



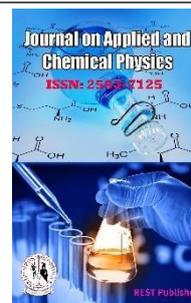
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# A Study on Clinical Aspects of Laser Application in Dermatology

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**Abstract.** "LASER" is a term with acronym for "light amplification by stimulated emission of radiation". Laser emits light through the optical amplifier based on stimulated emission of electromagnetic radiation. In 1917 Albert Einstein made an optical amplifier, he explained the presence of new irradiative process. That is called stimulated emission. This work remains undeveloped until 1954. After Einstein, C. H. Towns and Arthur Leonard Schawlow, based on stimulated emission they develop a microwave amplifier.

## 1. INTRODUCTION

Which is called Maser. In 1960 Theodore. H. Maiman built the first laser at Hughes laboratories. Today laser is used in many varieties of profession. on that, one of the most important laser technologies is used in medicine. Laser have entered into the most medical fields, include dermatology, urology, neurosurgery, cardiology, and ophthalmology. There are many types of lasers used for various types of skin problems. The common skin problem treated with the laser are vascular lesions, infection lesions, pigmentation lesions, tattoos and many number of cosmetic conditions like wrinkles, texture changes, hyperpigmentation. The laser was invented half a century ago, but it provides benefits for medicine field. The laser treatment is between the optical irradiation and biological tissues and the appropriate laser is used for particular disease. The turning point of science is the development of the laser.

## 2. LASER DEVELOPMENT

From historical point of view, the treatment for various pathological phenomena or to improve health, the sun radiations has used as a therapeutic tool for many centuries. The ancient Egyptians, Greeks and Romans believed and used the sunlight as Phototherapy or Heliotherapy. In sun radiation the action of light -sensitive substance applied to the skin, leading to a tissue healing process. With the help of this method Egyptians and Indians cure skin disease like Leukoderma. which is today called photochemotherapy. The Chinese also used the sunlight to cure the disease such as rickets and skin cancer. Theodore Maiman formed the first red ruby laser in 1960. Following this physician began to test the application of laser radiation. They found using the ruby laser radiation they can drill holes through razor blades. Physicians also compared the laser light with the other light source, the light radiation is used in medical treatment. during the twentieth century in dermatology and ophthalmology, light radiation was in wide spread and used for cure the disease. The first real success in laser was in detached retina treated in rabbits. Ch . J .Campbell and Ch. Zweng performed the first successful operation on a human patient . In 1961 Leon Goldman used the laser radiation to cure the human skin disease. he treated a skin melanoma. In 1963 Goldman and co-workers published the first study on effects of laser radiation on the skin. This study describe the selective destructive of skin pigmentation using the ruby laser beam. Subsequently, a number of continuous lasers were developed: argon , carbon dioxide , and neodymium :yttrium-aluminumgarnet (Nd:YAG) This method become very popular for treating skin disease, birthmarks , tattoos with slightest scars.

## 3. LASER PRLINCIPLES

The unique properties of laser light is based on the therapeutic action of laser energy .laser light is monochromatic. It emits the light in discrete wavelength determined by the lasing medium (solid , liquid , gas), the laser light

passes through the optical cavity . when the laser is used on the skin the light get absorbed , emitted , reflected or scattered .for clinical effect the light should be absorbed by the tissue, on the transmitted or reflection light has no effect .The absorbed energy is known as density and it is measured in joules per square centimetre. Once the laser energy is absorbed in the skin , three types of basic effects occur. which is photo thermal , photochemical and photomechanical are commonly observed in current laser surgery . the laser energy get penetrate in depth through the skin dependence on the absorption and scattering. Whereas scattering is minimal in the epidermis , result of the presence of collagen fibres scattering is greater in the dermis. Scattering amount of laser light is inversely proportional to wavelength of the incident light. In general the depth of laser energy penetration increase with the wavelength until the mid infrared region of the electromagnetic spectrum . penetration of 300 to 400 nm wavelength are limited by strong scattering of the beam whereas scattering is minimal at longer wavelength 1000 to 1200 nm , allowing greater penetration into the skin. The laser-tissue interaction was greatly improved by Anderson and parish in theory of selective photo thermolysis . the theory describe how to control destruction of a targeted is possible without significant thermal damage to surrounding normal tissue . for photothermolysis , selected intended tissue target or chromophore a proper wavelength is absorbed . the exposure duration of the tissue to light(pulse duration) must be shorter than the thermal relaxation time(after laser irradiation time is required for the targeted site to cool) to limit the amount of thermal energy deposit within the time. The energy density delivered from the laser must be sufficient to achieve destruction of the target within the allotted time .therefore the basis of the principle laser parameter (wavelength, pulse duration )can be used for specific cutaneous surgery .

#### **4. HOW LASER LIGHT INTERACTS WITH TISSUE**

When laser come contact with the tissues they can interact with four ways , absorbed by the tissue, transmitted through the tissue ,scattered within the tissue or reflected by the tissue. The fundamental goal of the clinical laser , laser light should absorb the radiation by specific tissue target. Light must absorb the tissue to give an effects on that tissue. the components on the tissue absorb the photon is depends on the wavelength. The light absorbing tissue component is chromophore. Photon frequently targeted chromophores in the skin melanin , haemoglobin , and water. In transmission the light passes through the skin without any effect. reflection refers it repels the light on the surface of the tissue without entering into the tissue. approximately 4-7% light gets reflected. the amount of light reflected increase with increase in angle of incident when the laser beam directed perpendicular to the tissue. scattering within the tissue occurs after the light entered into the tissue. scattering happens due to the heterogeneous structure in the tissue. the amount of scattered is determined by the variation in particle size and different parts of index refraction. this spreads the radiation of larger area than anticipants. It limits the depth of penetration it can occurs in forward and backward form, scattering light is due to interaction with the dermal collagen. the scattering light is inversely proportional to the wavelength of laser, longer wavelength can more deeply penetrate in the tissue. the wavelength above 1300 nm will penetrate high adsorption coefficient of tissues in water. Laser tissue interaction has been categorized by three types, photo thermal photochemical or mechanical photo disruptive, depending on the absorbed laser energy. they can convert into thermal or chemical or acoustic energy . the most common type of interaction with the tissue is photo thermal when the tissue absorb the light that results in a rise in tissue temperature which is depending on the dose applied to the tissue, this lead to the various stage of tissue damage. the additional heating coagulation of the tissue cells occur. this can be seen as mitochondrial swelling, eosinophilia and vacuolization. the next stage is vaporization. This tissue gets interacted by becoming a gas . this create the plume of smoke that comes under safety. Through diffusion of energy, cell around the vaporization tissue will absorb some energy. by adding the heat the tissue gets blackened, changes the optical properties of the tissue which results in increase of adsorption, reflection and scattering . at this stage the surgeons creates a detrimental peripheral tissue damage over the energy absorbed by the cells. where the tissue reaches temperature 350°C sparks may visualized. when it reach up to 2500°C the snaps and crackles sound can be heard . when the impact site reaches the temperature increases in the termal zone injury and this results in healing.

#### **5. TECHNIQUE AND LASER PARAMETERS**

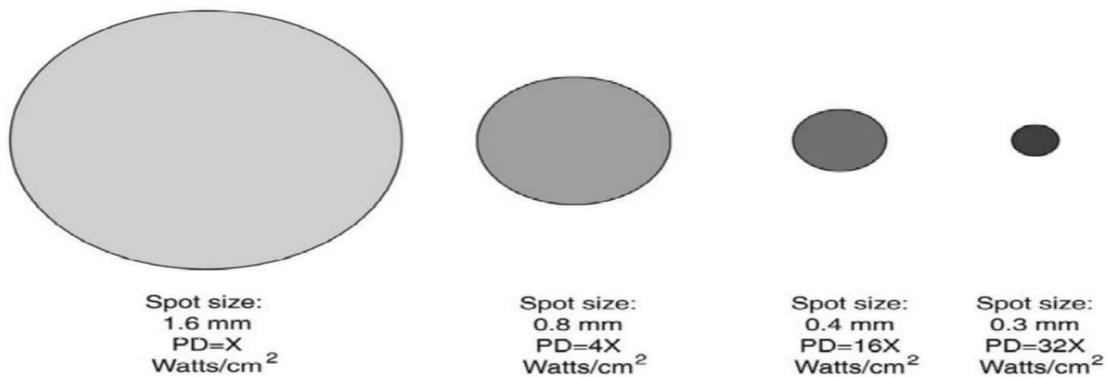
It is very important to understand how this energy is to be correctly applied to the tissue to minimize the collateral tissue damage . the laser tip should be held in perpendicular to tissue . this lead to minimize the reflected beams and maximized the energy interaction with tissue. The energy and power have density depends on the size of the laser tip that deliver to the laser beam. Some laser has lens to allowed the focused energy, this helps to adjust the spot size is based on the distance from the tip on the tissue. The focused energy is used for vaporized tissue. The defocused energy or larger spot sized is used to coagulate the tissues.

**Spot size:** The spot size of a laser is equivalent to the laser beam cross section. The fluence and the irradiance of a laser beam was directly affected by the spot size. Fluence and irradiance are inversely proportional to the square of the radius of the spot size. The energy density or power density by a factor of 4, can increase the spot size. Spot size in small allows more scattering both backwards and sideways than a larger spot size. A large spot size of 7 to 10 mm is needed for maximal penetration of laser light to mid-dermal or deeper targets. We can increase the depth of penetration levels off with spot size of 10 to 12 mm.

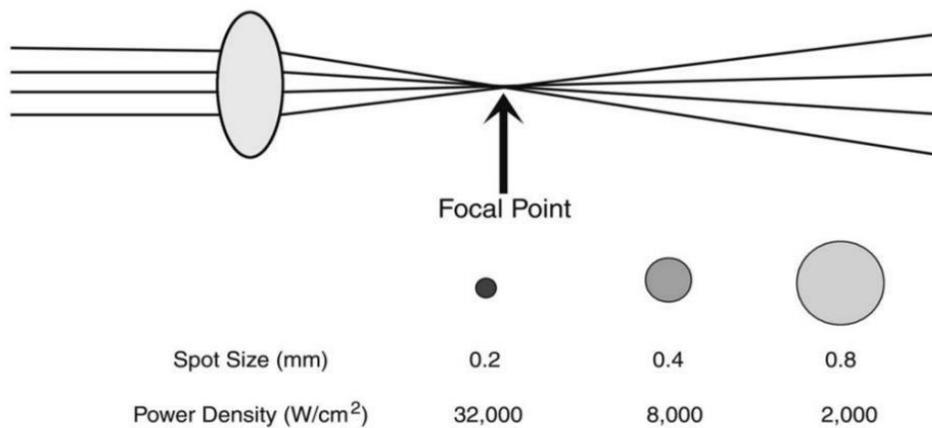
**Pulse Duration:** Laser light can be released in a continuous wave or a pulsed wave. Pulsed delivery of laser light allows for more selective tissue damage. The duration of time of exposure to a laser beam determines the rate at which the laser energy is delivered. Pulse duration ranges from very short (nanoseconds) to long duration (milliseconds). The pulse duration of the laser is determined by the thermal relaxation. The thermal relaxation time is generally proportional to the size of the target structure

**TABLE 1.** Measurements of laser output

Spot size	= laser beam cross-sectional area
Fluence	= watts seconds/cm <sup>2</sup> = joules/cm <sup>2</sup>
	= laser
output pulse duration / spot size	
Irradiance	= Watts/cm <sup>2</sup> = laser output / spot size



**FIGURE 1.** Spot size and its effect on power density



**FIGURE 2.** Focal Point And Its Power Density

## 6. RESULTS IN CLINICAL APPLICATIONS

**Vascular Lesion:** In 1992 the International Society for the Study of Vascular Variations classified vascular lesion, such as haemangiomas and malformations. pulsed yellow dye laser adjusted to 585nm and 595 nm for greater

dermal penetration. the most popular type. The KTP laser (532 nm; green light) targets only oxyhemoglobin, the pulses duration is longer much longer, and tend to coagulate rather than disrupt vessels.



**FIGURE 3.** Nd:Yag Lasers Are Used To Cure The Vascular Lesions

**Tattoos:** Tattoos has different types, such as professional, amateur, accidental (traumatic) . Putting Unwanted tattoos can give an enormously negative impact for the patients . In the skin the absorption of the laser pulse breaks up the tattoo pigments into smaller particles which is absorbed by the natural defence system by an inflammatory reaction . Black and dark tones as well as red and tan tones can easily removed .The ruby laser with the wavelength 694 nm and the alexandrite laser with the wavelength 755 nm can be used for green, blue and black colours. Flashlamp pumped dye lasers with the wavelength at 560 nm can be used for green tattoos. The same type of dye laser with a wavelength at 585 nm can be used for sky-blue colours. The Nd:YAG laser (1064 nm) can be used for black and dark blue colours and, frequency doubled at 532 nm for red tattoo colours.



**FIGURE 4.** Actual Client Photos

**Pigmentation Lesion:** Pigmented lesion lasers target melanin. Congenital nevi will also lighten with laser therapy, but this use of laser is controversial. In malignant transformation laser will increases their risk, it may delay the diagnosis of a changing nevus by masking the colour change it makes nevus changing of a diagnosis melanoma.



**FIGURE 5.** Pigmentation Lesion

**Acne scars:** Complex acne scarring can be treated by the ability to provide up to 20 resurfacing treatment modalities, improving virtually all common acne scar types by using the lasers. for acne scars light breaks the scar tissues and replace the tissue.



**FIGURE 6.** Acne Scars

## 7. CONCLUSION

The history of laser development in medical field is extremely interesting. the medical application of laser started half a century ago, after the invention of laser today, laser are applied to almost all the fields of medicine, providing considerable benefits for both the doctor and patients from life threatening disease to psychologically stress full cosmetic defects. Laser therapy has led to achievements in countless. for many treatments lasers patients prefer laser because of, there is less bleeding, swelling, pain, or scarring and healing time is shorter.

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