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Review Article

Newly Discovered Way of the Function of Cardio-Vascular System and the Latest Theory of the Development Hypertension and Other Cardio-Vascular Diseases

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Abstract

Background: It is known that the power of the heart alone is about 3.3 W, and the length of the vessels is about 100,000 km. It made us doubt that with this power the heart can deliver blood to the capillary bed. Effects on the vascular wall of various modes of laser radiation (wavelength of 630 - 640 nm) showed that if continuous radiation did not affect the parameters of blood pressure, frequency regimes had an impact. This leads us to the idea that the root cause of the development of different cardiovascular diseases is the system disturbance of the activity of the vascular pump leads to the increase of intra vascular pressure and the emergence of the hypertensive illness and the coronary heart disease. The local disturbances can cause various diseases depending on the organ where they develop.

Rationale: According to our calculations - the length of the arterial bed is 29.1 - 504, 6 km. Mathematical modeling showed that if the delivery of blood from the heart to the capillary bed, the required power ranges from 660 to 11942W. Thus, the main load during transportation the blood to the capillary bed rests on the artery but not on the heart and the vascular pump plays the major role in transportation of blood. Even minor changes in the wall of the arteries, which disrupts vascular pump, lead to the emergence of various vascular diseases. The rationale for this idea I got Ming Chien Kao Awards 2015 [1].

The mortality from the diseases due to the affection of vessels came out now on the first place. The use of the Intravenous laser blood irradiation (ILBI) within the last 30 years showed its high efficiency in a treatment of diseases of vessels and heart, and other system diseases. Therefore ILBI, as the method of the system impact on the blood system, allows to lower the lethality and to increase the life expectancy [2].

The lasers used for treatment of various diseases, the waves having length of 630 - 640 nanometers are the most effective for the direct impact on the blood and the vascular wall. The energy of the waves of this length is absorbed by oxygen, improves the microcirculation in tissues, changes the viscosity of the blood and affects the wall of vessels [3].

Keywords: *Mathematical Model; Function of Cardio-Vascular System; Power of the Heart; Cardio-Vascular Diseases*

Introduction

Without any doubt, the deployment of any methods of the prevention and the treatment of diseases of vessels is the most important problem of modern medicine.

Moreover, according to World Health Organization, mortality from coronary heart disease ranks first in the world [4].

The activity of the vascular system is carried out through the work of heart and vessels. Since old times and still today, the main reason of the vascular diseases has been seen in the development of pathology of the heart. According to the World Health Organization data from 2000 to 2011, the mortality from the coronary heart disease increased from 5.8 up to 7 million people [5].

However in our opinion - the main reason of the development of the coronary heart disease and the other cardiac pathologies is the development of the pathological processes in the walls of body's vessels leading to the disturbance of their function. Then these changes lead to the changes in the coronary arteries and the myocardium [2].

For the first time this idea arose when we used different types of ILBI. The continuous irradiation had no impact on the indicators of a blood pressure of the patients with a hypertensive illness. When we used impulse irradiation the reliable decrease in indicators of a blood pressure of this category of patients was revealed [3].

From the point of view of the mechanics it is impossible to explain how at the average power of the heart in rest - 3,3 W [6-8]. The heart can pump the blood through the vascular system which length makes about 100 thousand kilometers.

Although according to well-known authors, mainly in the transportation of blood was heart [9-11].

To confirm my idea that the main role in the delivery of blood to tissues primarily is played by the vessels and not the heart, we conducted the following studies:

1. Built a new mathematical model.
2. Changed features of the anatomical structure of different types of arteries.
3. Explained how the synchronization of the heart and blood vessels transport the blood to the tissues.

Mathematical model to determine the capacity of the heart to deliver blood to the capillaries

First, I determined the approximate length of the blood channel from the heart to the capillary bed according to [11]. It was taken only of the artery, which was presented in the muscle fibers.

The results on total length of the arteries are presented in table 1.

	Large arteries	Medium arteries	Small artery	Branch	Small branch	Terminal artery	Arterioles	Terminal arterioles
Number	288	1152	3456	20 736	82944	497 664	18 579 456	238 878720
Length (cm)	1,4 - 2,28	1,0 - 2,2	0,6 - 1,7	0,3 - 1,3	0,2 - 0,8	0,01 - 0,6	0,02 - 0,38	0,01 - 0,18
Total length (cm)	403,2 - 656,64	1152 - 2534,4	2073,65 - 875,2	6220,8 - 26956,8	16588,8 - 66355,2	4 976,6 - 298598,4	371589,1 - 7060193,28	2388787,2 - 42998169,6

Table 1: *Arterial system*.*

**does not account for aorta, main branches and capillaries*

L- The total length of all arteries vessels in (cm):

L_{min}- 2791791,3 (27917.91m)

L_{max}- 50459339,5 (504593,39m)

The next step was to determine the capacity of the heart, which is necessary for delivering blood to a capillary bed:

S -the cross-sectional area of the aorta (3 cm), was determined by the formula

S = 0,032 π/4

S = 0, 0009 . 3.14/4 = 0,00071 m^2.

g- the density of blood plasma is almost equal to the density of water is:

g = 1,0 . 10^3 kg/m^3.

Since plasma consists of 90% water and the rest : 7%- proteins, and the rest inorganic elements [11].

v - the average flow velocity in the aorta is 20 cm/s (0,2 m/s)

v = 0,2 m/s

A - work required to deliver blood to the capillary bed was determined by the formula:

A = S g v^2 L/2

A_{min} (total length of all arteries vessels L_{min})

A_{min} = 0,00071 . 1000 . 0,04 . 27917.91/ 2 = 396.43 J

A_{max} (total length of all arteries vessels L_{max})

A_{max} = 0,00071 . 1000 . 0,04 . 504593,39/2 =7 165,22 J

The power of the heart (P), required to transport blood to the capillary bed, was calculated according to the formula:

$P = A/1 - 0,4$

$P_{min} = 396,43/1\text{-}0,4 = 660.71$ W

$P_{max} = 7165,22\ /1\text{-}0,4 = 11942,03$ W

The results show that the power of the heart (3.3W) is only 0,49 - 0,027% of the power needed to transport blood to the capillary bed.

These calculations confirmed our clinical results that the main role in transportation of blood is played by arteries and veins. The heart acts only as a trigger for synchronized a complex process that involves different kinds of nerve receptors in the vascular wall, the Central and autonomic nervous system, smooth muscles, collagen and elastic fibers of the vascular wall.

Features of the structure of walls of various types of arteries and how they affect the transport of the blood

I took a new look on the anatomical structure of the walls of the various arteries that were discovered by our scientists K. Strong 1938 and others [7,9,12,13].

Taking into account the functional peculiarities of the structure of the wall of various types of arteries, I divided them into the following types:

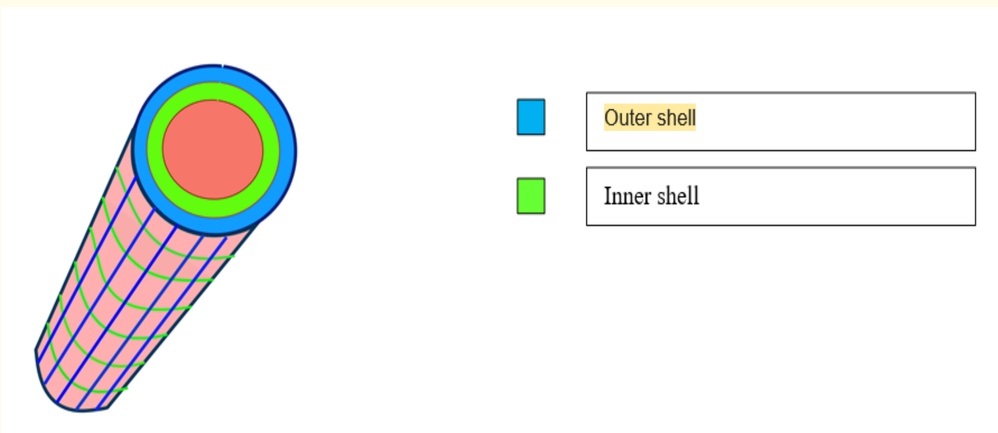

Figure 1: *Elastic type (aorta, pulmonary trunk, pulmonary, common carotid artery) consists of two shells (only elastic frame)- performs the function of a compression chamber, expanding during systole and tapering during diastole. There are baroreceptors that respond to mechanical stretching.*

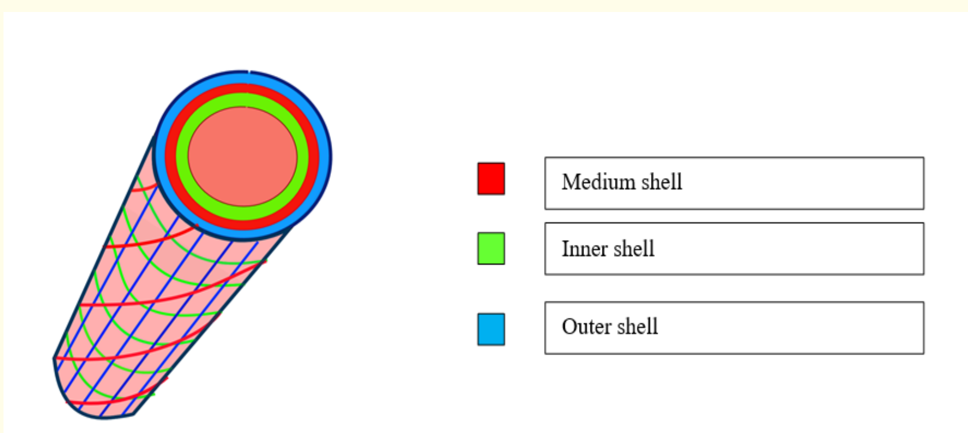

Figure 2: *Elastic and muscular type (subclavian, external and internal iliac, femoral, mesenteric artery, celiac trunk)- joins the muscular layer (spiral arrangement of fibers). This arrangement of fibers while reducing the flow makes blood spiral. The baroreceptors disappear and sympathetic adrenergic vasoconstrictor fibers appear.*

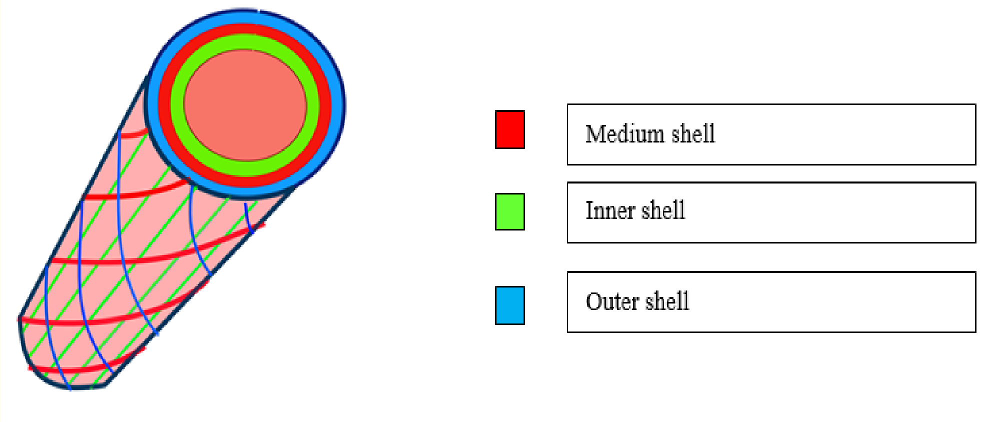

Figure 3: *Muscle type (vertebral, brachial, radial, popliteal, arteries of the brain, etc.) – this type has the greatest ability to tighten the blood in the spiral and push it forward. This is achieved in that spiral arrangement of fibers not only in the muscular layer, but in the external elastic membrane.*

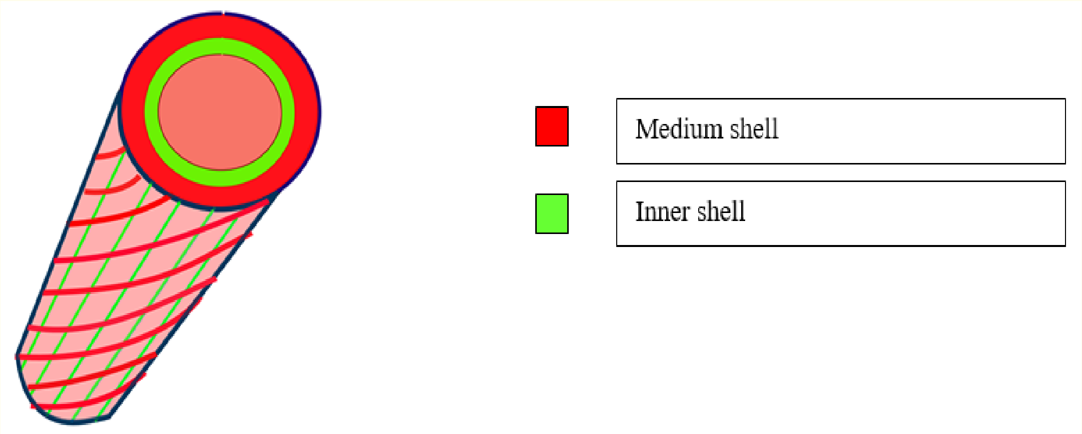

Figure 4: *Muscle-elastic type (small artery) disappears in the external elastic membrane. Muscular layer of the spiral arrangement of fibers. In the inner shell decreases the thickness of the connective tissue and internal elastic membrane.*

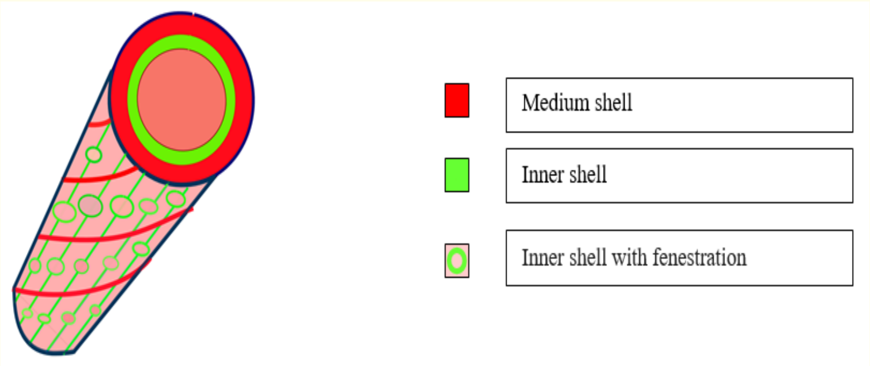

Figure 5: *Precapillary type - thinner muscular layer, reduced the thickness of the connective tissue and internal elastic membrane which becomes fenestrated. This leads to the contact of endothelial cells with smooth muscle cells, which have the opportunity to respond to hormone - active substances which get into the blood.*

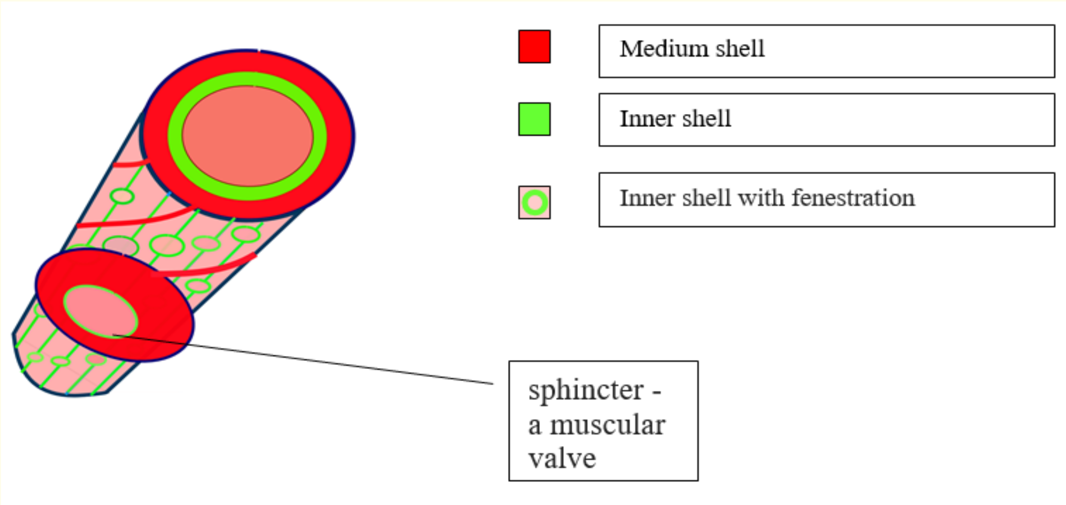

Figure 6: *Precapillary type – remains 1-2 layers of muscle cells, which at the end of the spiral moving in a circular thickening and form a precapillary sphincter. This sphincter is a muscular valve which prevents the backflow of blood and maintains the pressure in the capillary system. Fenestrate inner membrane is enhanced.*

Diagram of blood flow in various types of arteries:

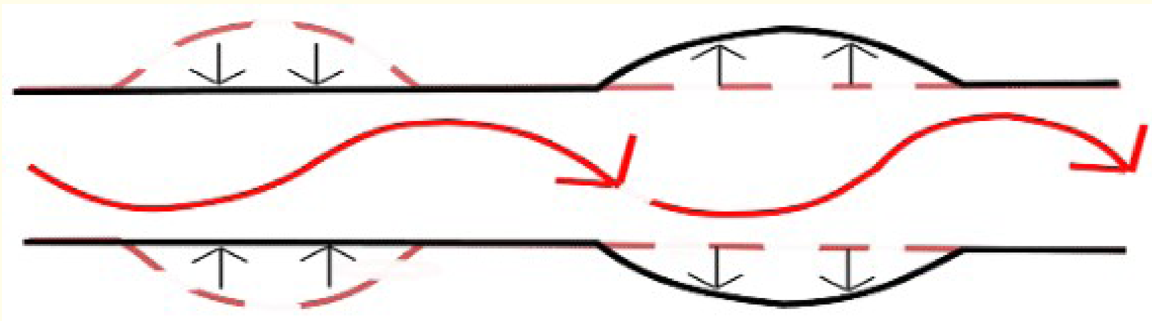

Figure 7: *Elastic type*

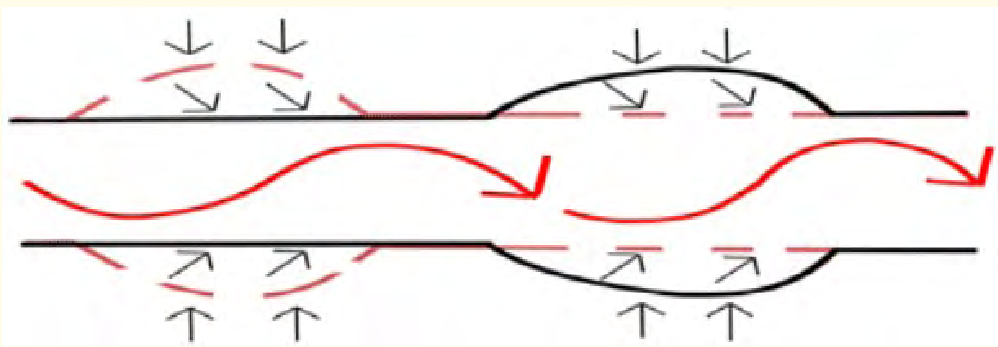

Figure 8: *Elastic and muscular type.*

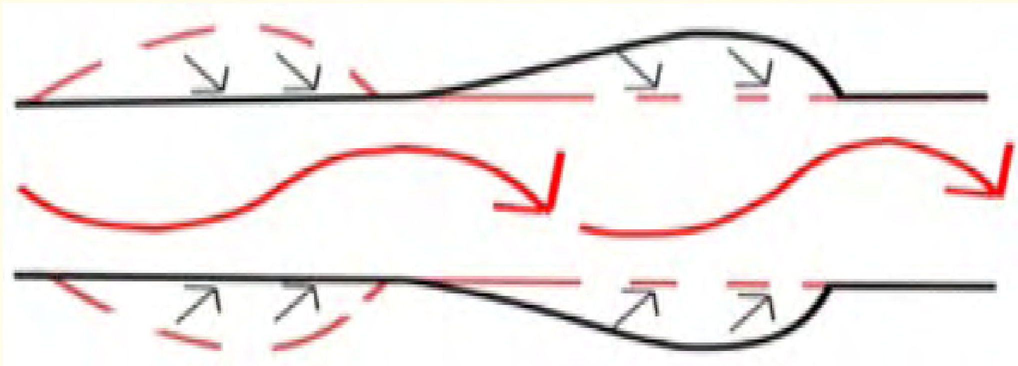

Figure 9: *Muscle, Muscle-elastic, Precapillary types.*

The obtained data clearly confirms the main role of the vessels in the movement of blood in the bloodstream. If you consider that the length of all arteries (L) is 27,91 to 504,59 km.

Cardiac output gives the blood a spiral movement. This is the trigger for contraction of the arteries, which have a very important anatomical feature a spiral orientation of muscle fibers. This allows spiral supports blood flow throughout their length until it gets to the beginning of the capillary bed.

Nervous regulation of cardiovascular system

I tried to take a fresh look at known data on neuro-humoral regulation of the work of arteries and veins. I helped Gipertsikl's modern theory - the Principle of the natural self-organization causing integration and coordinated evolution of system of functionally connected self-replicated units [14].

This theory allows to understand and systematize the principles of the regulation of various functional systems of an organism and the development of various pathological processes.

The Regulation and synchronization of the activity of all systems of an organism happen due to neuro and humoral regulation. But if the nervous system of the system is autonomous and its regulating influence is carried out through a complex of nervous cells, the humoral regulation can't be carried out without the existence of the organs producing hormones and the vascular system which delivers hormones and other biologically active agents to target organs.

Afferent impulses from the baroreceptors reach cardio inhibitory center and vasomotor center located in medulla oblongata, as well as in other departments of the Central nervous system. Depending on stretching of the artery wall - the frequency of these pulses varies which results in wave-like inhibition of the sympathetic centers and the stimulation of the parasympathetic centers. Thus the Central nervous system regulates the tone of the sympathetic vasoconstrictor fibers, and the frequency and the strength of contractions, the heart and blood vessels [15-19].

Innervations of blood vessels are carried out through a superficial plexus in the outer layer, admissions or edge, the plexus on the border of the outer and middle shells. From the last fiber go to the average shell wall and form an intermuscular plexus, which is especially pronounced in the arterial wall. Individual nerve fibers penetrate to the inner layer of the wall [13]. These plexuses afferent impulses from the baroreceptors directly affect all the contractile elements of the wall around the blood vessels. Given that the heart muscle works offline, through these plexus synchronizes the contractions of the heart and blood vessels. All these make the complex very stable self-regulating system. An important feature is that the velocity of propagation of pulse wave through the vessels is much higher than the flow velocity. The pulse wave propagates to the arterioles stops in 0.2s, whereas the particles ejected heart blood during this time only reaching the descending aorta [20-22].

This means that the pulse wave after its passing creates a zone of lower pressure than the pressure in the aorta. The blood is just absorbed into the bloodstream after systolic ejection.

Thus, the vascular pump of a recession and rigidly synchronized with the work of the heart. This allows you to pump blood with minimal cost across the vascular bed. The Central nervous system and hormonal factors regulate the redistribution of blood at a lower level, depending on the needs of the various parts of the body.

The development of cardio-vascular diseases

In my opinion the main difficulty on the delivery of oxygen, blood cells, nutrients to tissues and removal of waste products is carried out by the vascular pump. Synchronized, wavy reduction of smooth muscles of vessels allows to move blood on such huge distances and to deliver back to the heart. Even absolutely minor local changes in the vessel wall breaking a blood flow can lead to the appearance of various diseases [2].

The system disturbance of the activity of the vascular pump leads to the increase of intra vascular pressure and the emergence of the hypertensive illness and the coronary heart disease.

Therefore any actions, allowing to keep the contractive function of walls of vessels, will allow to avoid the emergence of many diseases and to increase the life expectancy. No matter in which way it will be reached – by the use of medicaments, physical, chemical or wave methods of exposure. The main point is that the exposure should be systematic.

Discussion

The defeat of the vascular system is one of the most severe defeats in an organism. It is confirmed by the fact that the mortality from the vascular diseases has come out now on top in the world [4,5]. Therefore the maintenance of its functional activity is the most important problem of the modern medicine.

If the disturbances in other systems is possible to correct by means of medicaments, the use of only medicaments in the treatment of cardiovascular diseases isn't enough. The increase of a blood pressure, the malnutrition of myocardium, the elasticity disturbance and the stenosis of vessels – arise after the pathological dysfunctions of the vessel's walls, which break the ability of vessels to contract and to push the blood to organs and tissues. The disturbance of the transportation function of vessels brings to the disturbance of the delivery of oxygen, various cells, hormones and nutrients to tissues. The drainage function is broken - when the products of the disintegration don't come out from the tissues, that leads to their dysfunction [2].

Mathematical calculations show that the power of the heart (3.3W) is only 0,49 - 0,027% of the power needed to transport blood to the capillary bed. Therefore, the basic loading for the transport of blood falls on the vascular system. These settings should have an even lower value, as we did not take into account blood viscosity, peripheral, hydrodynamic resistance, the reflected wave and other factors. It just would have complicated mathematical calculations. Arterial system supports a spiral blood flow from the heart to the capillaries. Primarily this reduces energy losses during transportation due to reduction of hydrodynamic resistance and the reflected wave. But most importantly, the spiral arrangement of the fibers allows not only to move blood and create a lower pressure area after the passage of the wave.

Thus, blood drawn from the aorta and large arteries to the smaller vessels down to the capillary bed. The rapid spread of pulse wave in comparison with velocity of blood flow is tightly synchronized with the heart rate. The operation of the system heart – blood vessels, is a fully self-contained nature of the Central nervous system Regulation of frequency of reductions at the level of the aorta and large arteries is synchronized in nature and is governed by the heart. At a lower level (the level of small arteries and arterioles) - regulation begins to be segmental in nature, which allows you to redistribute blood to different organs and tissues, depending on their needs.

The operating principles of the vascular system is the same everywhere, only in the venous system joined by other factors (greater number of veins, the valves, the muscular pump, etc). We did not count the length of the venous bed, nor the power needed to transport blood to the heart. It is not hard to do, but it does not matter and only would have complicated the understanding of new principles of functioning of the cardiovascular system and of cardiovascular diseases.

Conclusions

1. The main role in transportation of blood to the capillary bed is played by the artery, the power of the heart is only 0,49 - 0,027% of the power needed to transport blood to the capillary bed.
2. The vascular pump is regulated by the frequency of contractions of the heart muscle and is tightly synchronized with the work of the heart.
3. The rapid spread of the pulse wave causes a suction effect. Following the reduction of the vessel wall, the blood is just drawn from the aorta and large arteries to the smaller vessels down to the capillary bed.
4. Systematic irregularities in the vascular pump are the starting point in the development of diseases of the cardiovascular system. These illnesses may be both local and systemic, depending on the size and the location of pathological changes in the vascular wall.

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