Remove Skin Deformities by Using CO2 and Nd:Yag Laser

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Abstract. The treatment of some skin damage have been studied influence the laser beam CO2 and the Nd:Yag with wavelengths (10600nm and 1064 nm) respectively as foundation of radiation. The current research aims to verify effect of altered laser dosages of the skin in an attempt to recognize how the laser achieves medicinal effects to treat skin lesions. And the aims to establish the correlation between laser dose and biological influence and so after that calculate its low dose with higher medical influence and minimal harm to.
The number of cases included four different diseases, ranging between 18-50 years. Areas of the body were exposed to laser beams and different wavelengths by type laser user. The first case, represent the image of a girl suffering from autoimmune disease, Nd:YAG laser was used with Q-switch Nd: YAG to treat this condition and the wave length is 1064 nm, second case, image of a person suffering from the impact. Fractional Co2 Laser and wavelength 10600 nm where used and third case: An image of a person suffering from costs, treatment by using Q-switch Nd-YAG laser short pulse has a wavelength of 1064nm.

1 . Introduction
Low-intensity laser therapy (LLLT) in the near-infrared visible spectrum between wavelengths (390-1100 nm) the absorption of laser light at the electron level, without the occurrence of heat generation. Lasers are broadly using in biology and medicine, most health offices and hospitals use laser systems for diagnosis or treatment. Scientists had been presented various applications in medicine for the various laser devices Used in many surgical cases and other medical aspects. Medical laser can be classified into two parts: treatment as well as diagnosis. The difference between laser applications in treatment and diagnosis Represents a kind of interaction between the tissue and the laser. In the case of diagnosis, a method of arranging a non-laser insertion into the tissue must be thought to a large extent to know the normal tissue behavior without causing any damage or specific effect on the tissue, the applications of laser in the medical field depends on the nature of the interaction between the laser and tissues. By
knowing the cases of laser-tissue interaction, medical workers can find the best types of lasers and determine the treatment mechanism [1, 2].

Various optical treatments have been used in clinical cases and this was done by providing these treatments using continuous laser or pulse light, which led to good cases in many clinical applications in the treatment of dermatology and plastic surgery. Carbon dioxide is a continuous wave that is most commonly used in laser therapy today.

Water absorbing the wavelength 10.600 nm significantly, depend upon the cell constituent’s in the tissue. [3]

This laser can be use in removing of hair, tattoo and skin resurfacing are the public applications where continuous CO2 laser works a important role. Laser therapy depends upon the direct communication of light with the tissue, in addition to the opportunity of tissues restoration and repair later. Some researchers are founding that the interaction of skin with laser radiation depends on many factors. First, the color or amount of pigment in the skin is very significant to find out the quantity of lesions will result in the use of a particular of pulsed laser. In addition, the quantity of keratin found in radiation-prone area; thirdly, laser properties, especially wavelength. In addition, skin reactions vary widely with laser radiation, depending on the surrounding conditions and skin type. [4]

At the same time, the light can know as a current of photons, have a zero mass, and zero of electric charge, carry a definite energy. In other express, energy transmitted by the electromotive wave that is not distributed in continuous case on front of wave determined via the peaks. The located of energy in separate points along the wave front. Photons formed within atoms which irradiated region when these atoms are irritated and returned to normal. Photons move at the speed of light. When the photons absorb by the atoms which consist the matter, they energy losing because transfer in atom. Energy of photon is inversely proportional with its wavelength as follows: -

\[ E_{\text{photon}} = \frac{hc}{\lambda} \]  \hspace{1cm} (1)

Therefore, the definition of laser medical applications depends on the kind between laser light- tissue of interaction. Information of laser and tissues interaction can be help those working in this field to choose the best lasers and determine the sort of treatment. In the current research, the biological tissue visual properties of like penetration, absorption, dispersion, and fluorine, as well as these properties effects of on the penetrated case of the laser of the tissues, which had been demonstrated. [5,6,7]

The mechanisms of laser use in the medical field include Physical, chemical and biological aspects. However, the topic is important enough and interesting to the specialists or others. A number of researchers, possession materials of biological which have different properties of the nonliving materials complicate the study of scientific difficulties of medical nature and others. It can be seen that the amount problems of biology and medicine is very high large. It can be examine the state in which medicine and physics are closely related, the state of communication between the laser beam with biological tissue. like interactions may be use in different parts, as dentistry, surgery and dermatology.

There are also perceptions of the state of laser use that most people are concerned about using. The basic knowledge of laser-material interaction mechanisms is essential in order to suitably assess the hazards and aids of using laser in medical. It can be examine the case in which physics and medicine have wavelengths ranging from infrared, where \( \lambda = 10.6 \, \mu\text{m} \), CO2 laser until visible and ultraviolet where \( \lambda = 0.248 \, \mu\text{m} \) called excimer laser, which either pulse or continuous and symbolize latter with the symbol (CW), which is the abbreviation of continuous wave. Both types have a special P value. In case of continuous lasers, the symbol
P generally defined by amount of energy over time. In pulse mode, the energy relationship is given on the pulse time.[4]

2. Absorption and Reflection of the Laser Beam

Laser absorption: The absorbed laser light may cause tissue coagulation or vaporization. Laser light mainly affects pigments, hemoglobin, or water. Pigments that contain iron, which gives blood the red color, prevent a large quantity of light transmission via tissues. Hemoglobin has three absorption peaks: blue (415 nm), green (540 nm) and yellow (577 nm). The ideal absorption is between 514-590 nm. Oxyhemoglobin forms the primary component of blood absorption and reduces hemoglobin uptake which shows strong band in the ultraviolet, blue, green and yellow spectrums of the spectrum. When the sun rays enter the skin. The pigment melanin protects the skin from many damages, especially protecting it from ultraviolet rays, By absorbing some wavelengths, which cause harm to humans. This property of pigment melanin makes it help and interfere with laser in surgery depend upon the type of damage involved in the skin. Melanin is mainly found in the skin of the body and hair follicles are widely absorbed across the optical spectrum.

Excessive doses of UV rays cause photochemical damage to tissues. UV photons disrupt the DNA structure directly or indirectly by creating free radicals. When free radicals are formed. The skin suffers from various effects that may be mild, such as redness of the skin, to the appearance of ulcers and swelling when the effects are severe, and sometimes the effect reaches high impact cases such as the occurrence of skin cancer, as in Figure [1]. [8] [9]

![Figure 1](image)

Figure 1 shows the absorption coefficient of some lasers

In the case of transparent media, with the refractive index \( n_0 \) and \( n_1 \), the reflectivity resulting from the interference of the two mediums is given by the following equation

\[
R = \frac{(n_1 - n_0)^2}{(n_1 + n_0)^2} \quad (2)
\]

Light absorbed by the tissue is the only one useful in medical applications. When exposed to the tissue, the light is absorbed by water or other absorbers, the color of the hemoglobin and melanin (a dark brown pigment that gives hair color, iris in humans and animals that is responsible for skin color changes when exposed to sunlight.

When the intensity of the falling light \( I_0 \) hits the medium of thickness \( d \), is given by the following equation:-

\[
I = I_0 (1 - \alpha) e^{-\alpha d} \quad (3)
\]
Where $\alpha$ represents the absorption coefficient and $\alpha^{-1}$ represents the absorption of length. Absorption of length is a calculate of the width in which energy of light can be spread in the irradiated of medium. The longer the absorption time is, the smaller area of diffusion in the irradiated medium. It is therefore possible to focus on a specific small position during the treatment process when absorption time very low. We will see in this case, quantitative assessment of the energy laser beam required easy processing. In fact, when we plot the area exposed to the laser beam in the tissue, it is $AL$, and the length of absorption, $\alpha^{-1}$, the propagation volume is given by the following formula:

$$V = AL\alpha^{-1}$$

We assume that the energy ($E$) per unit size required a specific spread of the beam of laser, the required beam energy of laser is:

$$E_L = E \times V$$

The lasers excitation are given the following equation.

$$F_L = \frac{E_L}{A_L} = E\alpha^{-1}$$

In general, the absorption of light can occur during electronic irritation. [10]

3. Thermal Diffusion

When using a laser beam, the energy should not move away from the exposed area. In general, the light is absorbed by electronic diffusion. Where excited electrons are unstable. It is losing its energy to achieve stability. This causes the irradiated of material to heat up. The transition from light to thermal energy is extremely fast. Thus, the heated area by laser which correspond precisely to the zone that irradiated, i.e. there is no spread outside irradiated area. The heat is spread through material at a percentage can be determined by nature of material which irradiated. When the spread of heating main method, and the length of the thermal spread.

4. Effects of thermal

When absorbed energy, There will be different triggers, depend upon the long of wavelength, flux of laser and the nature of material which irradiated. The most commonly by using thermal heating of radioactive materials. at this case, the spread of heat is insignificant, the absorbed of energy equal to totality of the output heat energy needed to the volume of heat that was converted temperature in tissue plus the heat of latent the heat required to convert a solid into a liquid or vapor, or a liquid into a vapor, without change of temperature of that transform. [11]

Applications of biomedical lasers depend on interaction with biological systems. The important factor in light effects on the tissue is wavelength, time of exposure and energy are also significant. The reaction of laser it can be cause a wide optical of effects that can divided into three parts. The low level laser light, where the absorption, reflection, and fluorine processes occur through the material and there are no substitutions in the material. Second, the use of UV and optical light of low intensity, in which case an electronic excitation process occurs in the particles, and photobiological effect causes chromophores and causes tissue damage due to heat. Figure 4 shows the depth of the optical penetration of the laser where there is about 50% optical penetration of the light and the depth of the treatment can be very large beyond the optical penetration depth of the laser. For example, the optical penetration depth of the CO2 laser is ~ 20 microns only. [5]
Figure 1.4 shows the penetration depth of the laser beam to the different skin layers [5]

5. Skin

Skin of Human is the border among it and its environment. One of the surrounding environment issues it has to treaty with UV rays. UV rays can cause harmful effects for example redness, cancer aging of skin. Top layer called epidermis, works as a natural filter for UV rays and may produce strong pigments as an adaptation to excess ultraviolet exposure. In other words, ultraviolet rays stimulate the manufacture of vitamin D3 in the human skin and thus provide A major natural resource of this vitamin for peoples. Thus, we note that the human skin was not developed to protect against the sun's rays but as a barrier from the harmful effects of the sun.

Due to the nature of the living matter that makes up the skin, blue light penetrates deeper less than red light. The purpose that the human skin is composed of group of absorbers that had been absorption coefficients of scattering largely dependent on the amount of wavelength. The properties of scattering of the tissues are producing the properties of attenuation of color swatch and also to particle size within the tissue which also controls the type of scattering that occurs, i.e. scattering of Rayleigh. The scattering cause to the scattering of light within tissues which ultimately leads to a decrease in the energy density with increasing depth. A number of researchers allowed the laser light to pass through different skins using laser beams between 532-1064 nm, and the results showed that laser light penetrates the most into the skin.

High intensity pulsed light (IPL) is within the spectral range of wavelengths 400-1200 nm. As for the wavelengths 1000 nanometers, There is no known amount of knowledge regarding the amount of penetration depth, and very little information about the photo biological effects of ferrets for wavelengths above 1000 nm. [12]

The skin is the largest human organ. Its area is between 1.5 - 2 m², which constitutes about one sixth of the body weight. The skin plays a large role in human physiology. It protects man from the effects of the environment and acts as a channel for communication with the outside world. For example, as the skin protects the human body from water loss, ultraviolet rays, sunlight, contact with the ocean and other influences. Also helps us in regulating metabolism and body temperature. All bioluminescent responses are strongly influenced by the optical skin properties. Optical effect of rays on human skin depend upon absorption and diffusion properties of three layers of the skin: epidermis, dermis, and subcutaneous. The components of these layers and pigments determine the amount of radioactive attenuation in the skin. The best state of penetration of photoelectric radiation as well as knowing the best type of ray for pathology use can be achieved by studying the wavelength-related interactions of light with the skin. As example, we note pigment of melanin shows maximum absorption in the range UV spectral and blue light region, while blood absorbs blue and yellow light most. [5]
In skin’s three layers, excesses in skin, as hair, nails, and glands can be found as an outer skin layer. The thickness of the skin is about 0.1 milometers. The region of face may be thin 0.02 milometers, but in soles feet’s thickness of 1-5 milometers. Skin is made up of 90% from keratinocytes, acts as a barrier against damaging substances to avoid water and other essential substances to emission from the body. but regarding other 10% of skin which consist of small cells, make distributed of melanin. The interaction of the laser with the skin requires knowledge of the biomedical optical properties and the best dose of radiation used. There are two important properties that control the interaction of light with the skin, namely absorption and scattering, as absorption occurs by pigments found in the skin such as water, melanin and hemoglobin. Scattering results from differences in parameters refraction between the compounds of tissues.

Melanin is one of the strongest pigments and refractory index 1.7, absorption and precipitation in the skin depends on the visible and near infrared spheres of NIR on its content of melanin and water, respectively. The dermis consists of substances similar to gel, water, and collagen in the first place. This class includes known organic substances such as blood vessels, lymph channels, muscle cells and nerve fibers. The water and human blood parameters determine their absorbent properties in the visible and NMR region of spectral bands. Hypodermis is composed of a spongy connective tissue that is permeated by lipid cells that store energy cells of fat, its assembled with together in large groups similar to cushions kept by collagen fibers which called bonding of tissue granules or casing. A subcutaneous layer is associated with vessels of blood, confirming rapid carriage of stored nutrients as needed. [5,13]

The dispersion of light by skin is greater than the dispersion obtained by dermis or fat within range of wavelength. this known that the visual properties of the skin in spectral region 370-1200 nm are measured by the amount of contained of melanin. [14]

Which has a high refractive index relative to the surrounding mean of about 1.3. Therefore, the scattering of light in the skin is significantly higher than that of other skin layers. In dermis, scattering often results from collagen fibers and associated small components. [8]

6. Results and calculations

6.1. The first case (removal of Otto mole)

Before treatment

After treatment
Table 1 shows laser parameters used to treat moles removal

| Seq. | NO. of sessions | Energy(J/cm²) | Frequency(Hz) | Pulse(ms) | Spot Size(mm) |
|------|-----------------|---------------|---------------|-----------|---------------|
| 1    | First sessions  | 8.8           | 3             | 9         | 4             |
| 2    | Second sessions | 10            | 5             | 9         | 5             |
| 3    | Third sessions  | 10.7          | 5             | 9         | 5             |

6.2. The second case: - (removal of wounds and scarring)

![Before and After treatment images](image1)

Table 2 shows the laser parameters used to treat the effects of wounds

| Seq. | NO. of sessions | Power(W) | Energy(J) | Pulse(ms) | Stalk(ms) | Stalkdaily (ms) |
|------|-----------------|----------|-----------|-----------|-----------|----------------|
| 1    | First sessions  | 22       | 22        | 0.25      | 4         | 1              |
| 2    | Second sessions | 25       | 25        | 0.25      | 4         | 1              |
| 3    | Third sessions  | 30       | 30        | 0.25      | 4         | 1              |

6.3. The third case: - (removal of costs)

![Before and After treatment images](image2)
Table 3 shows the laser parameters used to process the costs

| Seq. | NO. of sessions | Energy (J/cm²) | Frequency (Hz) | Pulse (ms) | Spot size (ms) |
|------|----------------|---------------|---------------|------------|----------------|
| 1    | First sessions | 7             | 2             | 9          | 9              |
| 2    | Second sessions| 8             | 2             | 9          | 9              |

6.4 The fourth case (removal of blood vessels)

Table 4 shows laser parameters used to remove blood vessels

| Seq. | NO. of sessions | Energy (J/cm²) | Frequency (Hz) | Pulse (ms) | Spot size (ms) |
|------|----------------|---------------|---------------|------------|----------------|
| 1    | First sessions | 7             | 2             | 9          | 9              |
| 2    | Second sessions| 8             | 2             | 9          | 9              |

7. Discussion

These cases were carried out in Imam Sadiq Hospital as well as in the clinic of Dr. Ihsan Jaraa Attia for an extended period from March 2018 to the month of August for the same year. The number of cases included four different diseases, ranging between 18-50 years. Areas of the body were exposed to laser beams and different wavelengths by type Laser user.

7.1 First case

In Table 1, the image of a girl suffering from autoimmune disease is 5 years old and is now 15 years old. The Nd:YAG laser was used with Q-switch to treat this condition and the wavelength is 1064 nm. Is one month. A carotid pigment usually appears at birth, but some in adolescence may affect the skin and mucous membranes in the mouth or affect the area of the eye's whites. The color is usually black or grayish and is about 80% in women. The laser used to treat this condition is an indica that is suitable for all skin types. The goal is to treat the melanin pigment found in melanocytes, which is present in melanocyte cells. It is preferred to treat with sub-micro pulse because the thermal relaxation time of the melanin is very short. This laser is more safe and does not affect the normal skin. Its results are selective for melanin and the laser here works by the effect of photodynamic mechanism. As the laser waves cause sudden heat rise, it causes an acoustical shock with a shock wave which, in turn, ruptures or removes the permeability of the laser. Love the outside of the cells of pigment cells and thus cause shrinkage and death of pigment cells and fragmentation into small particles.
7.2 Second case

In Table (2) we have a picture of a person suffering from the impact of an old wound from the age of one and a half and now 18 years of age has been used Co2 laser to address this situation and the technique of fractal laser called Fractional Co2 Laser and wavelength 10600 nm and the period between one session and one month where A Fractional Co2 Laser is used to radiate wavelengths absorbed by water molecules in the skin, causing evaporation of surface tissues and causing plume to leave the skin. Resurfacing is very useful in treating scarring and rejuvenation caused by old wounds, burns or skin lesions. This laser stimulates the reduction and rearrangement of tissues such as collagen and elastin fibers. This effect lasts several months after laser operation. The mechanism of laser work in this case is that the laser works on collagen fibers where it is shed on the wound at the wound area, the collagen is irregular, the laser is then rearranged and the wound does not disappear, but its shape is acceptable or better than the state it was.

7.3 Third case

In Table 3, the image of a person suffering from cost has been used for 5 years, and the Q-switched Nd-YAG laser short pulse has a wavelength of 1064nm. The cost of direct exposure to sunlight, Psychological, contraception or pregnancy itself targets the melanin dye that collects in the deep layers of the dermis.

There are two types of epidermes, which are present in the basal layer of the skin in melanocytes. The second type is deep in the dermis, where the melanin is collected in the dermal layer in the form of melanophage. In this case, it requires laser treatment to break up the pigment which is located in deep layers of the skin. This laser is safe for the skin of the color of the light and has a wavelength that allows deeper permeability reaches the deep layers of the skin. If we use a 532 nm wavelength to target the region near the surface of the skin.

7.4 Fourth case

Table (4) is a picture of a person suffering from an enlarged vascular area in the face area. Note that the age of the person 50 years has been used the Nd:DYG laser and the length of the wave 1064 nm Long Pulse Nd.YAG. Blood vessels expand as a result of exposure to sunlight or the use of local medicine Or genetically and infect the white skin more because of exposure to the sun in fact, this laser is not the best existing types for the treatment of hemorhages and the expansion of blood vessels, but the reason for choosing this type of laser -To be available at the hospital.

-It has a wavelength that allows for the permeability of deep layers of skin.
-It should be safe for the skin with the color Asmar, as most of our disease in Iraq; the color of the skin is black.
-This wavelength is characterized by penetrating the skin into deep layers and chloroform is the hemoglobin. The hemoglobin is selectively absorbed by the laser without affecting the surrounding tissues and thus causes blood clotting in the blood vessels, leading to the disappearance of the enlarged blood vessels and treatment without gene effects.

8. Recommendations before undergoing laser session

1 - In many cases, the laser causes certain burns in the skin area, because the laser contains many of the radiation, which if used frequently lead to burning skin, and the most exposed to those burns are the owners of dark skin.

2 - The skin is exposed to a defect in pigmentation, in certain cases lead to excessive laser to a large secretion in the dye melanin, which gives the skin the appropriate color, and this
condition is called excessive pigmentation, and there is another case is a lack of pigment in the skin. And the inability to give the skin the right color, and therefore keep the skin light.

3. Laser causes damage to the eyes, so care must be taken and caution during treatment, and work to protect and prevent direct exposure to these rays.

4. The feeling of continuous itching in the skin exposed to laser, and this itching is a side effect of the laser.

5. Exposure of the skin to redness and swelling in the area that has been treated.

6. Change the color of the skin to acquire purple color during the treatment.

7. If the patient neglects the treated area; they will be susceptible to infection.

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