

LASER TREATMENT OF CUTANEOUS VASCULAR ANOMALIES AND PIGMENTED LESIONS

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Introduction

Portwine stains are the congenital vascular lesions which do not regress spontaneously. These lesions commonly occur on the face and neck, eyelids, etc. resulting in marked cosmetic disfigurements. Various modalities of treatment for hemangiomas and tattoos have been tried with unacceptable complications and results due to inadequate removal and scarring. Portwine stains differ histologically from other common congenital vascular anomalies and persist into adult life. They are also associated with systemic abnormalities such as glaucoma, epilepsy in association with Sturge Weber Syndrome.

The use of radiation for therapeutic purposes is as old as the history of mankind. The earliest experiences depend upon nature's light source, the sun. Light source has been used for many years to treat various skin disorders. The word laser is an acronym for light amplification by stimulated emission of radiation¹⁰. The basic concepts of maser/laser devices were first discussed in 1917 by Albert Einstein in his classic publication, "Zur Quantum Theorie der Strahlung." The basic theories provided the foundation for the development of lasers of today.

Maiman in 1960 constructed the first ruby laser and was first to write on its use. In 1964, Basov and Prokhorov received the Nobel Prize in physics for independently suggesting the use of stimulated emission for microwave ampli-

fication. Continuous wave laser operation was first demonstrated by Javan in 1961 with the helium-neon laser.²⁵

Mechanics of Laser

The laser is a generator and intensifier of radiation and depending on the lasing material, emits all, or nearly all, of its energy as monochromatic (one wavelength) coherent light. All of the light energy can be focused to a single point of enormous energy density.

Basic Components of Laser and Properties of Laser Light

1. Lasing medium
2. Light source
3. Electrical power source
4. A laser cavity

A generalized laser device is shown in Figure 1.

The lasing medium may be gas (e. g. argon or carbon dioxide), solid (e. g. ruby), or liquid (e. g. organic dyes). The pumping system stimulates the medium, raising electrons to a higher energy level, when the number of electrons trapped in a metastable energy level is sufficient, stimulated emission of radiation occurs as electrons decay from their excited states to their ground state. This starts a chain reaction and photons are reflected back into the material where the reaction continues. When a critical energy level is reached and photons arrive at a partially reflecting mirror, only a portion are reflected back, the rest emerge as a

laser beam. The laser light may be released in a pulsed or continuous fashion. A pulsed laser in a form of high intensity photon energy is emitted in a continuous fashion and may be used as a continuous wave or short pulses by means of a shutter mechanism. Argon laser has been used for the treatment of vascular lesions of skin and CO₂ lasers have been used for treatment of tattoos and excision of various lesions.

Materials and Methods

A group of 232 patients were examined in consultation for hemangiomas, tattoos, nevi and warts. Out of 232 patients, 117 patients were treated with laser. A test dose was administered before treating any patient definitively, Twenty-five patients were rejected for treatment after the test dose due to the development of hypertrophic scars, dissatisfaction on the part of the patient due to the length of time subjected during multiple treatments, and poor results. A total of 92 patients were followed and treated with laser. Forty-eight patients (52.17%) consisted of hemangiomas, mainly portwine stains and 32 patients (34.78%) were treated with tattoos. A small group of 10 patients (9.2%) comprised of nevi and 2 patients (2.17%) of warts, (See Table 1),

Table I
Total Patients Treated—92

	No. of Pts.	Percentage
Hemangiomas	48	52.17%
Tattoos	32	34.78%
Nevi	10	9.2%
Warts	2	2.17%

The vast majority of lesions in hamangiomas were found in females (54.34%) and were located on the face, neck, eyelids, ears. However, tottoos were more commonly encounte-

red in males (25%) in contrast to 9.7% in contrast to 9.7% in females. (See Table II). Spider nevi and warts comprised a small group of patients.

Table II
Proportion of Males and Females Treated with Laser

Females : 50
Males : 42

	Males	Females	Total
Tattoos	23	9	32
P. WS Hemangioma	13	35	48
Spider Nevi	4	6	10
Nevi			
Warts	2	0	2
Total	42	50	92

An argon series installed by spectraphysics was set up in outpatient laser laboratories to treat outpatients under local anesthesia and a CO₂ laser from sharplan was used.

Another argon laser was installed in the inpatient surgical suite to be used under general anesthesia if necessary. These lasers delivered a maximum of 10 watt power and the beam size could be adjusted from 1mm to 5mm according to the treatment required. Most treatments were carried out from 0.8 watt to 2.0 watt with argon laser for the treatment of hemangiomas and nevi and a power of 5 watts to 10 watts was used with CO₂ laser for the treatment of tattoos. The minimum number of exposures for the complete treatment of a lesion ranged from one to six treatments and a duration of six months to minimum two years. Special permission sheets and records were maintained. Photographic documentation of care was attempted. Patients were given printed instructions for the post-operative care as well as instructed verbally by the physician and nurse.

Results

A total of 92 patients were followed up following laser treatment for evaluation of the results. Patients with portwine stains of face and neck had excellent results following multiple laser treatments. The average age of these patients was 22 years. The youngest patient was 11 years of age and the oldest 57 years. Twenty-five patients decided against laser treatment after the test dose of laser. Some of them developed hypertrophic scars and some decided to drop out because of the length of treatment with laser for about six to eight settings and the involved cost of the treatment. Six patients failed to return for evaluation of laser treated sites.

Most patients with portwine stains had excellent results; where as the combination of portwine and cavernous hemangiomas involving lip, ear, etc. did not regress completely. Incidence of hypertrophic scar in hemangioma was 9.25%. Hypertrophic scars were common over areas treated near the lip. Three patients treated with CO₂ laser for tattoos in the arm, developed hypertrophic scar requiring local injection of steroids. In patients with portwine stain, the lesions were treated in such a fashion that normal areas were spared in between the treated areas sparing cutaneous elements to prevent scarring. The power of argon laser for treatment of lesions did not exceed above two watts/second, resulting in high proportion of good to excellent results. As indicated by histopathological examination on experimental basis, it was found that higher power of laser energy used for the treatment of lesion resulted in coagulation necrosis and damage to cutaneous structures.²⁵

The treatment of the entire lesion was not considered, only at one treatment, due to unpredictable response of healing with different power of energy used.

Discussion

Many surgical methods have been tried for the treatment of portwine stains and tattoos without success. Clinical trials with laser have demonstrated that argon laser appears to be the treatment of choice for portwine stain and CO₂ laser for tattoos. The CO₂ laser can also be used for surgical excision of cavernous hemangiomas.¹⁸ A predictable cosmetic result is observed after the use of precise microsurgically adapted CO₂ laser.²² The machine is unique in that the absorption of its radiant energy is sharply localized that it produces a narrow zone of coagulation and very little injury to the underlying dermis. This well demarcated layer of necrosis can be gently debrided. Removal of this charred cellular debris maintains a visual control over the depth of laser treatment. CO₂ laser has a wave length of 106,000A, resulting in precise destruction.¹⁹

The argon laser has a wavelength of 4,800 to 5,400 A, resulting in blue-green light beam. This results in selective absorption of color towards the red end of the spectrum, hence selectively absorbed by the hemoglobin pigment in blood. CO₂ laser is a continuous wave laser and the energy produced is steady. The energy is absorbed at a depth of 0.1 to 0.2 mm. and hardly any energy is scattered¹⁹. Energy causes vaporization of water at a temperature of 100°C. Thermal damage from CO₂ laser has been shown to extend for about 30-50 um. from the site of impact¹⁴. The decorative tattoos are professional, relatively superficial, uniform in the dermis and sharply demarcated. Amateur tattoos, however, have varying levels in the epidermis, dermis and sometimes in subcutaneous tissue. They are crude and contain pigments varying from India ink shoe polish, paint ink, pencil lead, or even carbon particles from burning charcoal¹. Most of the tattoos

treated in this study were professional thus had predictable results following treatment with 102 laser.

In our study, argon laser treatment of port wine stain was used at room temperature. Chilling of lesional skin with ice immediately prior to treatment produced a better response, as studied by Gilchrest¹². We used ice directly on the lesion following the treatment with laser. According to the histological study by Finley¹¹ the lesions which contain large ectatic blood filled spaces responded better to argon laser than those which are small vessels free of erythrocytes. All the patients were treated under local anesthesia. Post treatment care was aimed at reducing the swelling by application of ice and elevation of the part. Patients were instructed to wash the area three times a day and apply antibiotic ointment with nonadherent dressing. The incidence of hypertrophic scarring was 9%. This was reported by other authors. Control with triamcinolone injection resulted in relief of symptoms. Telangiectasis of face and neck represented the most successful group of lesions treated with argon laser.² Treatment of children with portwine of eyelid is possible by use of plastic eye shields plated with silver.¹³ Every person using argon lasers was protected with special glasses. It is well known that argon lasers cause burns of retina and blindness.

An acceptable result was seen in a majority of patients with 9.78% hypertrophic scarring. A 5% to 11% incidence of hypertrophic scarring

was observed by other authors.^{8,9,23} The results were graded according to the appearance by some author as *excellent*—total or subtotal blanching without scarring, *good as marked*—lightening without scarring, *fairgood*—moderate lightening with some scarring, and *fair* with minimal or limited improvement.²⁴ According to this analysis, most of the patients in our series had excellent to good results. Thus, the type of skin in caucasian patients²¹ is almost transparent to the argon laser beam and was followed without scarring, except for those patients who had hypertrophic scars over the lip or patients with tattoos. CO₂ laser can also be used for excision of localized lesions due to tumors and cavernous angiomas.^{14,15} The neodymium and yag laser has also been used for control of intrauterine hemorrhage and gastric hemorrhage.¹⁷

Many studies on carcinogenic effects of laser have been performed, but the laser appears to be safe.^{3,16}

Summary

A total of 232 patients with portwine stains and tattoos were examined from 1978 to 1982. One-hundred-seventeen patients were subjected to the test dose of laser to evaluate the initial result and applicability for further treatment. Twenty-five patients were discarded for treatment. A total of 92 patients, 48 patients with hemangiomas, 32 with tattoos, 10 with nevi and 2 patients with multiple warts, were treated with excellent results.

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