

Weekly Pulsed Dye Laser Treatments for Port-Wine Birthmarks in Infants

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IMPORTANCE Early treatment of port-wine birthmark (PWB) can be life-altering and is often associated with improved outcomes and quality of life. There is growing evidence that shorter treatment intervals may play a role in more rapid PWB clearance; however, the optimal treatment interval has not been established.

OBJECTIVE To describe the outcomes of once-weekly pulsed dye laser (PDL) treatments for PWB in infants.

DESIGN, SETTING, AND PARTICIPANTS This case series analyzed the medical records of patients with PWB who received once-weekly PDL treatments between January 1, 2022, and December 31, 2023, at the Laser & Skin Surgery Center of New York. These patients were younger than 6 months. Before-and-after treatment photographs were independently assessed and graded 2 months after initiation of treatment.

INTERVENTION Once-weekly PDL treatments.

MAIN OUTCOMES AND MEASURES The primary outcome was the percentage improvement of PWB, which was graded using the following scale: 0% (no improvement), 1% to 25% (mild improvement), 26% to 50% (moderate improvement), 51% to 75% (marked improvement), 76% to 95% (near-total clearance), and 96% to 100% (total clearance).

RESULTS Of the 10 patients (6 males [60%]; median [range] age at first treatment, 4 [<1 to 20] weeks) included, 7 (70%) had experienced either near-total clearance (76%-95%) or total clearance (96%-100%) of their PWB with once-weekly PDL treatments after 2 months. The other 3 patients all saw marked improvement (51%-75%) and subsequently went on to achieve near-total clearance with additional treatments. The median (range) duration of treatment and number of treatments to achieve near-total or total clearance in all patients were 2 (0.2-5.1) months and 8 (2-20) treatments, respectively. No adverse events were noted.

CONCLUSION AND RELEVANCE This case series found that once-weekly PDL treatments for PWB in the first few months of life was associated with near-total or total clearance of PWB with no reported adverse events, suggesting improved outcomes can be achieved with shorter overall treatment duration. Further investigation into this novel decreased treatment interval of 1 week is warranted.

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Port-wine birthmarks (PWBs) are low-flow congenital vascular malformations that can present as an isolated lesion or, less commonly, as part of a syndrome. The natural history of untreated PWB is that feeding vessels become ectatic and pink macular lesions can evolve over time to become darkened, thickened lesions that carry a more characteristic deep red-purple color with potential soft-tissue and/or bony hypertrophy.¹⁻³ In some cases, the lesions can become symptomatic proliferative nodules or pyogenic granulomas, which can be problematic due to their proclivity for bleeding. Untreated facial PWB and related facial disfigurement are associated with substantial psychosocial disturbance in both childhood and adulthood.^{4,5}

In the US, laser-based therapy with pulsed dye laser (PDL) is the gold standard treatment for PWB. Laser treatments tend

to be less effective in the treatment of thickened or hypertrophic PWB and proliferative nodules. Previous retrospective studies found that early intervention with laser treatment when lesions are macular can inhibit progression, with some evidence suggesting decreased risk for recurrence with treatment for patients under 1 year of age.^{2,3,6-11} Although the optimal treatment interval has not been established, there is evidence to suggest that shorter treatment intervals (every 2 to 3 weeks rather than 4 to 6 weeks) may be more effective and have the potential to reduce the overall duration of treatment.^{12,13} Preclinical work by Gao et al¹⁴ demonstrated that proangiogenic genes, such as vascular endothelial growth factor, which stimulate revascularization, peak at 7 days after PDL exposure and may be a barrier to achieving optimal therapeutic outcome. This finding prompted us to postulate that treatment

at shorter 1-week intervals may yield better therapeutic outcomes with shorter overall duration of treatment. Additionally, we have anecdotally noted that in the first few months of life, patients are much less likely to develop posttreatment-related purpura, which would otherwise require recovery prior to the next interval treatment. In this age group, this treatment characteristic makes once-weekly treatment a more feasible option to examine while limiting the risk for postinflammatory hyperpigmentation. To our knowledge, no study has investigated laser treatment of PWB at shorter 1-week intervals. In this case series, we aimed to describe the outcomes of once-weekly PDL treatments for PWB in infants.

Methods

We reviewed the medical records of patients with PWB who underwent once-weekly PDL treatments starting at age 6 months or younger at the Laser & Skin Surgery Center of New York between January 1, 2022, and December 31, 2023. The Allendale Investigational Review Board approved the study protocol and waived the informed consent requirement because this retrospective study was considered minimal risk.

All patients were treated with a novel PDL (VBeam Prima; Candela Corp) at a spot size of 13 mm with fluence ranging between 6.5 and 8 J/cm² and a pulse duration of 1.5 ms. Two laser surgeons (S.B., R.G.G.) performed all PDL treatments. Hair-bearing sites, including scalp and eyebrows, were not treated and served as internal controls. Notably, in this age group, posttreatment-related purpura spots were less likely to be seen, but if present, particularly as patients got older, retreatment of focal purpuric areas was avoided until healed.

The clinical end point was mild erythema. Effectiveness of the weekly treatment was ascertained using before-and-after clinical photographs. The primary outcome was the percentage improvement of PWB, which was graded using the following scale: 0% (no improvement), 1% to 25% (mild improvement), 26% to 50% (moderate improvement), 51% to 75% (marked improvement), 76% to 95% (near-total clearance), and 96% to 100% (total clearance). Two dermatologists (J.T., D.A.H.) independently assessed and graded before-and-after photographs of each PWB.

Statistical Analysis

Descriptive statistics were used to summarize patient characteristics and outcomes. No statistical software was used.

Results

Ten infants (4 females [40%], 6 males [60%]; median [range] age at first treatment, 4 [<1 to 20] weeks) with PWB who were treated with PDL once weekly (median interval of 7 days) were identified and included in this retrospective case series. Of 10 patients, 8 (80%) had Fitzpatrick Skin Type (FST) I to III, and 2 (20%) had FST IV. All treated patients initiated treatment at younger than age 6 months (range, 5 days to 5 months).

Key Points

Question Are once-weekly pulsed dye laser (PDL) treatments for port-wine birthmark (PWB) effective in infants younger than age 6 months?

Findings In this case series of 10 patients, 7 patients achieved either near-total or total clearance of PWB at 2 months after starting treatment. The other 3 patients achieved near-total clearance with additional treatments.

Meaning These findings suggest that during the first few months of life, once-weekly PDL treatments for PWB, which were well tolerated due to the absence of posttreatment-related purpura in this age group, are associated with improved therapeutic outcomes and shorter overall treatment duration.

The PWB size was smaller than 20 cm² for 2 patients (20%), between 20 cm² and 39 cm² for 2 patients (20%), and larger than 40 cm² for 6 patients (60%). Of the 6 patients with PWB larger than 40 cm², 3 had PWBs larger than 200 cm² and both facial and extra-facial involvement. Three patients (30%) had involvement of the trunk, with 2 of them also having involvement of the upper and lower limbs. The other 7 patients (70%) all had PWB either on the head or neck without body involvement. Anatomic locations of these PWBs are provided in the **Table**, including centropacial involvement.

At a mean (SD) time point of 2 months (1 week) of once-weekly PDL treatments, 7 patients (70%) had achieved either near-total clearance (76%-95%; n = 6) or total clearance (96%-100%; n = 1) of their PWB. The other 3 patients (30%) all showed marked improvement (51%-75% clearance) at this time point. Notably, the 3 patients with marked improvement (not near-total or total clearance) had PWBs larger than 40 cm², and 2 of them had extra-facial and lower-limb involvement. With additional treatments, these 3 patients ultimately achieved near-total clearance (76%-95%). Seven patients had PWBs that involved hair-bearing areas, including the scalp and eyebrows, which were left untreated and served as internal controls. These areas did not experience any significant lightening. **Figure 1** and **Figure 2** show the PWBs before and after once-weekly PDL treatments.

The median (range) duration of treatment and number of treatments to achieve near-total clearance (76%-95%) or total clearance (96%-100%) in all patients in this series were 2 (0.2-5.1) months and 8 (2-20) treatments, respectively. No patients experienced any adverse events, including pigmentary alterations, scarring, burns, erosions, or infections. A summary of patients' demographic and treatment characteristics is provided in the **Table**.

Discussion

Early intervention with PDL treatment of PWB can be life altering. For patients who achieved near-total or total clearance of their PWB in early infancy, often before they have formed memories, such treatments offer the potential for a life

Table. Patients' Characteristics and Treatment Responses

Patient sex	Fitzpatrick skin type	Age at initial treatment, wk	Surface area of lesion at initial treatment, cm ²	Location of facial involvement	Extra-facial involvement	% Clearance after 2 mo of treatment	Total No. of treatments to achieve near-total or total clearance	Period in which all treatments were completed, mo
Male	II	5	76	V1, V2; centropacial	Scalp	51-75 ^a	14 ^b	4
Male	I	8	225	Bilateral V1, V2; centropacial	Scalp	96-100	8 ^b	2
Female	IV	4	>600	Bilateral V1, V2, V3; centropacial	Back, bilateral proximal and distal arms, bilateral hands, scalp, proximal and distal leg, foot, buttocks, pubic area	51-75 ^a	20 ^b	5
Male	I	<1	>600	V1, bilateral V2 and V3; centropacial	Chest, proximal and distal arm, scalp, bilateral proximal and distal legs, buttocks	51-75 ^a	17 ^b	5
Male	IV	4	11	V1, V2; centropacial	None	76-95	2	<1
Female	III	2	36	V3	Neck, scalp	76-95	9 ^b	2
Female	II	4	40	V2, V3; centropacial	Neck, scalp	76-95	7	2
Female	II	2	30	V1, V2	Scalp	76-95	8 ^b	2
Male	II	20	68	V3	Neck, back	76-95	5	1
Male	II	<2	9	V2; centropacial	None	76-95	8 ^b	2

Abbreviations: V1, ophthalmic branch of trigeminal nerve; V2, maxillary branch of trigeminal nerve; V3, mandibular branch of trigeminal nerve.

^a Went on to achieve near-total clearance (76%-95%) with additional

treatments.

^b Received additional sessions beyond 2 months of treatments.

Figure 1. Before and After Treatment of Port-Wine Birthmark (PWB) in 3 Patients



Panels A, B, and C show PWB before laser treatment and panels D, E, and F show near-total (76%-95%) or total (96%-100%) PWB clearance after 2 months of once-weekly treatments. Hair-bearing sites were not treated.

Figure 2. Before and After Treatment of Large Port-Wine Birthmark (PWB) in 1 Patient



Panels A, C, E, and G show pretreated PWBs. Panels B, D, F, and H show PWB after 5 to 7 months of treatment. The size of the PWB was larger than 600 cm².

free from facial disfigurement and psychosocial stigma associated with their PWB. Thus, in the field of laser surgery, optimizing the treatment paradigms for PWB, including ideal interval, technique, and settings, remains a clinical priority. Although we recognize this is a case series with limitations, we aimed to call into question the current treatment paradigms and to open dialogue on whether a more frequent treatment interval can improve outcomes for patients who are assessed on the basis of effectiveness of treatment, treatment duration, and/or durability of results.

We attempted to examine once-weekly treatments in the youngest patients with the clinical rationale that (1) early intervention has been shown to be most effective,^{10,15,16} perhaps because the thinner dermis in infant skin allows for optimal laser targeting of vessels that are smaller and more superficial when treatment is associated with decreased light scatter, and (2) in the first 3 months of life, patients are less likely to develop posttreatment-related purpura and thus require less interval healing time prior to subsequent treatments, increasing feasibility and reducing risk of postinflammatory pigmentary alteration from once-weekly treatments. Decreasing treatment interval in the youngest patients also allows for more condensed treatments during the period when PWB may be maximally responsive to laser treatment and may reduce overall treatment duration. Furthermore, early treatment is a more practical way to treat infants, who are easier to stabilize during treatments, and, although controversial, mitigates the potential need for repetitive exposure to general anesthesia, which can pose both a safety and financial burden to families.¹⁵

Thus far, there have been limited attempts to elucidate the ideal treatment interval for PWB. Prior to the present study, to achieve the best clinical outcome in the youngest patients at the Laser & Skin Surgery Center of New York, we favored an early and more aggressive intervention of 2-week treatment intervals, although this interval is far from the accepted consensus among clinicians who treat PWB in this population.¹⁷ One prospective split-lesion study involving 15 adults with PWB investigated the effectiveness of 2 treatments with PDL, in which one-half of a PWB lesion was treated at 2-week intervals and the other half was treated at 6-week intervals.¹² Blinded photographic review and lightening via objective spectrophotometer readings both confirmed that the 2-week treatment interval was associated with greater lightening without increased rates of adverse events compared with the 6-week interval.¹² Similarly, a retrospective study of infants who were younger than age 1 year at treatment initiation found that PWB had improved clearance when treated at 2- and 3-week intervals compared with 4-week intervals.¹³ While there have been rare reports of PWB transiently lightening during early infancy, which is believed to be due to a physiological drop in hemoglobin level, substantial spontaneous involution of PWB rarely occurs, and over time the majority of PWBs will progress if left untreated.¹⁸⁻²⁰ In a subset of patients, we did not treat hair-bearing areas, such as the scalp and eyebrows. In these patients, the untreated anatomic sites did not experience any lightening. These untreated but affected sites served as an internal control in patients with involved hair-bearing areas,

suggesting that improvement cannot be attributed to physiological lightening.

Early and more frequent intervention may bypass barriers associated with incomplete clearance of PWB lesions. Various reasons for incomplete PWB clearance and/or recurrence after PDL treatment have been postulated, including inadequate depth penetration of PDL laser light to deeper capillaries and, for larger capillaries, inadequate conduction of heat from the main centrally located chromophore within vessels (hemoglobin) to the outer vessel walls, thus inhibiting the complete destruction of blood vessels during treatment and allowing for repair and regeneration of vasculature after treatment.²¹ Studies have shown that clinical effectiveness of PDL treatment for PWBs is inversely correlated with vascular depth, epidermal thickness, and stratum corneum thickness.²² Earlier intervention and faster duration of overall treatment may allow for improved targeting of more superficial vascular plexuses, and decreased interval treatment may improve effectiveness by allowing for less lead time for repair and repopulation of incompletely destroyed vessels between treatments. On a mechanistic level, decreased treatment interval may better focus laser treatments within the optimal therapeutic window before vasculogenic growth factors have time to facilitate revascularization.¹⁴

In addition to age at intervention, both lesion size and anatomic site have been shown to affect treatment effectiveness.^{6,7,23} Morelli et al⁶ found that initial PWBs smaller than 20 cm² were associated with increased likelihood of achieving near-total or total clearance with fewer laser treatments compared with PWBs larger than 20 cm². We also observed that no patients with an initial lesion size larger than 40 cm² had total clearance of their PWB. We incidentally treated 2 patients with FST IV who achieved near-total or total clearance with once-weekly treatments without experiencing any dyspigmentation or scarring afterward. A major advantage of treating very young skin of infants with darker skin tones, in addition to minimal posttreatment-related purpura, is the lack of sun exposure and decreased melanin content that may absorb incidental laser light. Nonetheless, caution must be used in treating patients with skin of color, and additional studies with a larger subset of

patients are needed to ascertain whether weekly intervals are safe for darker skin types.

In this case series, although over half of the patients had PWBs larger than 40 cm² and/or centrofacial or extremity involvement, all of which are known to make treatments more challenging, all patients experienced excellent outcomes with substantial clearance of their PWBs. Further investigation is necessary, but we hypothesize that laser surgeons may achieve increased clearance of conventionally challenging PWBs (on distal lower extremities, larger lesions, and centrofacial lesions) with early intervention and decreased interval of treatments.

Limitations

In this case series, the shorter time interval was well tolerated, as none of the 10 patients treated had adverse events. However, because this study is a case series with a small number of patients and no comparison arm, readers should be aware that we are limited in our ability to draw conclusions or to make treatment recommendations from the findings. First and foremost, systematically identifying the optimal treatment interval would necessitate a formal investigation with a comparison group and objective assessment metrics for treatment outcome, such as optical coherence tomography or reflectance spectrophotometry. Furthermore, we cannot comment on treatment durability without longer-term follow-up.

Conclusions

Among a series of 10 infants, many of whom had conventionally challenging PWBs (larger lesions, involvement of extremities, and centrofacial involvement), all achieved near-total or total clearance of their PWB with once-weekly PDL treatments (mostly within only 2 months) without adverse events. These outcomes are compelling and warrant attention and further investigation into the possibility that this novel and decreased treatment interval of 1 week, made possible by the absence of posttreatment-related purpura, is associated with potential improvement in outcomes and shorter overall treatment duration.

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