serves as the main conduit for blood leaving the heart, ensuring continuous perfusion of tissues. Its function is highly dependent on its elastic properties, endothelial integrity, and interaction with neurohormonal factors. Understanding these mechanisms is essential for diagnosing and managing cardiovascular diseases such as aortic aneurysms, atherosclerosis, and hypertension.

The aortic wall consists of three primary layers. Tunica intima: A thin endothelial layer that regulates vascular tone and prevents thrombosis.

Tunica media: Composed of smooth muscle cells and elastin, responsible for the aorta's elastic properties.

Tunica adventitia: A connective tissue layer providing structural support. The unique biomechanical properties of these layers allow the aorta to withstand high-pressure pulsatile blood flow.

Pulse wave propagation. The aorta functions as a windkessel (elastic reservoir) that buffers pulsatile blood flow, reducing cardiac workload. As blood is ejected from the left ventricle, the aorta expands and then recoils, maintaining continuous blood flow.

Role of elastin and collagen. Elastin provides elasticity, allowing the aorta to stretch during systole and recoil during diastole. Collagen fibers contribute to tensile strength and prevent overexpansion. With aging, elastin degrades, and collagen deposition increases, leading to reduced aortic compliance and higher pulse pressure.

The endothelium plays a critical role in: Vasodilation: Mediated by nitric oxide (NO), prostacyclin, and endothelium-derived hyperpolarizing factors (EDHF) .

Vasoconstriction: Controlled by endothelin-1 and angiotensin II. Dysfunction of the endothelium is a key factor in aortic diseases such as atherosclerosis and hypertension.

Neurohormonal control of aortic function. The aorta is influenced by the autonomic nervous system and various hormones: Sympathetic stimulation (norepinephrine) increases vascular resistance. Parasympathetic stimulation promotes vasodilation. Renin-angiotensin-aldosterone system (RAAS) regulates blood volume and pressure through angiotensin II-mediated vasoconstriction.

Aortic aneurysm and dissection. Caused by elastin degradation, chronic hypertension, and genetic factors. Matrix metalloproteinases (MMPs) play a role in extracellular matrix remodeling.

Atherosclerosis. Initiated by endothelial injury and lipid accumulation. Involves inflammation, foam cell formation, and plaque rupture.

Hypertension and stiffness. Chronic hypertension accelerates arterial stiffening, increasing cardiac workload. Pulse wave velocity (PWV) is used as a marker of arterial stiffness.

Conclusion. The aorta is a highly specialized artery that ensures efficient blood distribution through its elastic and regulatory mechanisms. Age-related changes and pathological conditions such as hypertension and atherosclerosis significantly impact its function. Advances in molecular research continue to provide new insights into aortic health, with potential therapeutic implications for cardiovascular diseases.

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