

Original Article

Efficacy and safety of quasi-continuous, frequency-doubled Nd:YAG (532nm) laser therapy of port-wine stains

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Abstract *Background* The quasi-continuous, frequency-doubled neodymium yttrium aluminum garnet (Nd:YAG) 532nm laser has been used for the first time in the treatment of port-wine stain (PWS).

Objectives To determine the efficacy and side effects of quasi-continuous Nd:YAG 532nm laser in the treatment of PWS.

Methods Twenty patients were enrolled in the study. The site and colour of PWS were recorded and assessed subjectively and by photography both before and after treatment. The patients had test areas treated and followed up after four weeks. Maximally eight treatments were given on any one site or until >75% improvement occurred. Final evaluation was done one month after the last treatment session on a four-point scale.

Results Twenty patients were treated, age range 15-35 years with 14 females. All the patients had PWS in the head and neck region and achieved >25% improvement. Patients underwent a mean of 7.55 treatment sessions. Overall, fifteen (75%) showed 75-100% improvement. The side effects seen in the study were hyperpigmentation in 65% cases, textural changes in six (30%) and eczematization after laser therapy in four (20%) of patients. Other complications included intraoperative hemorrhage and pyogenic granuloma-like lesions that occurred in two cases (10%) each.

Conclusion We have shown that frequency doubled Nd:YAG 532nm is effective and safe in the treatment of PWS.

Key words

Port-wine stain, quasi-continuous, frequency-doubled, Nd:YAG laser

Introduction

Port-wine stain (PWS) is a congenital vascular malformation, which occurs in 0.1-2% of newborns.^{1,2} PWSs range in size from a few millimeters to many centimeters and maintain their relative size throughout life.³ Their colour varies from pale pink to purple. With increasing age PWSs darken and may become nodular.³ Lesions are usually unilateral and may be present at any site but

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most frequently face is affected followed by upper trunk.

Patients with PWS experience extreme psychosocial problems including feelings of stigmatization, guilt, loss of self-esteem and confidence, embarrassment, anxiety, depression and difficulties in sexual and interpersonal relationships.³⁻⁸ Suicidal attempts have been made by some, when these problems become profound enough.⁷ Patients desperately look for an effective treatment throughout their lives.⁸ The physical morbidity associated with PWS include bleeding after minor trauma,⁴ seizures due to cerebral involvement, blindness because of glaucoma and hypertrophy of soft tissues and bones.³

PWS is a therapeutic challenge. Traditional therapeutic modalities for PWS include cosmetic camouflage, tattooing, skin grafting, cryosurgery and ionizing radiation. Clinical results with these measures are inconsistent and produce lot of complications including pigmentary changes and scarring.⁹ Laser is the latest addition for treatment of PWS. A number of lasers including argon (514nm), argon dye (577nm-600nm), copper vapor (578nm), krypton (568nm), pulsed dye (585nm-600nm), Nd:YAG (1064nm) and frequency-doubled Nd:YAG (532 nm) have been used for treatment of PWS.¹⁰ The pulsed dye laser is considered to be treatment of choice for PWS¹¹ but only in a small percentage of patients gives total clearance of the blemish.¹²

The laser installed in the Department of Dermatology, Mayo Hospital, Lahore, is a quasi-continuous, frequency-doubled,

Nd:YAG (532nm). This was used in the present study - the first of its kind from Pakistan. This study was designed to evaluate the efficacy and safety of frequency-doubled Nd:YAG (532nm) laser in the treatment of PWS and to compare the results with other studies.

Patients and methods

Twenty adult patients were enrolled in the study. Detailed history and clinical examination was recorded on a specially designed proforma. None of the patients ever had had any kind of treatment of the PWS. The laser machine used in the study was a quasi-continuous frequency-doubled Nd:YAG laser (Model: Emerald; Manufactures: Crystal Focus®, France). The specifications included: wavelength 532nm, pulse duration 1.6µs, frequency 14kHz, power range 0.1-4.5W, exposure time from 0.01s to continuous and a spot size of 2mm. Red helium-neon (630nm) light served as the aiming beam. The pulse energy was verified with a laser power/energy meter (Model DG X OPHIR, France) at frequent intervals.

After taking informed consent, photographs under standardized conditions were taken before treatment. No anesthesia either local or general was used. The laser therapy was instituted by free hand tracing mode. The laser personnel and the patients used protective goggles during laser therapy. The energy fluence used was 7.25 J/cm² and 9.67 J/cm² for patch and plaque type of PWS, respectively. The same area was retreated after an interval of 4-6 weeks. The laser pulses were given at non-contiguous, adjacent spots. Postoperatively the patients

were advised application of topical antibiotic ointment till the crust fell off, strict avoidance of sunlight and regular use of sunscreen. Patients were followed up monthly. At each visit improvement as well as side effects, were noted.

Subsequent treatments were given at minimum of four weeks intervals. Maximally eight treatments were given on any one site or until grade 4 (>75%) improvement occurred. Final evaluation was done one month after the last treatment session and photographs were taken at this point again.

Improvement was evaluated subjectively by comparing the treated areas with pre-treatment photographs. Responses were graded on a scale from 0-4, as follows: grade 0, no improvement (poor); grade 1, 1-25 % improvement (fair); grade 2, 26-50% improvement (good); grade 3, 51-75 % improvement (very good); and grade 4, 76-100% improvement (excellent). Side effects were graded as mild, moderate and severe, at the same time.

Results

Immediate post-treatment effects included ash-grey discoloration of the skin (**Figure 1**), which was considered to be the immediate therapeutic effect. In addition, edema was also seen. The subjective effect was pain; either pricking or burning in nature and was well tolerated by the patient. The intensity of edema and pain varied depending upon the patient's tolerance, site and fluence used. The pain or discomfort was more marked over periorbital and perioral regions. Post-operative burning

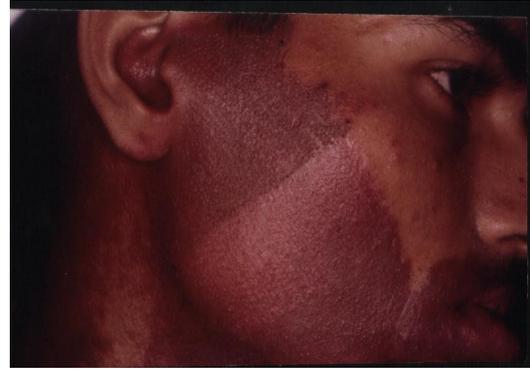


Figure 1 Immediate post-opt grayish discoloration



Figure 2 Port-wine stain on right cheek before treatment.



Figure 3 Grade 4 improvement after seven treatments.

sensation was experienced for 1-6 hours. Crusts were formed on second or third day post-operatively and lasted for 7-10 days.

All the patients achieved lightening of the

Table 1 Demographic data and treatment results in the study cohort

No.	Age(yrs)/ Sex	Colour type	No. of treatments*	Improvement grades	Treatment area selected
1	20/F	Red/patch	8	3	Right cheek
2	35/F	Pink/patch	8	4	Right cheek
3	23/F	Red-purple/plaque	6	4	Right side of neck
4	21/M	Pink-red/patch	6	4	Right cheek
5	22/M	Pink/patch	8	4	Right cheek
6	21/F	Pink-red/patch	8	4	Both cheeks
7	23/F	Red/patch	8	4	Right cheek
8	32/M	Red/patch	8	4	Right half of upper lip
9	20/F	Red/patch	8	3	Right cheek
10	15/F	Red/patch	8	4	Left side of forehead
11	23/F	Pink/patch	8	4	Right cheek
12	30/F	Purple/plaque	7	4	Left side of forehead
13	17/F	Red/patch	8	3	Right side of nose
14	30/F	Red-purple/patch	7	4	Left cheek
15	20/M	Red-purple/plaque, nodular	8	2	Right cheek
16	21/F	Red/patch	7	4	Left cheek
17	35/F	Red/patch	8	4	Left cheek
18	20/M	Pink/patch	8	2	Left side of nose
19	25/F	Red/patch	8	4	Right cheek
20	17/M	Red-purple/patch	6	4	Right side of forehead

* Average no. of treatment session per patient=7.55

PWS. The results are presented in the **Table 1**. Out of the total 20 patients enrolled, 15 (75%) showed grade 4 improvement (**Figure 2** and **3**). Three patients (15%) had grade 3 fading while 2 patients (10 %) had grade 2 improvement.

The side effects seen in the study were transient and mild to moderate in intensity. Hyperpigmentation in was seen in 65% cases. However, it resolved within 2-6 months. Patients were advised sunlight avoidance as much as possible, daily sunscreen use and topical hydroquinone. Textural changes were observed in 6 (30%). Eczematization after laser therapy was observed in 4 (20%) of patients (**Figure 3**). Other complications included intraoperative hemorrhage and pyogenic granuloma that occurred in 2 cases (10%) each.

Discussion

This study clearly shows the efficacy of quasi-continuous Nd: YAG 532nm laser where grade 4 (76-100%) improvement occurred in two thirds of the total number of patients ($p<0.001$).

The wavelength of this laser 532nm is close to one of the peaks (542nm) of absorption for hemoglobin, the targeted chromophore in the laser therapy of PWS. As there are no studies available regarding laser treatment of PWS with quasi-continuous frequency-doubled Nd:YAG 532nm, this study can be compared with the quasi-continuous copper vapor laser, Q-switched Nd:YAG 532nm laser and FPDL which has been considered the treatment of choice for PWS.¹¹

Laffite *et al.*¹³ in their preliminary report showed excellent results with Q-switched

frequency doubled Nd:YAG 532nm laser along with automatic scanner (pulse duration 150ns), thus emphasizing the importance of scanners. Chowdhury *et al.*¹⁴ have used frequency doubled Nd:YAG 532nm laser having pulse widths between 1 and 50 ms on FPDL resistant PWS. 17% of cases showed more than 50% improvement. Neumann *et al.*¹⁵ achieved good to excellent results with the quasi-continuous copper vapor laser (578nm wavelength) but with a high percentage of side effects. A study by Sheehan-Dare and Cotterill¹⁶ found copper vapor laser superior to argon laser in the treatment of PWS. FPDL has been considered to be the ideal laser for treatment of PWS. Katugampola and Lanigan¹⁷ reported excellent (>75%) lightening in 38% patients, after a median of eight treatment sessions.

The results of this study were obtained after 6-8 treatment sessions. It is in accordance with the previous literature that multiple treatment sessions are required for an optimal response.¹⁸

In our study, the color of PWS was found to be important. Pink-red and darker color lesions responded better than pink PWSs, conforming to the report of Fiskerstrand *et al.*¹² that the red color of PWS is a favorable prognostic factor in the treatment of PWSs by FPDL. Chowdhury *et al.*¹⁴ reported no correlation with color of PWS and the treatment outcome FPDL resistant PWS.

PWSs of the head and neck region in adults demonstrate differences in response to treatment with the frequency-doubled Nd:YAG (532nm) laser according to their anatomical location. The medial aspect of

cheeks and nose responded less favorably than lesions located elsewhere on the head and neck region. Renfro and Geronemus¹⁹ in their retrospective study, FPDL therapy of PWSs made the same observation. However, two of the patients in this study had lesion over the upper lip who had excellent results but Renfro and Geronemus¹⁹ found that upper lip responded less well in their study. A larger study group is of course required to make a confident remark, on this fact.

The age of the patient or the age group (children, adults, and elderly), as a treatment outcome factor could not be assessed in the study. Children under twelve years of age were unable to bear the pain, which occurred immediately after laser therapy. As no form of anesthesia was used prior to laser therapy, children could not be treated. The maximum age of study-patient was thirty-five years. There was no patient in the older age group in this study.

The side effects noted in the study were mild to moderate in intensity and transient. Common complications included hyperpigmentation and textural changes, which resolved in 2-6 months. Hyperpigmentation has been reported after FPDL therapy of PWS in up to 27% of cases.²¹ Scarring neither atrophic nor hypertrophic was seen in the study. Scarring was observed in 7% cases of patients, in the study by Chowdhury *et al.*¹⁴ who used frequency doubled Nd:YAG 532nm laser having pulse widths between 1 and 50 ms on FPDL resistant PWS. Laffitte *et al.*²² in their study with Q-switched frequency doubled Nd: YAG (532nm) also reported no scarring in any of their patients. Incidence of atrophic and hypertrophic scarring with copper vapor

laser is up to 20%²³ and with FPD laser, 1-3 %.²⁰

Conclusion

Frequency-doubled Nd: YAG (532nm) laser is safe and effective in the treatment of PWSs. It is significantly effective than flashlamp pumped pulsed dye (585nm) laser. Side effects are mild and transient.

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