American Journal of Botany and Bioengineering
https://biojournals.us/index.php/AJBP
ISSN: 2997-9331

Studying the Effect of Laser Rays on Blood Gases

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Received: 2024 07, Sep
Accepted: 2024 07, Sep
Published: 2024 08, Oct

Abstract: In this research, blood samples were taken for 5 people (4 males and female) at Al-Husseini Hospital in Karbala governorate under the supervision of the head of the intensive care laboratory department. At the level of blood gases, they were irradiated at the University of Karbala, College of Science, Department of Physics, with a multiplexed Nd: Yag laser with a wavelength of 532 nm and a capacity of 23 milliwatts in green color and at specific times for each blood sample 5 minutes and at a distance of 18 cm, then we measured the percentage of gases Again for the same blood samples, but after laser irradiation and we compared the results before and after laser irradiation. The results showed us that the percentage of PH and oxygen decreased after exposure to the laser, and the percentage of carbon dioxide increased in all cases, and the reason for changing the most appropriate is due to two types of interaction For the laser used for this study, these reactions are the photochemical reaction and the second reaction is the thermal reaction.

Introduction

Laser is the amplification of light by stimulated emission of radiation and it has been widely used in many fields. Its characteristics are monochromatic, coherent, traveling in straight lines. The effect of the laser beam on biological systems depends on experimental conditions such as the type of laser irradiated cells, wavelength The intensity of the light, as irradiation with high-energy lasers causes tissue damage. As for irradiation with low-energy lasers, it can deform cells, especially white blood cells and red blood cells, which leads to cells losing their basic functions [1]. Modern science in the use of the laser beam and its medical applications has reached the diagnosis and treatment of many diseases based on its multiple properties, its precise effects and its different wavelengths, especially those whose wavelengths are in the infrared region, due to the intensity of the absorption of its energy by the water present in living tissues, such as urinary tract surgeries. And ophthalmology, and by using the Indiac laser to remove glaucoma in the eyes, and the green argon laser with a wavelength of 515 nm in retinal detachment welding for the intensity of blood absorption of its energy, as well as for the removal of tumors, physical therapy, removal of stomach and duodenal ulcers, and speed of wound healing, especially for urinary patients. Diabetes is for those who have difficulty healing wounds, as its chemical effect depends on those tissues. Many of the current studies and practical experiments have studied the possibility of benefiting from the low energy laser in a large way to study the components of the blood in a separate way and knowing their effect on the times of blood preservation and changing the properties of treatment using a low energy laser (Low Level Laser Therapy) is a form of laser therapy, which depends on tissue stimulation different and activates cells to work [4]. Lasers are widely used in biology, medicine, and most health centers and hospitals for the purpose of diagnosis and treatment.

Researchers have different medical applications for different lasers used in surgeries and other medical treatments. Medical lasers can be classified into both branches of diagnosis and treatment. The main difference between the applications of lasers in diagnosis and treatment is the type of interactions between tissues and lasers. In the case of diagnosis, one tries to arrange a way that the laser is not inserted into the tissue to study it significantly, in order to study the normal behavior of tissues without any obvious damage or effect on the tissues. But in the case of treatment, such as surgery, the surgeon uses the laser as a knife or to affect a specific area. Therefore, the definition of medical laser applications depends on the type of interaction between laser light and tissues.

1-2 Medical optics:

The spectral region between the two wavelengths (400-1100 nm) is called the optical window. Most of the living tissues can be classified by the strong optical scattering in this region, in other words, the photons of the laser light are scattered and attenuated (diffuse and attenuate) in the living optical tissue. The scattering of the laser beam by cells, mitochondrial nuclei and microparticles resulting from light propagation in living tissues.

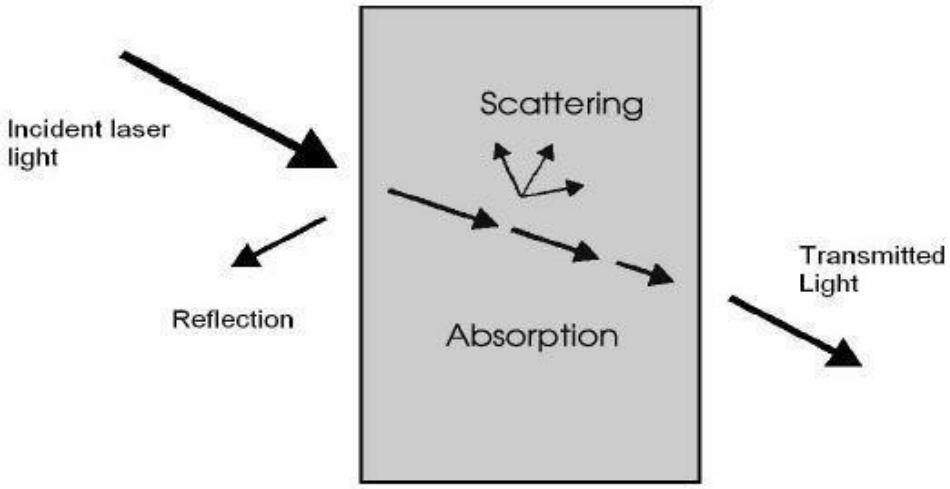

Figure (1-1) schematic diagram of scattering in a dense medium [25].

The absorption coefficient (a) can be defined as the probability of absorbing light in the medium for each unit length of the path, and the inverse (a) refers to the rate of absorption length. (Hb and HbO2) [25] Optical absorption in living tissue originates from water, melanin, and hemoglobin .

3-1 Blood:

Blood is a dark, viscous liquid that fills blood vessels and rushes to all parts of the body thanks to the constriction of the heart muscle. Its functions are multiple, the most important of which is the process of respiration, where the blood carries oxygen from the lungs to the tissues, as well as carbon dioxide generated from tissue activity to the lungs to be put into the exhaled air. The second function is nutrition, as the blood carries the primary nutrients absorbed by the intestine to the various cells for use in energy production Necessary for the activity of the body and thus the blood carries the harmful waste remaining as a result of the metabolism process in the body through the excretory organs such as the kidneys and skin, and the body gets rid of them through urine and sweat 26,271]. Blood constitutes about 7% of the body depending on the size of the body. The color of blood varies between arteries and veins. For example, arterial blood is bright red because it contains high levels of oxygen, but venous blood (mostly deoxygenated) has a dark red standing color. The normal pH ranges from 7.35 to 7.45, and it is slightly alkaline, as the viscosity increases in the presence of blood cells and plasma proteins [27, 81]

4-1 Components of blood:

Blood consists of cells, organic and inorganic materials, and water with dissolved particles, called blood plasma. Figure (1-2) The main components of blood Plasma makes up about 55% and cells about 45% of blood volume.

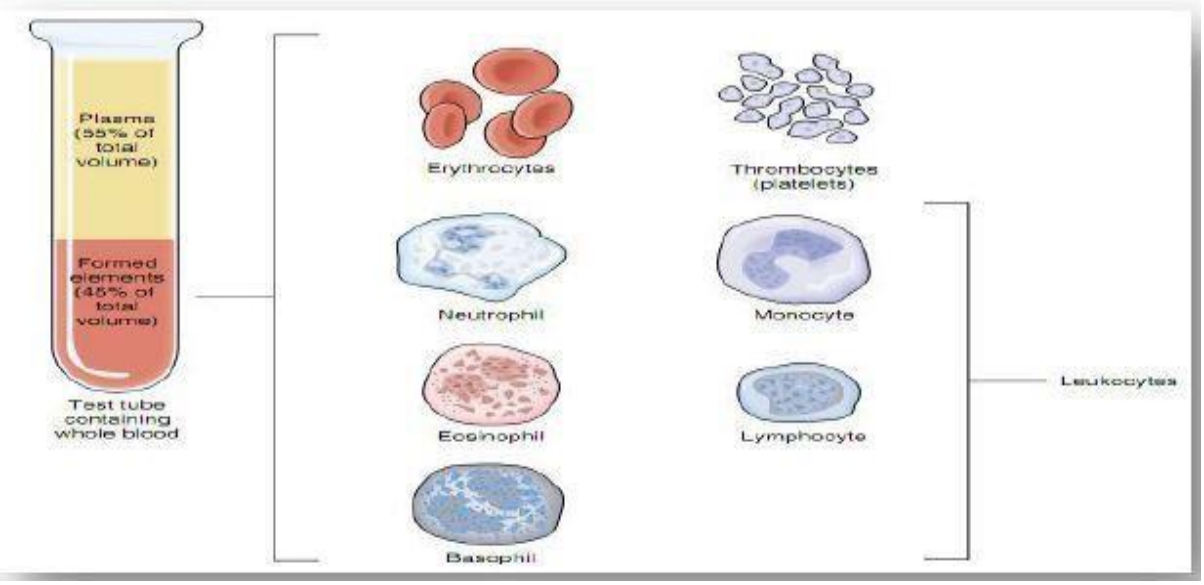

Figure (1-2) The main components of blood [27]

5-1 Blood cells:

There are three types of blood components, which are red blood cells (RBC), white blood cells (WBC), and platelets. Red blood cells are also called erythrocytes, and they have a biconcave disk shape with a diameter of about 7 microns. The life span of red blood cells is about 120 days, and the process of hemolysis is carried out by phagocytic reticulum cells. Red blood cells contain a protein called hemoglobin (Hb), to which oxygen (0) and carbon dioxide (CO) are bound. Red blood cells contain about 280 million hemoglobin molecules [26,28] Hemoglobin is a complex protein consisting of globin and an iron content called haem. The primary function of red blood cells is to combine with oxygen in the lungs and transport it to various tissues in the body. Then it combines with carbon dioxide in the tissues and transports it to the lungs to be excreted from the body [26,28]. White blood cells, also called leukocytes, are classified into two groups, granular and agranular. Granular cells include neutrophils, eosinophils, basophils and leukocytes, non-granulocytes are lymphocytes and monocytes. The number of white blood cells ranges from 5000 to 10,000 per microliter. White blood cells play an important role in defending the body against microbes and other foreign substances. Neutrophils and monocytes can phagocytose pathogens. Eosinophils are believed to act as a detoxifier and to have a role in antiparasitic immunity. Basophils have heparin, which helps prevent abnormal blood clotting within the blood vessels and is released as part of the inflammatory process, thus making the capillaries more permeable. Lymphocytes contain two main types, B cells and T cells that produce antibodies and destroy specific target cells upon infection by pathogens [28]. Platelets, or platelets, are small cellular fragments that arise in the bone marrow from the cytoplasm of giant cells. Small disc-shaped platelets ranging in size from 2 to 4 micrometers, and can last for 5 to 9 days. Platelets clump together with damaged blood vessel walls and release enzymes that activate the blood clotting process, to stop bleeding [26,28].

6-1 Plasma Blood

plasma constitutes about 91.5% of water and 8.5% of dissolved substances, most of which are proteins. Plasma protein includes albumins, globulins, and fibrinogen. The important function of these proteins is to maintain the osmotic pressure of the blood, which is important in the exchange of fluids across the capillary walls. Among the solutes are electrolytes, which are involved in regulating water across cells and muscle contraction, transmitting nerve impulses, forming secretions and maintaining a balance between acids and alkalis [29].

1-7 Hemoglobin

The main function of the hemoglobin protein found in red blood cells is to transport oxygen from the lungs to the rest of the organs, and return carbon dioxide from different parts of the body to the lungs

1-8 Blood gases

those gases that it carries Blood is like oxygen and carbon dioxide, and the importance of measuring the proportion of these gases lies in the knowledge of respiratory diseases, heart disease and heart muscle diseases. Blood is taken for measurement only from arterial blood loaded with oxygen, and to measure carbon dioxide we take from venous blood coming from the lung.

1-9 Previous Studies

1	**Z.Q.*etal*.,(2008)**	In this study, laser irradiation with a wavelength of 632.8 nm 532 nm was observed on the rheological properties of blood in the laboratory. The laser irradiation reduced the blood viscosity of the blood samples with high viscosity. The deformation of red blood cells was improved by laser irradiation when the deformation of the sample from the patients was already weak. , the 532 nm laser has shown more efficient effects | On modifying the rheological properties of 632.8 nm laser. This wavelength effect corresponds to the absorption spectrum of hemoglobin [11].
2	**Etal.,John Zhang (2008)**	This study reported on the effects of laser acupuncture on blood pressure, body weight and heart rate variability by stimulating acupuncture points. After using laser treatment for 90 days, both systolic and diastolic blood pressure decreased significantly ($p < 0.05$), as they decreased High blood pressure from 127 mmHg to approximately 122 mmHg [12]

3	**Ibrahim(2009)**	The purpose of this study is to investigate the in vitro effect on hematocrit (HCT) and viscosity of red blood cells and He-Ne laser radiation on the erythrocyte sedimentation rate (ESR). A He-Ne laser beam with a wavelength of 632.8nm and a beam diameter of 5mm was used on blood samples. The results of this study showed that the increase in ESR is inversely correlated with HCT, where the erythrocyte sedimentation rate decreases with the increase in viscosity [13].
		In this paper, the effect of a helium-neon laser beam with the power | . was tested Low (3mW) and 632.8 nm wavelength depend on the viscosity and hydrogen ion concentration (pH) of normal blood. The results of the study proved that irradiation With a helium-neon laser beam with a spot diameter of 5mm, it reduces the viscosity value and increases the pH value for each of the blood samples when

4	**Ahmmedand Alglam(2011)**	compared with the non-irradiated samples, and this change in the viscosity value was evident at the level of 90 minutes of exposure to the laser beam. This means that the effect of a low-power helium-neon laser beam depends on the exposure time And it increases the pH value of each of the blood samples when compared with the non-irradiated samples, and this change in the viscosity value was evident at the level of 90 minutes of exposure to the laser beam. This means that the effect of a low-power helium-neon laser beam depends on the exposure time [14].

1-2 Blood Gas Analyzers (ABG):

It is used to measure gases in the blood and is available in hospital laboratories that have intensive care. In the arterial blood gases test, the partial pressure of oxygen and carbon dioxide, hemoglobin saturation with oxygen, and the pH (pH) are checked.) in the arterial blood. To take the sample, a superficial artery must be found, usually in the wrist or elbow area, and in very few cases in the upper thigh. A thin needle is inserted and about 2 milliliters of blood is taken into a syringe containing a small amount of heparin, a substance that prevents blood clotting. Components of blood gas analyzers Despite the great development that took place in the technology of manufacturing devices responsible for analyzing blood gases, the basic components and parts in that did not differ significantly except in their different sizes, As its size has become smaller, in addition to some other options that have been added, but they all pour into the same crucible in the method of work, and the following parts and components are among the most important components of blood gas analyzers, the electrode responsible for the pH. Carbon Dioxide Sensors Oxygen Sensors .

Figure (2-1) ABG . blood gas analyzer

2-2 The principle of work of blood gas analyzers and the method of work:

As we have previously talked about the main parts of blood gas analyzers, the principle of work of each of them depends on the formation of an electric current between two solutions, one of which has a known concentration of a certain substance, and the other solution represents blood,

and in the following The principle of work of these devices and the role of each part of the electrode responsible for the pH: it consists of a thin film of glass containing a solution known acidity on one side, while the blood sample to be analyzed is entered on the other side of the membrane, and as a result of the difference in acidity level and number The hydrogen content between each of them, their presence on both sides of the membrane generates an electric current, which leads to knowing the pH of the blood sample by measuring the amount of this electric current. Carbon dioxide gas sensors: The discovery of this depended on the discovery of the pH electrode, as the scientists worked on placing the thin glass membrane and covering it with a thin plastic material, and then adding bicarbonate salts with a known concentration, so that it was adjusted to the previous solution with known acidity, which He worked to link the level of acidity in the blood with the level of carbon dioxide concentration in the blood. Oxygen gas sensors: These sensors were invented by installing a thin wire of platinum so that it was melted inside a glass stick as a measuring tool, as this helped to reduce the flowing oxygen atoms to the dissolved platinum atoms, which leads to the formation of an electric current resulting from the reduction of these atoms. In such a way that this current reflects the partial pressure of the oxygen concentration in the blood.

Figure (2-2) shining a double NdYak laser on a blood sample

After samples were drawn from 5 people (4 males and one female) in the intensive care unit of Al-Hussein Hospital in Karbala under the supervision of the official of the Intensive Care Laboratory Department, we measured the percentage of blood gases in these samples with an ABG device and recorded the results, and then the samples were taken to the University of Karbala, College of Science The laboratory of the General Physics Department and under the supervision of Dr. Khawla, the five samples were irradiated with a double neodymium Yak laser with a capacity of 23 milliwatts and a wavelength of 530 nm, green color, with a time period of 5 minutes for each blood sample, and the distance between the laser device and the blood sample was 18 cm, as in the figure below.

After laser irradiation, we took samples and measured the percentage of gases again after being exposed to the laser beam and compared the results before and after exposure to the laser beam. Low oxygen saturation of hemoglobin or low oxygen pressure in the arterial blood indicates the following hypoxia that may occur to individuals living at altitudes and lung diseases. An increase in the concentration of carbon dioxide in the arterial blood indicates a chronic obstructive pulmonary disease, such as: bronchitis and acute asthma, indicating A decrease in the concentration of carbon dioxide in the arterial blood leads to hyperventilation resulting from the following: anxiety and severe stress, high blood acidity, i.e. less than 7.35, and a high concentration of carbon dioxide, i.e., higher than 45 mm Hg means that the patient suffers from respiratory acidity (Respiratory). acidosis), which can be caused by a chronic obstructive pulmonary disease, such as: bronchitis, acute asthma, and pneumonia, a neurological disease. A defect in the function of the rib cage wall, which prevents breathing properly.

Figure (2-3) ABG . blood gas analyzer

sample number	Gender	p^H	$P^{CO}2$	$P^{O}2$
1	**female**	**7.592**	**26.4**	**68.3**
2	**Male**	**7.396**	**35.6**	**96.6**
3	**Male**	**7.347**	**47.4**	**136**
4	**Male**	**7.561**	**26.5**	**152**
5	**Male**	**7.443**	**39.8**	**180**

Table (2-1) shows the results of measuring blood gases before exposure to laser beams

sample number	Gender	p^H	$P^{CO}2$	$P^{O}2$
1	**female**	**7.457**	**35.6**	**83.2**
2	**Male**	**7.235**	**49.7**	**81.1**
3	**Male**	**7.305**	**54.5**	**93.8**
4	**Male**	**7.453**	**31.5**	**99.9**
5	**Male**	**7.215**	**64.7**	**88.7**

Table (2-2) shows the results of blood gas analysis after exposure to laser beams

From these results, we conclude that the acidic pH decreased and that the percentage of oxygen in the blood decreased as well, but the percentage of carbon dioxide increased after exposing it to laser beams.

3-2 Discussion and Conclusion:

There are two types of interaction for the laser used for this study, which has a wavelength of 532 nm and a power of 32 milli watts for its interaction with blood.

First: the photochemical reaction, and in this case the following processes take place where this leads to an increase in the activity of mitochondria, which It leads to an increase in metabolic processes due to the consumption of oxygen present in red blood cells (hemoglobin), which leads to a decrease in the quantities of oxygen as shown in Table No. (1 and 2), where its percentage was before laser irradiation (180) and after that its percentage reached (88.7).

This is what some previous studies have found, where they showed that there are many changes that occur when tissues are exposed to laser radiation, and these changes include increasing the formation of ATP, the final product of the metabolism process, accelerating enzyme activities, and increasing the dissociation O2 of hemoglobin (Huang *etal*.2009).

for the reason for the low PH. To the consumption of sugar in the blood resulting from laser irradiation of blood, which leads to the dissolution of sugar and the release of hydrogen element H, which leads to an increase in acidity in the blood, i.e. the pH decreases, where its ratio was (7.443) and after laser irradiation, its percentage reached (7.215)

One study also found that the photolysis of carbon monoxide (Co) from hemoglobin, and the final conclusion indicated an increase in the dissociation of Co from Hp by shining a 632 nm helium-neon laser (Rose - et al. 2015). Laser treatment activates cell pathways in the case of low sugar and increases acids H. (Heymann Metal), 2018.

Its rise is due to the same reason, which is the increase in the consumption of glucose to produce ATP energy due to the disintegration of the glucose molecule to produce energy and hydrogen ions, as well as the increase in the percentage of carbon dioxide, where its percentage was before irradiation (39.8), and after laser irradiation it became (64.7)

The current data agree with what Demidov Hamblin found in 2006, which confirmed the increase in metabolic activities and respiratory rates when exposed to a low level of laser beam or near infrared rays.

It was also found that irradiation of cells using LLLT leads to an increase in metabolic activities and that these activities improve more with He-Ne laser irradiation with a wavelength of 632.8 nm

100 J.m.

Second: The second interaction that can occur in the use of this type of laser is the interaction In this case, all the previously mentioned decreases are caused by a negative thermal effect, which results in the destruction of red blood cells, and this leads to the dissolution of sugar, which results in a decrease in acidity PH As for the increase in CO2 due to the thermal effect, its reason is to reduce the effectiveness of white blood cells. Which leads to a decrease in the use of oxygen in the blood and an increase in the proportion of carbon dioxide.

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