Clinical efficacy of 595-nm pulsed-dye laser in treatment of childhood facial spider nevi: a retrospective study of 110 patients

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Abstract

Background: Spider nevi (SN) are quite common in children. SN are treated via different techniques, and complete removal often requires multiple treatments. However, few studies have evaluated the treatment of SN. The present study aimed to evaluate the therapeutic effect and safety of a 595-nm pulsed-dye laser (PDL) for treating facial SN in children.

Methods: A total of 110 children aged 0.2 to 12 years with facial SN were treated with a 595-nm PDL in a single institution from January 2016 to February 2018. In accordance with the treatment method, the patients were retrospectively divided into the small-spot-combined-with-large-spot group (SL-group) and the large-spot group (L-group). Patients with poor therapeutic results were re-treated every 6 weeks until the lesions disappeared. The minimum follow-up period was 1 year. The groups were compared using independent-samples *t* tests, Mann-Whitney *U* test, Chi-square test, and Fisher exact probability test.

Results: The therapeutic efficacy was significantly higher in the SL-group than in the L-group, with clearance rates of 90.9% and 53.0% after the primary treatment, respectively ($\chi^2 = 17.937$, $P < 0.001$). For skin lesions with a central spider body diameter ≥1 mm, the once-treatment cure rates were 100% in the SL-group and 34.8% in the L-group ($\chi^2 = 20.780$, $P < 0.001$). For skin lesions with a central spider body diameter <1 mm, the once-treatment cure rates were 82.6% in the SL-group and 62.8% in the L-group ($\chi^2 = 3.961$, $P = 0.138$). The rates of adverse reactions and recurrence did not differ between the two groups ($P = 0.141$ and $P = 1.000$, respectively).

Conclusions: The 595-nm PDL might be a safe and effective treatment option for facial SN in children. The small-spot-combined-with-large-spot method is especially suitable for SN with a central spider body diameter ≥1 mm.

Keywords: Lasers; Telangiectasis; Child; Spider nevi

Introduction

Spider nevi (SN), also known as spider angiomas, are small, red arterial papules with radially extending capillaries. The nevus exhibits arterial pulsation, with the blood flowing from the figurative spider body to the legs. When the central spider body is pressed, the dilated capillaries temporarily disappear. SN appears as single or multiple lesions that are present in up to 15% of healthy adults, with a higher incidence among children.[1] SN have been treated for cosmetic purposes via electrocoagulation, pulsed-dye lasers (PDL), potassium-titanyl phosphate (KTP) lasers, and neodymium:yttrium-aluminium-garnet (Nd:YAG) lasers.[2-5] However, the complete removal of these skin lesions often requires multiple treatments, especially for SN with a body diameter ≥1 mm; this may be due to the thick arterial walls or because the large blood flow in the small arteries of SN can easily dissipate the heat from the laser. Multiple treatments are not only expensive but also increase the discomfort of pediatric patients. The present study analyzed the efficacy of PDL in the treatment of facial SN in children, and compared the efficacy and incidences of adverse reactions and recurrence of different operating methods.

Methods

Ethical approval

The present study was conducted in accordance with the *Declaration of Helsinki* and was approved by the Ethics Committee of Anhui Provincial Children's Hospital. The

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guardian of each participant provided written informed consent for laser treatment and study inclusion.

Study population

We retrospectively collected data from 110 patients with facial SN who had been treated with the 595-nm PDL in the Department of Dermatology, Anhui Provincial Children's Hospital between January 2016 and February 2018. The treatment procedure, benefits, and risks were explained to the guardian of the patient and the patient before treatment. The inclusion criteria were: (1) Age $\leq$12 years; (2) Chinese Han population; (3) skin classification Fitzpatrick III–IV; (4) healthy children with no history of liver disease or other systemic diseases; and (5) no previous treatment history for skin lesions. Among the 110 children with SN, there were 54 males and 56 females, giving a male to female ratio of 0.96 to 1. The central spider body diameter was <1 mm in 66 cases, and ≥1 mm in 44 cases. The lesions were located in the orbital region in 41 cases, and in the non-orbital region in 69 cases. Participants were divided in accordance with the operation method used in the treatment of SN into the small-spot-combined-with-large-spot group (SL-group) and the large-spot group (L-group).

Instrument

A Candela PDL system (Vbeam Perfecta; Candela Corporation, Wayland, MA, USA) was used with the following parameters: wavelength 595 nm, pulse width 0.45 to 40 ms, pulse frequency 1.5 Hz, and adjustable output energy fluence 4 to 40 J/cm^2. The spot sizes used were 3, 5, 7, 10, and 12 mm circular spots and 3 mm × 10 mm oval spots. An injection time of 0 to 100 ms and an injection delay of 10 to 100 ms were used for the dynamic cooling device.

Treatment and assessment

After obtaining pre-treatment photographs, the treatments were performed by the same laser practitioner. The dynamic cooling device was set with a spray/delay of 30/20 ms. The center of the lesion was placed in the center of the laser handle head and maintained vertically.

For the L-group, a 7-mm spot size with an energy fluence of 8 to 12 J/cm^2 and a 1.5 ms pulse width was applied to the center of the SN. Regarding the treatment of the area outside the 7-mm-diameter, if the "legs" of the SN disappeared, then no more treatment was required; if the legs were still present, laser treatment was performed using the same laser parameters, and the pulses were overlapped by a maximum of 10% across the effect. The clinical endpoint was a change in the color of the skin lesion from red to purple.

For the SL-group, the laser parameters used in the central spider body included a 3-mm spot size, an energy fluence of 14 to 18 J/cm^2, and a pulse width of 1.5 ms. Regarding the treatment of an area outside of the 3-mm-diameter, if the "legs" of the SN disappeared, then no more treatment was required; if the legs were still present, laser treatment was performed using a 7 mm spot size, an energy fluence of 8 to 12 J/cm^2, and a pulse width of 1.5 ms, with the pulses overlapped by a maximum of 10% across the effect. The clinical endpoint was a change in the color of the skin lesion from red to purple.

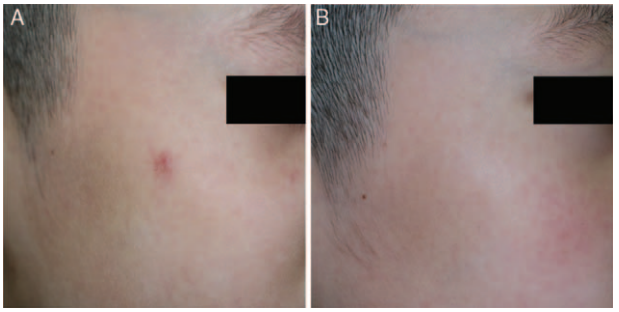

Figure 1: Spider nevus on the right side of the face of a 10-year-old male patient in the small-spot-combined-with-large-spot group. (A) The lesion before treatment; (B) the patient was cured after one pulsed-dye laser treatment.

Post-operatively, an ice pack was intermittently applied to the affected area for 10 min. Exposure to water was avoided after the procedure, and antibiotic ointment was applied to the affected area for 1 week to prevent local infection. Prolonged exposure to sunlight was avoided after the procedure to prevent hyperpigmentation. The patients and their parents were instructed to avoid scratching the affected area. Laser treatments were repeated every 6 weeks if further treatment was required. Follow-ups were conducted via telephone and photographs for a minimum duration of 1 year.

The therapeutic effect was evaluated by an experienced dermatologist who was blinded to the treatment groups. This assessor compared pre- and post-treatment photographs and evaluated the treatment effect in accordance with the following criteria. SN was classified as cured if the dilated blood vessels had completely disappeared [Figure 1], as improved if the dilated blood vessels had partially disappeared, or as ineffective if the dilated blood vessels had not changed. The adverse reactions associated with each method were also recorded and compared. The observed adverse effects included localized edematous erythema, hyperpigmentation, hypopigmentation, scabbing, blisters, infection, and scarring.

Statistical analysis

The data were analyzed using SPSS 19.0 software for Windows (IBM SPSS, Chicago, IL, USA). Measurement data that were normally distributed are represented as the mean ± standard deviation, and the two groups were compared using independent-samples *t* tests. Data that were not normally distributed are represented as medians and interquartile ranges (IQR), and the Mann-Whitney *U* test was used to compare the two groups. Countable data are presented as rates, and inter-group comparisons were

Table 1: Basic characteristics of patients with spider nevi in the L-group and the SL-group.

Characteristics	L-group ($n = 66$)	SL-group ($n = 44$)	Statistics	P
Sex, *n* (%)			0.297*	0.586
Male	31 (47.0)	23 (52.3)		
Female	35 (53.0)	21 (47.7)		
CSBD, *n* (%)			1.824*	0.177
<1 mm	43 (65.2)	23 (52.3)		
≥1 mm	23 (34.8)	21 (47.7)		
Lesion location, *n* (%)			1.095*	0.295
Orbital region	22 (33.3)	19 (43.2)		
Non-orbital region	44 (66.7)	25 (56.8)		
Age (years), mean ± SD	6.6 ± 2.5	6.8 ± 2.6	–0.329†	0.742
Onset age (years), mean ± SD	5.2 ± 2.7	5.5 ± 2.8	–0.704†	0.483
Disease duration (months), median (IQR)	12 (6–24)	12 (6–24)	–0.439‡	0.661

* χ^2 values. † *t* values. ‡ *Z* value. L-group: Patients with spider nevi treated with a 595-nm pulsed-dye laser via the large-spot method. SL-group: Patients with spider nevi treated with a 595-nm pulsed-dye laser via the small-spot-combined-with-large-spot method; CSBD: Central spider body diameter; SD: Standard deviation; IQR: Interquartile range.

Table 2: Comparison of the therapeutic effects in the L-group and the SL-group after one treatment.

Items	Therapeutic effect, *n* (%)			χ^2	P
	Cured	Improved	Ineffective		
CSBD ≥1 mm				20.780	<0.001
L-group ($n = 23$)	8 (34.8)	13 (56.5)	2 (8.7)		
SL-group ($n = 21$)	21 (100)	0	0		
CSBD <1 mm				3.961	0.138
L-group ($n = 43$)	27 (62.8)	11 (25.6)	5 (11.6)		
SL-group ($n = 23$)	19 (82.6)	4 (17.4)	0		
Total*				17.937	<0.001
L-group ($n = 66$)	35 (53.0)	24 (36.4)	7 (10.6)		
SL-group ($n = 44$)	40 (90.9)	4 (9.1)	0		

* All 110 patients with facial spider nevi. L-group: Patients with spider nevi treated with a 595-nm pulsed-dye laser via the large-spot method; SL-group: Patients with spider nevi treated with a 595-nm pulsed-dye laser via the small-spot-combined-with-large-spot method; CSBD: Central spider body diameter.

performed using the Chi-square test or Fisher exact probability test. Statistical significance was set at $P < 0.05$.

Results

Baseline characteristics

The Chi-square test showed that the L-group and the SL-group did not significantly differ regarding sex ($\chi^2 = 0.297$, $P = 0.586$), central spider body diameter ($\chi^2 = 1.824$, $P = 0.177$), and lesion location ($\chi^2 = 1.095$, $P = 0.295$). The independent-samples *t* test showed that the two groups were comparable regarding age ($t = -0.329$, $P = 0.742$), age of onset ($t = -0.704$, $P = 0.483$), and disease duration ($Z = -0.439$, $P = 0.661$) [Table 1].

Clinical efficacy

Of the 66 cases of facial SN in the L-group, 35 were cured, 24 were improved, and seven were judged as ineffective after the primary treatment, yielding a once-treatment cure rate of 53.0%. Of the 44 cases of facial SN in the SL-group, 40 were cured, four were improved, and none were judged as ineffective after the primary treatment, yielding a once-treatment cure rate of 90.9%. The SL-group exhibited a significantly higher once-treatment cure rate than the L-group ($\chi^2 = 17.937$, $P < 0.001$). For cases with a spider body diameter ≥1 mm, the once-treatment cure rate in the L-group (34.8%) was significantly lower than that in the SL-group (100%; $\chi^2 = 20.780$, $P < 0.001$). For cases with a spider body diameter <1 mm, the once-treatment cure rate in the L-group (62.8%) was similar to that in the SL-group (82.6%; $\chi^2 = 3.961$, $P = 0.138$) [Table 2].

Adverse reactions

In the L-group, eight patients developed adverse reactions after treatment; the adverse reactions included one case of localized edematous erythema (1.5%), six cases of mild hyperpigmentation (9.1%), and one case of atrophic scarring (1.5%) [Figure 2]. In the SL-group, ten patients developed adverse reactions after treatment; the adverse

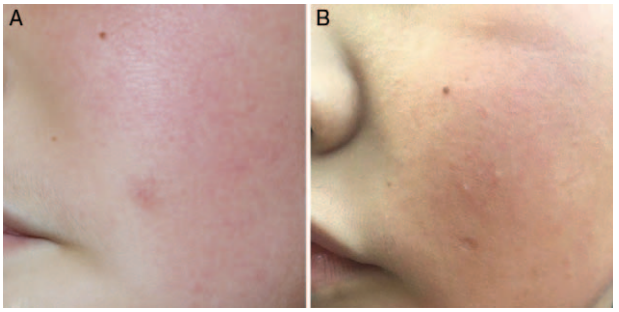

Figure 2: Spider nevus on the left side of the face of an 8-year-old male patient in the large-spot group. (A) The lesion before treatment; (B) atrophic scarring after a single pulsed-dye laser treatment.

reactions included three cases of localized edematous erythema (6.8%), three cases of mild hyperpigmentation (6.8%), and four cases of scabbing (9.1%). The incidence of adverse reactions did not significantly differ between the two groups ($\chi^2 = 2.170$, $P = 0.141$).

Recurrence

There were two cases of recurrence in the L-group, and one case of recurrence in the SL-group. The recurrence rate did not significantly differ between the two groups ($P = 1.000$).

Discussion

The present results showed the marked efficacy and safety of 595-nm PDL laser for childhood facial SN, and revealed that the small-spot-combined-with-large-spot method is superior to the large-spot method for children with a central spider body diameter of larger than 1 mm.

In the field of dermatology, variable-pulse 595 nm PDL is now being widely used to treat vascular skin lesions,[6-9] and has been successfully used to treat SN. However, several treatment sessions are needed because of its high flow,[3] and there are few reports on the efficacy of different operational methods of 595-nm PDL in the treatment of SN. One study reported that 438 of 744 patients (58.87%) achieved 50% to 100% improvement after a single treatment of SN.[10] Another study evaluating the treatment of SN in 26 patients with a 595-nm PDL (2.04 ± 1.00 treatments with a spot size of 3 mm, pulse width of 1.5 ms, and energy fluence of 12–15 J/cm^2) suggested that it was ideal to use small laser spot sizes to target the central arterial vessel without injuring the surrounding skin.[11] For the 595-nm PDL, a small spot enables easy manipulation of the fluence on the target blood vessels to achieve the desired energy and result in more laser energy scattering.[12] Small blood vessels absorb less light energy than large blood vessels because they contain fewer target chromophores, and small spot sizes are associated with greater light scatter, necessitating a compensatory higher fluence. The central bodies of SN are composed of arterioles with high intravascular pressure, and so these areas require higher fluences to achieve effective thermocoagulation. In our study, 14 to 18 J/cm^2 energy fluence was applied to the center of the SN in the SL-group. Blood vessels in SN range in diameter from 0.1 to 0.5 mm,[4] and the choice of pulse width depends on the vessel diameter. We selected an irradiation time of 1.5 ms to treat these vascular lesions, which was consistent with a previous study.[13] In the present study, we used high energy fluence with a 3-mm spot size in the central spider body, combined with a large spot for larger areas outside of the 3-mm-diameter zone; this method improved the efficacy of treatment compared with the large-spot method. This small-spot-combined-with-large-spot strategy solved the problem observed in previous clinical treatments wherein the peripheral capillaries often disappeared after one treatment, while the large central body of SN required multiple treatments.

There were some minor adverse reactions seen in the present study population. Among the 110 cases, localized edematous erythema occurred after laser treatment in four cases, including three cases in the SL-group; this adverse effect may have occurred because the energy fluence was high and the dynamic cooling device could only cool the epidermis. Nine cases showed hyperpigmentation, which may have been caused by excessive exposure to sunlight or melanocyte damage. Hyperpigmentation was gradually absorbed and disappeared spontaneously during a period of 3 to 12 months. Scabbing occurred in four cases in the SL-group. The scab usually fell off spontaneously without scar formation within 7 to 10 days. The occurrence of scab formation mainly in the SL-group may be due to the mild degree of textural change associated with the use of excessive energy fluency. One patient in the L-group exhibited atrophic scarring. Blistering did not occur, and scratching of the skin lesion area after laser treatment was prohibited. The scarring was considered to have been caused by the rapid overlapping of the two pulses of the laser, leading to a concentration of energy on the large laser spot and consequent vascular heating, causing thermal damage to the skin.[14]

Recurrence developed in three of the 110 patients, including two in the L-group and one in the SL-group; this corresponds to recurrence rates of 3.0% and 2.3%, respectively. These recurrence rates are lower than those reported in a previous study.[15] Recurrence is thought to be caused by high pressure of intravascular blood flow. A previous study recommended that SN could be reclassified as belonging to the group of high-flow arteriovenous malformations.[1]

The current treatment methods for SN also include long-pulse 1064-nm Nd:YAG lasers, KTP 532-nm lasers, 585-nm PDLs, and multi-wavelength combined laser methods. One study that included 26 cases of SN treated by the 1064-nm Nd:YAG laser reported a primary cure rate of 38.5% (10/26) and an incidence of adverse reactions of 30.8% (8/26).[4] However, the long-pulsed 1064-nm Nd:YAG laser is not a preferred treatment option for facial vascular diseases.[4] The Nd:YAG laser offers an effective,

well-established method for treating deep and large vascular lesions located up to 10 mm below the skin.[16] However, because of its relatively weak absorption by blood, the Nd:YAG laser requires high energy density to cause effective vessel damage, which may burn the surrounding collagen.[17] A KTP 532-nm laser uses light at a second wavelength of 532 nm; light of this wavelength is obtained by using a KTP crystal to halve the primary 1064-nm wavelength of the Nd:YAG laser.[18] Melanin strongly absorbs light at a wavelength of 532 nm, and light of this wavelength is more widely scattered in the tissues than light with a wavelength of 595 nm, resulting in greater adverse reactions in darker skin and reduced efficacy for SN in deeper locations.[19] One study used a doubled 532-nm Nd:YAG laser to treat SN and obtained a clearance rate of 51%,[2] while another study in which SN were treated with a 532-nm KTP laser reported a rate of 50% to 100% improvement of 93.5% and a mean number of treatments of 1.4 ± 0.8.[20] PDL selectively targets vascular structures through the appropriate selection of a light wavelength absorbed by oxyhemoglobin; this transforms oxyhemoglobin into methemoglobin, and leads to thrombus formation. One study reported that 585-nm PDL treatment of SN achieved a successful result in 191 of 201 patients (95%), with clearance after a mean of 1.8 treatments (range, 1–7) and a recurrence rate of 36%.[15] The 595-nm PDL has a longer wavelength than the 585-nm PDL, and can penetrate deeper into the dermis to a maximum penetration depth of 1 mm.[7] A dynamic cooling device is used to spray coolant onto the skin prior to each laser pulse to minimize pain and thermal damage. Multi-wavelength laser therapy, which involves the use of a 595-nm PDL followed by a 1064-nm Nd:YAG laser, reportedly achieved a once-treatment cure rate of 93% in 38 patients with SN.[21]

As can be seen from the above-mentioned information, the results of our study are well characterized, and we believe that the findings of the present study contribute to the current knowledge in the field of laser treatment of SN. However, our study had some limitations. First, this was a retrospective study, and the efficacy and safety of 595-nm PDL should ideally be confirmed in a randomized controlled trial. Second, our sample size was relatively small.

In conclusion, our results reveal that 595-nm PDL is a safe and effective laser modality for SN. The small-spot-combined-with-large-spot method is especially suitable for children with a central spider body diameter of larger than 1 mm. This treatment may be a viable option for SN, as it provides acceptable cosmetic results and has a relatively low incidence of adverse effects. However, these findings require confirmation in randomized controlled trials with larger sample sizes.

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Conflicts of interest

None.

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