

## Dermatological Uses of Pulsed Dye Laser with Special Emphasis on Port Wine Stain: Review Article

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### ABSTRACT

**Background:** For its lasing medium, a dye laser uses a solution of organic dye in a solvent. Among the laser dyes are rhodamine, fluorescein, coumarin as well as malachite green. In addition to water and glycol, other solvents include ethanol, methanol, hexane, cyclohexane, and cyclodextrin. The time it takes for the target structure to drop to half its peak temperature after being irradiated by a laser is shorter than the pulse duration of the laser energy.

**Objective:** Review of the literature on Dermatological Uses of Pulsed Dye Laser.

**Methods:** We looked for data on laser therapy and pulsed dye laser, treatment in medical journals and databases like PubMed, Google Scholar, and Science Direct. However, only the most recent or extensive study was taken into account between December 2001 and February 2022. References from related works were also evaluated by the writers. There are not enough resources to translate documents into languages other than English, hence those documents have been ignored. It was generally agreed that documents such as unpublished manuscripts, oral presentations, conference abstracts, and dissertations did not qualify as legitimate scientific study.

**Conclusion:** Pulsed dye laser (PDL) therapy has shown promise in the treatment of a variety of skin conditions. Port wine stains can be removed using PDL (vascular malformation), cherry angiomas, telangiectasias, and poikiloderma of Civatte are examples of acquired cutaneous vascular lesions.

**Keywords:** Pulsed Dye Laser, Port Wine Stain.

### INTRODUCTION

An umbrella term for a diverse range of vascular abnormalities that continue to provide diagnostic and therapeutic problems. Correct diagnosis and treatment of vascular abnormalities depend on the vocabulary used to define and classify these conditions. Hemangiomas and other vasoproliferative or vascular neoplasms are placed in category 1, while vascular malformations are placed in category 2<sup>(1)</sup>. Congenital and acquired forms of postcapillary venous shunts<sup>(3)</sup>.

(PWSs), also known as nevus flammeus, are cutaneous vascular abnormalities associated with the postcapillary venules that can cause severe physical and psychological difficulties. PWSs don't involute like hemangiomas do. PWSs are distinct, smooth, and expand along with the child in size<sup>(2)</sup>.

In the clinic, it manifests as areas of pinkish red to violet skin. Despite the higher prevalence of congenital PWSs, the incidence of PWSs in babies is low (0.3%-1.4%) and shows no sex predilection



**Figure (1):** Port wine nodules, which range in size from a mung bean to a pea, are a telltale sign of a spilled drink (black arrows). on the angular, dark purple-red plaques with distinct margins.



**Figure (2):** Stains from red port wine; blotchy pink areas.



**Figure (3):** Hypertrophic port-wine stains: irregular purplish-red plaques with well-demarcated borders.



**Figure (4):** Port wine stains seem like purple, uneven patches with clear edges.

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Selective photothermolysis is the underlying premise of current laser systems for treating PWS. PDL therapy is still the standard of care in the medical field, and it has paved the way for the creation of various laser and intense pulsed light (IPL) apparatuses and supporting technology <sup>(1)</sup>.

#### **PULSED DYE LASER**

Dyes made from organic compounds are dissolved in a solvent and utilized as the laser medium in a dye laser. A high-energy light source, either a fast-discharge flashlamp or an external laser, is needed to pump the liquid past its lasing threshold <sup>(4)</sup>.

To prevent triplet absorption and prolong the life of the dye, the dye solution is often cycled rapidly. The dye molecules get ready to release stimulated radiation after being excited by the incoming light. Visible light pulses of 585 or 595 nm wavelength and 0.45–40ms pulse duration are generated by pulsed dye lasers. Combining radiofrequency with pulsed dye laser treatment can increase efficacy while reducing side effects <sup>(5)</sup>.

#### **MECHANISM OF THE PULSED DYE LASER**

As with other forms of selective thermolysis, Pulsed dye lasers are used in dermatology because of their precision and ability to target pigmented areas. The chromophores in the targeted structure absorb the laser light more intensely than the surrounding tissue. The time it takes for the target structure to drop to half its initial temperature after being irradiated by a laser is less than the duration of the laser's energy pulse. Pulsed dye laser has the potential to cure several skin

conditions (PDL). Lights via means of the Food and Drug Administration (FDA) of the United States <sup>(6)</sup>.

#### **CUTANEOUS VASCULAR LESIONS**

Photodynamic therapy is effective for treating a wide range of vascular anomalies, including port wine stains, superficial haemangiomas, and a variety of kinds of acquired cutaneous vascular disorders <sup>(7)</sup>.

The pumped-flashlamp PDL emits light, and the oxyhemoglobin in the blood arteries absorbs most of it, protecting the rest of the body from overheating. The location and shape of the lesion(s), as well as the patient's skin type, all play into determining the optimal laser treatment parameters. Fluences of 5-10 J/cm<sup>2</sup> are typically delivered using spot sizes of 2-10 mm <sup>(5)</sup>.

An increase in laser power and spot size permits more extensive skin penetration and the destruction of larger blood vessels. In areas of the body where scarring is more likely to occur, like the anterior chest, neck, and periorbital region, lower energy densities are required. Laser pulses should be used by the doctor in a nonoverlapping pattern to reduce the risk of thermal injury (burns). Possible outcomes include scorching and scarring <sup>(7)</sup>.

The shorter wavelength of 585 nm, when used in conjunction with a pulse dye laser and a cryogen cooling device, was significantly more effective at eradicating port-wine stains than the longer wavelength of 595 nm. Most port-wine stains go completely after 8-10 treatments. In general, lesions on the head and neck heal faster than those on the legs and feet <sup>(7)</sup>.

The 585 nm pulse dye laser has the best efficacy as well as safety records for treating hemangiomas, face telangiectasias as well as port-wine stains<sup>(4)</sup>.

## VASCULAR CLINICAL APPLICATIONS

### 1. *Infantile haemangioma:*

Individual that IH undergoes spontaneous involution, there is no formula to identify when and what kind of intervention is best for every given case of IH<sup>(8)</sup>.

In addition, IH manifests itself and progresses clinically in many different ways in different patients. In recent years, beta-blockers (propranolol) have become the drug of choice for the initial treatment of most IH cases. Many Chinese parents are hesitant to pick oral propranolol for their children due to concerns over its potential for adverse effects and contraindications. Small, superficial IHs may be candidates for therapy with topical propranolol<sup>(9)</sup>.

### 2. *Port-wine stain:*

The blood vessels in pink PWS are thinner and shallower, while those in purple PWS are thicker and deeper, making it more difficult to destroy them<sup>(10)</sup>. For the PWS patients in the Chinese population, lesions on the trunk and limbs had a poorer response to PDL than lesions on the face as well as neck<sup>(11)</sup>. It is unclear why PWS do not respond adequately to PDL in the trunk and limbs. This is because hair follicles and the bigger diameter blood vessels that supply them have migrated deeper into the dermis, beyond the reach of PDL. Lower success rates in PDL treatments are associated with larger, more deeply set arteries in the central face<sup>(12)</sup>. Deeper vessels made up facial PWS as opposed to neck PWS. Lesions of PWS in the midface and along dermatome V2 had a poorer response than lesions in other parts of the head and neck<sup>(13)</sup>.

### 3. *Telangiectasia:*

Treatment for facial telangiectasias that does not cause purpura is highly beneficial to the patient. Facial telangiectasia has been treated with the "stacked pulses" method. As compared to the formerly stated parameters by **Woo et al.**<sup>(14)</sup>. Spot size of 7 or 10 mm, pulse width of 3-10 ms, and energy density of 4-15 J/cm<sup>2</sup> are all examples as well as **Alam et al.**<sup>(15)</sup> findings.

### 4. *Haemangioma (reactive or tumour):*

Pyogenic granuloma, epithelioid haemangioma spindle cell haemangioma, as well as lobular capillary haemangioma, are all examples of lesions where the dispute over whether they are reactive or tumorous continues<sup>(9)</sup>. So, they used the term "solitary haemangioma" to refer to the lone vascular abnormality (reactive or tumour in nature). Solitary haemangioma patients who underwent PDL treatment had a 90% success rate and no serious side effects. To effectively

treat a solitary haemangioma, PDL is the gold standard<sup>(9)</sup>.

### 5. *Spider nevi:*

Spider nevi are a type of telangiectasia that are fed by a single, central artery. It is estimated that 47.5% of children and 15% of adults in good health have spider nevi<sup>(16)</sup>.

### 6. *Others:*

Large venous abnormalities of the lip require surgical excision as the final treatment option. To improve the cosmetic results of surgery, we used PDL as an adjuvant technique to initially reduce the size of the lesion. In the case of angiokeratoma of Mibelli, enlarged blood arteries may or may not contain thrombi that serve as a structural framework for the tumor<sup>(17)</sup>.

**Su et al.**<sup>(17)</sup>, adjusted pulse duration and fluence to reduce the number of treatments needed.

**Lai et al.**<sup>(18)</sup> and **El-Naby et al.**<sup>(19)</sup> reported significant progress in MLM patients who received PDL. The primary targets of PDL were the red blood cells that reside in the enlarged lymphatic channels of MLM. More research is needed to identify the factors that contribute to success and prevention.

## CONCLUSION

Pulsed dye laser (PDL) therapy looks promising in treating a wide variety of skin conditions. Pulsed dye laser light from a flash lamp or a laser device like the FDA-approved Vbeam Perfecta®. Superficial haemangiomas, various acquired cutaneous vascular lesions as well as Port wine stains (a vascular malformation), respond well to photodynamic therapy (PDL).

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