Published in final edited form as:

Lasers Surg Med. 2009 August ; 41(6): 423–426. doi:10.1002/lsm.20788.

Port Wine Stain Progression: A Potential Consequence of Delayed and Inadequate Treatment?

Kira Minkis, MD, PhD¹, Roy G. Geronemus, MD^{1,2}, and Elizabeth K. Hale, MD^{1,2,*}

¹New York University School of Medicine, New York, New York

²Laser & Skin Surgery Center of New York, New York, New York

Abstract

Background and Objectives—Port wine stains are congenital low-flow vascular malformations of the skin. Unlike hemangiomas, PWS do not involute with time, but rather if left untreated can hypertrophy and develop nodularity. Laser therapy of PWS particularly with pulsed-dye lasers, is a safe, well-established treatment that is successful in the majority of patients, especially for younger patients. Patients that fail to receive treatment early in life may subsequent develop lesions more likely to progress.

Study Design/Patients and Methods—A case report and review of the literature are presented. We report a 43 year-old man born with a port-wine stain on the right side of his face that extended in the V2 distribution on his face. He had undergone several sessions with a pulsed-dye laser, the sequential dual-wavelength (595 nm and 1064 nm) laser and a CO₂ resurfacing laser from the age of 26 but failed to follow through with a sufficient number of treatments to prevent hypertrophy.

Results—Due to an insufficient number and interval of treatments (with only 7 treatments over 16 years starting at age 26) with the various lasers, the patient's port wine stain continued to progress in color and development of nodularity.

Conclusions—Patients born with port wine stains should have early laser treatment to achieve optimal results. Delay in treatment, as in this patient until age 26, may result in hard to treat PWS that can continue to progress in nodularity. This case illustrates the hypertrophy and nodularity that can occur due to progression of a PWS with failure to follow through with sufficient number of laser treatments.

INTRODUCTION

Port wine stains are congenital low-flow vascular malformations of the skin that represent a progressive ectasia of superficial cutaneous vascular plexus. The incidence of congenital PWS is 0.3%, and they are most commonly found on the face and neck [1]. Over 40% of PWS are anatomically restricted to the cutaneous distribution of the trigeminal nerve. Furthermore, a strong association between PWS in the distribution of the ophthalmic (V1) branch of the trigeminal nerve and neuro-ocular pathology has been shown to exist,

*Correspondence to: Laser & Skin Surgery Center of New York, New York, NY 10016. Elizabeth.Hale@nyumc.org. .

including Sturge–Weber syndrome (SWS) [2]. SWS is a neurocutaneous disorder with angiomas involving the leptomeninges and skin of the face (PWS). Major neurologic manifestations include seizures, headaches, developmental disorders, and glaucoma, with potential for visual loss and blindness. Another associated syndrome is Klippel–Trenaunay–Weber syndrome, a congenital vascular disorder characterized by port wine stain, venous malformation and skeletal tissue hypertrophy. PWS are thought to be a result of an alteration in neuronal modulation of vascular tone through a maturational defect in the local sympathetic nervous system [3,4].

CASE REPORT

A 26-year-old man was initially sent for evaluation of a port wine stain in a V2 distribution over the right side of his face. Over the past several years prior to evaluation, the lesion developed significant nodularity (Fig. 1A–D). Over the course of the next several years, the patient underwent treatments at irregular and infrequent intervals, seven treatments in total over the course of 16 years, with various laser treatments including pulsed-dye laser (595 nm), the sequential dual-wavelength (595 and 1,064 nm) laser and a CO₂ laser (10,600 nm) for vaporization of the nodules. Specifically, beginning in 1991, the patient had four sequential treatments with combined Argon and pulsed-dye laser and then was lost to follow-up until 1999. He had one treatment with the pulsed-dye laser in 1999. He was once again lost to follow-up until 2007 at which time he underwent one treatment with the sequential dual-wavelength (595 and 1,064 nm) laser and one treatment with the pulsed-dye laser with CO₂ laser to the nodules in 2007. Clearly, the patient did not adhere to a regular laser treatment regimen. Normally, we recommend initiating treatment early [5] and continuing with treatment at two to three month interval, which has demonstrated more consistent improvement. Despite multiple laser treatments, the port wine stain continued to progress (Fig. 1E,F).

DISCUSSION

Unlike hemangiomas, PWS do not involute over time, but often continue to progress and evolve into adulthood. Whereas port wine stains first appear as macular lesions, a review of over 400 patients with port wine stains by Geronemus et al. [6] revealed ~65% were hypertrophied and/or nodular by the fifth decade of life, with a mean age of hypertrophy of 37 years. With the nodularity and hypertrophy, the risk of spontaneous bleeding and hemorrhaging upon injury also increases. The development of pyogenic granulomas within the hypertrophied lesions may lead to spontaneous bleeding. Geronemus et al. [6] describe a decreased risk of development of pyogenic granulomas in patients previous treated with laser therapy. While the size and distribution of the lesions do not change with age, increased age correlates with progressive vascular ectasia and color shifts from pink to purple [7]. The hypertrophy and nodularity has been rarely associated with intralesional basal cell carcinoma [8], pyogenic granulomas [9], and squamous cell carcinoma [10]. Skin cancer development within PWS can be attributed to ionizing radiation treatment as well as de novo development. In fact, the development of such lesions is multifactorial and depends on other factors including radiation therapy, smoking history, history of UV exposure, as well as the vascular milieu of the PWS with cytokine secretion. Apart from cosmetic

disfigurement caused by the darkening and hypertrophy, the progressive lesions can also lead to functional compromise if present periorbitally, periorally, or perinasally. Clinically, the cobblestone pattern represents a localized exaggeration of the ectasia process.

In the past, options for treatment of PWS included camouflage with cosmetics, skin grafting, radiation, cryosurgery, dermabrasion, tattooing, and electrotherapy, without good cosmetic outcomes. The current modality of choice for treatment of PWS is laser photocoagulation.

Argon lasers were one of the first lasers used in the treatment of PWS. However, although blanching of the PWS was achieved, this was not without significant adverse effects, including hypertrophic scarring [11]. The argon laser utilizes 488 and 514 nm wavelengths which led to melanin absorption, leading to epidermal heating and injury resulting in scarring and dyspigmentation. Additionally, the relatively long pulse duration of 0.5 seconds resulted in perivascular heating and resultant collagen damage [12].

In an effort to specifically target lesions without resultant thermal injury to the surrounding tissue that leads to scar formation and dyspigmentation, the theory of selective photothermolysis was introduced [13]. This technique focuses on selection of laser wavelengths to approximate absorption peaks of target chromophores, in the case of PWS, oxyhemoglobin, and deoxyhemoglobin of the vessels. Therefore, wavelengths of ~577 nm (absorption band of oxyhemoglobin) can be chosen to achieve good light absorption of the targeted vessels. Slightly longer wavelengths (585–595 nm) are used clinically as this further increases the depth of penetration, in turn decreasing the melanin absorption [14]. Pulse duration is also important to decrease surrounding thermal injury. Pulse duration (pulse width) should approximate the vessel thermal relaxation time [13]. A pulse duration of 1–10 milliseconds is optimal in theoretical and experimental studies for the treatment of PWS [15]. The third important parameter in laser treatment of PWS is sufficient radiant exposure, energy sufficient to coagulate PWS blood vessels for irreversible vessel destruction but without injury to surrounding structures. Generally speaking with pulsed-dye lasers, fluences range from 6 to 9 J/cm², however, reducing the spot size on certain devices can increase the maximum deliverable fluencies. Specific parameters vary depending on the device being used.

In addition to significant advances in laser therapy with the theory of selective photothermolysis, cooling methods have also been developed for safer use of higher radiant exposures, allow treatment of patients with darker skin types, and decrease pain from treatments. These cooling methods include contact cooling, cryogen spray cooling, and continuous flow of chilled air (–4 to –32°C).

Currently, the pulsed-dye laser in conjunction with an epidermal cooling device is the most effective and safe method for treatment of these vascular abnormalities. Additionally, CO₂ lasers, through rapid vaporization of superficial cutaneous lesions, have been shown to be effective method of treatment of nodules and hypertrophy [16]. More recently, alexandrite, neodymium:yttrium–aluminum–garnet (Nd:YAG) [17] as well as potassium titanyl phosphate (KTP) [18] lasers have also been shown to be effective treatment for PWS. Pulsed-dye lasers have been shown to be both safe and effective in the treatment of PWS in

infants as early as 6 weeks of age [19]. In a recent review by Chapas et al. of 49 infants under 6 months of age undergoing PDL treatment of PWS, an average of 88.6% clearance was achieved. In this study, PDL with fluence of 7.5–9.5 J/cm², 10 mm spot size, 1.5 milliseconds pulse, and dynamic cooling spray DCD 30/30 was used every 4–6 weeks, illustrating the effectiveness of early treatment with high fluences on treatment of PWS [5]. In the study, the authors demonstrate nearly 90% clearance after 1 year of treatment, with an average of 9 treatments to a maximum of 16 at 4- to 6-week intervals. The patient population studied was newborns under 6 months. Given the fact that PWS in this young population have not yet undergone hypertrophy, data from this study can be extrapolated further to signify for older patients with nodular/hypertrophied lesions, a minimum of this number of treatments at 4- to 6-week intervals may be necessary for adequate resolution. Although several studies have demonstrated the improvement in efficacy of the lasers in treatment of PWS at a younger age, this area remains somewhat controversial [20–22]. Our patient deviated significantly from the parameters in the study, in terms of age of treatment (starting at age of 26 years vs. 6 months), frequency of treatment (years rather than weeks), and number of treatments (only 7 total over 16 years vs. 9–16 over 1 year).

The inability of laser energy to penetrate beyond several 100 µm could explain why thicker PWS with nodularity and hypertrophy are less likely to respond. In addition, through the destruction of subsurface PWS blood vessels following selective photothermolysis, an inflammatory reaction is evoked, resulting in recruitment of cytokine-secreting inflammatory cells. The secretion of pro-inflammatory cytokines cause a pro-angiogenic response leading to laser-induced wound healing and reformation of PWS blood vessels [23]. Recently, Chang et al. [24] have demonstrated superior results by inhibition of this process through the use of Imiquimod as an anti-angiogenic agent in combination with pulsed-dye lasers.

Despite advances in laser therapy, there remains a subset of patients that due to insufficient quantity and quality of treatments, continue to have PWS that become hypertrophied and nodular. The treatment of port wine stains in their macular stage can help to prevent the development of hypertrophy and nodularity of the lesions. By decreasing the size and quantity of PWS blood vessels by laser treatments of the lesions, the likelihood of these lesions to progress to a more ectatic state is decreased. Perhaps our patient would have responded better had treatment been initiated at a younger age, before the development of nodularity and hypertrophy. His most recent response following several treatments with high energy pulsed-dye laser and CO₂ to the nodules did in fact prove efficacious and lead to significant reduction in nodularity of his PWS (Fig. 1I). This serves to underscore the importance of adherence to a consistent laser regimen.

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Fig. 1.

Progression of a port wine stain. **A–D:** The patient's port wine stain had progressed from birth within the first three decades of life from a light pink plaque to a deep violaceous patch with significant nodularity. **E–G:** Due to inadequate and inconsistent laser therapy, the patient's port wine stain continued to hypertrophy, deepen in pigmentation and develop increasing nodularity. **H,I:** Effective treatment of his PWS using high energy pulsed-dye laser and the CO2 laser to the nodules.