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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 11942 W. 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 Intravenous Laser Blood Irradiation (ILBI). The continuous irradiation had no impact on the indicators of a blood pressure of the patients with a hypertensive illness. Comparing the results of the continuous (ILBI) and the Frequency Intravenous Laser Therapy (FILT) of lasers emission (630-640 nm.) in patients with essential Hypertension II-III st. showed - FILT significantly decreased systolic (22.2%) and diastolic (8.3%) pressure. The average duration was 2.7 months [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).

**Table 1: Arterial system**

<table>
<thead>
<tr>
<th>Number</th>
<th>Large arteries</th>
<th>Medium arteries</th>
<th>Small artery</th>
<th>Branch</th>
<th>Small branch</th>
<th>Terminal artery</th>
<th>Arterioles</th>
<th>Terminal arterioles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm)</td>
<td>403.2 - 656.64</td>
<td>1152 - 2534.4</td>
<td>2073.65 - 875.2</td>
<td>6220.8 - 26956.8</td>
<td>16588.8 - 66355.2</td>
<td>4976.6 - 298598.4</td>
<td>371589.1 - 42998169.6</td>
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<td></td>
</tr>
</tbody>
</table>

*does not account for aorta, main branches and capillaries

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

-\[ L_{\text{min}} = 2791791.3 \text{ (27917.91 m)} \]
-\[ L_{\text{max}} = 50459339.5 \text{ (504593,39 m)} \]

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

- The cross-sectional area of the aorta (3 cm), was determined by the formula
  \[ S = 0.032 \pi /4 \]

S = 0.0009. 3.14 = 0.00071 m².

- The density of blood plasma is almost equal to the density of water is: g = 1.0. 103 kg/m³.

- The average flow velocity in the aorta is 20 cm/s (0.2 m/s)
  \[ v = 0.2 \text{ m/s} \]

- Work required to deliver blood to the capillary bed was determined by the formula:
  \[ A = S \cdot g \cdot v^2 \cdot L /2 \]

- Work in the aorta (total length of all arteries vessels): \[ A_{\text{min}} = 0.00071 \cdot 1000 \cdot 0.04 \cdot 2791791.91/2 = 396.43 \text{ J} \]
- Work in the aorta (total length of all arteries vessels): \[ A_{\text{max}} = 0.00071 \cdot 1000 \cdot 0.04 \cdot 5045939.5 = 71652.2 \text{ J} \]

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

\[ P = A /1 - 0.4 \]

- Power in the aorta: \[ P_{\text{min}} = 396, 43/1-0.4 = 660.71 \text{ W} \]
- Power in the aorta: \[ P_{\text{max}} = 7165, 22 /1-0.4=11942.03 \text{ W} \]

The results show that the power of the heart (3.3 W) 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 [9-14].

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.

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 [15].

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...
The disturbance of outflow of waste function of a liver. The disturbance of the delivery of the immune system’s cells to tissues increases the probability of the development of oncological process. The disturbance of outflow of waste products of cells causes the intoxication and the dysfunction of cells in the affected organ. 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 (3.3 W) 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 principle 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.

References


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