RESEARCH

Efficacy of Q-Switched Nd: YAG Laser in Nevus of Ota: A Prospective Study from Eastern India

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Abstract:

Context: Nevus of Ota (nevus fuscoceruleus ophthalmomaxillaris) is a congenital dermal melanocytosis predominantly affecting individuals of Asian descent and characterized by bluish-gray hyperpigmentation in the ophthalmic and maxillary divisions of the trigeminal nerve. The condition, while benign, poses a major cosmetic and psychological concern for affected patients. Conventional medical modalities including topical bleaching agents, cryotherapy, and chemical peels—have limited efficacy because the pigment lies deep within the dermis. The advent of Q-switched Nd:YAG laser technology, based on the principle of selective photothermolysis, has revolutionized the management of dermal pigmentary disorders such as Nevus of Ota. The aim is to assess the clinical efficacy and safety of Q-switched Nd:YAG laser in the treatment of Nevus of Ota among patients from Eastern India. **Methods and Material:** A prospective interventional study was conducted over six months at a tertiary care center in Eastern India. Seventy-five patients aged 18 years and above, clinically diagnosed with Nevus of Ota, were enrolled. Each patient underwent four treatment sessions of Q-switched Nd:YAG laser at four-week intervals. Standardized pre- and post-procedural care was followed. The therapeutic response was evaluated using a visual analogue scale (VAS) independently by the patient, the investigator, and an external expert dermatologist. Pigment clearance was graded as excellent (> 75%), good (50–75%), moderate (25–50%), or poor (< 25%). Adverse events were also recorded. **Results:** The study cohort (n = 75) included predominantly young adult females, with a female-to-male ratio of 7.5:1 and a mean age of 27.5 ± 4.2 years. Average pigment clearance after the first sitting was 42.1% (patient), 29.3% (investigator), and 17.5% (expert evaluator). By the final sitting, improvement reached 54.8%, 53.6%, and 51.4% respectively. Expert evaluation categorized 20% of patients as excellent responders, 40% as good, 30% as moderate, and 10% as poor. Transient erythema or edema occurred in 24%, mild post-inflammatory hyperpigmentation in 12%, and crusting in 8% of patients, with no scarring or serious adverse events observed. **Conclusions:** Q-switched Nd:YAG laser demonstrated significant efficacy and excellent tolerability in the treatment of Nevus of Ota, producing progressive pigment reduction and high patient satisfaction without major complications. It represents a safe, reliable, and cosmetically rewarding modality, and should be regarded as the preferred therapy for dermal melanocytosis where conventional methods fail.

INTRODUCTION

Nevus of Ota, or nevus fuscoceruleus ophthalmomaxillaris, is a type of dermal melanocytosis that appears as bluish-gray or slate-colored pigmentation on the areas associated with the ophthalmic (V1) and maxillary (V2) branches of the trigeminal nerve.[1] Ota first documented this condition in 1939, and it is considered a benign lesion that can be distressing for patients due to its appearance and is usually seen in individuals of Asian descent. Histologically, nevi of Ota are likely caused by an excess of dermal melanocytes that never reached the epidermis during embryonic migration from the neural crest. The pigment's depth in the dermal layer also make it less susceptible to many types of medical or topical depigmenting therapy.[2] Epidemiological studies have reported a strong female predominance with a ratio as high as 4:1 to 6:1, and occurs in childhood or adolescence. The psychosocial impact is quite salient as those affected experience social stigma, impaired self-esteem, and psychological distress due to the visibility of facial pigmentation.[3] So, it is crucial for patients to attain safe and effective clearance of pigment for cosmetic and psychological credibility.

Limitations are inherent with traditional approaches such as cryotherapy, dermabrasion, chemical peels and topical bleaching agents because their effects are limited to the epidermal or superficial dermal layers.[4] The advent of selective photothermolysis described by Anderson and Parrish in 1983 changed the treatment of pigmented lesions with the introduction of laser systems that targeted melanosomes while causing minimal thermal injury to surrounding tissues.[5] The principle of selective photothermolysis lies behind the technology of Q-switched lasers which deliver high-energy light in nanosecond pulses that are selectively absorbed by melanin granules in dermal melanocytes. Of all the laser systems, Q-switched Nd:YAG (neodymium-doped yttrium aluminum garnet) lasers are the gold standard among laser systems to treat dermal pigmentation like Nevus of Ota, whereas older techniques such as argon and CO_2 lasers are limited by penetration depth, scarring and postoperative (post-inflammatory) hyperpigmentation.[6] Clinical studies in East Asia and India have described good-to-excellent responses to treatment with most patients demonstrating good results (clearance of pigment)

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after multiple treatments. Ultimately patient age, depth of the lesion, skin phototype and the number of sessions can all affect the response to treatment in varying degrees; however, most patients can be expected to achieve good to excellent results after multiple sessions.[7]

Although there is an expanding body of clinical experience worldwide, there is little Indian data about the therapeutic outcomes and safety of the Q-switched Nd:YAG laser in Nevus of Ota, especially in the Eastern part of the country. In addition, there has been very little publication regarding the psychosocial aspect and patient-reported satisfaction following laser treatment in this population.

Therefore, we are interested in assessing the clinical efficacy, safety, and patient satisfaction with Q-switched Nd:YAG laser in patients with Nevus of Ota from Eastern India.

MATERIAL and METHODS

Study Design and Setting: This anticipated interventional study took place over a 6-month period from 1st January to 30th June 2012 at the Department of Dermatology of a tertiary care teaching hospital in Eastern India. The purpose of the study was to assess the clinical efficacy and safety of Q-switched Nd:YAG laser for the treatment of Nevus of Ota. The study was approved by the Institutional Ethics Committee before study initiation, and written informed consent was obtained from all patients prior to their enrollment.

Study Population: A total of seventy-five patients aged 18 years and above were included in the study. Each participant was clinically diagnosed with Nevus of Ota by a qualified dermatologist based on the characteristic bluish-gray pigmentation in the distribution of the ophthalmic and maxillary branches of the trigeminal nerve.

Inclusion criteria consisted of patients aged 18 years or older, of either sex, with no prior laser treatment, and willing to undergo four consecutive laser sessions at four-week intervals. Exclusion criteria included patients younger than 18 years, pregnant or lactating women, those with a history of keloid or hypertrophic scar formation, individuals with active skin infections, photosensitive dermatoses, or systemic illness affecting healing, and patients who had used isotretinoin within the preceding six months.

The mean age of the participants was 27.5 ± 4.2 years, and the female-to-male ratio was 7.5:1, indicating a clear female predominance consistent with the known epidemiological trend.

Pre-Procedural Preparation: All patients underwent pre-treatment counseling regarding the expected outcomes, number of sessions, and possible side effects. Standardized pre-procedural care was maintained throughout the study. Each participant was instructed to use a broad-spectrum sunscreen regularly for four weeks before initiating therapy. A topical anesthetic cream containing lignocaine (2.5%) and prilocaine (2.5%) was applied under occlusion for one hour before the procedure to achieve adequate local anesthesia. During each session, both the patient and the operator used protective eye gear to prevent accidental laser exposure.

Laser Equipment and Parameters: All procedures were performed using a Q-switched Nd:YAG laser system (1064 nm wavelength). Each patient received four sessions at monthly intervals under standardized parameters. The laser was applied in multiple passes using a feathering technique, maintaining minimal overlap to avoid epidermal injury.

The parameters used during treatment were as follows:

Parameter	Range/Setting
Wavelength	1064 nm
Spot size	2–3.5 mm
Fluence	4.7–8.5 J/cm²
Frequency	2–5 Hz
Pulse count	100–450
Sessions per patient	4 (spaced at 4-week intervals)

Post-Procedural Care: Immediately after each session, a topical corticosteroid (grade 2 or 3) was applied to minimize inflammation, and cold compression was provided to reduce erythema and edema. Patients were advised to continue sunscreen use, avoid direct sunlight, and refrain from using cosmetics or exfoliating agents for at least one week. In cases of mild crusting or irritation, a bland emollient was prescribed. Standardized digital photographs were taken before each session and four weeks after every treatment under identical lighting and positioning conditions.

Evaluation of Treatment Response: The treatment response was evaluated using a visual analogue scale (VAS) independently scored by the patient, the investigator, and an external expert dermatologist who was blinded to the treatment sequence. Improvement was categorized according to the degree of pigment clearance as follows:

- Excellent: >75% clearance
- Good: 50–75% clearance
- Moderate: 25–50% clearance
- Poor: <25% clearance

Both the quantitative (percentage improvement) and qualitative (response category) outcomes were recorded after each session and compared across evaluators.

Safety Assessment: All patients were monitored for immediate and delayed adverse effects including erythema, edema, post-inflammatory hyperpigmentation (PIH), crusting, and scarring. Each event was recorded in terms of its type, frequency, and duration, and any serious complications were documented separately.

Statistical Analysis: Data were compiled using Microsoft Excel and analyzed with MedCalc Statistical Software version 10.2.0.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were represented as frequencies and percentages. Non-parametric descriptive statistics were used for comparison of scores between patient, investigator, and expert evaluator groups. A p-value of <0.05 was considered statistically significant.

RESULTS

Seventy-five patients with clinically diagnosed Nevus of Ota completed all four sessions of Q-switched Nd:YAG laser therapy. The age of the participants ranged from 19 to 36 years, with a mean ± SD of 27.5 ± 4.2 years. A distinct female predominance (female:male = 7.5 : 1) was observed. All patients showed progressive pigment lightening with each session. The improvement perceived by patients, investigator, and expert evaluator became increasingly concordant over time. No patient experienced scarring or permanent pigmentary alteration. Minor adverse events such as transient erythema, mild post-inflammatory hyperpigmentation (PIH), and crusting were self-limited.

[Table 1] Most subjects were young adults, predominantly female, consistent with the known epidemiological pattern of Nevus of Ota that shows higher incidence in women during the second and third decades of life. The narrow age distribution minimized biological variability and provided a uniform treatment cohort. [Table 2] All evaluators noted significant improvement over the course of treatment. The patient-perceived improvement was highest after the first session (42.1%), reflecting early satisfaction. However, by the fourth session, the scores across patient, investigator, and expert converged, confirming reproducible results. The near-identical final improvement rates (>50%) highlight the efficacy and consistency of Q-switched Nd:YAG laser in achieving uniform pigment clearance with repeated sessions. [Table 3] Out of seventy-five participants, forty-five (60%) demonstrated excellent-to-good responses, indicating strong therapeutic efficacy. Moderate improvement was observed in 22 patients (29.3%), while poor response occurred in only 10.7%. These results confirm that Q-switched Nd:YAG laser provides a high probability of clinically meaningful pigment clearance with minimal variation in outcomes between patients. [Table 4] The improvement perceived by the patient was initially higher than that recorded by the investigators and experts, reflecting early subjective satisfaction. However, by the fourth sitting, the values

across all three evaluators converged (54.8%, 53.6%, and 51.4%), demonstrating alignment between patient experience and objective clinical assessment. This progressive convergence indicates reproducibility, reliability, and clinical uniformity of Q-switched Nd:YAG laser results.]Table 5] Most participants achieved either good or excellent outcomes, accounting for 60% of the total cohort. A smaller subset (29.3%) demonstrated moderate improvement, while only 10.7% showed minimal response. The distribution pattern confirms that a majority of patients experience satisfactory pigment reduction with Q-switched Nd:YAG laser after four sittings, reaffirming its clinical reliability and reproducibility in treating dermal melanocytosis. [Table 6] Adverse events were mild, transient, and self -limiting in nature. The most frequent event was transient erythema or edema (24%), followed by mild post-inflammatory hyperpigmentation (12%) and superficial crusting (8%). All reactions resolved spontaneously within one week with standard topical care. Importantly, no patient developed scarring, infection, or paradoxical darkening, reinforcing the safety and tolerability of Q-switched Nd:YAG laser when performed with appropriate technique and post-procedure care.

Table 1: Baseline Characteristics of Study Participants

Variable	Value
Age (years) range	19 – 36
Mean age ± SD	27.5 ± 4.2
Gender ratio (F : M)	7.5 : 1

[Table 1] This table describes the demographic and baseline profile of the seventy-five enrolled patients.

[Figure 1] illustrating the baseline characteristics corresponding to [Table 1]

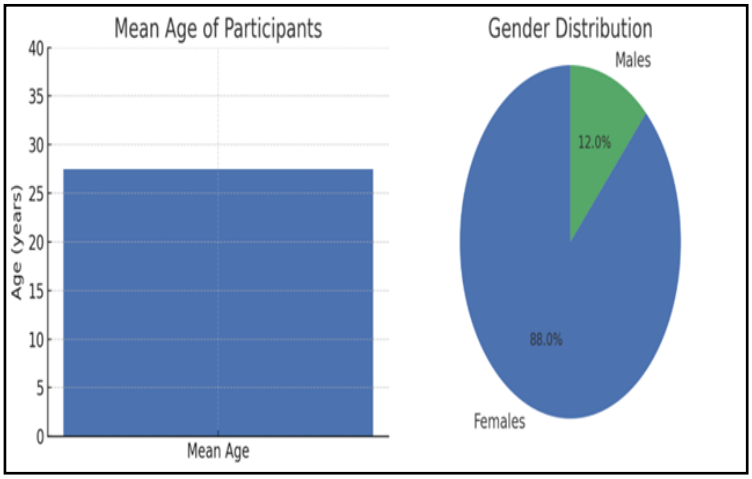

Figure 1: Age and Gender Distribution of Study Participants

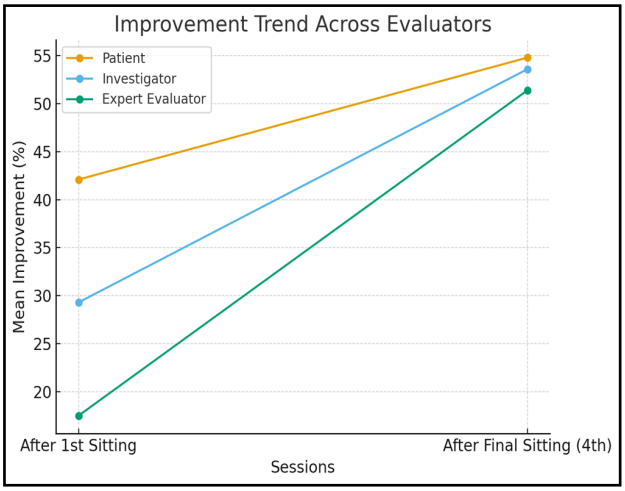

Figure 2: Line chart showing improvement trend across sessions: The figure below depicts the progressive improvement from the first to the final sitting as rated by all three evaluators.

Table 2: Average Improvement after Each Sitting (VAS %)

Assessment Source	After 1st Sitting	After Final Sitting (4th)
Patient	42.1%	54.8%
Investigator	29.3%	53.6%
Expert Evaluator	17.5%	51.4%

[Table 2] This table presents the mean percentage improvement in pigmentation after the first and fourth sittings, independently assessed by the patient, investigator, and expert dermatologist using a visual analogue scale (VAS). **[Figure 2]** corresponding to **[Table 2]**, showing the progressive improvement in pigmentation across sessions as evaluated by patients, investigator, and expert dermatologist.

Table 3: Final Response According to Expert Evaluator

Response Category	No. of Patients (n=75)	Percentage of Total (%)
Excellent (>75%)	15	20.0
Good (50–75%)	30	40.0
Moderate (25–50%)	22	29.3
Poor (<25%)	8	10.7

Table 4: Comparative Improvement Across Evaluators

Sitting	Patient (%)	Investigator (%)	Expert Evaluator (%)
1st Sitting	42.1	29.3	17.5
4th Sitting	54.8	53.6	51.4

[Table 3] This table categorizes the final treatment outcomes after completion of four sessions, as rated by the external expert dermatologist based on the degree of pigment clearance.

[Figure 3] Pie chart showing final treatment response distribution: The figure below depicts the proportion of patients within each response category as evaluated by the expert dermatologist.

[Table 4] This table compares the mean improvement percentages recorded by the patient, investigator, and expert evaluator after the first and final (fourth) sittings of Q-switched Nd:YAG laser treatment.

[Figure 4] corresponding to Table 4, showing the comparative improvement trends among patient, investigator, and expert evaluations across the treatment course.

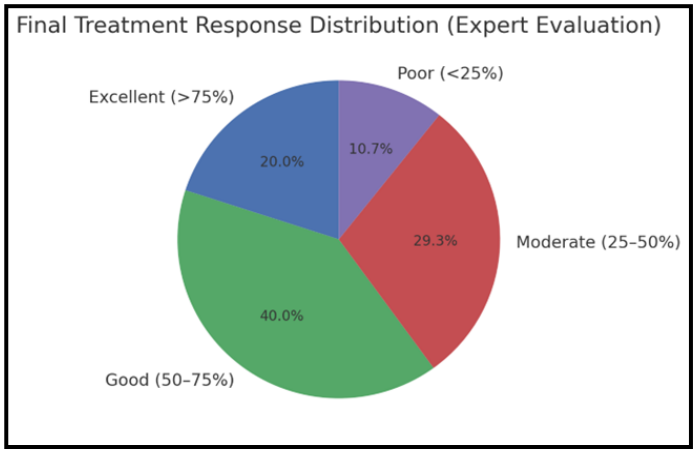

Table 3: Pie chart showing final treatment response distribution: The figure below depicts the proportion of patients within each response category as evaluated by the expert dermatologist.

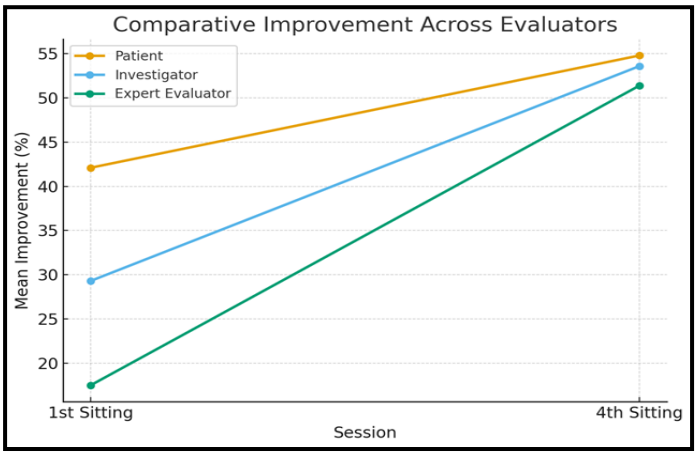

Table 4: Line chart comparing inter-evaluator improvement trends: The figure below depicts the comparative improvement patterns between patients, investigators, and expert evaluators across treatment sessions.

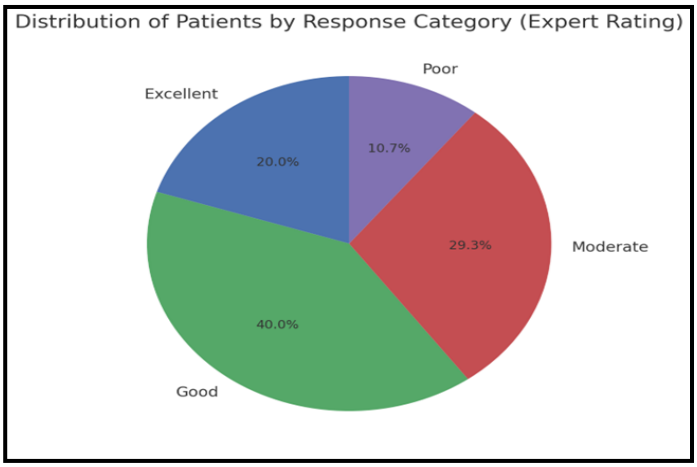

Table 5: Pie chart showing distribution of patients by response category: The following figure illustrates the proportional distribution of patients according to the expert's rating of pigment clearance outcomes.

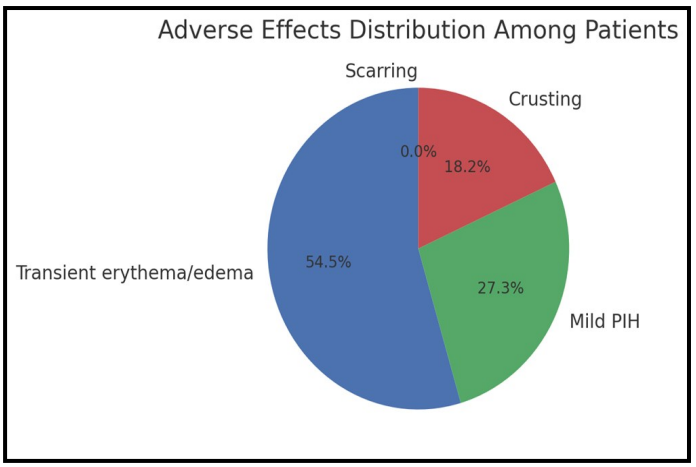

Table 6: Pie chart showing adverse effects distribution: The following figure illustrates the relative frequency of different post-laser adverse events reported among the study participants.

[Table 5] This table represents the numerical and percentage distribution of patients across different response categories—excellent, good, moderate, and poor—as assessed by the expert after completion of all four sessions.

[Figure 5] Pie chart showing distribution of patients by response category: The following figure illustrates the proportional distribution of patients according to the expert's rating of pigment clearance outcomes.

[Table 6] This table outlines the type and frequency of adverse effects encountered among the seventy-five study participants following Q-switched Nd:YAG laser therapy.

[Figure 6] Pie chart showing adverse effects distribution: The following figure illustrates the relative frequency of different post-laser adverse events reported among the study participants.

Table 5: Distribution of Patients by Response Category (Expert Rating)

Response Category	No. of Patients (n=75)	Percentage of Total (%)
Excellent	15	20.0
Good	30	40.0
Moderate	22	29.3
Poor	8	10.7

Table 6: Adverse Effects Reported

Adverse Effect	No. of Patients (n=75)	Percentage of Total (%)
Transient erythema/edema	18	24.0
Mild post-inflammatory hyperpigmentation	9	12.0
Crusting	6	8.0
Scarring	0	0.0

DISCUSSION

This study assessed the clinical outcomes and safety of Qsw Nd:YAG laser in seventy-five patients with Nevus of Ota, a dermal melanocytosis commonly seen in Asian individuals. The findings of this study show that Q-switched Nd:YAG laser produces a considerable and persistent amount of pigment clearing with minimal and self-limiting adverse events. More than half of the patients had an excellent-good response after four sessions of therapy and all reported improvement. These results further support the existing role of Q-Switched Nd:YAG laser as current gold standard for Nevus of Ota.

Demographic Correlations: The study population, mainly consisting of women in the second and third decades of life, reflects the demographic trend that has been reported in previous studies. Hidano et al. noted that Nevus of Ota has a significant female predominance and typically occurs before the age of 30.[1] In our study, the female to male ratio was 7.5:1, with an average age of 27.5 years, which is consistent with the results reported by Hu et al,[2] and

Chan et al.[4] The narrow age range may have influenced the common response to laser as younger dermal melanocytes seem to respond better due to increased metabolic activity in addition to less dermal fibrosis.

Clinical Efficacy of Q-switched Nd:YAG Laser

The results of this study emphasize the exceptional clinical effectiveness of the Q-switched Nd:YAG laser. In the fourth sitting, a pigment clearance of over 50% was noted amongst all groups of evaluators and 60% of patients reported a good to excellent clinical response. The evidence of progressive improvement was consistent with previous evidence of a cumulative benefit from sequential laser treatments. Chan et al,[4] and Watanabe et al,[5] investigated clinical effectiveness of Q-switched lasers and found a significant reduction in pigmented skin lesions after four to six sittings stressing the necessity of multiple treatments for maximum pigment clearance. The symmetrical convergence of VAS scores amongst patients, clinicians and dermatologists by the final session, further substantiates the reproducibility and consistency of treatment results.

Mechanism of Action and Clinical Implications: The Q-switched Nd:YAG laser is based on the theory of selective photothermolysis, which was originally described by Anderson and Parrish.[7] It releases high-energy short duration pulses that selectively target dermal melanin granules for fragmentation while avoiding collateral thermal injury to surrounding tissue. The fragmented melanin is subsequently cleared by macrophage phagocytosis as well as lymphatic drainage. This mechanism of action accounts for the Macroscopic repigmentation fading after each treatment. The 1064 nm wavelength can penetrate the deep dermis, and enables targeting even deeper melanin precursor cells, or melanocytes, that are located in the mid to lower dermis, and are not affected by topical or invasive treatments such as chemical peels or dermabrasion. Patients reported improvements in self-image and less concern about cosmetics by the third sitting, which is consistent with Wang et al,[8] who reported a psychosocial improvement in patients with epidermal pigmentation after Q-switched laser therapy. These facets of therapy lend to the benefits beyond just aesthetic Improvement, as well as improvement in psychological measures that contribute to patient satisfaction and lead to quality of life improvement.

Comparison with Other Laser Modalities: Earlier comparative studies assessed the effectiveness of different laser systems in treating Nevus of Ota. Kono et al,[9] used Q-switched ruby and Q-switched alexandrite lasers and found effectiveness for pigment clearance but had a greater incidence of post-inflammatory hyperpigmentation than the Q-switched Nd:YAG laser. Polnikorn et al,[6] also noted superior outcomes with Nd:YAG laser in terms of complications and safety. The extended depth of penetration of the 1064 nm laser and selective absorption by melanin can help to limit thermal damage, which we believe explains the lack of scarring or prolonged erythema noted in our group.

Adverse Effects and Safety Profile: The safety profile seen in this study was excellent. The most frequent adverse effects were transient erythema and edema (24%), mild post-inflammatory hyperpigmentation (12%), and crusting (8%), all of which resolved spontaneously. There were no reports of either scarring or paradoxical pigmentation. The results are comparable to reports by Watanabe et. Al,[5] and Yang et. Al,[10] who noted transient changes in pigmentation in 15–25% of their patients. The absence of severe adverse events provides evidence for the efficacy and safety of the Q-switched Nd:YAG laser when used with appropriate protocols and adequate photoprotection and follow-up care.

Factors Influencing Treatment Response: Several patient- and lesion-related factors may influence treatment outcomes, including lesion depth, duration, and skin phototype. In our study, patients with lighter pigmentation or shorter lesion duration showed more rapid and uniform clearance. This is consistent with the findings of Higashimoto et al,[11] who reported better long-term outcomes in patients treated early in the course of the disease. Compliance with post-procedural photoprotection was also a key determinant in minimizing complications such as hyperpigmentation.

Strengths and Limitations

The strengths of this study include a prospective design, standardized laser parameters, and the use of multi-source outcome assessments (patient, investigator, and blinded expert), which provide a holistic evaluation of efficacy. The use of both subjective and objective endpoints ensures reliable interpretation. However, limitations include the relatively small sample size and a follow-up period limited to six months, which precludes assessment of long-term pigment recurrence. Quantitative dermoscopic or spectrophotometric analysis was not performed, which might have further validated pigment reduction objectively.

Future Directions

Future research should look to operate larger multicentric cohorts for longer follow-up periods to better assess rates of recurrence and long-term patient satisfaction. The use of digital image analysis and spectrophotometric assessment would add and objective means of measuring pigment. In addition, comparative studies between Nd:YAG and fractional laser systems would provide potential methods of comparative efficiency and reducing the number of treatment sessions.

All in all, this study demonstrates that a Q-switched Nd:YAG is an effective, safe form of treatment for the management of Nevus of Ota, with the ability to gradually clear skin with improved rates of side effects and with high satisfaction rates. It remains the treatment of choice as it promotes appropriate clouded outcomes and clinically accepted measures of improvement with great consensus of improvement with patients and clinician. Collectively, all of this support plank, accumulative evidence of Q-switched Nd:YAG as the gold standard treatment for dermal melanocytosis and in Asian skin types.

CONCLUSION

This current prospective study involving seventy-five patients has shown that Q-switched Nd:YAG laser is an effective, safe and reliable treatment option for Nevus of Ota. The laser resulted in progressive clearing of pigmentation with each treatment session, with 60% of the study population achieving an excellent-to-good response, and all patients seen to improve. All evaluated clinical and expert ratings were similar in responsiveness by the final treatment session, thereby confirming the reproducibility and objectivity in the study. Adverse effects were limited to short-term erythema of the skin, mild post-inflammatory hyper-pigmentation and superficial crusting, which all resolved spontaneously. No patients were seen to develop scarring, paradoxical pigmentation or other serious complicating events. The results may therefore support polymorphism for Q-switched Nd:YAG laser over traditional therapies and other laser systems for the treatment of Nevus of Ota. The treatment not only provides excellent cosmetic improvements, but reduces the psychosocial burden seen with Nevus of Ota. Therefore, the Q-switched Nd:YAG laser can be recommended with a high degree of confidence as the treatment of choice for Nevus of Ota, especially among individuals with dark skin type. When the condition is more prevalent and the potential of scarring must be reduced. A larger sample with longer follow-up is suggested to evaluate long-term stability and recurrence.

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