

# Efficacy and safety of Q-switched Nd:YAG laser in the treatment of facial pigmentary lesions: A retrospective observational study

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**Background:** The Q-switched neodymium: yttrium aluminum garnet laser (QS-Nd:YAG) is effective in the treatment of tattoos and different pigmentary conditions; however, little has been published regarding the removal of facial cutaneous pigmented lesions. The aim of this study was to determine the effectiveness and safety of QS-Nd:YAG laser in the treatment of facial pigmentary lesions in Indian patients.

**Methods:** Data of 100 patients with pigmented facial lesions treated with QS-Nd:YAG laser were analyzed. Clinical improvement of skin lesions was assessed by the physician's global assessment of two blinded observers. This was done based on photographs taken at the baseline and after the last treatment session. Side effects were recorded if present, and patient satisfaction was evaluated after each treatment session.

**Results:** The majority of the patients had post-inflammatory hyperpigmentation (n = 41), followed by melasma (n = 19), photomelanosis (n = 15), nevus of Ota (n = 5), periorbital melanosis (n = 5), nevus spilus (n = 3), Riehl melanosis (n = 3), Café-au-lait macules (n = 2), freckles (n = 2), lichen planus pigmentosus (n = 2), compound nevus (n = 1), Hori's nevus (n = 1), and pigmentary demarcation lines (n = 1). 10% of patients showed more than 50% improvement in pigmentation from the baseline level; no response was seen in 22% of patients, while 7% experienced worsened pigmentation.

**Conclusion:** The degree of improvement and efficacy in clearing pigmentation is partial, variable, and inconsistent. Worsening of pigmentation may be seen and needs to be discussed with the patient prior to treatment

**Keywords:** café-au-lait macules, Hori's nevus, lichen planus pigmentosus, melasma, nevus of Ota, pigmentary lesions, post-inflammatory hyperpigmentation, Q-switched

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## INTRODUCTION

Cutaneous hyperpigmentations are frequent complaints constituting 8.5% of all dermatological consultations <sup>1</sup>. The color of an individual's

skin is generally determined by the number of chromophores, namely melanin, hemoglobin, and carotenoids <sup>2</sup>. Hyperpigmentation of skin is usually caused by excess production and/or clumping of the melanin pigment <sup>3</sup>. The majority

of the Indian population possess Fitzpatrick type III-V skin, with a high prevalence of pigmentary disorders<sup>4</sup>. Pigmentation, especially on the face, may cause significant emotional and psychological distress<sup>5</sup>. Melasma, freckles, post-inflammatory hyperpigmentation, and café-au-lait macules are some of the common pigmentary conditions seen in daily clinical practice.

Various modalities of treatment are used for facial pigmentation with varying results, and the condition remains difficult to treat, particularly as the treatment modalities themselves may lead to hyperpigmentation and worsening of the condition. The Q-switched Nd:YAG laser (QS-Nd:YAG) can be an alternative treatment option for refractory benign pigmentary lesions<sup>6</sup>. Lasers work on the principle of selective photothermolysis. At 1064 nm, the QS-Nd:YAG emits light with a longer wavelength and relatively deeper dermal penetration than at 532 nm. Hence, dermal pigmentation is better treated with 1064 nm, while epidermal pigmentation can be managed using 532 nm<sup>3,5</sup>. The efficacy and safety profile of QS-Nd:YAG laser has not been adequately studied on Indian skin.

In this study, we recorded the efficacy and side effect profile of QS-Nd:YAG laser treatment for facial pigmentary lesions.

## PARTICIPANTS AND METHODS

This work took the form of a retrospective study conducted at a private dermatology clinic. The study was conducted from May 2011 to March

2014. Records of a hundred patients with facial pigmentary lesions treated with QS-Nd:YAG laser (SPECTRA-LUTRONICS™) in whom other modalities of treatment had been unsatisfactory or unavailable were analyzed. Patients who were not regular for follow-up and who were on other modalities of treatment were excluded from the study. A wavelength of 532 nm was applied for epidermal lesions, while dermal lesions were treated with 1064 nm at three-week intervals. The fluence for the 532 nm laser ranged from 0.9-1.2 J/cm<sup>2</sup> with a spot size between 2.6-3 mm, while the fluence for the 1064 nm laser ranged from 1.2-3.4 J/cm<sup>2</sup> with a spot size 4-8 mm. The average number of sessions per patient was 3.6 sessions (Table 1). Patients were photographed at each visit. Clinical improvement of the lesions was assessed according to the physician's global assessment<sup>7</sup> (Table 2) by two blinded observers based on photographs taken at the baseline and after the final treatment session. Patient satisfaction with the treatment was also evaluated at each visit. Data were presented as descriptive statistics using numbers and percentages.

## RESULTS

In total, 100 patients were included in the study, of which 68 were female and 32 were male. Most of the patients had post-inflammatory hyperpigmentation (PIH) (n = 41), followed by melasma (n = 19), photomelanosis (n = 15), nevus of Ota (n = 5), periorbital melanosis (n = 5), nevus

**Table 1.** Laser parameters applied in different pigmentary conditions

Condition	Wavelength (nm)	Fluence (Joules)	Spot Size (mm)	Average No. of sessions
PIH	1064	1-1.8	8	4
Melasma	1064	1.2-1.8	8	4
Photomelanosis	1064	1-1.8	8	4
Periorbital melanosis	1064	1-1.4	8	2
Riehl melanosis	1064	1-1.8	8	4
Freckles	532	0.9-1.1	2.6	2
Lichen planus pigmentosus	1064	1-1.8	8	6
Pigmentary demarcation lines	1064	1.6	8	2
CALM	532	1-1.6	8	3
Nevus of Ota	1064	1.2-3.4	8	4
Nevus spilus	1064, 532	1.2-1.6	8, 3	4
Compound nevus	1064	5	4	3
Hori's nevus	1064	1.7-3	8	5

Abbreviations: CALM: Café-au-lait macules; PIH, post-inflammatory hyperpigmentation.

**Table 2.** Physician's global assessment <sup>7</sup>

Score	Description
0	Clear, except for possible residual discoloration (>90%)
1	Almost clear/very significant clearance (75-90%); only minor evidence of hyperpigmentation remains
2	Marked improvement/significant improvement (50-75%); some disease evidence of hyperpigmentation remains
3	Moderate improvement, intermediate between slight and marked improvement; 25-50% improvement in appearance of hyperpigmentation
4	Slight improvement/some improvement (1-25%); significant evidence of hyperpigmentation remains
5	No improvement; hyperpigmented condition unchanged
6	Worse; condition worse than at week 0

spilus (n = 3), Riehl melanosis (n = 3), Café-au-lait macules (CALM) (n = 2), freckles (n = 2), lichen planus pigmentosus (n = 2), compound nevus (n = 1), Hori's nevus (n = 1), and pigmentary demarcation lines (n = 1) (Table 3).

**Post-inflammatory hyperpigmentation.** Forty-one PIH patients were included in the study, of which 4 (9.7%) patients had 50-75% improvement, 12 (29.26%) showed 25-50% improvement, and 12 (29.26%) had 1-25% improvement (Table 4). Only one (2.4%) patient had 75-90% improvement (Figure 1). No change in pigmentation was noted in eight (19.5%) patients, while four (9.7%) had worsened pigmentation. The number of laser sessions was between 3 to 4.

**Melasma.** Nineteen patients of melasma were included in the study. Improvement of 1-25% was seen in nine (47.3%) patients, while two (10.5%) had improvement between 25-50% and two (10.5%) had 50-75% improvement. No improvement in pigmentation was noticed in five (26.3%) patients. One patient (5.2%) complained of worsening of their pigmentation. The number of laser sessions

**Table 3.** Various facial pigmentary conditions included in the study

Diagnosis	No. of patients (n = 100)	Sex	
		Male	Female
PIH	41	12	29
Melasma	19	5	14
Photomelanosis	15	8	7
Nevus of Ota	5	2	3
Periorbital melanosis	5	2	3
Nevus spilus	3	1	2
Riehl melanosis	3	0	3
CALM	2	1	1
Freckles	2	0	2
Lichen planus pigmentosus	2	0	2
Compound nevus	1	0	1
Hori's nevus	1	1	0
Pigmentary demarcation lines	1	0	1
Total	100	32	68

Abbreviations: CALM: Café-au-lait macules; no, number; PIH, post-inflammatory hyperpigmentation.

was between 3 to 4.

**Photomelanosis.** The majority of patients (8 out of 15; 53.33%) with photomelanosis had 1-25%

**Table 4.** Improvement in various pigmentary conditions after laser therapy

Diagnosis	Score 0 (>90%)	Score 1 (75-90%)	Score 2 (50-75%)	Score 3 (25-50%)	Score 4 (1-25%)	Score 5 (no response)	Score 6 (worse than baseline)
PIH	-	1	4	12	12	8	4
Melasma	-	-	2	2	9	5	1
Photomelanosis	-	1	-	2	8	4	-
Nevus of Ota	-	-	1	1	2	-	1
Periorbital melanosis	-	-	1	3	1	-	-
Nevus spilus	-	-	-	1	-	1	1
Riehl melanosis	-	-	-	1	1	1	-
CALM	-	-	-	1	-	1	-
Freckles	-	-	-	-	2	-	-
Lichen planus pigmentosus	-	-	-	-	1	1	-
Compound nevus	-	-	-	-	-	1	-
Hori's nevus	-	-	-	1	-	-	-
Pigmentary demarcation lines	-	-	-	-	1	-	-
Total		2	8	24	37	22	7

Abbreviations: CALM: Café-au-lait macules; PIH, post-inflammatory hyperpigmentation.



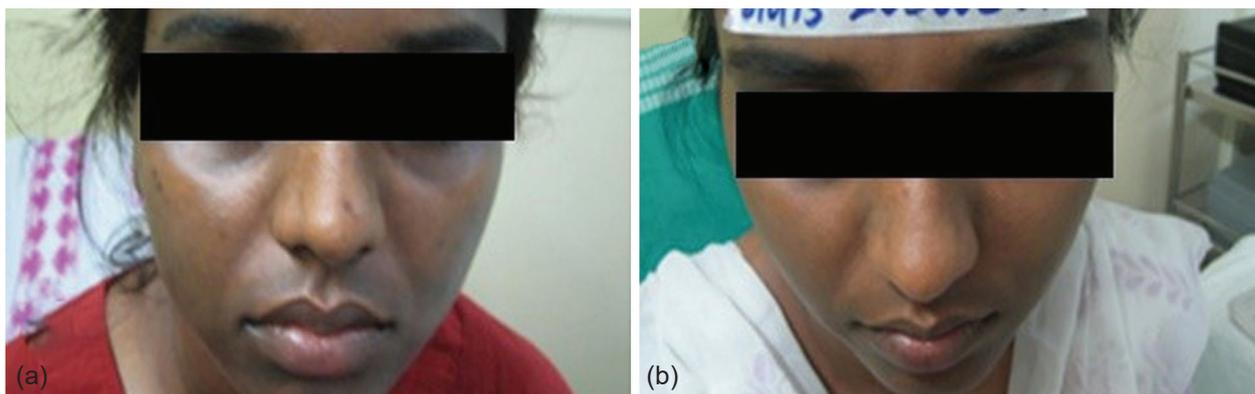
**Figure 1.** Patient with post-inflammatory hyperpigmentation before (a) and after (b) two sessions of laser (score 0).

improvement, while two (13.33%) patients showed 25-50% improvement and one (6.6%) had 75-90% improvement (Figure 2). Four patients (26.6%) had no change in pigmentation. The number of laser sessions was between 3 to 4.

**Periorbital melanosis.** Out of five patients with

periorbital melanosis, three had 25-50% improvement (Figure 3), one had 1-25% improvement, and one had 50-75% improvement. The number of laser sessions was between 3 to 4.

**Riehl melanosis.** Out of the three patients with Riehl melanosis, one patient had no response, one



**Figure 2.** Patient with Riehl melanosis before (a) and after (b) three sessions of laser (score 3).



**Figure 3.** Periorbital melanosis before (a) and after (b) two sessions of laser treatment (score 3).

had 1-25% improvement, and one had 25-50% improvement (Figure 4). The number of laser sessions was between 3 to 4.

**Freckles.** Out of the two patients with freckles, both had 1-25% response after an average of three sessions.

**Lichen planus pigmentosus.** Two patients were included in our study, out of which one showed no response and one had 1-25% improvement after 10 sessions.

**Pigmentary demarcation lines.** One patient was included in the study. He had 1-25% improvement after three sessions of laser treatment.

**Café-au-lait macules.** Of the two patients with CALM, one had no response after three sessions while the other showed 25-50% improvement after five sessions of laser treatment.

**Compound nevus.** One patient had compound nevus; the patient underwent three sessions of laser treatment and showed no response to the treatment.

**Hori's nevus.** One patient of Hori's nevus was included in the study. The patient had 25-50%

improvement after four sessions of laser treatment.

**Nevus of Ota.** Two patients with nevus of Ota showed 1-25% improvement, while 25-50% and 50-75% improvement were seen each in one patient. Worsening of pigmentation after three sessions of laser treatment was noted in one patient. The number of laser sessions was between 3- 6.

**Nevus spilus.** Out of the three patients with nevus spilus, only one patient showed 25-50% improvement after five sittings; one patient had no response while one patient had worsened pigmentation.

Most of the patients (90%) had no side effects, proving the safety of the QS-Nd:YAG laser in the treatment of pigmentary lesions. The side effects noted were hyperpigmentation in six patients, erythema in two patients, hypopigmented macules in one patient, and depigmented macules in one patient, which subsequently improved during follow-up without any treatment.

Satisfaction levels of 50% or more were seen in 34% of patients, whereas 66% of patients had < 50% satisfaction. On the physician's global assessment,



**Figure 4.** Photomelanosis before (a) and after (b) four sessions of laser treatment (score 1).

10% of patients showed 50% or more improvement in pigmentation, whereas 61% had less than 50% change in pigmentation from the baseline level. No response was seen in 22% of patients, while 7% experienced worsened pigmentation relative to baseline.

## DISCUSSION

Lasers are sources of high-intensity monochromatic coherent light that can be used for the treatment of various dermatological conditions<sup>8</sup>. In pigmented lesions, laser treatment is based on the theory of selective photothermolysis. This theory holds that when a specific wavelength of energy is delivered to the target chromophore in a period of time shorter than the thermal relaxation time, the energy is restricted to the target and causes less damage to the surrounding tissue<sup>8</sup>. A selective window for targeting melanin lies between 630-1100 nm, where there is good skin penetration and preferential absorption of melanin over oxyhemoglobin<sup>8</sup>.

The QS-Nd:YAG laser delivers extremely high energy in a very short pulse<sup>6</sup>. Epidermal lesions are best treated with 532 nm (doubled frequency), while dermal lesions respond better to 1064 nm<sup>9</sup>. Deeper pigments require longer wavelengths that penetrate greater tissue depths<sup>10</sup>. The use of laser toning mode with 1064 nm has enhanced the safety of this laser. Despite the availability of this laser for over a decade, very few publications are available concerning Indian patients, particularly in conditions such as photomelanosis and PIH. This publication seeks to fill this void by documenting the data regarding QS-Nd:YAG laser use on Indian patients, among whom hyperpigmentation is a very common and cosmetically disturbing condition<sup>11</sup>.

Post-inflammatory hyperpigmentation is an acquired pigmentary disorder of the skin that occurs as a result of inflammation induced by various cutaneous diseases or injuries. More than 50% improvement was noticed in 41% of patients. No change in pigmentation was noted in 19.5% of patients, though 9.7% of patients had worsened pigmentation. Cho and colleagues treated three patients of PIH with QS-Nd:YAG 1064 nm laser at fluences of 1.9–2.6 J/cm<sup>2</sup> for five sessions and noted good results<sup>12</sup>.

Melasma is an acquired pigmentary disorder characterized by brownish hyperpigmented macules

on the face. The etiopathogenesis of melasma involves the interplay of various factors such as ultraviolet radiation, hormonal factors (pregnancy and oral contraceptive pills), genetic predisposition, and phototoxic drugs. Q-switched Nd:YAG is the most widely used laser for the treatment of melasma<sup>8</sup>. In our study, > 50% improvement was noted in only 21% of patients. Zhou and colleagues treated 50 patients of melasma with 1064 nm QS-Nd:YAG laser at low energy levels (fluence of 2.5–3.4 J/cm<sup>2</sup>) weekly for nine sessions and found 70% of patients had > 50% improvement from baseline<sup>13</sup>. One patient (5.2%) complained of worsening of their pigmentation.

Photomelanosis is a clinical condition where increased skin pigmentation occurs due to sun exposure. Photomelanotic pigmentation in overexposed areas acts as partial protection against extensive ultraviolet radiation damage<sup>14</sup>. Out of 15 patients with photomelanosis, > 50% improvement was noted in three patients. Four patients had no response after 4-6 sessions of laser treatment.

Periorbital hyperpigmentation is characterized by hyperpigmentation around the eyes. It has a multifactorial etiology that includes both endogenous and exogenous factors<sup>15</sup>. In our study, variable rates of improvement were noted among the five patients with periorbital melanosis, with only one patient experiencing 50-75% improvement. Tian-hua *et al.* treated 30 women with infraorbital dark circles using a low-fluence QS-Nd:YAG laser (1064 nm). Twenty-six of 30 patients showed excellent global improvement; twenty-eight rated their overall satisfaction as excellent or good<sup>16</sup>.

Riehl melanosis is a rare cause of skin hyperpigmentation characterized by the rapid onset of gray-brown reticular pigmentation that typically occurs on the face and neck<sup>17</sup>. In our study, improvements of 1-25% and 25-50% were noted each in one patient, whereas one patient showed no response after four sessions of laser treatment. No patients showed complete clearance of the lesion. Smucker *et al.* reported a patient with Riehl melanosis resistant to intense pulse light treated with frequency-doubled QS-Nd:YAG (532 nm) laser. After three sessions of treatment, the patient noted complete clearance of the lesion<sup>17</sup>.

Freckles are small brown macules that appear on sun-exposed areas. Hyperpigmentation is due to an increase in melanin pigment concentration

in the melanocytes<sup>18</sup>. Two patients with freckles were treated with QS-Nd:YAG laser. Both patients had a response of 1-25% after an average of three sessions of laser treatment. Rashid *et al.* treated 14 patients who complained of freckles with QS-Nd:YAG laser (532 nm) for a variable period with an interval of 4-12 weeks. More than 50% improvement was noticed in 10 patients. On follow-up of these patients for 24 months, four showed recurrences<sup>19</sup>.

Lichen planus pigmentosus is characterized by diffuse hyperpigmented dark-brown to slate-grey to black macules present mostly in overexposed areas and flexures<sup>18</sup>. Two patients with lichen planus pigmentosus were treated with QS-Nd:YAG laser. None of the patients showed complete clearance of the lesions after three sessions of treatment. Kim *et al.* reported the complete clearance of pigmentation in a patient with linear lichen planus pigmentosus over the forehead treated with low-fluence QS-Nd:YAG (1064 nm) in three weekly sessions combined with 0.1% tacrolimus for a duration of 4 months<sup>20</sup>.

Café-au-lait macules are well-circumscribed, evenly pigmented macules and patches that range in size from 1 mm to 20 cm<sup>21</sup>. Two patients with CALM were treated with QS-Nd:YAG laser. After three sessions of laser treatment, one patient had 25-50% improvement and one had no response. Kim *et al.* treated 39 CALM lesions in 32 patients with 1064 nm QS-Nd:YAG laser. Clinical improvement of > 50% clearance was noted in 29 lesions (74.4%). Of the patients, 75% were satisfied and only 9.4% were unsatisfied with the treatment<sup>22</sup>.

Nevus of Ota is characterized by speckled or mottled coalescing blue-grey pigmentation usually located unilaterally within the distribution of the first and second branches of the trigeminal nerve<sup>18</sup>. In a prospective trial, acquired nevus of Ota was treated with QS-Nd:YAG laser (fluence 8-10 J/cm<sup>2</sup>; spot size 2-4 mm) and found to have 100% clearance in 68 of 70 patients after two to five sessions of treatment. Transient hyperpigmentation was noted in 50% of patients without scarring or textural changes<sup>23</sup>. A similar study done by Polnikorn *et al.* showed good to excellent results in 50% (33/66) of patients who received more than two treatment sessions with QS-Nd:YAG laser<sup>24</sup>. In the present study, three patients with nevus of Ota had less than 50% improvement and none had 100% clearance. One patient noted worsening of their

pigmentation after three sessions of laser treatment. Aurangabadkar *et al.* treated 50 patients of nevus of Ota with QS-Nd:YAG laser and noted > 60% of improvement in 66% of patients, while no patients experienced worsened pigmentation<sup>25</sup>.

Nevus spilus is a relatively common cutaneous lesion that is characterized by multiple pigmented macules or papules within the pigmented patch<sup>26</sup>. Out of three patients with nevus spilus, only one showed 25-50% improvement after three sessions of laser treatment. Kar *et al.* treated 15 patients of nevus spilus with QS-Nd:YAG laser, of which four had 25-50%, six had 50-75%, and three had more than 75% improvement. Only two patients developed PIH<sup>27</sup>.

The patient with compound nevus showed no response whereas the patient with pigmentary demarcation lines and the patient with Hori's nevus showed 1-25% and 25-50% improvement, respectively.

The majority of the patients showed at least one score improvement; however, the number of patients showing more than 75% improvement was less than 10% in all conditions. Satisfactory responses were recorded in cases of photomelanosis, PIH, and periorbital melanosis. Though the degree of improvement was not substantial, the majority of patients were satisfied with even a minor improvement in pigmentation in lesions that had not responded to other modalities. Many patients needed further sittings but discontinued treatment after a few sittings due to affordability issues even though some improvement was noted.

Our study shows that the QS-Nd:YAG laser can be used with safety as an additional tool in selected cases of refractory pigmentation not responding to other modalities of treatment after proper counseling of the patient with regard to its efficacy.

## CONCLUSION

The QS-Nd:YAG laser can be used with safety as an additional tool in the treatment of facial pigmentary conditions refractory to topical treatment. It can be a treatment option in selected cases of refractory pigmentation not responding to other modalities of treatment after proper counseling. Efficacy in clearing pigmentation is partial, variable, and inconsistent. The QS-Nd:YAG

laser is effective and worth trying in conditions such as photomelanosis, PIH, and periorbital melanosis. The response after multiple sessions was variable in melasma, nevus of Ota, and Riehl melanosis. Recurrence remains a major drawback in melasma. Adjunctive measures to maintain this response need to be explored in the near future. Its use in nevus spilus, lichen planus pigmentosus, and compound nevus was unsatisfactory and thus can be avoided. Few side effects were noticed, all of which resolved without any treatment. As follow-up data were not available, recurrence could not be assessed. The limitations of our study include the small sample size, short-term follow-up, and lack of a control group.

**Conflicting Interest:** None declared.

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