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Treatment of cutaneous spider veins using long pulse 1064nm Nd: YAG laser

A Dissertation Submitted to the Institute of Laser for Postgraduate Studies, University of Baghdad in Partial Fulfillment of the Requirements for the Degree of Higher Diploma in Laser in Medicine / General Surgery

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بِسْمِ اللَّـهِ الرَّحْمَـٰنِ الرَّحِيمِ

وَلَا تَمْشِ فِي الْأَرْضِ مَرَحًا ۖ إِنَّكَ لَن تَخْرِقَ الْأَرْضَ
وَلَن تَبْلُغَ الْجِبَالَ طُولًا

الاسراء (37)

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Dedicated to my father and mother

To wonderful my wife

To my children, brothers, and everyone supported me.

Laith

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ABSTRACT

Lower extremity spider veins affect approximately 40% of women and 15% of men, with higher prevalence in women and underlying genetic and hormonal factors. Higher occurrence is found in our societies in which occupational health and obesity also play a role as underlying predisposing causes. Women are also more concerned about the aesthetic aspects of spider veins, which prompts them to seek treatment. Although spider veins have no major medical risks, the demand for aesthetic treatment of these veins continues to grow all over the world. The aim of the study was to determine the efficiency and safety of 1064 nm Nd YAG laser in the treatment of spider leg veins. Ten patients with lower limbs spider veins were included in this prospective study. They were treated with a long pulsed (Nd: YAG) laser in no contact technique using the following laser parameters (wave length 1064nm, energy 30-73 J, pulse duration 10- 30 ms, frequency 2Hz, spot diameter 3-7mm). Laser therapy was performed on day zero and day fourteen. Clinical assessments were carried out before laser therapy and immediately after the first laser therapy, 2 weeks, 4 weeks, and 6 weeks later.

Results showed that there was a remarkable improvement for 80% of patients after the third treatment. Only five patients showed a complete disappearance of the spider veins with no significant intraoperative and postoperative pain and complications, within short operative time.

Conclusion

The long pulsed (Nd: YAG) laser (1064 nm) is an effective and safe treatment option for lower limbs spider veins.

List of Contents

List of Tables

List of Figures

List of Abbreviations

Abbreviations	**Item**
ANSI-Z136	*American national standers institute*
C	*Velocity of light*
Cm	*Centimeter*
CO_2	*Carbon dioxide*
CW	*Continuous wave*
E	*Energy*
H	*Plank constant* 6.626×10^{-34} *joule/sec*
Hz	*Hertz*
I	*Irradiance*
IEC	*International electrochemical commission*
IR	*Infrared*
J	*Joule*
Mm	*Millimeter*
mW	*Milliwatt*
Nd: YAG	*neodymium: Yttrium-Aluminum-Garnet*
MPE	*Maximum permissible exposure*
NHZ	*Nominal hazard zone*
Nm	*Nanometer*
OD	*Optical density*
P	*Power*
PDT	*Photodynamic therapy*
sec.	*Second*
Uv	*Ultraviolet*
V	*Frequency*
W	*Watt*
µW	*microwatt*
Λ	*Wavelength (spatial period)*

Chapter One

Introduction and Basic Concepts

Introduction

Spider veins are small veins that can appear on the surface of the legs or face. Spider veins can be blue, purple, or red and may appear in the form of thin lines, webs, or branches. People sometimes also refer to them as thread veins. They are usually not painful or harmful, but some people may wish to treat them for cosmetic reasons. Spider veins on the lower limbs are very common and have been reported to be present in 41% of women over the age of 50 years in the United States [1]. Spider veins occur in two-thirds of patients before the age of 25, and increase in incidence with age. They represent an important aesthetic problem [2].

Telangiectasias, also known as spider veins, are small dilated blood vessels [3] that can occur near the surface of the skin or mucous membranes, measuring between 0.5 and 1 millimeter in diameter [4]. These dilated blood vessels may be developed anywhere on the body but are commonly seen on the face around the nose, cheeks and chin. Dilated blood vessels may also be developed on the legs, although when they occur on the legs, they often have underlying venous reflux or "hidden varicose veins”. Many factors cause spider veins such as; genetic factors, Venous hypertension [5]. Also, there are predisposing factors to the development of varicose and telangiectatic leg veins include; Age, Gender:[6], Pregnancy [7], Lifestyle/occupation [8].

Acquired telangiectasia, not related to other venous abnormalities, for example on the face and trunk, can be caused by factors such as; Cushing’s syndrome, Acne rosacea, Blepharitis[9],Environmental damage .Age [10],Trauma to skin, Radiation ,Chemotherapy, Carcinoid syndrome, Limited systemic sclerosis/scleroderma (a Scleroderma sub-type),Chronic treatment with topical corticosteroids may lead to telangiectasia.[11], Tobacco smoking[12].compressed socks can help prevent spider veins forming. Certain lifestyle changes and self-care tips can help prevent new spider veins appearing or stop existing ones from getting worse. These include; Wearing sunscreen, applying sunscreen, use sun-protective hats and clothing when outdoors for extended periods, maintaining a healthy weight, wearing compression stockings, staying mobile, avoiding tight clothing, avoiding the overuse of hot tubs and saunas, limiting alcohol consumption, getting regular exercise, elevating the legs, seeing a dermatologist, using cover-up products.

Sclerotherapy is typically considered the first line of treatment for leg veins smaller than 4 mm in diameter. Frequent side effects are pain and hyperpigmentation, caused by hemosiderin deposition through extravasated erythrocytes or by post inflammatory hyper melanosis. Rarely, systemic allergic reactions, skin necrosis, and thrombophlebitis may occur. Moreover, patients with needle phobia may have aversions to this invasive procedure. [13,14] Lasers have been used to treat dilated leg veins since the 1970s. [15,16]

Lasers have some theoretical advantages compared with sclerotherapy for treating leg telangiectasias. For example, the risk of hemosiderin deposition would be expected to be lower, as blood vessels are effectively coagulated, preventing inflammation and extravasation of erythrocytes. Early treatments used a variety of wavelengths and radiant exposures resulting in lack of vascular selectivity and thermal confinement leading to unacceptable results, hyperpigmentation, and scarring in many cases. [17]

Their mechanism of action is based on the theory of selective photo thermolysis. [18]

Sclerotherapy, laser and intense-pulsed-light therapy, radiofrequency (RF) or laser ablation,[7] and ambulatory phlebectomy are the modern techniques used to ablate varicosities. Numerous reports describe success rates of greater than 90% for less invasive techniques, which are associated with fewer complications, with comparable efficacy. [19,20]

A variety of lasers [21, 22, 23].and light sources [24, 25] have been used to treat small superficial red telangiectatic vessels on the lower extremities. However, the challenges remain in treating lower extremity deeper telangiectasia and larger reticular veins. [26] These vessels, which are under increased hydrostatic pressures, tend to be larger and blue in color.

The first study on the selective use of a 1064-nm laser on leg telangiectasias and reticular veins was reported by Weiss and Weiss in 1999. [27] Previous applications of this laser were limited to deep laser coagulation of tissue, large hemangiomas and vascular malformations without considering selective targeting. These investigators demonstrate that the 1064 nm wavelength is much more effective in the treatment of 0.5–3.0 mm dilated leg vessels than that of the shorter wavelength lasers used previously. The longer wavelengths allow for increased penetration of light into the dermis. The advantage of Nd: YAG laser over alexandrite and diode lasers is that with equivalent absorption of blood, the 1064 nm laser has weaker melanin absorption and can penetrate deeper. Newer longer-pulsed millisecond Nd: YAG lasers provide longer pulse durations to heat larger caliber blood vessels while at the same time providing adequate cooling to protect the epidermis.[28]

With this technique, blood vessels are selectively obliterated while sparing the surrounding tissue based on three essential requirements: (1) a wavelength that penetrates deeply enough and is preferentially absorbed by hemoglobin, (2) pulse duration less than or equal to the thermal relaxation time of the target structure, and (3) sufficient radiant exposure to cause irreversible damage to the target structure. [12]

Nowadays, all vascular laser modalities are based on this principle. [3]

In this fashion, laser and light devices have become refined during the past several decades, leading to our current ability to apply high fluences to tissues very specifically resulting in selective destruction of unwanted lesions while sparing the patient from non specific side effects such as crusting, bleeding, scabbing, or scarring. [15]

In the case of vascular specific laser systems, the intended target is intravascular oxyhemoglobin, which has absorption over a broad range of wavelengths with peaks at 418, 542, and 577 nm. shows the different absorption spectra of the various chromophores found in the skin. The most commonly devices used today include the 532-nm potassium titanyl phosphate (KTP), the 595-nm pulsed dye laser (PDL), the 755-nm alexandrite, the 1064-nm neodymium-yttrium-aluminum-garnet (Nd: YAG), and various intense pulsed light (IPL) systems.

By targeting oxyhemoglobin, energy is transferred to the surrounding vessel wall. Currently, the 1064-nm Nd: YAG laser and the visible/near infrared (IR) intense pulsed light (IPL) devices both give good results. The main difference, however, either Nd: YAG lasers can penetrate much deeper and are therefore more suitable for the treatment of larger, deeper blood vessels such as leg veins, or its lower absorption coefficient for melanin, there is less concern for collateral epidermal damage so it may be more safely used to treat darker pigmented patients. The risk for post inflammatory hyper pigmentation can further be minimized by epidermal cooling devices. Epidermal cooling is imperative to safeguard against collateral damage from melanin absorption. Also, Longer wavelengths more uniformly than the shorter wavelengths with higher absorption coefficients. [2, 16, 17, 18, 21].

1.1Pathophysiology

Spider veins are normal veins that have dilated under the influence of increased venous pressure.

In healthy veins, one-way valves direct the flow of venous blood upward and inward. Blood is collected in superficial venous capillaries, flows into larger superficial veins, and eventually passes through valves into the deep veins and then centrally to the heart and lungs. Superficial veins are superficial, while deep veins are within the muscle fascia. Perforating veins allow blood to pass from the superficial veins into the deep system.

Most commonly, superficial venous valve failure results from excessive dilatation of a vein from high pressure of reverse flow within the superficial venous system. Valve failure can also result from direct trauma or from thrombotic valve injury. When exposed to high pressure for a long enough period, superficial veins dilate so much that their delicate valve leaflets no longer meet.

The sequelae of venous insufficiency are related to the venous pressure and to the volume of venous blood that is carried in a retrograde direction through incompetent veins.

Pathologically dilated vessels of the venous microcirculation can be subdivided in telangiectasias (≤0.3 mm, <1 mm according to some authors) [29], venulectasias (0.4–2mm), and reticular veins (>2 mm). A distinct pathological feature is telangiectatic matting, which is defined as a fine network of dilated telangiectatic veins and is often the result of an earlier treatment, such as sclerotherapy. [30] Telangiectasias may be red or blue depending on the dominance of an arteriolar or venous component respectively.

Telangiectasias and venulectasias originate from the superficial plexus. Reticular veins, however, are situated in the deep dermis and subcutis and have a blue appearance. [29, 30]

Reticular veins often have an insufficient connection with the venous system.[31]

Dilated leg veins often originate from a so-called feeder vein, a dilated draining vein that causes an increase in hydrostatic pressure in all of its tributaries. [32]

The cutaneous microcirculation is organized as two horizontal plexuses. One is situated 1–1.5 mm below the skin surface and the other is at the dermal–subcutaneous junction. Ascending arterioles and descending venules are paired as they connect the two plexuses. From the upper layer, arterial capillaries rise to form the dermal papillary loops that represent the nutritive component of the skin circulation. There are sphincter-like smooth muscle cells at the point where the ascending arterioles divide to form the arteriolar component of the upper horizontal plexus. At the dermal–subcutaneous junction, there are collecting veins with two cusped valves that are oriented to prevent the retrograde flow of blood. [34]

1.2 Anatomy and pathology of the lower extremity cutaneous microcirculation:

A basic understanding of the anatomy of the cutaneous microcirculation and its pathological mechanisms is mandatory for clinicians treating abnormalities of the small vasculature of the lower extremities, as diameter and localization of the affected vessel largely determine the treatment of choice. Essentially, the cutaneous microcirculation consists of two horizontal plexuses. The superficial plexus is formed by arterioles, venules, and capillaries located in the papillary dermis 1–1.5 mm under the skin surface, whereas the deep plexus is found at the dermal subcutaneous interface and is directly interconnected to the superficial plexus by vertically oriented vessels.

The deep plexus is connected to perforating vessels from the underlying muscle. Hence, the veins of the deep plexus drain on the veins of the microcirculation of both the superficial compartment, including the great and small saphenous vein, and the deep compartment. [35]

Pathological dilation of lower extremity veins can be explained by abnormalities in the organization and ultrastructure of the cutaneous microvasculature rather than by neovascularization.

Histological examination demonstrates dilated blood vessels in a normal dermal stroma with a single endothelial cell lining, limited muscularis, and adventitia.

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Dilated leg veins often originate from a so-called feeder vein, a dilated draining vein that causes an increase in hydrostatic pressure in all of its tributaries. [39]

Treatment of the feeder vein is crucial in the prevention of recurrences. When considering laser treatment; these characteristics are of pivotal importance in the choice of the laser modality and settings.

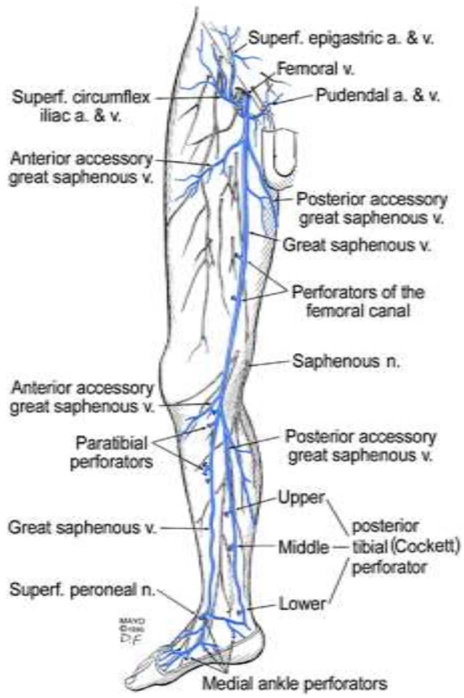

Fig. (1-1) venous anatomy of lower limb

1.3 Lasers principles

1.3.1 Theoretical background

The word laser is an acronym of Light Amplification by Stimulated Emission of Radiation. A laser emits a beam of electromagnetic radiation that is always monochromatic, collimated and coherent in nature. Lasers sources consist of three main components: a lasing medium (solid, liquid or gas), a stimulating energy source (pump) and an optical resonator; and have a wide variety of uses in clinical medicine. Lasers cause tissue damage by various mechanisms and these are mainly determined by power density (irradiance) of the beam and exposure time. It is imperative to be aware of the risks associated with laser use in terms of tissue damage (burns and eye injuries) and fire hazards. Strict controls should be implemented governing the safe use of lasers in hospital practice, and all staff must be familiar with all laser safety measures to prevent injury and fires. [40]

1.3.2 Spontaneous Emission

By quantum mechanics the lower energy level is more stable than higher energy levels, so electrons tend to occupy the lower level. Those electrons in higher energy levels decay into lower levels, with the emission of EM radiation. This process is called spontaneous emission.

1.3.3 Stimulated Emission

This is crucial if lasing is to occur. Suppose the atoms of the active medium are initially in E2. If external EM waves with frequency n0 that is near the transition frequency between E2 and E1 is incident on the medium, then there is a finite probability that the incident waves will force the atoms to undergo a transition E2 to E1. Every E2-E1 transition gives out an EM wave in the form of a photon. We call this stimulated emission since the process is caused by an external excitation. The emitted photon is in phase with the incident photon, has the same wavelength as it and travels in the same direction as the incident photon.

1.3.4 Non-Radiative Decay

Note that the energy difference between the two levels can decay by non-radiative decay. The energy difference can change into kinetic energy or internal energy through collisions with surrounding atoms, molecules or walls.

1.3.5 Population Inversion

Normally the population of the lower energy levels is larger than that of the higher levels. The processes of stimulated radiation/absorption and spontaneous emission are going on in the same time, yet even if we ignore the decay factors, stimulated absorption still dominates over stimulated radiation. This means that the incident EM wave cannot be amplified in this case.

Amplification of incident wave is only possible when the population of the upper level is greater than that of the lower level. This case is called Population Inversion. This is a mechanism by which we can add more atoms to the metastable level and hold them there long enough for them to store energy, thereby allowing the production of great numbers of stimulated photons.

In practice laser action cannot be achieved for only two levels, as described above. Three and four level systems work however. An analysis of these systems follows, followed by a description of the pumping schemes for each system.

(Note: A metastable level is one that has a long lifetime and the for which the probability of spontaneous emission is low. This favors conditions for stimulated emission. If an atom is excited to a metastable state it can remain there long enough for a photon of the correct frequency to arrive. This photon will then stimulate the emission of a second photon.

1.3.6 Amplification of Light

If population inversion exists, N2>N1, the incident signal will be amplified. The incident signal has energy equal to the number of photons times the photon energy we have

This means that the signal will increase exponentially when there is population inversion. The exponential increase continues until the population inversion reaches a certain point, then the signal saturates, and reaches the steady state.

1.4 laser source Elements

All lasers, regardless of size, shape, style, or application, have three main components: [2]

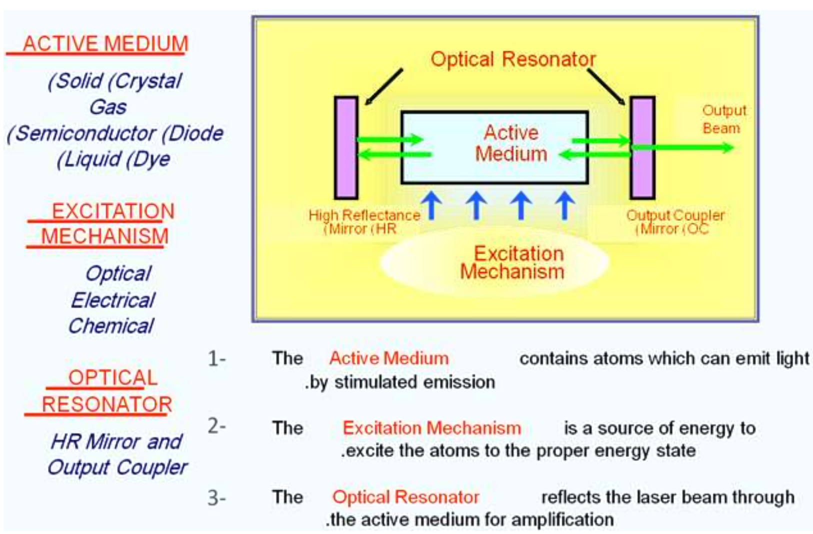

Figure (1-2) Laser Components

1. Active medium.

The active medium is a collection of atoms, molecules or ions that absorb energy from an outside source and generate laser light by stimulated emission, the active medium can consist of a solid, liquid, gas or a semi- conductor material. [41]

- Solid state as Nd: YAG laser.
- Liquid as dye laser.
- Gas, as CO2 gas laser.
- Semiconductor, diode laser.

2. Excitation mechanism

Excitation mechanisms pump energy into the active medium by one or more of three basic methods; optical, electrical or chemical to create a population inversion.

For a laser to create a "population inversion" where most or all of the particles are in the excited state, this is achieved by adding energy to the laser medium (usually from an electrical discharge or an optical source such as another laser or a flash lamp); this process is called pumping most common optical pumping by flash lamp, electrical pumping by electrical current, chemical reaction pumping, or the use of another laser light source. [42,43]

3. Optical Resonator

Reflect the laser beam through the active medium for amplification. It is consisting of: -

-High Reflectance Mirror: A mirror which reflects 100% of the laser light.

-Partially Transmissive Mirror: A mirror which reflects less than 100% of the laser light and transmits the remainder.

The resonant cavity thus accounts for the directionality of the beam since only those photons that bounce back and forth between the mirrors lead to amplification of the stimulated emission. Once the beam escapes through the front mirror it continues as a well-directed laser beam. However, as the beam exits the laser it undergoes diffraction and does have some degree of spreading. Even more, the resonant cavity also accounts for the amplification of the light since the path through the laser medium is elongated by repeated passes back and forth.

Typically, this amplification grows exponentially. If the direction is parallel to the optical axis, the emitted photons travel back and forth in the optical cavity through the lasing material between the totally reflecting mirror and the partially reflecting mirror. The light energy is amplified in this manner until sufficient energy is built up for a burst of laser light to be transmitted through the partially reflecting mirror; most lasers have three or more levels. [43]

1.5 Properties of Laser Light

Unlike ordinary light, laser light is **coherent, collimated, monochromatic, directionality, and brightness**. [44]

1- ***Coherency:*** refers to overlap in speed and time, where all individual waves are in step or ‘in –phase,’ with one another at every point.

a) Coherent light b) Incoherent light

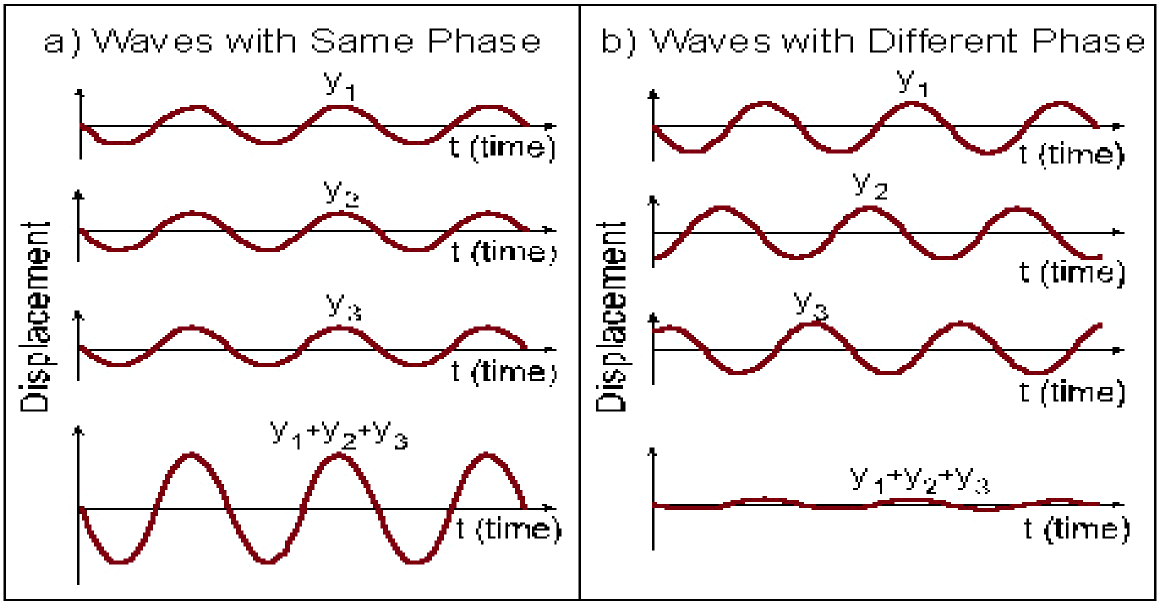

Figure (1-3) (a)-Coherent Light+ (b) - Incoherent Light [6]

2- Monochromatiy: refers to single wavelength (color) of a laser beam. Ordinary white light is a mixture of colors, as can be demonstrated by passing ordinary light through a prism, will be dispersed into its components wavelengths (colors) (Figure 1-5). Because wavelengths of laser light determine its effects on tissues & energy to be delivered to it as $E=h\mu= hC/\lambda$.

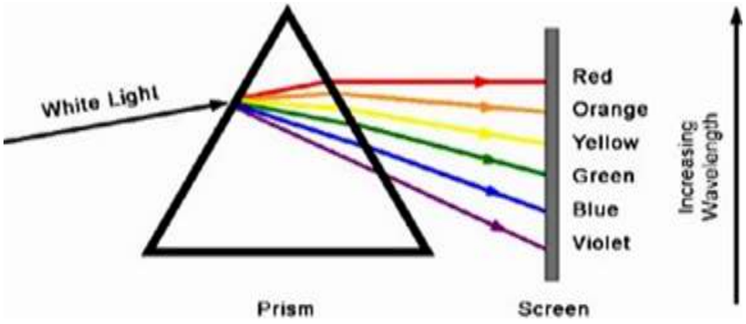

Figure (1-4) Dispersion of white light by a prism. [45]

3- Collimating: refers to the parallel nature of the laser beam, it can be emitted in a very thin beam, with all light rays parallel. By focusing and defocusing this beam, a surgeon can vary its effects on tissue.

4-Directionality: divergence of beam is very small.

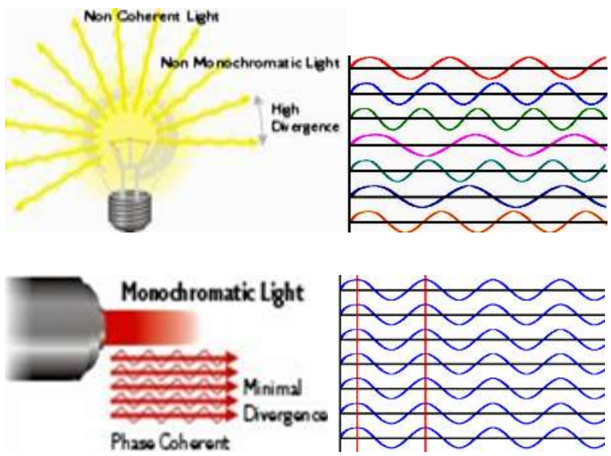

Figure (1-5) Difference between Light Bulb & Laser and its Directionality

1.6. **Laser Beam Modalities:** Laser may be divided into two broad groups .

1. Continuous wave (CW) laser.

2. Pulsed laser.

A CW laser is one whose power output undergoes little or no fluctuation with time. It exhibits a steady flow of coherent energy. Helium neon and argon gas lasers are typical examples, and are measured as power in watts. A larger group of lasers has output beams that undergo marked fluctuations i.e., beam power changes with time and said to operate in the "Pulsed mode". ND: YAG solid crystal lasers and CO2 gas lasers often, but not always, is operated in pulsed mode, and is expressed as energy in joules, & peak power =output energy / pulse duration. [46]

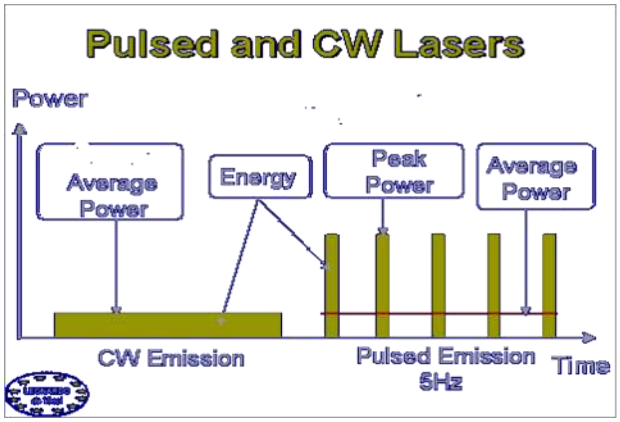

Figure (1-6) Laser beam modalities

1.7. Laser parameter

The interaction between tissue and lasers is governed by the properties of the laser beam as well as those of the tissue, although these may not seem important for clinicians who "simply" want to treat patients, they are, in fact, crucial parameters that the clinician can vary in the commercial laser system. They determine the efficacy of the treatment and enable clinicians to compare their results with those obtained by others.

i. Energy: define energy as the ability to do work. This naturally applies to the radiant energy in a laser beam. The energy units which are commonly used are joules (J), where 1J=0.24cal.

ii. Power: If energy E is emitted in time t, the average emitted radiant power P (also called flux) is P=E/t. The units commonly used are watts (W), where 1 watt is equal to 1 joule per second.

iii. Power density: The ratio of the emitted power (P) to the cross-sectional area (A) is called the power density, or irradiance (I). The units of I=P/A are W/cm2. For example, lasers that emit 100 W in a beam of area 1 cm2 have a power density of 100 W/cm2. If a lens is inserted into the beam, the power does not change but the beam area may be reduced to 0.5 cm2 and the power density doubles. The importance of this will be clarified when we consider the interaction of laser beams and materials.

Fluence: A laser beam may be operated intermittently, or the power delivered by the laser onto a given area may vary with time. The total energy delivered; divided by the area (the energy per unit area) is called fluence. In a number of instances, fluence is the most important parameter for laser therapy. [47,48,49]

1.8. Laser Tissue Interactions

1.8. ` Effect of tissue on the light;

When light hits a tissue, many phenomena:

*Reflection: is defined as the returning of the electromagnetic radiation upon which it is incident. There are two types of reflections; the specular reflection, seen in smooth surfaces (mirrors) where the surface irregularity is small compared to the wave length of radiation. The other is the diffuse reflection where the roughness of the reflecting surface is comparable or even larger than the wavelength of the radiation. [45]

Refraction is the bending of a wave when it enters a medium where its speed is different. The refraction of light when it passes from a fast medium to a slow medium bends the light ray toward the normal to the boundary between the two media.

*Scattering: is the basic origin of dispersion, her there is absorption and re-emission. If the frequency of the wave is not corresponding to the natural frequency of the particles, scattering occurs. The resulting oscillation is determined by forced vibration. If the frequency of the wave equals the natural frequency of free vibration of a particle, resonance frequency occurs being accompanied by a considerable amount of absorption. [45]

*Absorption: is defined as the attenuation of the intensity of light when it passes through a medium. Factors affecting absorption are: 1- The electronic constitution of the medium. 2- The wave length of the radiation. 3- The thickness of the absorbing layer.4- Internal parameters; the temperature and the concentration of the absorbing agents. [45]

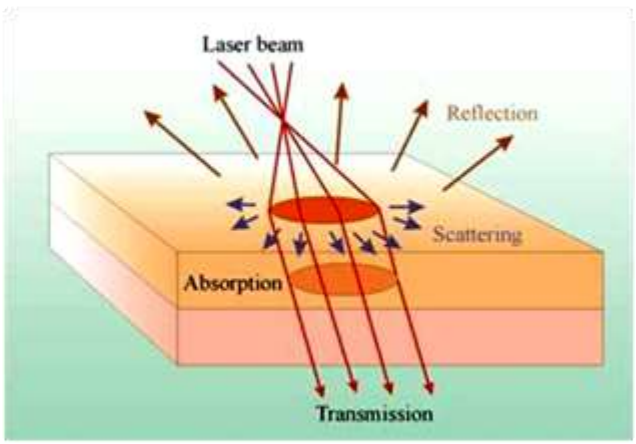

figure (1-7) Pathway of light when it passes from one media to another

1.8.2. Effect of light on tissue;

Five categories of interaction types are classified today. These are photochemical interactions, thermal interactions, photoablation, plasma-induced ablation, and photo disruption. Each of these interaction mechanisms will be discussed in this chapter. In particular, the physical principles governing these interactions are reviewed. Emphasis is placed on microscopic mechanisms controlling various processes of laser energy conversion. Each type of interaction will be introduced by common macroscopic observations including typical experimental data and/or histology of tissue samples after laser exposure. [45]

So, laser tissue interaction can be either:

1. Wavelength dependent

2-Wavelength independent mechanism.

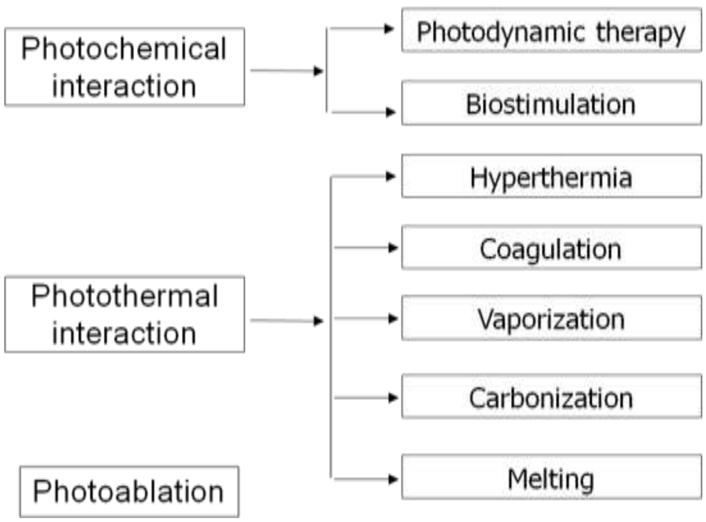

Figure (1-8) Wavelength dependent interaction

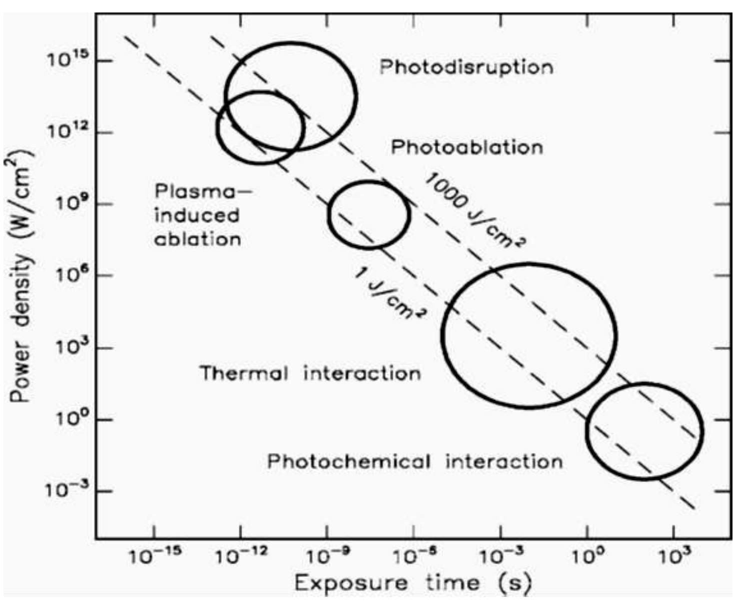

Figure (1-9) five interaction mechanisms depend on the duration of the light exposure and the irradiance, i.e., the power per unit area, in W/cm²

1.8.2.1 Wavelength—Dependent Interactions

The laser tissue interaction depends mainly on laser wavelength. Because the wavelength is a very important parameter that determines the index of refraction (governs the overall reflectivity of the target) as well as the absorption and scattering coefficients. [45]

a) Photochemical Interactions

Photochemical interactions take place at very low power densities (typically 1W/cm2) and long exposure times ranging from seconds to continuous wave. Careful selection of laser parameters yields a radiation distribution inside the tissue that is determined by scattering. In most cases, wavelengths in the visible range are used because of their efficiency and their high optical penetration depths, photochemical interaction mechanisms play a significant role during biostimulation and photodynamic therapy (PDT). [45]

1. Biostimulation: Is believed to occur at very low irradiances with the potential effects of extremely low laser power (1-5 mW) on biological tissue. Wound healing and anti-inflammatory properties by red or near infrared light sources such as helium-neon lasers or diode lasers were reported. Typical energy fluencies ranged from 1-10 J/cm2. [45]

Applications of biostimulation are: 1) wound healing 2) immune system
3) Pain relief.

2. Photodynamic therapy (PDT): A chromophore compound called photosensitizer which is capable of causing light induced reaction in non-absorbing molecules when injected into the body and after the excitation by laser radiation the photosensitizer performs several simultaneous or sequential decays which result in

intramolecular transfer reactions and at the end irreversible oxidation of cell structure result. [45]

b) Photothermal interactions

The term thermal interaction stands for a large group of interaction types, where the increase in local temperature is the significant parameter change. Thermal effects can be induced by either CW or pulsed laser radiation. However, depending on the duration and peak value of the tissue temperature achieved, different effects like coagulation, vaporization, carbonization and melting may be distinguished.

Table (1-1) thermal effect of laser

Temperature	Biological effect
37^0 C	normal
45^0 C	hyperthermia
50^0 C	reduction in enzyme activity, cell immobility
$60\ ^0$ C	denaturation of proteins and collagen, coagulation
80^0 C	increased permeability of membrane
100^0C	water vaporization, thermal decomposition (ablation)
>150 ^{0}C	carbonization
>300 ^{0}C	melting

Since the critical temperature for cell necrosis is determined by the exposure time, no well-defined temperature can be declared which distinguishes reversible from irreversible effect. Thus, exposure energy, exposure volume and exposure duration together determine the degree and extent of tissue damage.

The location and spatial extent of each thermal effect depend on the locally achieved temperature during and after laser exposure. [45]

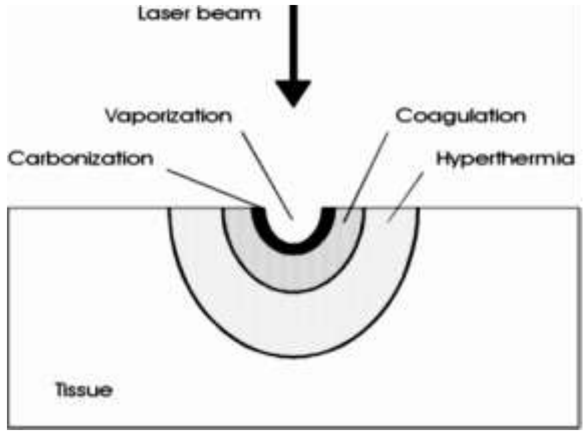

Figure (1-10) Location of thermal effects inside biological tissue

Flow chart with the important parameters for modeling thermal interactions

1) Heat generation is the conversion of light to heat, which determined by laser parameters and optical tissue properties.

2) Heat transport is solely characterized by thermal tissue properties such as heat conductivity and heat capacity.

3) Heat effects, finally, depend on the type of tissue and the exposure time of temperature achieved inside the tissue (tissue reaction).

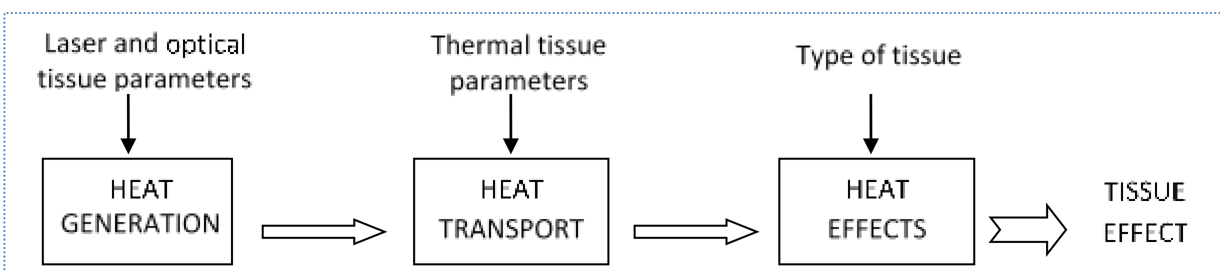

Figure (1-11) Flow chart of photothermal induction

c) Ablative Photodecomposition (Photoablation)

Photoablation occurs when material is decomposed and exposed to high intense ultraviolet laser irradiation. Typical threshold values are 107–108 W/cm2 at laser pulse durations in the nanosecond range. The geometry of the ablation pattern itself is defined by the spatial parameters of the laser beam. The main advantages of this ablation technique lie in the precision, its excellent predictability, and the lack of thermal damage to adjacent tissue. [45]

1.8.2.2. Wavelength—Independent Interactions.

These interaction mechanisms rely on plasma generation, at high power density 1011 -1016W/cm2 associated with lasers operating in short pulse duration (nanosecond, picoseconds). At high intensities, the electric field strength of radiation is also very large, which is sufficient to cause dielectric breakdown in the tissue. The generation of plasma with laser pulses in the nanosecond range is thermionic emission and, in the picoseconds, or femtoseconds range is multi-photon ionization. [45]

a) Plasma induced ablation

Optical break down can be induced when obtaining power densities exceeding 1011W/cm2 in solids and liquids. Ablation is obtained by ionizing plasma formation with an end result of very clean ablation associated with an audible report and bluish plasma sparking. Lasers with pulse duration of less than 500 ps can induce plasma formation. Power densities of up to 1013 W/cm2 may be achieved. Lasers used are pulsed YAG family and Ti: Sapphier lasers. Its clinical application is typical in corneal surgery and caries therapy. [45]

b) Photodisruption

In this type of interaction, in addition to plasma formation, shock wave is generated leading to cavitations and jet formation. This ends up with fragmentation and cutting of tissue by these mechanical forces. Pulse durations of more than 500 ps usually induce photo disruption. Power densities may reach up to 1016 W/cm2 and again the Nd: YAG and Ti: Sappier lasers are used. Typical clinical applications are lens fragmentation and destruction of urinary and biliary stones (lithotripsy). [45]

1.9. Medical laser systems;

Table (1-2) Types of lasers mostly applied in surgery

Laser type	**Wavelength**	**Power range**	**Mode**		**Delivery system**
CO_2	10600nm	0.1 -100 W	CW	Pulsed	Articulated arm
Nd:YAG	1060nm	5 – 120 W	CW	Q-switched	Fiber optic
Ruby	694nm	> 30j	Pulsed		Coupled to microscope
Doubled Nd:YAG	532nm	> 3j	Pulsed		Coupled to microscope
Argon ion	488–514nm	0.001–25W	CW	Pulsed	Fiber optic
Dye	400–700 nm	0.001 – 6W	CW		Fiber optic
He:Ne	632.8nm	10^{-3} – 10^{-2}W	CW		Fiber optic
Diode laser	630-1000nm	15-61W	CW	pulsed	Fiber optic

1- Carbon dioxide (CO_2)

The carbon dioxide (CO_2) laser emits light at a wavelength of 10 600 nm. Its photo thermal effect on tissue consists of the transformation of water into vapor, which leads to complete cell vaporization. However, as the CO_2 light only penetrates 0.3–1mm into the target and, the thermal damage to the tissue beyond the vaporization area is minimal.

In practical terms, the CO_2 laser is applied in a non- contact technique in CW and about 15W.As the laser light is in the far-infrared band, visual control can be achieved by the addition of visible guiding beam, such as a helium-neon or diode laser to mark the aimed focal spot. [45]

It is often used in the super-pulsed wave mode, which produces power peaks that are about ten times higher than the CW mode. This allows application with more precision and less thermal injury as the surrounding tissue can cool down between the power intervals. The CO_2 laser cannot be used for sealing vessels of more than 0.5 mm in diameter, The CO_2 laser is mainly a surgical tool. It can cut or vaporize tissue with fairly little bleeding as the light energy changes to heat. This type of laser is used to remove thin layers from the surface of the skin without going into the deeper layers. A carbon-dioxide laser kills tissues by destroying cells.

When touched by this type of laser, tissues that are composed of 80 percent to 90 percent water are destroyed by the steam formation in the cells. The area that is vaporized by the laser is both localized and also does not present any combustion because the intracellular temperatures never go beyond 100 degrees Celsius. Moreover, there is also very little damage to the surrounding areas, CO_2 laser is the standard laser in surgery. Depending on the type of treatment, CO_2 lasers can be operated in three different modes – CW radiation, chopped pulse, and super pulse. [45]

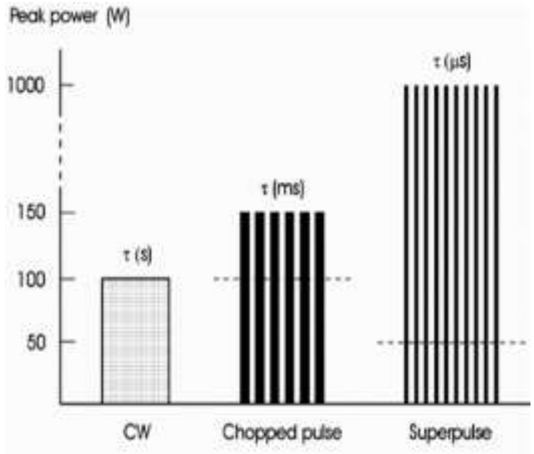

Figure (1-12) CW, Chopped pulses, and super pulses mode of a CO2 laser. Dash line denote mean power.

As shown in Figure. (1-12) Chopped pulses with durations in the millisecond range are obtained from CW lasers when using rotating apertures, Superpulses are achieved by modulation of the high voltage discharge, Thereby, pulse durations less than 1 ms can be generated. The peak power is inversely related to the pulse duration. The mean powers of CW radiation and chopped pulses are nearly the same, whereas it decreases in the case of Superpulses. Shorter pulse durations are associated with a reduction of thermal effects. Hence, by choosing an appropriate mode of the laser, the best surgical result can be obtained. [45]

Besides selecting the temporal mode, the surgeon has to decide whether he applies a focused or defocused mode as shown in Fig. (14) Only in tightly focused mode are deep excisions achieved. In partially focused mode, less depth but a larger surface is vaporized. In defocused mode, the power density decreases below the threshold of vaporization, and tissue is coagulated only. [45]

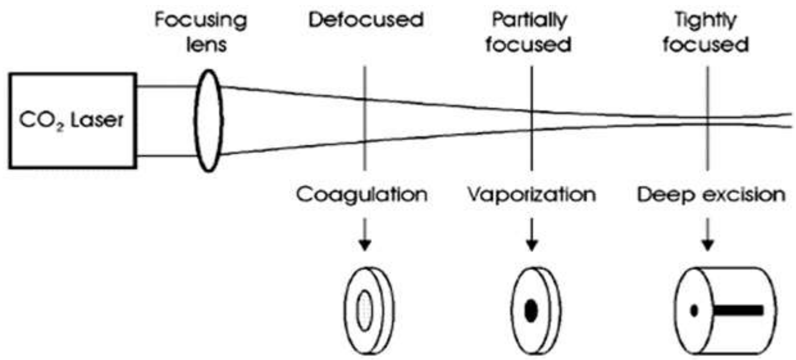

Figure (1-13) Coagulation, vaporization, and excision modes of a CO2 laser. Depending on defocused, partially focused, or tightly focused beam.

2- Neodymium: Yttrium-Aluminum-Garnet (Nd: YAG)

Nd: YAG laser is a solid-state laser emit in light in the near infrared region (NIR) at a wavelength of 1064 nm. The effect on tissue is different from the other lasers in terms of penetration and thickness of the damaged tissue. Due to the lower absorption of water, deeper penetration into the tissue and scattering in tissue, the Nd: YAG laser leads to a coagulation of depths of up to 3–7mm. In the non-contact technique, fine preparation and superficial application is not possible. It is therefore an instrument that is applicable for ablation and coagulation–e.g., of liver tissue–as it offers deep penetration and homogenous destruction with good coagulation effects. [50]

One benefit of the 1064-nm wavelength is its inherently lower absorption coefficient for melanin. With this wavelength there is less concern for coincident epidermal damage and it can be used more safely in pigmented patients. [51]

3- Diode laser: -

Operating at a wavelength of 980nm/810nm in the near infra-red portion of the spectrum, Diode laser provide good hemostasis effect and bloodless operating due to high absorption in water and Hemoglobin. [52]

1.10. Laser Safety

Laser safety is the safe design, use and implementation of lasers to minimize the risk of laser accidents, especially those involving eye injuries. Since even relatively small amounts of laser can lead to permanent eye injuries, the sale and usage of lasers are typically subject to government regulations, Moderate and high-power lasers are potentially hazardous because they can burn the retina of the eye, or even the skin. [53]

1.11. Laser radiation hazards and damage mechanism

Laser radiation predominantly causes injury via thermal effects and other effects. Even moderately powered lasers can cause injury to the eye. High power lasers can also burn the skin. Some lasers are so powerful that even the diffuse reflection from a surface can be hazardous to the eye. [53]

Table (1-3) summarizes various medical conditions to the eyes caused by lasers at different wavelengths. [43, 54]

Table (1-3) Bio effect on of the eye and skin

SPECTRUM	EYE EFFECT		SKIN EFFECT
	Location	Effect	
UV-C (200-280 nm)	Cornea	Photokeratitis	Erythema, cancer, accelerated aging
UV-B (280-315 nm)	Cornea	Photokeratitis	Erythema, increased pigmentation, cancer, accelerated aging
UV-A (315-400 nm)	Lens	Cataract	Erythema, increased pigmentation, skin burn
Visible (400-780 nm)	Retina	Retinal injury*	Photosensitive reactions, skin burn
IR-A (780-1400 nm)	Retina, Lens	Retinal burn, cataract	Skin burn
IR-B (1400-3000 nm)	Cornea, Lens	Corneal burn, cataract	Skin burn
IR-C (3000-1000000 nm)	Cornea	Corneal burn	Skin burn
* Retinal injury can be thermal, acoustic or photochemical.			

The skin is usually much less sensitive to laser light than the eye, but excessive exposure to ultraviolet light from any source (laser or non-laser) can cause short- and long-term effects similar to sunburn, while visible and infrared wavelengths are mainly harmful due to thermal damage. [55]

1.12. Maximum permissible exposure MPE

Is defined as the amount of laser radiation to which a person may be exposed without hazard effect or adverse biological changes in the eye or skin, depending on the wavelength of the laser and exposure duration (exposure time).MPE depends on: [39, 40]

- Wavelength
- Output Energy and Power
- Size of the Irradiated Area
- Duration of Exposure
- Pulse Repetition Rate

Classification of laser hazards

Revised system

Class 1

□ very low powered lasers (< 0.4 microwatts)

□ A Class 1 laser or laser system can be used without restriction in the manner intended by the manufacturer and without special operator training, qualification (Exempt from any control measures or other forms of surveillance).

Class 1M (NEW!)

□ Incapable of producing eye injury unless optics (focusing device such as: a lens or telescope) are used for viewing.

□ Exempt from any control measures other than to prevent potentially hazardous optically aided viewing; and also is exempt from other forms of surveillance.

Class 2:

□ Emits in the visible part of the spectrum.

- Low power laser > 0.4 µw but < 1 mw.
- No eye damage is likely, because the eye is protected by the “blink reflex.” i.e.: The laser does not have enough output power to injure a person accidentally, but may injure the eye when stared at for a long period.
- A “caution” label is required.

Class 2M (NEW!):

- Emits in the visible part of the spectrum.
- Less than 1 mw
- No eye damage is likely but it is potentially hazardous if viewed with certain optical aids (lens or telescope).

Class 3 laser system (medium-power) hazardous:

May be hazardous under direct and specular reflection viewing conditions, but is normally not a diffuse reflection or fire hazard. There are two subclasses:

Class 3R (Class 3A)

- power from 1 - 5 mw
- Eye damage may occur if the beam is viewed directly or by specular reflections and the eyes are stable.
- A caution sign must label the device.

Class 3B

- power from 5 - 500 mw
- Eye damage may occur for direct viewing or viewing of specular reflections.

- Not a diffuse reflection hazard or a fire hazard.
- A danger sign must label the device.
- Eye protection is required.

Class 4 (high-power):

- High Power Lasers and Laser Systems (< 500 mw)
- Eye and skin damage will occur for direct viewing or viewing of specular or diffuse reflections of the beam.
- Potential fire hazard.
- May produce laser generated air contaminants (LGAC) or plasma radiation.
- A danger sign will label this laser.
- Eye and skin protection are required. [54,56]

1.13. Safety measures

1.13.1. Safety guides of Eye protection

1- Natural eye protection or defense: when light strikes the eye, it stimulates the optical protective mechanism of the eye or what is called reflexes

2- Artificial or external eye protection: by using protective eyewear that is designed for that specific wavelength and optical density. the selection of eyewear must be proper fit, comfort, and visual performance.

Figure (1-14) Protective eyewear

3- Laser goggles

The use of eye protection when operating lasers of classes 3B and 4 in a manner that may result in eye exposure in excess of the MPE is required in the workplace by the U.S. Occupational Safety and Health Administration.

Protective eyewear (Figure1-14) in the form of spectacles or goggles with appropriately filtering optics can protect the eyes from the reflected or scattered laser light with a hazardous beam power, as well as from direct exposure to a laser beam. Eyewear must be selected for the specific type of laser, to block or attenuate in the appropriate wavelength ranges which have a visible beam, but it is more expensive, and IR-pumped green laser products do not always specify whether such extra protection is needed. [57]

Eyewear is rated for optical density (OD), which is the base-10 logarithm of the attenuation factor by which the optical filter reduces beam power. In addition to an optical density sufficient to reduce beam power to below the maximum permissible exposure, laser eyewear used where direct beam exposure is possible, should be able to withstand a direct hit from the laser beam without breaking. [57]

1.13.2. Safety guides of Skin protection

If lasers having the potential of causing skin damage are being used, adequate precautions should be taken to protect the skin, such as: -

1. Protective clothing and face shields must be used.
2. Preoperative site should be protected by use of the least amount of power or energy required.
3. Avoid inflammable drapes as paper or plastics.
4. Avoid alcohol or must be dry before application.
5. Recommended cloth saturated with water around operative sites.
6. Wearing long sleeves and gloves made of appropriate fire-resistant material.
7. Laser resistant drapes for personnel.

Aim of the study

To determine the efficiency and safety of 1064 nm Nd YAG laser in the treatment of spider leg veins.

Chapter Two

Patients Materials and Methods

2. 1. Introductions

This study was done in the clinics of the Institute of laser for postgraduate studies beginning from July 2020 to the end of February 2021.

2.2. Patients, and Methods

Ten female patients (22–52) years old with leg spider veins were treated with long pulse laser 1064nm Nd: YAG laser, (3-6) mm diameter spot size, frequency 2Hz, pulse duration (10-30) ms, and energy (30 -74) J. This postoperative study was done in the laser medicine research clinics of the Institute of laser for postgraduate Studies / University of Baghdad from July 2020 until the end of February 2021. Clinical assessments were carried out before laser therapy and immediately after the first laser therapy, 2 weeks, 4 weeks, and 6 weeks later. Each patient was getting ready for the procedure after full explanation and discussion regarding the nature of the procedure, the possible advantages and disadvantages, and complications expected. At the end of discussion, each patient was asked to sign an "informed consent" indicating the agreement.

Table (*2-1*) patient description

Case no.	gender	Age(year)	Occupation	Duration of symptom (year)
1	f	24	Pharmacist	5
2	f	37	Lecturer	10
3	f	47	Employee	13
4	f	41	Dentist	15
5	f	42	Dentist	7
6	f	50	Doctor	15
7	f	42	Women's haircut	11
8	f	24	Housewife	5
9	f	40	Dentist	15
10	f	29	Teacher	10

Preoperative evaluation: A case sheet was prepared to record all the necessary information. Medical and surgical histories were taken from the patients with clinical examination for each patient (figure 2-1).and underwent Doppler ultrasound to rule out deep system reflux at the saphenous junctions and in the perforating veins.

Ministry of Higher Education & Scientific Research

University of Baghdad

Institute of laser for Postgraduate Studies

Patient Case Sheet

Case No. ()

Name		Age
Occupation		Gender
Address		Marital status
Phone/		
Complaint	☐pain ☐restless legs ☐paresthesia ☐aching or tension ☐pruritus/itching ☐edema ☐skin changes ☐leg heaviness ☐burning sensation ☐night cramps ☐tenderness over a vein ☐exercise intolerance ☐other:	
Presumed cause	☐Pregnancy ☐drug ☐trauma ☐operation ☐occupation ☐vascular disease ☐family history ☐other:	
Past Procedure		
Past history	Operation /	
	Drugs /	
	Family /	

Finding:

Procedure:

Energy.: Pulse Duration: Spot diameter:
frequency: Result: Pain: Pigmentation: Pres. Sym.
Recurrence

Satisfaction

Figure (2-1) a case sheet for the patients

Laser Safety

In the present work, the laser employed is class IV laser. These types of laser can cause damage to eye and skin with direct intrabeam exposure and from specular or diffuse reflections.

All personnel were asked to wear protective glasses appropriate to Nd: YAG 1064 nm laser to eliminate the risk of eye damage. These glasses are designed with special wavelength and optical density for Nd: YAG laser. The patient goggles were completely shielded, doctor goggles were transparent, (Figure 2-2).

The eyes of the patient were covered with mops of cotton or gauze plus eye wear, taking into consideration the elimination of any reflecting materials, metals and polished plastic in the laser room.

Figure (2-2) goggles (a) for Nd: YAG laser operator (b) for patient

Fig (2-3) Nd: YAG Laser specifications

- ❑ Wavelength 1064nm infrared ray.
- ❑ Ray transmission system: optical fiber.
- ❑ The systems body is equipped with optical fiber/non-contact
- Output against tissue cell can be modulated within following range
- E: 10-110 J.
- PULSE: 10-40 ms
- Freq.:0.5-2Hz.
- ❑ Cooling device is hand piece conductive metal plates.
- ❑ Aiming beam:
  - Semiconductor diode laser.

Treatment Parameters and settings used in the study:

High peak power, long-pulse Nd: YAG laser system

Wavelength	1064 nm
Pulse duration	10-30ms
Frequency	2 Hz.
Pulse Energy	30-73 j
Spot size	3- 7 mm at the level of the hand-piece
Cooling	Epidermal (contact cooling to tissue by the hand piece via conductive metal plates.)

Figure (2-4) Laser parameters

Technique

Prior to laser therapy patients asked to shave the area of spider veins (if hair is present, it will absorb the laser energy and causing discomfort).

Patients lying after having put topical anesthesia (EMLA) for an hour. A test dose was performed at the initial consultation, and thereafter patients were reviewed and treated at 3-week intervals. However, in some cases, until achieving our desired clinical results, we increased fluence after decreasing the pulse width.

In< 0,5mm leg telangiectasia, maximum fluence was increased up to 400 J/cm^2 with 3mm spot size at the skin surface.

The average time taken for completing the procedure was (20 min.).

Proper eye protection for patient, physician and anyone else in the room is essential when using this laser. External skin cooling and topical anesthesia is optional.

All patients were advised to avoid sun exposure of treated area two weeks following laser treatment in order to minimize the appearance of hyperpigmentation.

Chapter Three

Results & Discussion

Results:

The results of this study depend on clinical examination and preoperative observation by inspection preoperatively, patient reactions during operation and postoperatively fallow up.

For five (50%) patients the spider veins after three session at interval two weeks between every other session has completely disappeared. At the other hand, the other five patients, three (30%) patients of them have improvement after four session but the spider veins not completely disappeared.

The last two (20%) patients don't response to the laser therapy. All patients tolerated the procedure.

There were all patients have a mild discomfort or mild burning sensation (tolerable) regarding.

In almost all patients, no allergic reaction, no cutaneous manifestation seen like; purpura, scarring or pigmentary changes were observed at the end of follow up.

There was no need for hospitalization; none of the patients encountered any immediate intraoperative or postoperative complications.

Patients don't need any analgesic and can resume their routine activities immediately post operatively. There was no recurrence detected during the follow up period which was 6 weeks after the laser sessions.

Table (3-1) The results after laser therapy

Case No.	Age(year)	Site (lower limb)	No. of session	Degree of improvement	Patients Satisfaction%
1	24	bilateral	4	cleared	70
2	37	unilateral	3	cleared	80
3	47	bilateral	4	cleared	50
4	41	bilateral	3	No response	20
5	42	bilateral	2	Improved	60
6	50	bilateral	5	Cleared	75
7	42	bilateral	4	Cleared	80
8	24	bilateral	3	Improved	75
9	40	bilateral	4	No response	20
10	29	bilateral	3	improved	70

Fig. (3-1): spider veins patient no.2

(a) before

(b) after 2wk.

(c) after 4wk

(d) after 6wk

Fig(3-2)spider veins patient no.5

a) before laser treatment

b) after 2wk Case improved not cleared

fig(3-3) spider veins patient no.4

a) before treatment

b) after 6wks no response

Discussion

Lower extremity spider veins affect approximately 40% of women and 15% of men, with higher prevalence in women and underlying genetic and hormonal factors. Higher occurrence is found in our societies in which occupational health and obesity also play a role as underlying predisposing causes [57]. Women are also more concerned about the aesthetic aspects of spider veins, which prompts them to seek treatment. Although spider veins no major medical risks, the demand for aesthetic treatment of these veins continues to grow all over the world [56]. Without intervention, approximately 50% of these cosmetically disturbing “leg veins” can progress and develop into a severe venous dysfunction [57]. The therapy of spider veins of lower extremity is more challenging than that of facial telangiectasias, since they have a larger diameter, a thick surrounding adventitial tissue, are located deeper and are exposed to greater intravascular pressure [56].

In our study, there are 50% patients with spider veins who have completely cleared after three sessions (six weeks) due to response to long pulse Nd: YAG laser 1064nm, (3-6) mm spot diameter, frequency 2Hz, pulse duration (10-30) ms and energy (30-74) J. this supported by Mardukh S. Ali in (September 2018) for six (60%) patients there was a disappearance of the spider veins.

Another study declared that Nd: YAG was superior to both diode laser and alexandrite in treating leg telangiectasia. Also, they concluded that there were more problems with alexandrite laser than the others.

According to the scarce evidence available, the Nd: YAG laser produces better clinical results than the alexandrite and diode laser. Penetration depth is high, whereas absorption by melanin is low, making the Nd: YAG laser suitable for the treatment of larger and deeply located veins and for the treatment of patients with dark skin types.[56]

On the other hand (30%) patients with spider veins improved after 6 weeks not completely cleared. That occur because of patients uncommitted in their visits. Or uncommitted in recommendations post operatively.

The last two patients (20%) who show no response, they may be multiple veins or big diameter and also patients uncommitted and neglect their selves.

Comparing the results of laser therapy of spider lower limbs veins with (injection) micro sclerotherapy shows that with the using laser these advantages will be achieved: Shorter operative time, Mild or no postoperative pain, no postoperative complications detected, Shorter healing time, no postoperative compression bandages were needed. It seems that the parameters chosen for photocoagulation were safe with no apparent damage to nearby tissues and no complications detected in the treated area.

Conclusion

This study concluded the long pulse Nd YAG laser 1064 nm is effective in the treatment of spider leg veins. This effectivity depends on some factors: the duration, size, number of spider veins. Also, this procedure is easy and safe to be performed., and with minimum adverse effects.

Recommendations:

1- Increase the number of cases included in the study to verify a statistical analysis of the result.
2- Should be increase the period of fallow up.
3- Use other types of laser in treatment of spider veins, and telangiectasia in all the body.

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الخلاصه:

تؤثر الأوردة العنكبوتية في الأطراف السفلية على ما يقرب من 40 ٪ من النساء و 15 ٪ من الرجال ، مع انتشار أعلى عند النساء والعوامل الوراثية والهرمونية الكامنة. تم العثور على الحدوث الأعلى في مجتمعاتنا حيث تلعب الصحة المهنية والسمنة دورًا أيضًا كأسباب مؤهبة أساسية. كما أن النساء أكثر اهتمامًا بالجوانب الجمالية للأوردة العنكبوتية مما يدفعهن لطلب العلاج. على الرغم من عدم وجود مخاطر طبية كبيرة في الأوردة العنكبوتية ، إلا أن الطلب على العلاج التجميلي لهذه الأوردة يستمر في النمو في جميع أنحاء العالم

الهدف من الدراسه هو تحديد كفتءة وأمان الليزر اندياك ذو النبضه الطويله 1064 نانومترفي علاج اوردة الساق العنكبوتيهز

تم تضمين عشرة مرضى يعانون من الأوردة العنكبوتية في الأطراف السفلية في هذه الدراسة المستقبلية.وذلك باستعمال تقنية عدم لمس الجلد.باستعمال اندياك ليزر ذو النبضه الطويله 1064 نانومتر.باستعمال مستشعرات الجهاز

طول الموجة 1064 نانومتر ، الطاقة 30 – 73 جول، مدة النبضة 10 - 30 مللي ثانية ، التردد 2) هرتزوالبقعة 3 - 7 مل م). تم إجراء العلاج بالليزر في اليوم الأول واليوم الرابع عشر.

تم إجراء التقييمات السريرية قبل العلاج بالليزر ومباشرة بعد العلاج بجلسة الليزرالأولى ، بعد أسبوعين و 4 أسابيع و 6 أسابيع.

أظهرت النتائج أن هناك تحسنًا ملحوظًا لدى 80 ٪ من المرضى بعد جلسة العلاج الثالثه. أظهر خمسة مرضى فقط اختفاءً كاملاً للأوردة العنكبوتية مع عدم وجود ألم ومضاعفات كبيرة أثناء العملية وبعد العملية في غضون وقت قصير من العلاج بالليزر.نستنتج من ذلك انه يعد الليزر ذو النبضه الطويله 1064 نانومتر علاجا فعالا وامنا لعلاج اوردة الاطراف السفلى العنكبوتيه.

وزارة التعليم العالي والبحث العلمي

جامعة بغداد

معهد الليزر للدراسات العليا

علاج اوردة الساق العنكبوتيه باستعمال اندياك ليزر ذو النبضه الطويله 1064 نانومتر

دراسة مقدمة الى

معهد الليزر للدراسات العليا /جامعة بغداد /كجزء من متطلبات نيل درجة الدبلوم العالي في الليزر في الطب/ الجراحة العامة

من قبل

ليث قيس مجيد

دبلوم عالي في الجراحه العامه

بكالوريوس طب وجراحةعامه

بإشراف

الدكتور

مردوخ سامي عبد علي

زميل المجلس العربي للاختصاصات الطبية/اختصاص دقيق تطبيقات الليزر بالجراحةالعامه

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