

Pulsed Dye Laser for Port Wine Stains in 974 Children: A 20-Year Study in China

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Importance: Port-wine stain (PWS) is a congenital vascular condition involving dilation of skin capillaries and venules, significantly affecting patients' physical and mental health. Pulsed dye laser (PDL) is widely used for PWS treatment; however, large-scale data on pediatric cases remain limited. This retrospective study aims to investigate the efficacy of laser treatment and its related factors in a large sample.

Objective: To assess the clinical efficacy and adverse reactions of 595nm PDL for treating pediatric PWS and to identify factors influencing treatment outcomes.

Methods: This retrospective study included 974 pediatric patients with PWS treated at Beijing Children's Hospital from 2003 to 2021. Inclusion criteria required patients to be under 18, with solitary PWS and Fitzpatrick skin types II–IV. Treatment efficacy was evaluated using standardized photographs taken before and after treatment, with outcomes categorized by Achauer's clearance criteria. Redit analysis assessed the impact of variables such as gender, age, lesion location, and treatment frequency on outcomes.

Results: The overall efficacy rate was 65.3%, higher in females (69.7%) than males (59.7%). Adolescents had the highest efficacy (100%) due to better compliance. Limb lesions responded best (87.5%), followed by neck (75.0%), trunk (66.7%), and head/face (63.0%). Smaller lesions (≤ 3 cm²) achieved 76.8% efficacy. Efficacy rose with sessions, reaching 84.0% after three. The mandibular branch (V3) had the highest trigeminal efficacy (68.5%). Adverse reactions (4.31%) included pigmentation changes (2.87%), hypopigmentation (1.03%), and minimal scarring (0.41%).

Conclusion: The efficacy of 595nm PDL for treating PWS in children is influenced by gender, age, lesion location, size, and the number of treatment sessions. PDL is an effective treatment for pediatric PWS with minimal adverse reactions.

Keywords: port-wine stain, 595nm pulsed dye laser, children

Introduction

Port-wine stain (PWS) is a congenital vascular malformation involving the dilation of skin capillaries and small venules, commonly located on the face and neck. PWS typically presents at birth and does not regress spontaneously. Without treatment, it may progress with age, resulting in darkening of color, skin thickening, nodularity, and susceptibility to bleeding after trauma.¹ PWS significantly affects a patient's appearance, psychological health, and normal social life.¹ Based on the principle of selective photothermolysis, pulsed dye laser (PDL) with a wavelength of 595 nm has been widely used as the standard treatment for PWS in clinical practice. However, the efficacy of PDL varies among pediatric patients. Currently, large-sample data on the use of PDL in treating pediatric patients with PWS are limited. This study aims to evaluate the efficacy and adverse effects of PDL treatment in children by reviewing 974 PWS cases over nearly 20 years, providing clinical treatment references.

In this study, we retrospectively analyzed 974 pediatric patients with PWS who underwent 595 nm PDL treatment at Beijing Children's Hospital over the past 20 years. We investigated treatment outcomes based on factors such as gender, age, lesion location, lesion color, area, number of treatments, and laser pulse durations.

Methods

Ethical Approval

This study was approved by the Ethics Committee of Beijing Children's Hospital, Capital Medical University, and was conducted in accordance with the principles of the Declaration of Helsinki. All guardians of the patients in this study signed informed consent forms. Written informed consent for publication of their images in Figures 1 and 2 was obtained from the parents or guardians of all children shown.

Data Collection

From February 2003 to January 2021, a total of 974 patients with PWS were admitted to Beijing Children's Hospital, Capital Medical University, and the National Center for Children's Health. The inclusion criteria were as follows: (1) age under 18 years; (2) diagnosis of solitary port-wine stain according to ISSVA (2018); (3) Fitzpatrick skin types II–IV; (4) healthy children without other systemic diseases.

Exclusion criteria were as follows: (1) previous treatment; (2) incomplete data; (3) thickened-type PWS; (4) pigmentation from sun exposure within 3 months prior to treatment; (5) involvement of two or more different anatomical sites simultaneously; (6) failure to follow the required follow-up.

Therapy Methods

The Vbeam 595 nm pulsed dye laser system (Candela Corporation) with a dynamic cooling device (DCD) was used in this study. The parameters were as follows: wavelength of 595 nm, pulse width of 0.45–40 ms, energy density of 4–40 J/cm², spot diameter of 7 mm, and pulse frequency of 1.5 Hz. The laser energy density and pulse width were adjusted based on factors such as the child's age, the nature of the lesion, and previous treatment efficacy. The energy ranged from 9–12.5 J/cm², and the pulse width ranged from 1.5–20 ms. The most commonly used settings were an energy density of 11 J/cm² and a pulse width of 1.5/3 ms. The DCD employed ice mist cooling, with a spray duration of 20–100 ms and a delay of 10–100 ms. Patients were informed of potential normal reactions during treatment, as well as possible adverse reactions post-treatment. Photos of the lesions were taken before and after each session using a standardized digital camera (Canon EOS 800D, 20X) in a well-lit treatment room. Detailed records of patient history, treatment parameters, and adverse reactions were documented. To prevent laser damage to the eyes, all patients wore metal ocular shields during treatment. For younger children, we placed a layer of moist sterile gauze or a disposable eye mask beneath the shields to ensure comfort and effective light-blocking. Both operators



Figure 1 A 6-month-old female patient with PWS before and after three sessions of PDL. There was obvious clearance after 3 treatments.



Figure 2 A 12-year-old male patient with a port-wine stain (PWS) exhibited significant clearance after five treatment sessions.

and accompanying parents wore laser safety goggles during the treatment. Treatment parameters were adjusted based on factors such as the patient's age, skin type, lesion location, color, size, and immediate response to laser treatment. The treatment was ended when the color lightened, and the lesion appeared purplish-gray during irradiation.

Aftercare

After treatment, ice packs were applied externally for 5–10 minutes to alleviate pain and burning sensations and to reduce the occurrence of erythema, blistering, and purpura. The treated area was to be kept clean, with sun protection and moisturizing cream applied throughout the treatment interval. Patients were advised to avoid water contact, makeup, and scratching. The treatment interval was generally 4–6 weeks.

Efficacy Assessment

The evaluation of PWS efficacy included: (1) changes in color; (2) changes in lesion area. Efficacy was observed during outpatient follow-up visits 4–6 weeks after each laser treatment. Evaluation method: photos were taken before and after treatment in the same clinic, under consistent lighting conditions and against the same background. Dermatologists who were experienced but unaware of the study performed the efficacy evaluation by comparing before-and-after photos. The evaluation criteria followed those of Achauer et al.² Ineffective: clearance rate $\leq 25\%$; Effective: clearance rate 26%–50%; Remarkable: clearance rate 51%–75%; Cured: clearance rate 76%–100%. The treatment endpoint was reached when the lesion either completely disappeared or showed no improvement after multiple treatments. Evaluation was based on the untreated area surrounding the treatment area and the lesion color before treatment. The efficacy rate was calculated as (number of cured cases + number of remarkable cases) / total cases.

Statistical Analysis

All data in this study were analyzed using SPSS 22.0 software. Count data were expressed as frequencies and percentages (%). Ordered categorical data, such as efficacy, were analyzed with the Redit analysis method. All tests were two-tailed, and a P-value of <0.05 was considered statistically significant.

Results

General Information

As shown in [Table 1](#), a total of 974 pediatric patients with PWS were enrolled between February 2003 and January 2021. Among them, there were 432 male and 542 female patients, with a male-to-female ratio of 1:1.25, and a median age at the initial visit of 24 months. The characteristics of the skin lesions were as follows: 354 cases on the left side and 362 cases on the right side, with a median area of 4.00 cm². The distribution of lesions was as follows: 826 cases on the head and face, accounting for 84.80% of the total study subjects; 64 cases on the neck, 48 cases on the limbs, and 36 cases on the trunk. Based on lesion color, 578 cases were classified as purplish and 140 cases as pink. A total of 542 cases involved the facial trigeminal nerve, including 134 cases in the ophthalmic branch region, 300 cases in the maxillary branch region, and 108 cases in the mandibular branch region.

Comparison of Gender and Efficacy

The overall effective rate was 65.3%, with a 59.7% effective rate in male patients and a 69.7% effective rate in female patients. Females demonstrated higher efficacy compared to males. Redit analysis showed significant differences in treatment outcomes between genders ([Table 1](#)).

Comparison of Treatment Age and Efficacy

According to the World Health Organization's pediatric age classification, due to the small sample size of neonatal patients, the neonatal group was incorporated into the infant group. Consequently, patients were divided into five groups. The efficacy rate for the infant group was 71.2%, while the adolescent group exhibited the highest efficacy rate at 100%. The treatment effect of the two groups were shown in [Figures 1](#) and [2](#). There were differences in efficacy among different treatment age groups. The difference between the adolescent group and the other four age groups was statistically significant. Except for the adolescent group, there were no statistically significant differences in efficacy among the treatment groups in the other four age groups, as shown in [Table 1](#).

Comparison of Lesion Location and Efficacy

Based on anatomical location, the skin lesions areas were divided into four regions: regions on the head/face, neck, limbs, and trunk. The limb region exhibited the highest efficacy rate at 87.5%, followed by the neck region with an efficacy rate of 75.0%. There was a statistically significant difference in efficacy among different lesion sites ([Table 1](#)).

Comparison of Lesion Area and Efficacy

Among 974 patients, the largest lesion area was 121 cm² and the smallest was 0.6 cm². We categorized the skin lesions of these patients into four groups based on their sizes. Statistical analysis showed a significant difference in efficacy among different lesion sizes. The highest efficacy was observed when the lesion area was ≤ 3 cm², with an efficacy rate of 76.8%. There was a statistically significant difference between the ≤ 3 cm² group and the other three groups (P<0.001). However, there was no statistically significant difference in efficacy among the remaining groups ([Table 1](#)).

Comparison of Clinical Types and Efficacy

All the 974 patients with PWS were juveniles, there were no hyperplastic type as a result. Patients were divided into two groups based on whether their lesion was pink or purple-red. The pink type was flat and range from light pink to red in color, blanching completely under pressure. The purple-red type were flat and range from light purplish-red to dark purplish-red in color, blanching partially or not at all under pressure. The pink type fades when pressed on by a finger,

Table 1 Demographic Data and Clinical Therapeutic Effect Assessment

Factors	Total	Therapeutic Efficacy, n (%)				Efficacy Rate (%)	P value
		Ineffective	Effective	Remarkable	Cured		
Sex, n(%)							
Male	432 (44.35)	60 (13.9)	114 (26.4)	194 (44.9)	64 (14.8)	59.7	P=0.002
Female	542(55.65)	50 (9.2)	114 (21)	280 (51.7)	98 (18.1)	69.7	
Age at diagnosis, n(%)							
Infants (0~1y)	326 (33.47)	22 (6.7)	72 (22.1)	166 (50.9)	66 (20.2)	71.2	P<0.001
Toddlers (1~3y)	290 (29.77)	42 (14.5)	74 (25.5)	136 (46.9)	38 (13.1)	60.0	
Preschool (3~6y)	188 (19.30)	40 (21.3)	42 (22.3)	74 (39.4)	32 (17.0)	56.4	
School Age (6~12y)	150 (15.40)	6 (4.0)	40 (26.7)	86 (57.3)	18 (12.0)	69.3	
Adolescents (12~18y)	20 (2.05)	0 (0.0)	0 (0.0)	12 (60.0)	8 (40.0)	100.0	
Lesion Location, n(%)							
Left	354(36.34)						P=0.017
Right	362(37.16)						
Head/Face	826(84.80)	102 (12.3)	204 (24.7)	384 (46.5)	136 (16.5)	63.0	
Neck	48(4.93)	2 (4.2)	10 (20.8)	24 (50)	12 (25)	75.0	
Limbs	64(6.57)	4 (6.3)	4 (6.3)	48 (75)	8 (12.5)	87.5	
Trunk	36(3.70)	2 (5.6)	10 (27.8)	18(50)	6(16.7)	66.7	
Area, n (%)							
0~3cm ²	250(25.67)	18(7.2)	40(16)	124(49.6)	68(27.2)	76.8	P<0.001
3cm ² ~10cm ²	396 (40.66)	48(12.1)	114(28.8)	186 (47)	48 (12.1)	59.1	
10cm ² ~30cm ²	200 (20.53)	26 (13)	42 (21)	98 (49)	34 (17)	66.0	
>30cm ²	128 (13.14)	18 (14.1)	32 (25)	66 (51.6)	12 (9.4)	60.9	
Lesion color, n (%)							
Purple-red	578(80.50)	66 (11.4)	152 (26.3)	284 (49.1)	76 (13.1)	62.3	P=0.144
Pink	140(19.50)	18(12.9)	28(20)	66(47.1)	28(20)	67.1	
Trigeminal nerve location, n (%)							
Ophthalmic branch (V1) region of the trigeminal nerve	134(24.72)	14 (10.4)	42 (31.3)	62 (46.3)	16 (11.9)	58.2	P=0.255
Maxillary branch (V2)region of the trigeminal nerve	300(55.35)	36 (12.0)	72 (24.0)	132 (44.0)	60 (20.0)	64.0	
Mandibular branch (V3) of the trigeminal nerve	108(19.93)	8 (7.4)	26 (24.1)	60 (55.6)	14 (13.0)	68.5	
Treatment Numbers, n (%)							
1	232 (23.82)	56 (24.1)	80 (34.5)	70 (30.2)	26 (11.2)	41.40	P<0.001
2	278 (28.54)	32 (11.5)	78 (28.1)	122 (43.9)	46 (16.5)	60.40	
3	214 (21.97)	12 (5.6)	40 (18.7)	134 (62.6)	28 (13.1)	75.70	
>3	250 (25.67)	10 (4.0)	30 (12.0)	148 (59.2)	62 (24.8)	84.00	
Laser pulse durations, n (%)							
1.5ms	466(53.56)	50(10.7)	96(20.6)	234(50.2)	86(18.5)	68.7	P=0.052
3.0ms	404(46.44)	50(12.4)	98(24.3)	198(40.0)	58(14.4)	63.4	

whereas purplish type does not fade. Ridit analysis results showed that there was no statistically significant difference in efficacy between the two types of classifications (Table 1).

Comparison of Efficacy in Different Facial Regions

Patients with PWS involving the facial trigeminal nerve area were divided into groups based on the ophthalmic branch (V1), maxillary branch (V2), and mandibular branch (V3) of the trigeminal nerve. There was no statistically significant difference in efficacy among the facial trigeminal nerve groups, as shown in Table 1. However, results indicate that the mandibular branch of the trigeminal nerve exhibited the highest efficacy, followed by the maxillary branch and then the ophthalmic branch.

Comparison of the Number of Treatment and Efficacy

Patients were divided into four groups according to the number of treatments. Ridit analysis showed a statistically significant difference in efficacy among different treatment frequencies. There was also a statistically significant difference between groups with different treatment frequencies. As the number of treatments increased, the efficacy rate improved significantly (Table 1).

Comparison of Pulse Width and Efficacy

In pediatric patients, the most commonly used pulse durations for PDL treatment are 1.5 ms and 3.0 ms. Consequently, our study divided the subjects into two cohorts based on these pulse durations to evaluate and compare therapeutic efficacy and adverse effects. The treatment effects of lasers with different pulse durations are shown in Table 1. There was no statistically significant difference in efficacy between the two pulse widths in the overall PWS study sample.

Adverse Reactions

The overall incidence of adverse reactions was 4.31%, as shown in Table 2. Among these, pigment deposition accounted for the largest proportion, with 28 cases representing 2.87% of the total. There were 10 cases of pigment fading, accounting for 1.03%, and 4 cases of superficial scarring, representing 0.41%. After 1 to 5 years of follow-up, both pigment fading and pigment deposition had resolved, while superficial scars had faded.

Discussion

Port-wine stain (PWS), also known as nevus flammeus, typically manifests at birth and does not regress spontaneously. PWS may progress with age, with the color gradually deepening or thickening, and nodules or bleeding may occur after trauma.¹ PDL was the first laser developed specifically for treating vascular lesions and is considered the gold standard for PWS treatment due to its high safety and efficacy, making it the most commonly used treatment modality in clinical practice.³ Since its initial use in the 1980s for vascular disease treatment, PDL has continuously improved in effectiveness with device advancements.¹ We conducted a large-scale retrospective study involving 974 cases, with all subjects being pediatric patients. This study aimed to investigate the efficacy and associated factors of PDL treatment for PWS in Chinese children with dermatological conditions. The overall treatment effectiveness rate was 65.3%.

In the present study, we found a statistically significant difference in treatment efficacy between genders, with females exhibiting better outcomes compared to males. This may be attributed to higher aesthetic demands from the parents of female children regarding facial appearance, leading to elevated treatment endpoint expectations and consequently higher overall efficacy rates in female children. There is also variation in efficacy based on age, with the highest efficacy rates observed during adolescence, reaching up to 100%. This could be due to adolescents’ greater aesthetic maturity compared to younger

Table 2 Adverse Reactions

Adverse Reactions	Pigment Deposition	Pigment Fading	Superficial Scars
Male, n	17	7	3
Female, n	11	3	1
Total, n(%)	28 (2.87)	10 (1.03)	4 (0.41)

children, their heightened demand for cosmetic improvements, and better compliance. Factors such as the smaller sample size in the adolescent group might have influenced this outcome. Additionally, the cure rate during adolescence can reach 40%, which is similar to rates reported in foreign literature.⁴ The efficacy rate during infancy is 71.2%, second only to the adolescent period. A study involving 848 adult patients with PWS in China reported a positive correlation between age and efficacy, with better outcomes associated with younger age, underscoring the significance of early treatment for PWS.⁵

Previous studies have shown better efficacy for facial lesions compared to those on the neck, trunk, and limbs.⁴ Our data reveal a statistically significant difference in PDL efficacy based on lesion location, with the highest efficacy observed in limb lesions at 87.5% and the lowest in head and face lesions at 63.0%. Efficacy rates decreased sequentially as follows: limbs > neck > trunk > head and face. Additionally, previous studies have demonstrated a negative correlation between factors such as vascular depth and epidermal thickness in facial and neck lesions, with deeper vasculature and thicker epidermis generally associated with lower treatment efficacy.⁶ These histological differences may partially account for variations in PDL efficacy across PWS lesions, even within the same patient. Further histopathological studies are essential to fully understand the underlying reasons for these variations in PDL efficacy, which could help in developing treatment protocols targeting specific histological characteristics. While other studies often report better outcomes for facial lesions than for other body regions, our data indicate that the head and face had the lowest efficacy rates. This discrepancy may stem from anatomical and physiological factors impacting PDL efficacy differently across regions. However, in our study, the head and face had the lowest efficacy rates. This discrepancy may be due to anatomical and physiological factors influencing PDL efficacy across different body regions. Specifically, skin thickness and structure vary by location. The thicker skin of the extremities may reduce light scattering, allowing for more focused energy delivery to the target area, thereby enhancing treatment outcomes. This enables improved treatment outcomes compared to facial regions, where thinner skin may disperse energy more readily.⁷ Additionally, vascular network complexity differs by location. While the face has a dense vascular network, potentially dispersing laser energy, the extremities have simpler, superficial vessels that may increase efficacy by allowing targeted energy absorption.⁸ Finally, sun exposure is more frequent in facial areas, raising the risk of post-inflammatory hyperpigmentation (PIH), which can diminish the perceived efficacy due to pigmentation changes post-treatment. The extremities, being less exposed to sunlight, experience reduced PIH, which could contribute to higher clearance rates.⁷ Another potential reason for the lower efficacy rates in the head and face group is the notably higher inefficacy rate of 12.3% compared to other groups. This could be attributed to a large proportion of patients in this group receiving only one treatment session before discontinuing treatment irregularly without completing the standard PDL regimen. Enhancing psychological surveys among parents of PWS patients could potentially improve efficacy rates for head and face lesions.

Lesion size is a significant factor influencing treatment efficacy. Our study demonstrates a statistical difference in efficacy across varying lesion sizes, with the highest efficacy rate observed at 76.8% for lesions measuring $\leq 3\text{cm}^2$. A statistically significant difference in efficacy was noted between the group with lesions $\leq 3\text{cm}^2$ and the other three groups, while no statistical difference was observed among the remaining groups. Previous studies have also shown that smaller lesion sizes correlate with improved efficacy, indicating lesion size as a determinant of treatment success.⁵ Additionally, lesion size influences parental compliance; larger lesions typically require more treatment sessions, which can lead to reduced compliance in pediatric patients. Considering treatment costs, larger lesion areas incur higher expenses, which may cause parents to adjust their expectations for treatment endpoints, further influencing efficacy.^{5,9,10} This trend aligns with findings by Ren et al, who observed that smaller PWS areas tend to achieve higher clearance rates than larger areas, further supporting the association between lesion size and treatment efficacy.⁶ Similarly, Naeini et al emphasized the predictive significance of lesion size in PDL treatment outcomes, particularly in facial PWS, confirming a positive correlation between smaller lesion areas and improved treatment response.¹⁰ PWS are clinically classified based on color and skin thickness into three types: pink, purple-red, and hypertrophic. Since the subjects in this study were children, there were no cases of the hypertrophic type. Therefore, patients were divided into two groups: pink and purple-red types. In our study, efficacy was similar between the purple-red and pink types, with no statistical difference observed. A study involving 261 Chinese PWS patients aged 0–60 years found that the efficacy rate in the purple-red group was higher than in the pink group ($P < 0.001$), suggesting that patients with larger blood vessels have a better response rate compared to those with smaller vessels.⁶ However, since all children in our study were under 18 years old and had a relatively narrow age range, there was no statistical difference in efficacy between the purple-red and pink groups.

In our study, there was a statistically significant difference in efficacy based on the number of treatment sessions. According to large-sample clinical studies, the overall efficacy rate of PDL can reach 76.73%, while the overall efficacy rate in our study was 65.4%, which is lower than the aforementioned study results.¹¹ However, the efficacy rate gradually increased from 41.4% after one treatment session to 84.0% after four treatment sessions. As the number of treatment sessions increased, the efficacy rate significantly improved.

Based on the distribution of facial rashes, they can be divided into the ophthalmic branch (V1), maxillary branch (V2), and mandibular branch (V3) of the trigeminal nerve. There was no statistically significant difference in efficacy among these three groups, with the mandibular branch of the trigeminal nerve exhibiting the highest efficacy at 68.5%, followed by the maxillary branch at 64.0%, and the ophthalmic branch showing the lowest efficacy at 58.2%. This is consistent with a small-sample study we conducted ten years ago, where the efficacy of the trigeminal nerve branches was ranked similarly, with the mandibular branch outperforming the maxillary branch, and the maxillary branch outperforming the ophthalmic branch.¹² A domestic prospective study also analyzed that PDL treatment for PWS is more effective in the lateral area compared to the central area.^{13,14} Since the ophthalmic, maxillary, and mandibular branches of the trigeminal nerve extend from the central to the lateral areas of the face, the efficacy of different areas in our study aligns with the findings of the aforementioned research.

Selecting the appropriate laser pulse duration is a key factor affecting therapeutic outcomes. In our study, there was no statistically significant difference in efficacy between laser pulse durations of 1.5 ms and 3 ms. The pulse should be long enough to fully target the vessel wall but not excessively long, to avoid damaging surrounding tissues. Some researchers suggest that a pulse duration of 1 to 10 ms is optimal.^{15–17} Similar findings indicate that the cure rate increases as the pulse duration decreases.¹⁷ A larger number of PWS patients received laser treatment with a pulse duration of less than 3 ms compared to those with longer pulse durations. Lasers with shorter pulse durations have less thermal conduction to surrounding tissues and are more readily absorbed by affected vessels.

In our study, the overall incidence of adverse reactions was 4.31%, with a total of 42 cases. This incidence is relatively low compared to adverse reaction rates of 11.5% reported in other studies.¹⁸ During 1 to 5 years of follow-up, the majority of adverse reactions gradually diminished. Superficial scarring is associated with excessive energy during treatment or inadequate local ice application after laser procedures. Pigment lightening and darkening are temporary changes, and careful selection of energy and pulse width is important. Typically, pigment changes return to normal within approximately six months to one year after completing the entire treatment course.

Conclusion

In conclusion, our study demonstrated that the efficacy of PDL treatment is influenced by factors such as gender, age, lesion location, lesion size, and the number of treatment sessions. PDL is an effective option for treating PWS, with a relatively low incidence of adverse reactions. Although complete clearance remains rare in clinical practice, clinical data suggest that combining PDL with lasers of greater penetration depth may improve its limited cure rate. Further research on the pathogenesis of PWS and the establishment of more standardized clinical diagnosis and treatment protocols are warranted.

Abbreviations

PWS, Port-wine stain; PDL, Pulsed Dye Laser; DCD, dynamic cooling device; PIH, post-inflammatory hyperpigmentation.

Data Sharing Statement

All data are available from the corresponding author by request.

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We would like to thank the participating patients and their families.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically

reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest.

References

1. Xiu BY, Wei L, Ma L. Research progress of 595 nm pulsed dye laser in the treatment of pediatric skin diseases. *Beijing Med J.* 2022;44(9):833–836. doi:10.15932/j.0253-9713.2022.09.012
2. Mathes EF, Frieden IJ. Early use of laser for port-wine stains: timing, efficacy, and shared decision making. *JAMA Dermatol.* 2019;155:421–423.
3. Zhang C, Ge HS, Yang S, Zhang XJ. Clinical efficacy of 595-nm pulsed-dye laser in treatment of childhood facial spider nevi: a retrospective study of 110 patients. *Chin Med J.* 2019;132(20):2417–2422.
4. Greve B, Raulin C. Prospective study of port wine stain treatment with dye laser: comparison of two wavelengths (585 nm vs 595 nm) and two pulse durations (0.5 ms vs 20 ms). *Lasers Surg Med.* 2004;34(2):168–173.
5. Shi W, Wang J, Lin Y, et al. Treatment of port wine stains with pulsed dye laser: a retrospective study of 848 cases in Shandong Province, People's Republic of China. *Drug Des Devel Ther.* 2014;8:2531–2538.
6. Yu W, Zhu J, Gu Y, et al. Port-wine stains on the neck respond better to a pulsed dye laser than lesions on the face: an inpatient comparison study with histopathology. *J Am Acad Dermatol.* 2019;80:779–781.
7. Yu W, Zhu J, Han Y, et al. Assessment of outcomes with pulsed dye laser treatment of port-wine stains located proximally vs distally on extremities. *JAMA Dermatol.* 2020;156(6):702–704. doi:10.1001/jamadermatol.2020.0363
8. Pellacani A, Nocini R. Surgery for port-wine stains: a systematic review. *J Pers Med.* 2023;13(7):1058. doi:10.3390/jpm13071058
9. Ren L, Ma G, Xu X, et al. Efficacy of pulsed dye laser in the treatment of small vs large port-wine stains. *J Cosmet Laser Ther.* 2017;19(2):118–122.
10. Naeini FF, Saki N, Abtahi-Naeini B, et al. Predictive factors for the efficacy of pulsed dye laser in the treatment of facial port-wine stains. *J Lasers Med Sci.* 2014;5(1):35–40.
11. Li M, Zhang SM, Li Y, et al. Clinical study of 595 nm pulsed dye laser treatment of port-wine stains in 1560 cases. *Chin J Dermatol.* 2012;45(3):201–202.
12. Li L, Xu ZG, Sun YJ, Ma L. Analysis of the efficacy of 595 nm pulsed dye laser in the treatment of childhood skin telangiectasia. *J Pract Dermatol.* 2011;4(4):200–202.
13. Yu W, Ma G, Qiu Y, et al. Why do port-wine stains on the lateral face respond better to pulsed dye laser than those located on the central face? *J Am Acad Dermatol.* 2016;74(3):527–535.
14. Sun Y, Zhang H, Lu J, et al. A prospective study on the efficacy and safety of the combination of 595 nm pulsed dye laser and 755 nm alexandrite laser for the treatment of port-wine stains. *Lasers Med Sci.* 2024;39(1):125–131. doi:10.1007/s10103-023-03542-1
15. Dierickx CC, Casparian JM, Vengopalan V, Farinelli WA, Anderson RR. Thermal relaxation of port-wine stain vessels probed in vivo: the need for 1–10 ms laser pulse treatment. *J Invest Dermatol.* 1995;105:709–714.
16. Kimel S, Svaasand LO, Cao D, et al. Vascular response to laser photothermolysis as a function of pulse duration, vessel type, and diameter: implications for port wine stain laser therapy. *Lasers Surg Med.* 2002;30:160–169.
17. Tan OT, Murray S, Urban AK. Action spectrum of vascular specific injury using pulsed radiation. *J Invest Dermatol.* 1989;92:868–871.
18. Li D, Chen B, Zhang H, Yuan Y, Fan W, Ying Z. Retrospective study of the treatment of port-wine stains with 595-nm pulsed dye laser in 261 Chinese patients. *Lasers Med Sci.* 2020;35(8):1811–1819.

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