# The Effect of Melatonin Hormones on Arterial Blood Vessels and The Histological and Physiological Changes of Blood Vessels and Their Significance

Umidakhon Tohikrovna Nugmonova
Head of the Department of "Histology and Medical Biology No. 2" of Tashkent State Medical University, Uzbekistan

Mohira Akmal kizi Rikhsiyeva
Assistant, Department of "Histology and Medical Biology No. 2" of Tashkent State Medical University, Uzbekistan

Omonboyeva Marjona Muzaffar kizi
Student of Group 107 B of the Faculty of "Dentistry No. 1", Uzbekistan

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## Abstract

*This research work is dedicated to studying the histological layers of arterial vessels and their functional interrelationship with the microcirculatory track (MCT) system. The article analyzes the role of the endothelial layer, smooth muscle cells, and elastic elements within the arterial wall in maintaining hemodynamic stability. Specifically, the mechanisms by which arterioles, acting as "resistive vessels," regulate pressure transformation in microcirculation are histomorphologically substantiated. The findings serve as a theoretical foundation for understanding the morphogenesis of vascular pathologies.*

Keywords: Arterial morphology, microcirculatory bed, tunica media, endothelial dysfunction, arterioles, hemodynamic resistance, vasa vasorum.



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## 1. Introduction

The stability of vital processes in the human body directly depends on the histophysiological state of the terminal sections of the circulatory system. Arterial blood vessels perform not only a transport function, but are also active organs that control hemodynamic flow. In the microcirculatory flow (MTO) system, the terminal branches of arteries, in particular arterioles, serve as a central link.

The morpho-histological structure of the arterial wall is adapted to the transformation of blood pressure in the terminal basins. It is at the level of arterioles that high-pressure blood flow from the heart encounters peripheral resistance. This process is necessary to protect thin-walled capillaries from hydrostatic damage and ensure normal gas exchange in tissues.

The purpose of this article is to analyze the microscopic structure of the layers of the arterial wall and their functional significance in the microcirculatory flow based on modern histological data. The study of the structural features of arterioles and precapillary sphincters serves as an important theoretical basis for understanding the morphogenesis of pathological processes accompanied by microcirculation disorders.

The study used classical histological methods. Artery samples were stained with hematoxylin-eosin and examined under a light microscope.

Also, through an analysis of the scientific literature, the morphofunctional properties of the arterial wall and its relationship with the microcirculatory system were studied.

The role of arterioles as resistive vessels was assessed morphologically and functionally.

As a result of the histomorphological analyses, the three-layer structure of the arterial wall and their transformation during the transition to microcirculatory flow were determined as follows:

1. Tunica intima (inner layer):

The endothelial cells lining the lumen of the artery are flat and lie on a basement membrane.

The subendothelial layer consists of thin connective tissue, which is well developed in large arteries, but is significantly reduced at the level of arterioles.

The internal elastic membrane has a distinct wavy appearance in muscular arteries, and in arterioles it has been observed that it changes to a faceted (perforated) appearance.

2. Tunica media (middle layer):

This layer determines the functional type of artery. In muscular arteries, smooth muscle cells are densely arranged in a spiral pattern, with a network of elastic fibers between them. The results showed that as the diameter of the artery decreases, the muscular layer predominates. In arterioles, this layer consists of only 1-2 rows of smooth muscle cells and acts as the main mechanism of resistance to blood flow.

3. Tunica externa (Outer sheath or Adventitia):

Consists of loose, irregular connective tissue, with collagen and elastic fibers arranged in a haphazard manner.

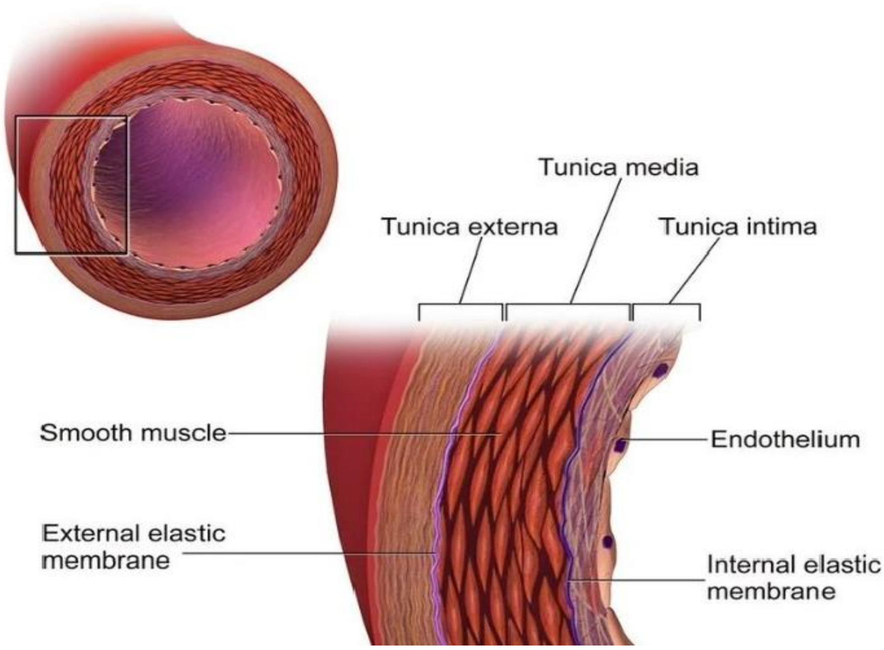
The outer sheath contains the vasa vasorum (blood vessels) and nerve fibers that nourish the vessel wall. In the terminal arterioles, the outer sheath becomes very thin and merges with the surrounding perivascular tissue.

4. Terminal parts of the microcirculatory flow:

In the area of transition from arterioles to capillaries, a collection of smooth muscle cells - precapillary sphincters - is formed. They participate in local control of the volume of blood passing into the capillary network.

Analysis of the histological types of arteries

According to the ratio of elastic elements and smooth muscle cells in the middle layer of the artery wall (tunica media), they are divided into three main types:




1. Elastic type arteries (Large arteries):

These include the aorta and pulmonary artery. Their medial layer contains a large number of fenestrated (holed) elastic membranes.

Function: To cushion (soften) the high pressure that occurs during cardiac systole and to ensure the continuity of blood flow.

2. Muscular-elastic (Mixed) type arteries:

Examples of this are the carotid and subclavian arteries. Their walls have almost equal amounts of smooth muscle cells and elastic elements.

Function: Adapt to pressure changes and participate in the regulation of blood flow.

Muscular type arteries (Medium and small arteries):

The most common type of arteries in the body. Smooth muscle cells predominate in their media.

Function: These vessels play a key role in the distribution of blood flow to organs and tissues. They directly control the volume of blood entering the organ by contracting or relaxing.

The results of the study show that the histological transformation of the arterial wall is directly adapted to hemodynamic needs. The abundance of elastic membranes in large arteries (elastic type) allows the conversion of high kinetic energy generated during cardiac systole into potential energy. This ensures continuous movement of blood flow not only during the heartbeat, but also in the diastole phase.

At the level of microcirculatory flow (MTO), the situation changes radically. The circular (circular) arrangement of smooth muscle cells in the walls of arterioles gives them the status of "resistance vessels". During the discussion, it was found that, despite the thinness of the media of arterioles, their contractility accounts for 70-80% of the total peripheral resistance.

In particular, the presence of precapillary sphincters ensures energy efficiency for the body. That is, in tissues at rest, not all capillaries are open; sphincters direct blood only to actively functioning cells. Through this mechanism, the arteries and the MTO system act as a complex "distributor" that not only transports blood, but also regulates the metabolic needs of organs.

The results obtained histologically confirm the theory of hemodynamic stability put forward by international researchers Pries A.R. and Secomb T.W. [4].

The history of melatonin research has been going on for more than 50 years, but interest in it has not diminished, but rather is increasing due to the emergence of new data every year about the multifaceted effects of its action on the human body. Reliable evidence has been obtained that melatonin is involved in almost all vital processes and regulates many body functions: sleep, cardiovascular, endocrine and immune systems.

Disruption of the function of the hormone Melatonin, which is secreted by the pineal gland, has several effects on blood vessels:

**Baroreceptor mechanism**. The afferent component of the reflex is impulses from the baroreceptors of the carotid sinus and aortic arch, which enter the vasomotor center of the central nervous system and lead to the predominance of parasympathetic tone over sympathetic tone.

As a result, the heart rate slows down, and vasodilation occurs. This restructuring of the cardiovascular system leads to a decrease in blood pressure.

**Chemoreceptor mechanism**. When blood pressure drops to 80 mm Hg or below, the chemoreceptor mechanism is activated. A decrease in the oxygen content in the blood and an increase in the carbon dioxide tension stimulate the chemoreceptors of the carotid sinus and aorta. These impulses reach the vasomotor center, stimulate the sympathetic nervous system, and lead to the restoration of blood pressure.

Ischemic reaction of the central nervous system. Ischemia of the vasomotor center occurs with a rapid decrease in blood pressure to 40 mm Hg. This leads to stimulation of the sympathetic nervous system and an increase in blood pressure.

**Autoregulation of vascular tone**. Experiments on denervated resistance vessels have shown that an increase in blood pressure leads to their vasoconstriction.

A decrease in blood pressure leads to dilation of arterioles. This response is aimed at maintaining a constant tissue blood flow. Particular attention should be paid to the autoregulation of cerebral blood flow, since this issue is of great clinical importance in assessing the risk of cerebral accidents during hypertensive crises and in cases of an unjustified rapid decrease in blood pressure in hypertensive patients during treatment.

Normal cerebral blood flow is 50 ml/min per 100 g of brain and is maintained by autoregulation in the range of average hemodynamic pressure from 60 to 120 mm Hg in healthy people and from 120 to 160 mm Hg in people with stable hypertension.

**Stress-induced relaxation of blood vessels**. With a rapid and significant increase in blood pressure, there is a slow dilation of blood vessels, which prevents further exacerbation of hypertension or leads to a decrease in blood pressure.

**Kidney volume mechanism**. When blood pressure drops, the kidneys reduce the excretion of salt and water, which are retained in the body and contribute to increased blood pressure.

**Fluid shift in capillaries**. A rapid and significant increase in circulating blood volume (for example, during massive infusion therapy) leads to an increase in blood pressure and intracapillary pressure. This increases fluid transudation through the capillary wall, reduces blood volume, and lowers blood pressure. Electrolyte balance. Sodium retention in the body leads to water retention, an increase in circulating blood volume, and an increase in circulating blood volume. In addition, the accumulation of sodium in the vascular wall leads to a narrowing of the vascular lumen and sensitizes the medial smooth muscle to the effects of pressure agents. Potassium in physiological concentrations has a depressant effect, and in high concentrations it has a vasoconstrictor effect. Deficiency of divalent cations - extracellular calcium and magnesium - enhances the hypertensive effect of sodium.

**Renin-angiotensin system**. Renin is an enzyme produced in the supraglomerular apparatus of the kidneys that catalyzes the conversion of angiotensinogen to angiotensin I. Under the action of angiotensin-converting enzyme, angiotensin I is converted to the biologically active angiotensin II, one of the most potent vasopressors.

**Growth factors**. Blood plasma contains a number of peptide growth factors that originate from various tissues (liver, salivary glands, pituitary gland, etc.) and have a mitogenic effect on them. Some of these factors are crucial in initiating abnormal growth responses. The vascular wall secretes growth factors that are involved in vascular remodeling and blood pressure regulation.

## 2. Conclusion

As a result of histomorphological analyses, the following conclusions were made in a physiological state in healthy people:

Structural adaptation: The three-layer structure of arterial blood vessels fully corresponds to their hemodynamic role in the body. The predominance of elastic elements in large vessels provides a depreciation function, and the development of muscular elements in small vessels provides a distributive function.

Terminal control: Arterioles and precapillary sphincters, which are the initial links of the microcirculatory flow, are able to sectionally control blood flow due to their histological structure (circular arrangement of smooth muscle cells).

Homeostasis: The functional interrelationship of the arteries and the MTO system ensures the blood supply (perfusion) of the tissues in accordance with their metabolic needs.

As a result of sleep disorders and a decrease in the release of the hormone melatonin from the pineal gland, the following conclusion can be drawn: In general, pressor systems are considered to have a stronger effect and greater functional reserves than depressor systems.

The interaction of hormones in hemodynamic regulation is still not well understood. There is also evidence that regulation occurs through different mechanisms in hyper- and hypokinetic blood circulation.

Thus, the current understanding of blood pressure regulation is largely qualitative, and numerous attempts to create quantitative mathematical models have not yet yielded sufficiently successful results. Research into the pathogenesis of hypertension is ongoing (S.A. Boytsov, 2006).

## References


1. Zufarov K.A. Gistologiya: darslik. – Toshkent: "Ibn Sino", 2005
2. Ahmedov A. Odam anatomiyasi. – Toshkent: "Iqtisod-Moliya", 2007.
3. Gartner L.P., Hiatt J.L. Color Textbook of Histology. – Saunders Elsevier, 2007.
4. Pries A.R., Secomb T.W. Control of Blood Vessel Structure and Function in the Microcirculation // American Journal of Physiology. – 2005. – Vol. 289, Issue 3. – pp. 1012-1025.
5. Aird W.C. Spatial and temporal heterogeneity of the endothelium // Vascular Pharmacology. – 2012. – Vol. 56. – pp. 159-167.
6. Ibragimov N.H. Arteriya qon tomirlarining morfologik va funksional oʻzgarishlari tahlili // Oʻzbekiston tibbiyot jurnali. – 2019. – №4. – 45-50-betlar.
7. Anderson S.M. The Architecture of the Microvascular System: A Review of Histological Features // Journal of Vascular Research. – 2021. – Vol. 58. – pp. 112-120.
8. file:///C:/Users/User/Downloads/sovremennye-predstavleniya-o-mehanizmah-regulyatsii-arterialnogo-davleniya.pdf