Ministry of Higher Education and Scientific Research
University of Baghdad
Institute of Laser for Postgraduate Studies

Comparative study of non-surgical blepharoplasty by fractional CO_2 laser versus plasma exeresis

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 / Ophthalmology.

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2021 AD **1442 AH**

بسم الله الرحمن الرحيم

﴿ اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ * خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ * اقْرَأْ وَرَبُّكَ الْأَكْرَمُ * الَّذِي عَلَّمَ بِالْقَلَمِ * عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ ﴾

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سورة العلق (1- 5)

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I certify that this dissertation (**Comparative study of non-surgical blepharoplasty by fractional CO_2 laser versus plasma exeresis)** was prepared under my supervision at the Institute of Laser for Postgraduate Studies, University of Baghdad, as a partial fulfillment of requirements for the degree of "Higher Diploma in Laser in Medicine / Ophthalmology.

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Acknowledgements

First of all I would like to thank ALLAH for inspiring me with patience and strength to do this work.

I found words inadequate to express my deep respect to my supervisor **Dr. Ahmed M. Hasan**, who supports me with his unlimited experience , inspiration and continuous valuable scientific suggestions throughout the preparation of this thesis and being patient with me in accomplishing this work .

I wish to express my great thanks to Professor **Dr. Hussein Ali Jawad**, Dean of the Institute of laser for postgraduate studies for his encouragement.

I wish to express my deep appreciation to **Dr. Layla M. H. Al. Amery**, the Institute of Laser for Postgraduate Studies, University of Baghdad for her encouragement and support.

Great thanks to all the staff of the Institute of Laser for Post Graduate Studies for their Kind help and great efforts! To all: Thank you very m

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Abstract

Background:

Surgical or invasive blepharoplasty has long been the gold standard for rejuvenation of upper eyelid dermatochalasis, although patients routinely experience bleeding, bruising, edema and scarring as well as the risks of serious complications such as retro bulbar hemorrhage and dryness, causing temporary or permanent loss of vision. This lead to the search for another safer alternative non-invasive methods such as plasma exeresis and fractional CO_2 laser.

Aim of study:

Comparative study of non -surgical blepharoplasty by fractional CO_2 laser versus plasma exeresis.

Patient and method:

In this study, non-surgical blepharoplasty was done to (32) patients whose ages ranged between (30-60) years in the ophthalmic clinic placed in Baquba city, Diyala province during the period from 01/08/2020 to 01/02/2021. The fractional CO_2 laser method was performed to (12) patients, while the plasma exeresis method was performed to (20) patients, and after performing the two non-surgical blepharoplasty methods, a comparison was made.

Result:

In plasma exeresis the results is the following:

1-excellent response was found in 16 patients (80%).
2-Moderate response was found in two patients (10%).
3-Poor response was found in two patients (10%).

In fractional CO_2 laser the result is the following:

1-excelent response was found in eight patients (66.6%).
2-Moderate response was found in two patient (16.6 %).
3-Poor response was found in two patient (16.6 %).

Conclusion:

The fractional CO_2 laser is better in terms of complications during and after the procedure regarding to pain, redness, swelling and crusting formed, as well as the time of the operation.

But the plasma method is more effective in removing eyelid wrinkles and tightening the skin, compare to fractional CO_2 laser.

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Chapter one Introduction & basic concepts

Introduction

Surgical or invasive blepharoplasty has long been the gold standard for rejuvenation of upper eyelid dermatochalasis, although patients routinely experience bleeding, bruising, edema and scarring as well as the risks of serious complications such as retro bulbar hemorrhage and dryness, causing temporary or permanent loss of vision. This lead to the search for another safer alternative non-invasive methods such as plasma exeresis and fractional CO_2 laser

1-1 Eyelid skin layers and anatomy

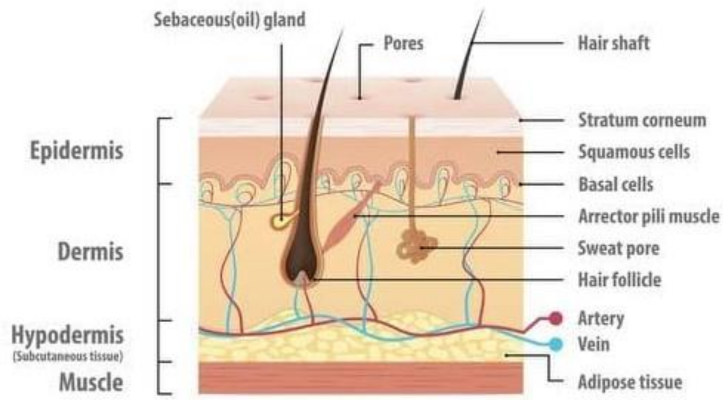
The eyelids correspond to the anterior limit of the orbits. They are muscular-membranous structures, forming part of the protective system of the eye. The eyelids have complex anatomy, with each eyelid being constituted of three externally visible regions, namely the external skin, the internal palpebral conjunctiva, and the eyelid margin, all well evaluated with a physical examination. Histologically, however, seven structures are identified in both eyelids, of which the deep structures [1].

The most anterior structure of each eyelid is the skin. Behind the skin, there is the first layer of loose connective tissue. The third layer is the orbicularis oculi muscle, composed of skeletal muscle fibers. The fourth layer, lying behind the orbicularis oculi muscle, is a second layer of loose connective tissue. The fifth layer of each eyelid is a fibro-elastic layer, centrally formed by the tarsal plate and peripherally formed by the orbital septum. The tarsal plate is a firm plate composed of dense connective tissue that helps to maintain the eyelid shape but also containing sebaceous glands called the meibomian glands. The superior tarsus is 8–12 mm in height and attaches to the superior tarsal muscle. The inferior tarsus is smaller, only 3–4 mm in height, and attaches to the inferior septum and inferior tarsal muscle. The orbital septum maintains the intraorbital fat in place and is involved in the ocular and palpebral movements [2]. The orbital septum of both superior and inferior eyelids attaches peripherally to the orbital rim bone, where it is continuous with the periosteum [3].

Centrally the orbital septum attaches to the junction of the inferior tarsal muscle to the tarsal plate in the lower eyelid and levator palpebrae aponeurosis in the upper eyelid [1].

Inferiorly to its attachment to the superior orbital septum, the levator palpebrae aponeurosis fuses with the anterior aspect of the superior tarsal plate [4]. Posteriorly, on the most cranial part of the levator palpebrae aponeurosis and at its junction with the levator palpebrae muscle [4], lies the “V” shaped superior transverse (Whitnall) ligament. The sixth layer of the eyelids consists of the tarsal muscles, composed of smooth muscle fibers, acting as eyelid retractors. The superior tarsal muscle, also known as the Müller’s muscle, inserts superiorly at the junction of the levator palpebrae aponeurosis and levator palpebrae muscle and attaches inferiorly to the superior margin of the superior tarsal plate

[1]. The inferior tarsal muscle inserts superiorly at the junction of the inferior tarsal plate and inferior septum, and inferiorly attaches to the fascia surrounding the inferior rectus muscle [1]. The most posterior layer of the eyelid is the palpebral or tarsal conjunctiva. The conjunctiva will reflect on the eyeball as bulbar conjunctiva, which is not part of the eyelid.



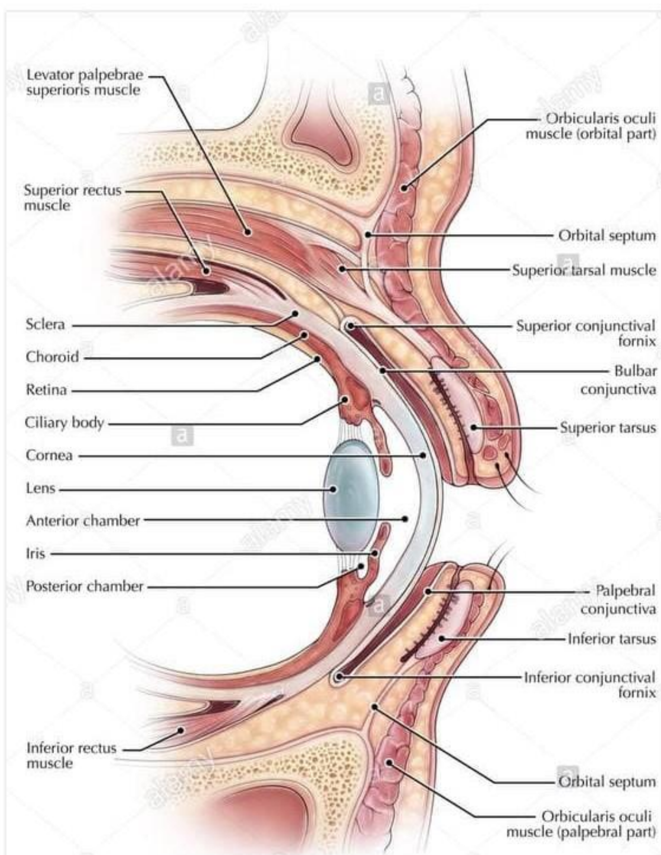


Figure (1-1) skin anatomy A-structure of skin B-anatomy of eye lid

1-2: Blepharoplasty

Blepharoplasty (Greek: blepharon, "eyelid" + plassein "to form") is the plastic surgery operation for correcting defects, deformities, and disfigurations of the eyelids; and for aesthetically modifying the eye region of the face. With the excision and the removal, or the repositioning (or both) of excess tissues, such as skin and adipocyte fat, and the reinforcement of the corresponding muscle and tendon tissues, the blepharoplasty procedure resolves functional and cosmetic problems of the periorbita, which is the area from the eyebrow to the upper portion of the cheek. The procedure is more common among women, who accounted for approximately 85% of blepharoplasty procedures in 2014 in the US and 88% of such procedures in the UK [5] [6].

Blepharoplasty is the surgical rejuvenation of the upper and lower eyelids. It is the fourth most common cosmetic procedure performed in the United States according to the 2016 American Society for Aesthetic Plastic Surgery statistics [7]. Both upper and lower blepharoplasties are technically demanding operations that require careful planning and meticulous execution to achieve optimal outcomes and avoid complications. Numerous techniques have been described for both upper and lower blepharoplasties, with no comparative data supporting the superiority of one technique over the other [7].

1-3: Surgical techniques evolution for blepharoplasty

Like other procedures in plastic surgery, the concept of blepharoplasty has evolved over the years secondary to increasing knowledge of periorbital anatomy, facial topography, and the aging process. As a result, several surgical techniques have been described in an effort to maximize safety and improve the aesthetic results. The choice of particular blepharoplasty technique has been heavily debated with several different schools of thought [8].

1-3-1: Surgical blepharoplasty

Traditional surgical blepharoplasty is currently the gold standard in periorbital rejuvenation but commonly causes pain, bruising, edema and the potential for serious complications. The postoperative healing period is typically 6 weeks [9]. Scarring is a feature of all incisional surgical procedures and can also be cosmetically undesirable.

A blepharoplasty procedure usually is performed through external surgical incisions made along the natural skin lines (creases) of the upper and the lower eyelids, which then hide the surgical scars from view, especially when effected in the skin creases below the eyelashes of the lower eyelid. The incisions can also be made from the conjunctiva, the interior surface of the lower eyelid, as in the case of a transconjunctival blepharoplasty [10].

The traditional eyelid surgery is a highly effective method, but lacks of all the above requirements of patients. Traditional blepharoplasty surgery requires full anesthesia, surgical rooms, sutures, incisions and long recovery periods. In cases where the patient is not satisfied with the results of eyelid surgery, after all this tedious, time-consuming and financially expensive process, it is almost impossible to think again to undergo such a procedure [11].

Surgical upper lid blepharoplasty offers a better option for severe dermatochalasis with excess skin, not amenable to nonsurgical treatment options. In addition, surgical blepharoplasty is more favorable in cases associated with significant steatoblepharon, brow ptosis, lacrimal gland prolapse or lash disorders [12].

Surgical intervention can leave a scar at the site of incision. However, scar complications as wound dehiscence, infections, granuloma formation, keloid formation and disfigurement are rare nowadays, but are still present. With proper surgical technique scarring with its associated complications is rarely a problem. Additionally, lid edema and ecchymosis usually improve within 1–2 weeks, especially if there is no bleeding tendency or if the patient is not on blood thinners [13, 14].

Transconjunctival blepharoplasty technique permits the excision (cutting and removal) of the lower-eyelid adipose tissue without leaving a visible scar, but the transconjunctival blepharoplasty technique does not allow the removal of excess eyelid-skin [15].

1-4: Non-surgical blepharoplasty

The fear of postoperative complications, especially with lower blepharoplasty, has driven many surgeons towards more conservative approaches sometimes at the expense of optimizing aesthetics [18].

Nonsurgical techniques have been introduced in a trial to achieve an acceptable aesthetic outcome without the need for surgical intervention.

Recent clinical studies have focused primarily on the efficacy of treatment of non-surgical blepharoplasty: A study on 50 patients who were suffering dermatochalasis of the upper eyelids was conducted by the Department of Dermatology of the University of Modena and Reggio Emilia. They utilized the global aesthetic improvement scale (GAIS), to measure patient satisfaction following a non-surgical blepharoplasty. One hundred percent of patients reported an aesthetic improvement, from being ‘satisfied’, to proclaiming an ‘outstanding result’. A further tool was used to assess dermatochalasis, this being the Wrinkle Severity Rating Scale by Waugh & Blitzer [19]. The study concludes that patients found a decrease in dermatochalasis, from which severe laxity became mild, minimal or completely absent [20].

1-5: Plasma

Plasma is one of the four fundamental states of matter, the others being solid, liquid, and gas. Plasma has properties unlike those of the other states. Plasma can be created by heating a gas or subjecting it to a strong electromagnetic field applied with a laser or microwave generator. This decreases or increases the number of electrons, creating positive or negative charged particles called ions, and is accompanied by the dissociation of molecular bonds, if present [21].

The presence of a non-negligible number of charge carriers makes plasma electrically conductive so that it responds strongly to electromagnetic fields. Like gas, plasma does not have a definite shape or a definite volume unless enclosed in a container. Unlike gas, under the influence of a magnetic field, it may form structures such as filaments, beams and double layers [21].

Plasma is the most abundant form of ordinary matter in the Universe, most of which is in the rarefied intergalactic regions, particularly the intracluster medium, and in stars, including the Sun. A common form of plasmas on Earth is seen in neon signs [21].

1-5-1: Plasma generation device

Plasma is formed by this device through the ionization of atmospheric gas. The amount of plasma generated depends on which of the three Plexr probe is used. The white probe has 0.7-W power and creates points on the skin with a diameter of 0.5 mm, the green probe has 1-W power and creates 1 mm points, and the red probe is the strongest with 2-W power and 2 mm points, respectively. This series of minuscule dots on the skin causes an instant tightening and contraction of the skin fibers subsequently leading to remodeling, lifting, and rejuvenating effects. After the treatment, a crust on the treated part will form that falls off in about a week, leaving no bruising or scarring [22].

1-5-2: The science of plasma medicine

Plasma generation occurs when an electrical discharge exits the device tip and enters the target area, in most cases the electrode tip is close enough to the target (skin) but never touches it. The first step is immediate tissue contraction and thermal disruption as an active plasma mechanism [23].

Secondly, the tissue is sublimed; a direct transfer of the tissue from a solid form to a gaseous state is created. The heat is absorbed by the tissue being targeted and is not transferred to surrounding tissue or the sub cutis [20]. Plasma induces a denaturation of collagen and other proteins in the skin [23]. Therefore, what follows is a cascade of neo-collagenisation, the thermal effects stimulate disruption of dermal solar elastosis, fibroblast activation and migration from the deeper dermis and cytokine release leading to tissue regeneration [23, 24].

1-5-3: Contraindications and clinical considerations

Contraindications to the use of plasma devices include pregnancy and breastfeeding, the use of isotretinoin, systemic illnesses, and infection at the treatment site, body dysmorphia and allergy to any of the topical preparations utilized.

Patients with a known history of keloid or hypertrophic scarring should also be avoided despite the treatment being recommended to treat scarring itself [25].

The success of plasma devices in the aesthetics area has been largely due to the most advertised application which is the rejuvenation of the periorbital region, the 'non-surgical blepharoplasty'. The American Society for Aesthetic Plastic Surgery states that blepharoplasty is today the fourth most demanded aesthetic treatment in medicine and aesthetic surgery [20]. This area is considered to be a principal aspect of facial aesthetic appearance by patients and is often primarily selected for facial rejuvenation [26].

1-5-4: Fractional plasma

Fractional plasma is a minimally invasive outpatient procedure. However, at least two sessions may be required to achieve the desired outcome, usually 3 weeks apart. The need for more than one session and the interval between the sessions may be a disadvantage for those who want to achieve the desired aesthetic outcome rapidly with the least possible visits. In addition, it is associated with mild lid edema and spark effect that resolves within 1–2 weeks [27].

The main advantage of fractional plasma compared with laser or radiofrequency is thought to be the high precision with no affection of the surrounding skin. It can be used in the management of acne scars, wrinkles as crow's feet or smoker's lines, skin tags, milia, syringoma and dermatochalasis (blepharoplasma) [28,29].

Fractional plasma is a type of energy based on the fourth state of matter. It delivers plasma energy on the desired tissue, formed by the gas ionization from the air. The generated plasma is used to raise the temperature in certain part of the skin using specific electrode by the creation of a series of small dots on the skin. The rise of temperature stimulates skin contraction and tightening through sublimation of the superficial layers only down to a depth of 0.1 mm at the level of the stratum corneum, without any ablative effect on the skin [28, 29].

1-5-5: Plasma exeresis (Plexr)

Plexr is a cordless micro-surgical handled device that intensifies heat to the accumulative skin tissues. It handles the dierentiation in voltage amid equipment and the patient's skin. This distinction in voltage creates a limited electrical arc, identical to a minute long lighting. The small lighting achieves sublimation of the liquids included in the superficial section of the skin, without undesirable heat transmission to nearby tissues [30].

The Plexr device is used to sublimate this excess, without penetrating the membrane basal, but with only propose to target the keratinocytes. Clinical studies proved that after one month collagen type 3 is formed (baby collagen). Through this procedure, potential skin harm is decreased in contradict to traditional lasers. 'Catch' innovation of new energy design took place at the State University "Tor Vergata" Rome, in Camerino. Plexr securely helps patient who does not wish surgery and doctor to support high end service at low cost and better outcomes [29].

These drawbacks of classical blepharoplasty come to surpass the process of the non–invasive blepharoplasty. Bloodless, without incisions and stitches, economically and with immediate effect. All this is possible by using Plasma Exeresis (Plexr®) method where there are great results especially in the sensitive region of the eyelids [28].

Plasma exeresis is the bloodless revolution in blepharoplasty because the doctor can do as many incidents as he wishes per day in his private practice, even take it to a cooperating office or clinic, without side effects and with the best outcome for the patient [31].

Plasma exeresis is a dynamic non-invasive method that allows the operator to urge the patient at any time during the procedure to open his eyes, highlighting aspects of skin that still need to be treated and avoiding going after gradual and controlled maneuvers that may have cost image lagopthalmos or excessive opening of the eyes. Regarding any corrective surgery the obvious advantage of plasma exeresis is that is also the perfect choice to avoid further suffering of the patient with correction in his private clinic in infinitesimal time. Histological studies from the University of Cheti and the University of Athens (Department of Pathology-Anatomy) also proved that the spots of Plasma Exeresis not pass the basement membrane of skin [30].

Plasma Exeresis method is effective not only because the patient avoids surgery, having the same effect with less cost but also for histological reasons. Histological analyzes before and after show that in regions that was applies Plasma Exeresis, the area is reconstructed and collagen type III was created after application [32].

1-6: Laser therapy

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.

1-6-1: Basic Elements of Laser

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

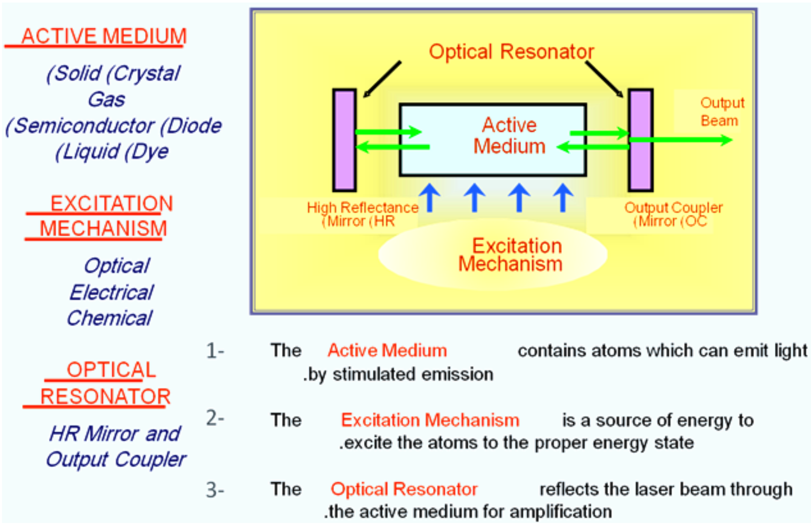


Figure (1-2) Laser Components

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 CO_2 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).

1-6-2: Properties of Laser Light

Unlike ordinary light, laser light is **coherent, collimated, monochromatic, directionality, and brightness**. (44)

1- ***Coherent:*** refers to synchronized phase of light waves, where all individual waves are in step or ‘in –phase,’ with one another at every point. So “coherence” is the term used to describe the in – phase property of light waves within a beam

a) Coherent light b) Incoherent light

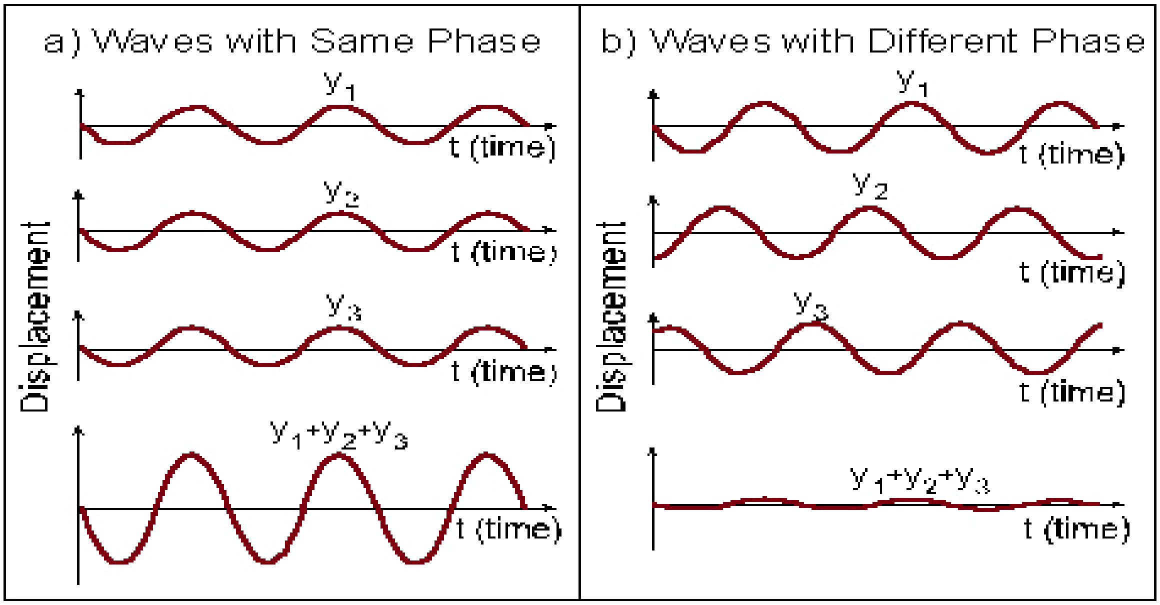


Figure (1-3) (a)-Coherent Light+ (b) - Incoherent Light [(6)]

2- Monochromatic: 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) Because wavelengths of laser light determine its effects on tissues & energy to be delivered to it as $E=h\mu= hC/\lambda$.

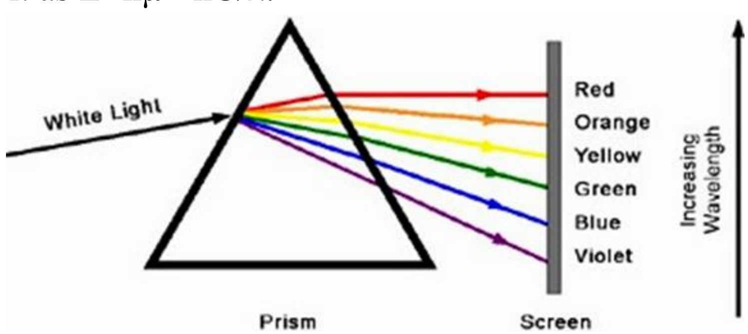


Figure (1-4) Dispersion of white light by a prism. (45)

3- Collimated: refers to the parallel nature of the laser beam, it is 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.

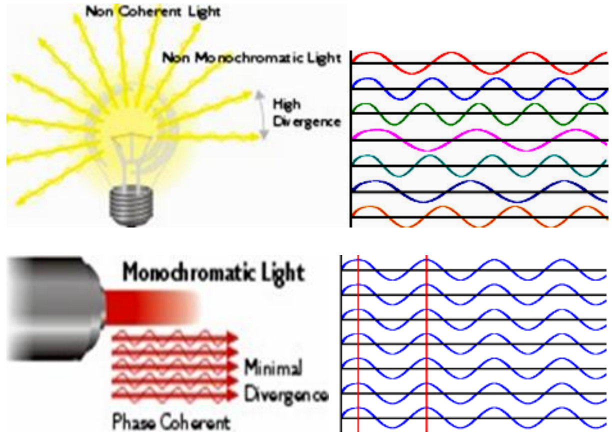


Figure (1-5) Difference between Light Bulb & Laser and its Directionality

5- Brightness: refers to the wave that contains a lot of energy. These properties allow a laser of a given power to be immensely more powerful than ordinary light of the same power.

These unique characteristics make the laser useful for thousands of applications including medical applications.

1-6-3 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)

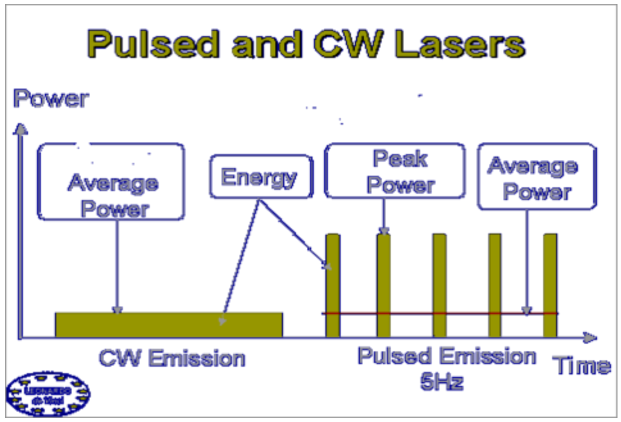


Figure (1-6) Laser beam modalities

1-6-4: 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: Laser emits light in a parallel beam. 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).

1-7: Laser Tissue Interactions

1-7-1: Effect of tissue on the light

*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)

*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)

*Transmition: light which pass through the tissue without any interactions between the photons of laser radiation and the tissue [this part constitutes the basic principle of optical diagnostics].

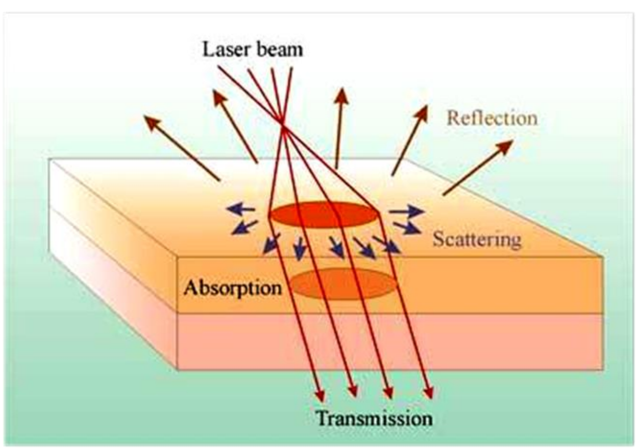


Figure (1-7) Pathway of light when it passes from one media to another

1-7-2: Effect of light on tissue

Five categories of interaction types are classified today. These are photochemical interactions, thermal interactions, photo ablation, 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).

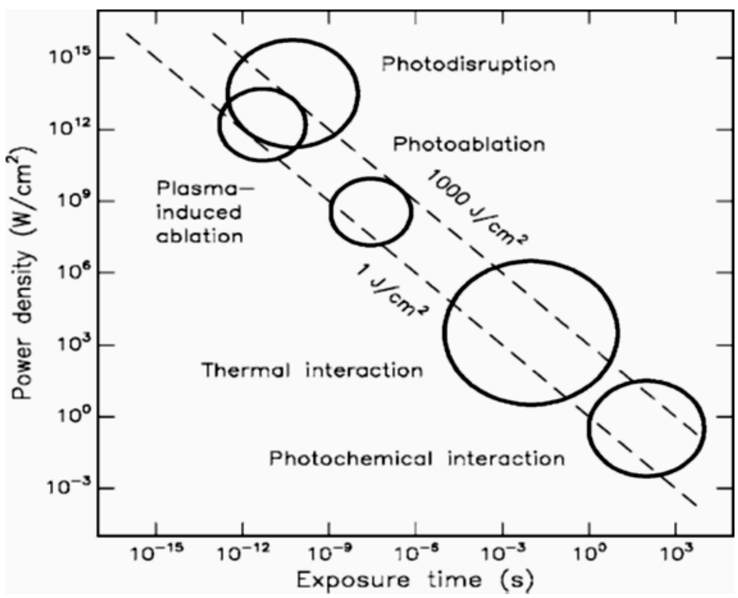


Figure (1-8) five interaction mechanisms depend on the duration of the light exposure and the irradiance, i.e., the power per unit area, in W/cm^2

So, laser tissue interaction can be either:

1. Wavelength dependent

2-Wavelength independent mechanism.

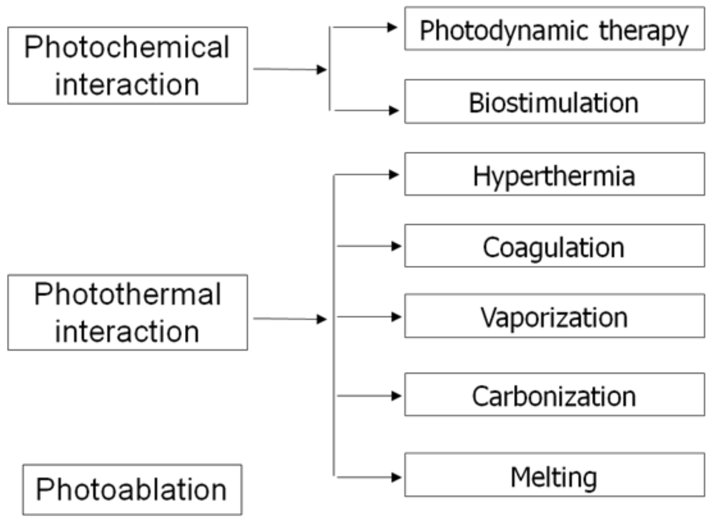


Figure (1-9) Wavelength dependent interaction

1-7-2-1: Wavelength—Dependent Interactions

Wavelength-dependent interactions of radiant energy depend largely on the laser wavelength that has impacted the tissue. 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. Bio stimulation: 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 bio stimulation 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) Photo thermal 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.

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

Table (1-1) thermal effect of laser

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)

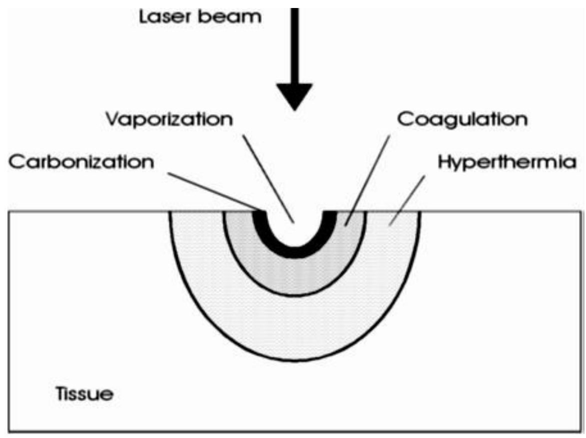


Figure (1-10) Location of thermal effects inside biological tissue

Flow chart with the important parameters for modeling thermal interactions

1) Heat generation is 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).

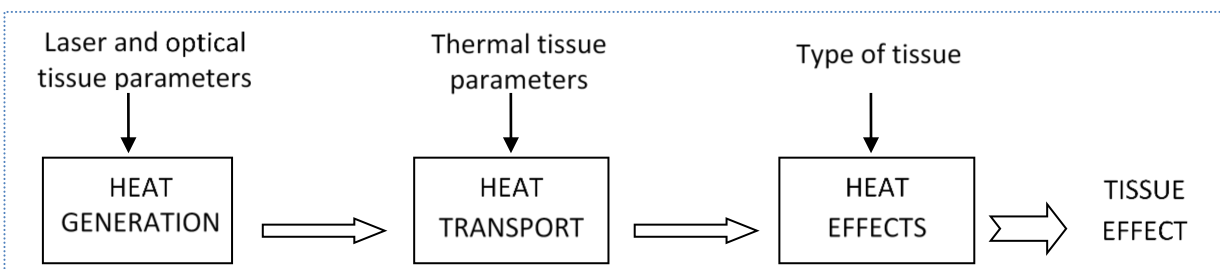


Figure (1-11) Flow chart of photo thermal induction

c) Ablative Photodecomposition (Photo ablation)

Photo ablation occurs when material is decomposed when 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. Only when photons from ultraviolet laser (wavelength < 350 nm) are absorbed, the energy gain is usually high enough to access an electronic state which exceeds the bond energy dissociating chemical bonds at the very next vibration. Therefore, this interaction is limited to the application of ultraviolet light (45).

1-7-2-2 Wavelength—Independent Interactions

These interaction mechanisms rely on plasma generation, at high power density (1011 - 1016) W/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) Photo disruption

In this type of interaction, in addition to plasma formation, shock wave is generated leading to cavitation 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)

Medical laser systems

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

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

1-8 Laser Safety

Laser safety is 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 is 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)

1-9 Laser radiation hazards and damage mechanism

Laser radiation predominantly causes injury via thermal 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)

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

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.			

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

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)

1-10 Maximum permissible exposure MPE

Is defined as the level 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)
- Incapable of producing eye injury.
- 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 $> 0.4\ \mu W$ 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):

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 mW to 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 mW to 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 (above 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)

1-11 Safety measures

1-11-1 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 (1-12) 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 (Figure1-12) 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)

1-11-2 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.

1-12 Carbon dioxide (CO_2)

The carbon dioxide (CO_2) laser emits light at a wavelength of 10600 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)

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)

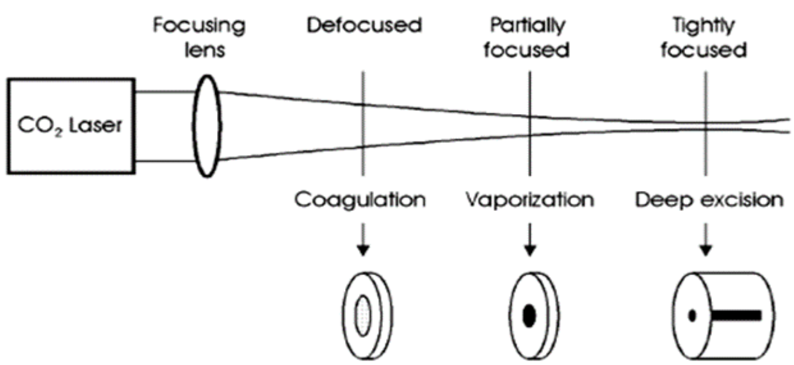


Figure (1-13) Coagulation, vaporization, and excision modes of a CO2 laser. Depending on defocused, partially focused, or tightly focused

1-12-1: Fractional CO_2 laser

Upper eyelid thinning, hooding, and drooping of the upper lid skin are common. Topical therapies to enhance collagen production and reverse aging such as tretinoin (Retin-A), Vitamin C, and alpha and beta hydroxyacids can be effective but have limitations [35, 36]. Surgical revision of dermatochalasis is the gold standard for treatment, but can expose patients to pain, bruising, and prolonged recovery times [37]. Fractional continuous wave CO_2 laser generates more residual heat in skin and induces immediate tissue tightening through selective skin vaporization collateral thermal effects and long-term collagen stimulation by stimulation of fibroblasts from the enhanced dermal heat [38, 39]. Laser rejuvenation of upper lid skin using continuous wave CO_2 laser is low cost, noninvasive, has shorter operative and recovery times with more natural outcomes, and no scarring compared with traditional surgical techniques [40, 41].

In general, CO_2 lasers including fractional use can cause serious side effects such as hyper- or hypopigmentation, recurrence of viral illness, scarring, and infection. When used near the eye, reported side effects include corneal or scleral burns, loss of vision, and ectropion. Newer techniques leave a healthy rim of tissue surrounding the treated area and utilize a nonsequential microspot to minimize collateral thermal damage. These advances minimize, but do not eliminate, pain and side effects associated with CO_2 laser [42].

Newer version of CO_2 lasers maximizes thermal effect but minimizes the buildup of heat, reducing pain, side effects, and downtime. Continuous wave lasers are unique in that they use lower laser energies to build heat in target tissues over longer periods of time. Continuous wave lasers are currently popular in other areas of ophthalmology, primarily glaucoma and retina. The micropulse laser trabeculoplasty (Iridex, Mountain View, CA) lowers intraocular pressure similarly to the selective laser trabeculoplasty (SLT; Lumenis, San Jose, CA) but with less inflammation and no structural damage to the trabecular meshwork by ultrasound microscopy compared with SLT [43]. The continuous wave retinal diode laser (Iridex) is the first of its type to be able to eliminate macular edema and drusen without scarring or damaging delicate retinal tissue [44].

The benefits of CO_2 laser resurfacing are undeniable, whether fully ablative or fractional. The mechanisms by which such improvement is achieved have been the subject of much debate [45]. Although fully ablative traditional and fractional CO_2 lasers have distinctive characteristics, much of the research on fully ablative CO_2 resurfacing is applicable to fractional resurfacing [46].

While fat bags require surgical intervention, several options are available for periorbital skin rejuvenation [47, 48]. Carbon dioxide (CO_2) laser is a laser device producing energy in the far infrared, using a wavelength of 10,600 nm. Resurfacing with CO_2 laser has been used in the treatment of scars and skin aging, as well as for unconventional applications [49].

Nevertheless, ablative CO_2 laser treatment requires general anesthesia or sedation, long-lasting recovery, and can induce potential adverse events [50, 51]. However, the high efficacy of ablative CO_2 laser makes it a powerful weapon in the treatment of many skin conditions by experienced hands [52].

CO_2 laser has shown a wide range of applications. In detail, its efficacy and safety have been shown in the treatment of scars and skin rejuvenation, as well as for other applications [49].

CO_2 micro ablative fractional laser has been developed to deliver controlled epidermal and dermal damage to achieve wound healing and remodeling with a short downtime [53, 54]. Nevertheless, the application of fractional technology to eyelids has shown some limitations.

The CO_2 laser was one of the earliest of the laser systems to appear. It was first developed in 1964 by Patel and colleagues working Bell Labs in the USA. It was quickly recognized as an ideal surgical laser because of its high water absorption, and many indications were pioneered by the late Professor Isaac Kaplan and others [55].

The CO_2 laser remains a workhorse across many specialties. In the hands of an appropriately trained practitioner, the CO_2 laser offers a very large range of dermatological indications, with great precision for procedures involving incision, excision, vaporization and coagulation. The residual thermal damage deposited by the CO_2 laser beam helps to ensure a dry field, limits blood loss and swiftly induces the wound healing and remodeling process. The high water content of soft tissue both makes it an excellent target for the 10,600 nm wavelength, and also offers a degree of inherent safety by preventing deeper penetration at appropriate parameters. Furthermore, the addition of fractional technology has opened up aesthetic dermatological indications to the CO_2 laser practitioner, offering proven applications in rejuvenation of photo aged skin both on and off the face, and scar revision especially for acne scars.

Technological advances which continue in CO_2 laser design and delivery will ensure that the role for this useful wavelength in dermatological practice will continue to expand [56].

The first equipment to employ this technique was the Fraxel®(Reliant City, US). Other devices were launched soon after, each with its unique advantages and disadvantages. Although the safety of the technique improved considerably, less aggressive non-ablative procedures do not remodel the surface of the skin significantly and can be insufficient to improve severe solar elastosis. Non-ablative lasers do not penetrate as deeply or promote as much new collagen formation as ablative mis that are surrounded by intact skin. The lesion depth is determined by the amount of energy supplied [57]. The fractioning of the laser allows it to reach much deeper layers (up to 1,500 µm) than non-fractional ablative resurfacing (10-300 µm) [58]. Although the laser fractioning made the technique less efficient for treating facial wrinkles, photo aging and scars, it greatly improved its safety [59].

1-12-2: Indications of CO_2 laser

Fractional CO_2 lasers are mostly indicated for cutaneous rejuvenation. It is a good option for treating facial aging, since it causes collagen to contract. It is also an option to treat pigmented lesions and improve actinic keratosis [58]. The fractioning of the laser allows the treatment of extra-facial areas as such the neck, chest, arms and legs [59]. Modern equipment allows more intense performances, therefore with more difficult or easier post-operative conditions, as recommended in each case.

Other indications are: acne, chicken-pox and surgical scars. The same indications for traditional CO_2 laser are valid, for it is possible to operate the equipment on the non-fractional method. The therapeutic indications are: seborrheic and actinic keratoses, warts, nevi acrochordons, rhinophyma, sebaceous hyperplasias, xanthelasmas, syringomas, actinic cheilitis, angiofibromas, keloids (adjuvating) and neurofibromas. CO_2 laser is not recommended for the removal of tattoos and permanent makeup [60].

1-12-3: Side effects of CO_2 laser

Although the very frequent incidence of side effects with traditional CO_2 laser decreased considerably with the new fractional technology, the effects of the new technique may have been initially underestimated [58,59].

1-12-4: CO_2 laser technique

The procedure must be planned at least 30 days in advance. The time of the year is important – especially for patients with darker skin; an extended holiday is an excellent option. Modern fractional CO_2 equipment's are very versatile, allowing the planning of lighter procedures in repeated sessions, or more aggressive ones, with a reduced number of sessions, if the photo type allows. It is important to obtaining a very detailed clinical history on a visit prior to the procedure, with a physical examination and laboratorial tests when necessary. Pictures should preferably be taken in advance, so that they are not forgotten on the day of the procedure. Pre-treatment use of topical medication such as sunscreen, vitamin C, tretinoin and/or glycolic acid can be useful to accelerate the healing process. Previous use of hydroquinone is quite debatable [61].

1-13: Aim of study

Comparative study of non-surgical blepharoplasty by fractional CO_2 laser versus plasma exeresis.

Chapter two patients and methods

2-1: Introduction

In this study, non-surgical blepharoplasty was done to (32) patients whose ages ranged between (30-60) years in ophthalmic clinic placed in Baquba city, Diyala province during the period from 01/08/2020 to 01/02/2021. The fractional CO_2 laser method was performed to (12) patients, while the plasma exeresis method was performed to (20) patients, and after performing the two non-surgical blepharoplasty methods a comparison was made.

2-2: Type of anesthesia and materials used

For the fractional CO_2 laser method, the local EMLA (5%) cream was used as topical anesthesia, while for plasma exeresis procedure the local injection of xylocaine 2% was needed in addition to topical EMLA (5%) cream in most cases (90٪) .

Cream of EMLA cream constitute is lidocaine 25 mg + prilocaine25 mg + polyoxyethylene ester + carboxypolymethylene + sodium hydroxide + pure water, or Xylocream, containing Lidocaine + Prilocaine (2, 5 + 2, 5) % w/w and inactive substances. Use of the cream was set every 5 minutes for 30 to 60 minutes and then the sublimation with plasma exeresis or fractional CO2 laser device was started.

Exclusion criteria

Patients with symptoms of connective tissue diseases, pregnancy ,patient with history of radiation therapy or scleroderma , patient with atopic dermatitis, patient-with koebnerizing skin diseases like vitiligo and psoriasis ,patient with recent chemical peeling ,laser treatment , botulinum toxin injection , patients with lid scar , patients with severe dermatochalasis and deep per orbital wrinkles were excluded from our study.

Inclusion criteria

Any patient with mild to moderate skin crease that involves upper or lower eye lid between 30 to 60 years old was included in this study.

2-3: Laser safety techniques

Protective eye goggles (completely opaque) worm by the patient and (wet gauze placed over their eyes) and emphasis on eye closure during procedure to prevent the risk of eye damage.

Physicians also used special eye glasses with special wave length filter and optical density for CO_2 laser.

Any polished, reflective or inflammable material were eliminated from the laser room. Good ventilation was assured in the room and vacuum to remove a vapor.

For plasma exeresis no need for safety measurement.

2-4: Methods

Plasma exeresis

All patients(females) were asked to remove any make up or any other topical remedies before treatment and to dry the area properly , contact lens if present were removed and the area was gently cleansed and then photos were taken of their face before the treatment and in order to see the difference after the treatment . The next step was to apply the anesthetic cream, wait for 30-60 minutes until the cream act so the patient won't perceive any pain while the treatment is going on. After the action of the cream, we remove it and apply the technique first on the right eyelid and then on the left (in the most cases 90% we used xylocaine injection 2%).The point where there is excess skin are sublimated. We did not enter wrinkles but areas of excess skin. For the machine to operate, it should not touch the skin as ionization gas are needed, so while the micro spots were pulled out, we leave little spaces of healthy tissue.

Figure (2-1) plasma exeresis device

Fractional CO_2 laser

All patients(females) were asked to remove any make up or any other topical remedies before treatment and to dry the area properly , contact lens if present were removed and the area was gently cleansed and then photos were taken of their face before the treatment and profile in order to see the difference after the treatment. The next step was to apply the anesthetic cream, wait for 30 minute until the cream act so the patient won't perceive any pain while the treatment is going on. After the action of the cream, we remove it and apply the technique first on the right eyelid and then on the left.

Laser parameter

Laser output Power from (40-50 mJ) joule.

Core fluence (200-250) J/cm2.

Laser action time duration was (1.1 ms) in each.

The interval between point and next point was (1 ms).

The distance between fractional points was (1.3 mm).

Figure (2-2) Fractional CO_2 laser device

Chapter Three
Results and discussion

3-1 Results

1-Plasma exeresis

- The total number of patients is twenty-seven patients, seven of the patients did not attend the second session for unknown reasons and did not complete the treatment.
- Twenty patients underwent the plasma exeresis procedure for the upper and lower eyelids, and the results were as follows:
  1-excelent response to the treatment was found in 16 patient (80%).
  2-Moderate response to the treatment was found in two patients (10%).
  3-Poorly response to the treatment was found in two patients (10%).

Undesirable effect were reported mainly

- Erythema was founded in 16 patient (80%).
- Mild to moderate swelling for 5-7 days after treatment this was found in all patient 100 % resolved well by systemic antihistamine with local steroid ointment .
- Crusting and erosion was found in all patient (100 %).
- Mild itching that persist for one week after treatment was found in fifteen patient (75%).
- Fortunately no infection report in this study.
- The procedure was comfortable by topical anesthesia cream (EMELA) with local Xylocaine (lidocaine HCl) 2% injection.
- 90% of patient can not tolerated this procedure with topical EMELA cream only
- The time for this procedure 30-45 minutes.

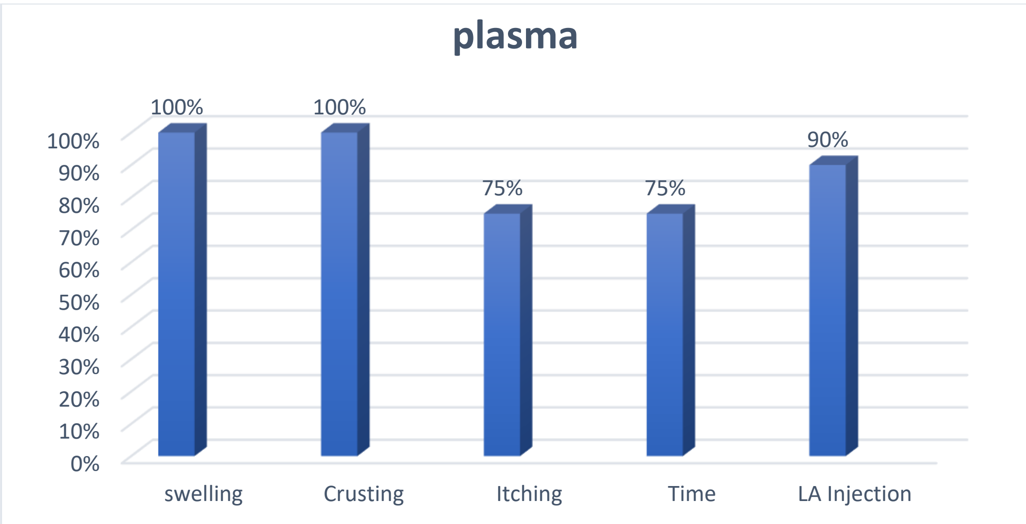


Figure (3-1) Undesirable effect of plasma

2-fractional CO_2 laser

- The total number of patients is twenty patients. Eight of the patients did not attend the second session for unknown reasons and did not complete the treatment.
- Twelve patients underwent the fractional CO_2 laser procedure for the upper and lower eyelid wrinkles and the results were as follows.
  1-excelent response to the treatment was found in eight patients (66.6%).
  2-Moderate response to the treatment was found in two patient (16.6 %).
  3-Poorly response to the treatment was found in two patient (16.6 %).

Undesirable effect were report mainly:-

- Erythema was found in 10 patient (83%).
- Mild to moderate swelling for 24-72 hours after treatments in 6 patient 50% these started after session with in few minutes this resolved well by systemic antihistamine.
- Erosion and Crusting noticed in 4 patients (27.3 %) which controlled by topical antibiotic.
- Mild itching that persist for one week after treatment was founded in five patient (41.3%).
- This procedure was comfortable apart from mild discomfort experienced by three patients (25 %).
- This procedure done under LA (EMELA) with no need for local Xylocaine (lidocaine HCl) 2% injection and the time of this procedure was 10-15 minute only.

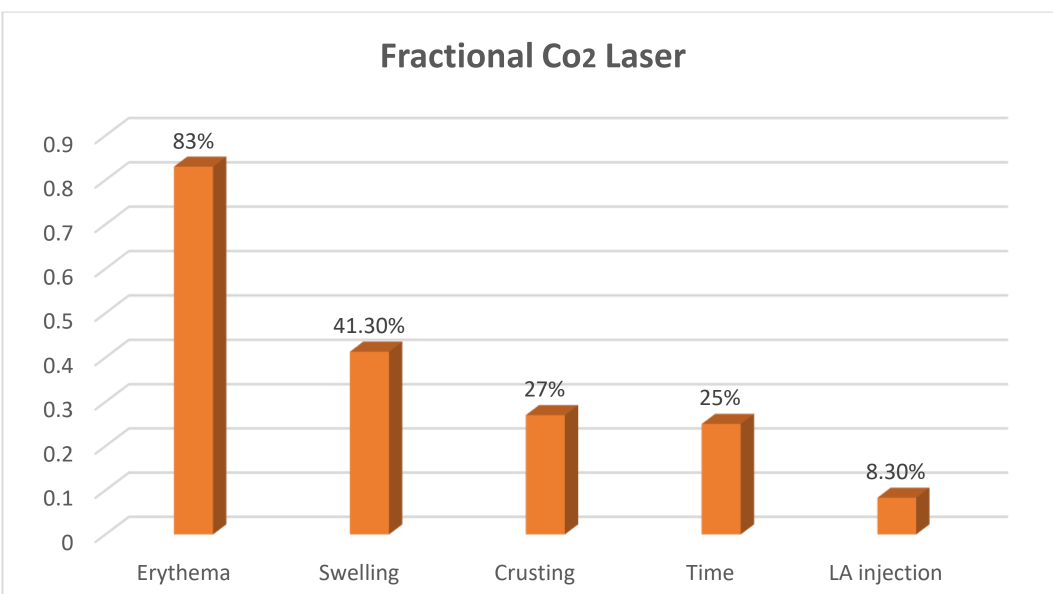


Figure (3-2) Undesirable effect of fractional CO_2 laser

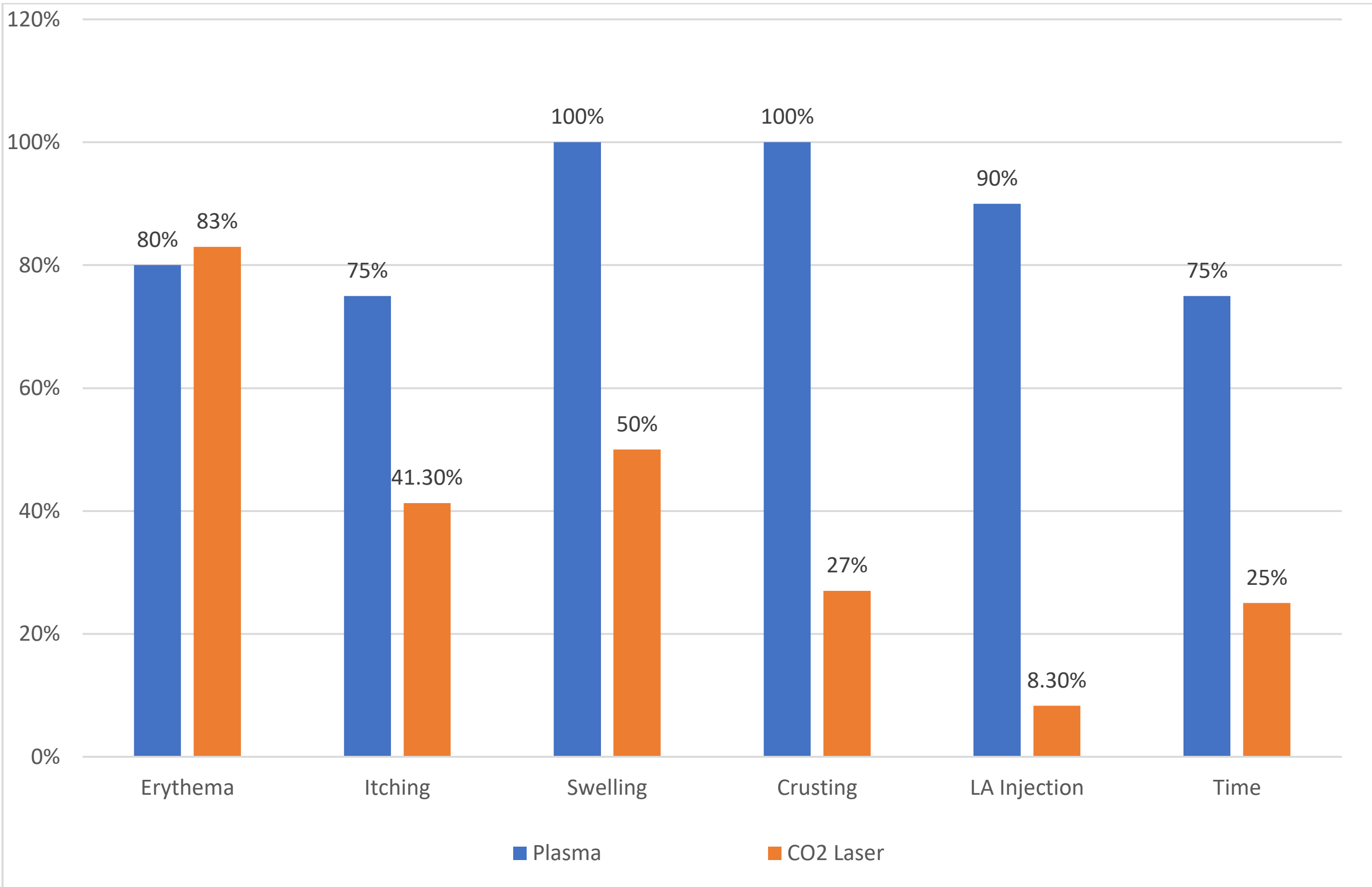
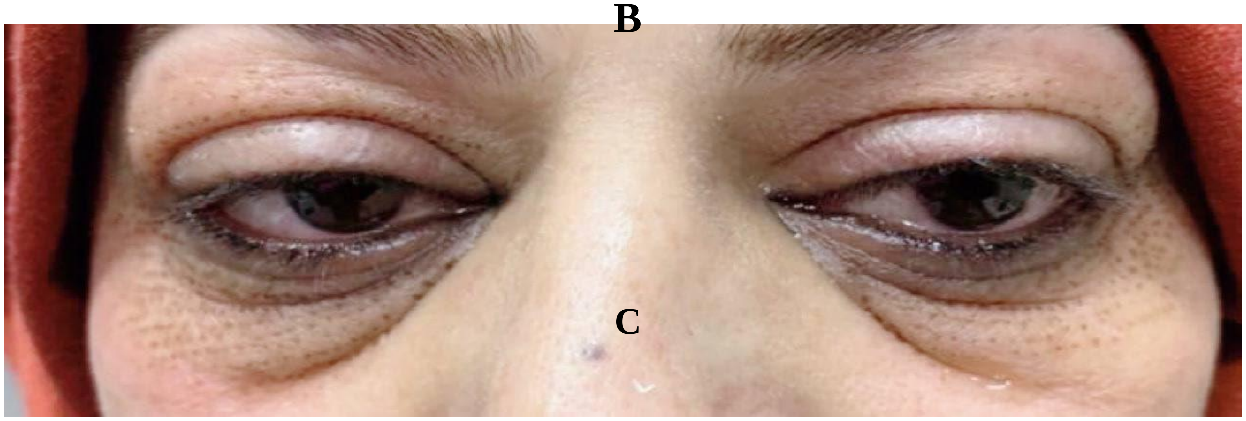


Figure (3-3) Chart show comparison between plasma and fractional CO_2 Laser regarding to erythema, itching, swelling, crusting, need for local anesthetic injection and time for operation

A

B



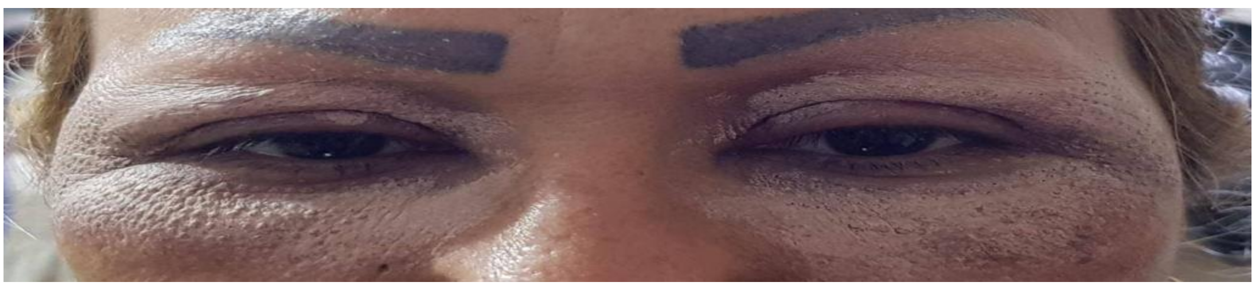
C

Figure (3-4) plasma exeresis A37 years old female **A**: before **B**: After session directly C: After 2months

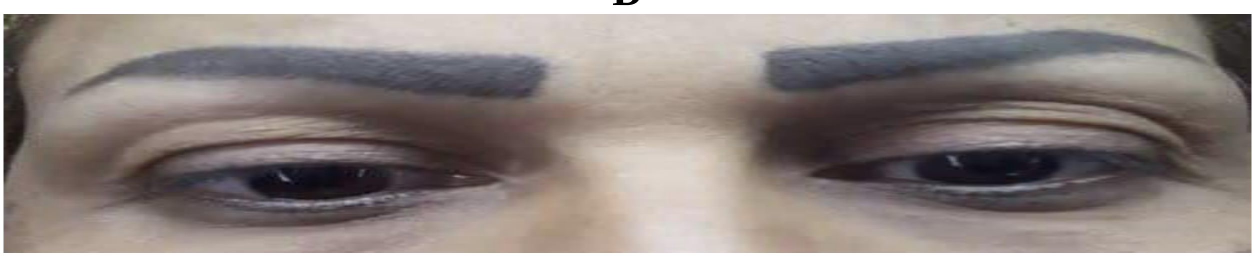
A

B

C



D



E

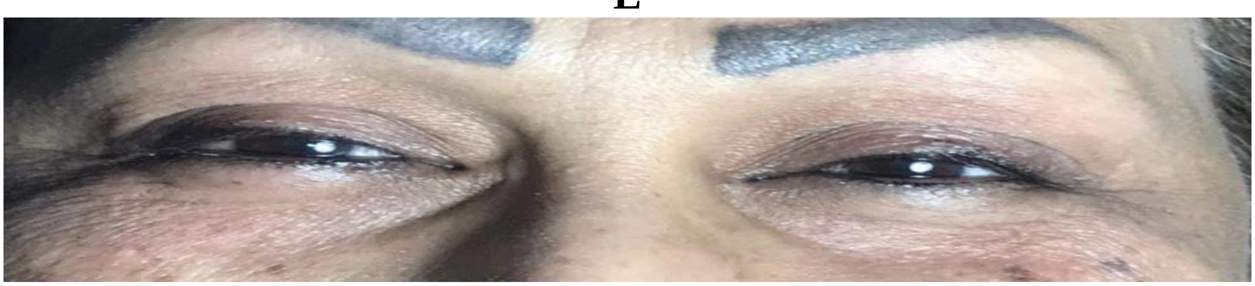


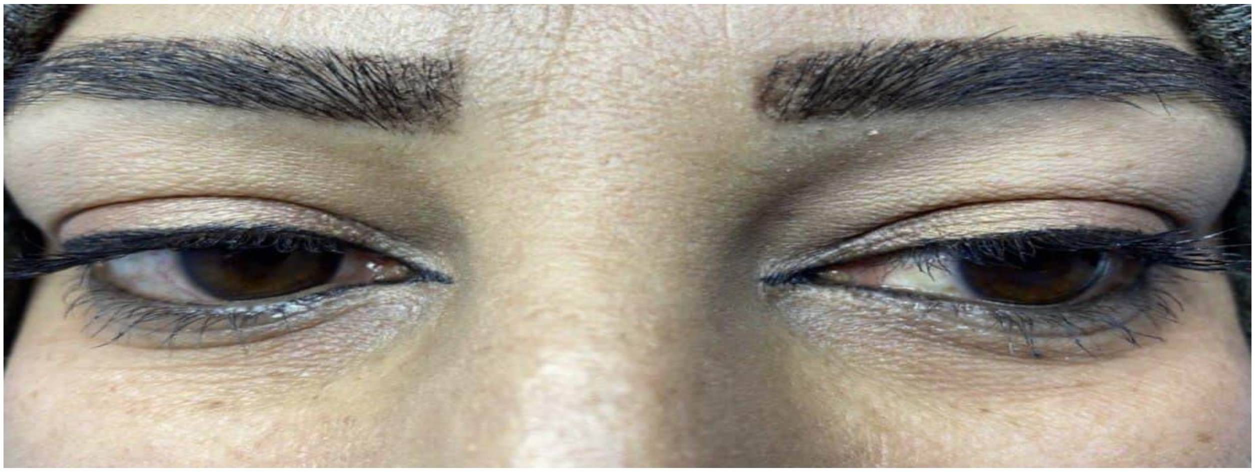
Fig. (3-5) plasma exeresis A48 years old female **A**: before **B**: directly after session **C**: after Two days **D**: after one month **E**: After three months

A

B

Fig. (3-6) fractional CO_2 laser A42 years old female A: before B: directly after session

A



B

C

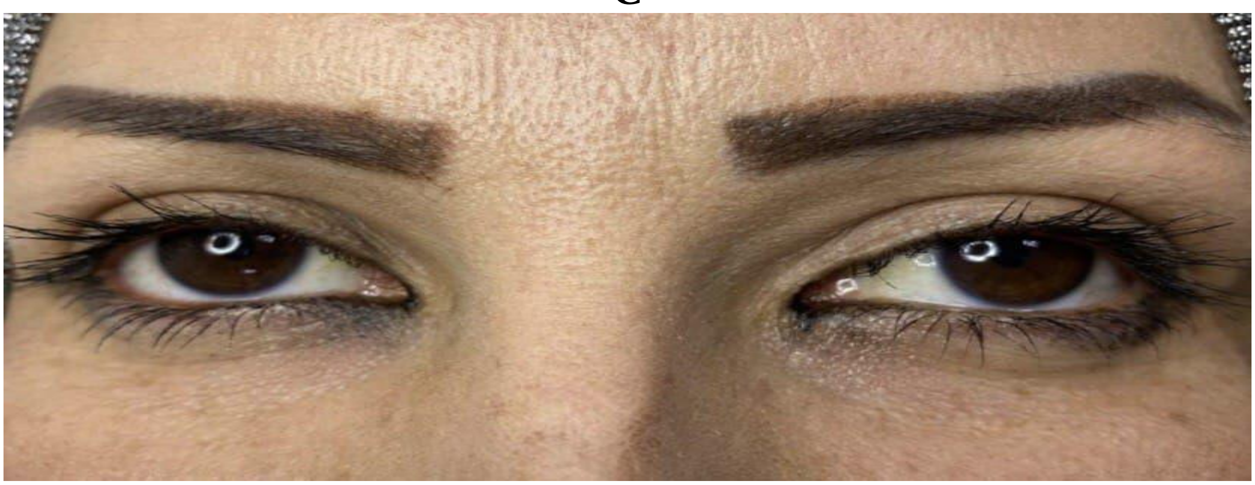


Fig. (3-7) Fractional CO2 laser A33 years old female A: before B: directly after session C: After three months

3-2 Discussion

This research is considered the first one in Iraq regarding the method of treating eyelid wrinkles by plasma exeresis.

Surgical or invasive blepharoplasty has long been the gold standard for rejuvenation of upper eyelid dermatochalasis, although patients routinely experience bleeding, bruising, edema, scarring, and downtime as well as the risks of serious complications such as retro bulbar hemorrhage and dryness, causing temporary or permanent loss of vision.

The need of the physician to provide improved innovative non-invasive techniques to patients with less pain and cost, but also the need of the patient for cosmetic procedures that prevented them from surgery.

The major advantage of plasma exeresis and fractional CO_2 laser is security that it provides to the patient in desirable effects.

Continuous wave micro-spot lasers are known to generate greater amounts of non-scarring heat within skin to stimulate skin to naturally tighten both immediately and long term and improve texture and resistance to gravitational effects in the other hand plasma exeresis shows promising remodeling effects on the collagen of the upper-and lower eyelid and seems to improve appearance.

Both Procedures can be performed in the office and outside of traditional operating rooms, reducing costs to both patients and practitioners. These method provides decreased recovery period, higher safety, and the potential for more natural cosmetic outcome compared with traditional blepharoplasty.

This study evaluated improvements in common lid measurements for dermatochalasis and skin laxity by using a fractional CO_2 Laser and plasma exeresis in patients with dermatochalasis with a follow period of 6-month .

This was proved by the results of the 32 incidents were subjected to bloodless blepharoplasty with Plasma exeresis and fractional CO_2 laser.

The plasma method is more effective in removing eyelid wrinkles and tightening the skin, compare to fractional CO_2 laser but the plasma method requires a long time (30 – 45) minutes for the procedure while fractional CO2 laser need less than 15 minutes. In plasma method most patients, 85% of patients cannot undergo the operation using topical anesthesia with EMLA cream and they need local Xylocaine (lidocaine HCl) 2% injection.

As for the fractional CO_2 laser method, more than (90%) of patients can do the surgery with EMLA cream anesthesia only.

Inflammatory response redness, swelling and pain after the operation is more severe and needs a long period of healing and this causes several inconvenience for patients.

The crusting post procedure occur in all patient (100%) with plasma exeresis but in fractional CO_2 occur only in (27.3 %).

3-3 conclusion

The fractional CO_2 laser is better in terms of complications during and after the procedure regarding to pain, redness, swelling and crusting formed, as well as the time of the operation.

But the plasma method is more effective in removing eyelid wrinkles and tightening the skin, compare to fractional CO_2 laser

3-4 Recommendations

1 - Increase the number of cases included in the study to verify a statistical analysis of the result.

2 - Continue to follow subjects for longer periods to further evaluate the longevity of clinical benefits.

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المقدمة :

لطالما كان رأب الجفن الجراحي هو المعيار الذهبي لتحسين تجاعيد الجلد في الجفن العلوي ، على الرغم من أن المرضى يعانون بشكل روتيني من النزيف والكدمات والوذمة والندبات بالإضافة إلى مخاطر حدوث مضاعفات خطيرة مثل نزيف خلف العين والجفاف ، مما يتسبب في فقدان مؤقت أو دائم للرؤيا . يؤدي هذا إلى البحث عن طرق بديلة أخرى غير جراحية أكثر أمانًا مثل البلازما وليزر ثاني أوكسيد الكربون الجزئي.

الهدف من الدراسة :

دراسة مقارنة لرأب الجفن غير الجراحي بواسطة ليزر ثاني أوكسيد الكربون الجزئي مقابل البلازما.

المريض والطريقه:

في هذه الدراسة تم عمل رأب الجفن غير الجراحي لـ (32) مريض تراوحت اعمارهم بين (30-60) سنة في عيادة العيون في مدينة بعقوبة بمحافظة ديالى خلال الفترة من 2020/08/01 الى 02/01 / 2021. تم تنفيذ طريقة ليزر ثاني أكسيد الكربون الجزئي لـ (12) مرضى ، بينما تم إجراء طريقة البلازما لـ (20) مريضاً ، وبعد إجراء الطريقتين غير الجراحيتين تم إجراء مقارنة.

النتيجه:

في علاج البلازما النتائج على النحو التالي

1- وجدت استجابه ممتازه عند 16 مريض (80٪).
2 - تم العثور على استجابة متوسطة عند مريضين (10٪).
3-ضعف الاستجابة عند مريضين (10٪).

في ليزر ثاني أوكسيد الكربون المجزء تكون النتيجة على النحو التالي

1- تم العثور على استجابة ممتازه للعلاج في ثمانية مرضى (66.6٪).
2-تم العثور على استجابة متوسطة عند مريضين (16.6٪).
3-ضعف الاستجابة عند مريضين (16.6٪).

الاستنتاج :

يعتبر ليزر ثاني أوكسيد الكربون الجزئي أفضل من حيث المضاعفات أثناء وبعد العملية فيما .يتعلق بالألم والاحمرار والتورم والقشور وكذلك وقت العملية.
لكن طريقة البلازما أكثر فاعلية في إزالة تجاعيد الجفن وشد الجلد ، مقارنة بليزر ثاني أوكسيد الكربون الجزئي

وزارة التعليم العالي والبحث العلمي
جامعة بغداد
معهد الليزر للدراسات العليا

دراسة مقارنة لرأب الجفن غير الجراحي بواسطة ليزر ثاني أوكسيد الكربون الجزئي مقابل البلازما

رسالة مقدمة إلى معهد الليزر للدراسات العليا / جامعة بغداد كجزء من متطلبات نيل شهادة الدبلوم العالي في الليزر في الطب / العيون

الطالب

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دبلوم عالي ليزر في الطب / العيون

2021 ميلادي **1442هجري**