

## Case Report

# QS Nd YAG Laser: Single Technology with Multiple Cosmetic Applications

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### Abstract

**Introduction:** Nd:YAG (neodymium-doped yttrium aluminum garnet) laser is the most widely used pigment specific laser used in dermatology. The effect of Q-switching allows delivery of powerful laser pulses with high peak power within short pulse duration. Following the theory of selective photothermolysis, melanosomes and tattoo particles are selectively targeted.

**Multiple Applications:** Earlier used for just tattoo removal and pigmentary disorders, Q-switched Nd YAG laser (QSNLY) is now becoming a popular choice for skin rejuvenation, dermatoheliosis, vascular lesions, skin lightening, acne and onychomycosis as well. Further, with the introduction of novel picosecond domain pulses and QSNLY working at wavelengths other than 1064 and 532nm, a whole new arena of applications and possibilities have unraveled themselves. Low fluences are regularly used for conditions like melasma, skin rejuvenation and vascular lesions.

**Conclusion:** QSNLY is a practical, ever-evolving non-ablative laser system with a wide range of applications. Even though its spectrum of complications, especially in skin type IV and above, cannot be overlooked, neither can its versatility. It is a must have technology in a cosmetic setup.

## Introduction

A non-ablative and selective photothermolysis system, quality switched Nd:YAG laser (QSNLY) is a cosmetic dermatologist's very own workhorse. Originally developed by Geusic et al. in 1964, it is commonly used to treat a variety of pigmentary disorders and for tattoo removal. It causes dermal, epidermal and melanocytic melanosome rupture and destruction of dermal melanophages, thereby decreasing the pigment in the lesion [1,2].

### What Is Q-Switched Nd:Yag Laser?

To explain simply, laser is a type of light that carries only a specific wavelength, as opposed to visible light that carries a range of wavelength. Qualities of laser light waves are that they are parallel to each other and are in the same phase. Visible lights are not parallel and does not move temporally in

the same phase. There are many lasers in the market. Nd:Yag laser is named after the laser medium, Neodymium:yttrium-aluminum-garnet.

It comes in 2 wavelengths, 1064 nm and 532 nm. It is a non-ablative laser. This means that there is no break in skin tissue continuity during the treatment. It is designed to target pigment cells penetrating 3 to 6 mm [2]. Q-switching refers to the technique of making the laser produce a high intensity beam in very short pulses. 1064 nm, in the infrared wavelength, targets deeper pigment while 532 nm wavelength is useful for superficial lesions [3]. This specific wavelength are absorbed preferentially by pigments (melanin) and the resultant heat will cause generation and propagation of waves that cause damage to the cells containing pigment. These damaged cells will then be cleared from the site resulting in lightening of the pigmented site.

## Applications Of Qs Nd:Yag Laser In Cosmetic Dermatology Practice

In a cosmetic practice in our part of the world ( India), QS NdYAG laser is the most talked about technology in a cosmetic technology mainly because of the eternal demand for fairness and also because the pigmentary disorders are in abundance. In a cosmetic practice, there is a demand for treatments with no or minimal downtime. QS NdYAG laser is ideal for multiple uses in cosmetic practice. Following are established uses of this laser technology:

### Tattoo

Though Q-switched ruby and Q-switched alexandrite lasers have been earliest lasers for tattoos, Q-switched NdYAG 1064 nm, due to its longer wavelength, higher fluence, and shorter pulse, has emerged as a better laser for the black and dark blue/ black tattoo pigment. The textural changes, scarring, and hypopigmentation of earlier lasers are remarkably low [4] (Figure 1). QSNDYL 1064 nm is a longer wavelength, minimally absorbed by epidermis, hence is the safest choice with minimal adverse effects in skin type VI and above [2].



Figure 1: Tattoo removal; after 3 sessions of QSNDYL.

Recently, the picosecond (ps) -domain pulses have been found to be more effective than ns pulses for removing all tattoos. While using the former, lower fluences are capable of delivering desired results as higher peak powers and superior photoacoustic effect over longer pulse-durations are attained. Furthermore, the removal of yellow ink more efficiently is an added advantage [4].

### Melasma

Melasma is an agonizing pigmentary disorder, notorious mainly due to its tendency to recur. Topical formulations like triple therapy; Kligman and Willis' formula; broad-spectrum photoprotection and camouflage constitute the first line therapy while chemical peels find their place in the second. Even till date, Laser and light therapies represent the third line, reserved mainly for refractory cases (Figure 2) as they pose a risk of worsening the disease. Nevertheless, low fluence mode laser toning with QSNDYL 1064nm has emerged as an effective option without serious side effects [5]. Longer wavelength penetrates deeper to target the dermal melanin without

affecting the overlying epidermis and the lower fluence causes rupture of melanosomes and release of the fragmented melanin granules in the cytoplasm [6].



Figure2: Melasma; after 6 sessions of QSNDYL.

### Vascular lesions

QSNDYL can be used to treat spider and thread veins, capillary malformations, varicose veins, telangectasia and small hemangionas. Short pulse duration, low fluence and quick repetitive bursts help in targeting superficial dermal vessels [3]. Lately, a novel low-fluence 585 nm QSNDYL was introduced and found efficacious in the treatment of post-acne erythema with negligible discomfort and quantifiable improvement. The clinical study included 25 patients with post-acne erythema, who underwent 3 sessions of laser treatment at 0.30-0.5 J/cm<sup>2</sup> fluence and 5mm spot size at 2-weekly intervals and at the end of 6 weeks displayed quantifiable improvement. Hence, in this lies a new therapeutic modality for inflammatory acne and initial acne scarring [7].

### Onychomycosis

Oral antifungals have ruled the onychomycosis therapy scene for decades. However patients are alarmed by drug interactions and systemic adverse effects as the treatment is continued for months. Surgical treatment too results in prolonged pain. In a study by Moon et al, 13 patients were subjected to 5 monthly sessions of long-pulsed Nd YAG laser treatment, of which all responded with more than 50% improvement in the condition. Therefore, a latest, safe and effective therapy has emerged to improve this ungual pathology; by eradicating the causative fungi; as well as the aesthetic appearance of the nails [8].

### Skin Rejuvenation and Rhytides

Another popular use of QSNDYL is laser toning for skin rejuvenation done at low fluence (less than 5J/cm<sup>2</sup>) and large spot size (8mm) settings. Improvement of pore size, sebaceous secretion, and skin texture and tone summarizes the rejuvenation effect (Figure 3) which is attributed to sub-threshold thermal heating of the dermis resulting in increase in collagen, elastin and dermal remodeling [6]. In contrast to the previous belief, topical carbon solution application did not enhance laser efficacy in several studies [9].



**Figure3:** Laser toning for skin rejuvenation, tone and textural improvement, after 6 sessions of QSNDYL.

A study of human skin fibroblasts explained the pathogenesis of use of QSNDYL in this condition. It concluded that synthesis of type I and III procollagen, inhibition of collagen degradation by downregulation of matrix metalloproteinases and upregulation of its tissue inhibitors is the underlying mechanism for the effect. Further, the investigators stated QSNDYL to be more effective for skin rejuvenation than the KTP laser [10].

## Dermatoheliosis

Photodamaged skin is described by thinning of the epidermis and dermis, coarse skin texture, rhytides, pigmentation, and telangiectasias. 1064nm QSNDYL can improve each of these components. Therefore its use in dermatoheliosis is promising, that too in the absence of an obvious downtime [11].

## Hair reduction

The laser in talk has been effectively used for hair reduction since many years. However, the longer-pulse (ms) has been shown to be more effective in safely removing hair than QSNDYL [3]. In spite of the recent advances in hair removal, fine hair still remain a therapeutic challenge for cosmetologists to face up to. An electro-optic QSNDYL was devised for the permanent treatment of unwanted fine hair and showed a high-patient satisfaction rate. Further studies are needed to reinstate its efficacy [12].

## Pigmented lesions

Post-inflammatory hyperpigmentation, lentigens, freckles, melanocytic nevi like nevus of Ota (Figure 4), nevus of Ito, Hori's nevus etc and Mongolian spots are few common pigmentary conditions where QSNDYL is used even as a first line of treatment. It highly absorbs melanin at 532nm and hence, even up to date no other laser like the Q switch ruby laser, and alexandrite laser or light based device like the intense pulsed light (IPL) matches its utility in these conditions [2].



**Figure4:** Nevus of Ota; after 6 sessions of QSNDYL.

## Inflammatory and non-inflammatory acne

For ages, drugs in oral or topical form and chemical peels ruled the scene when it came to treatment of acne vulgaris. Nowadays, laser and light based devices, though less popularly, are being used for the same purpose with impressive results. A novel technique using dual mode (quasi-long pulse and Q-switched mode) 1064-nm NdYAG laser following topically applied carbon suspension reckons to improve inflammatory as well as non-inflammatory acne with minimal downtime. The laser penetrates the dermis and selectively targets sebaceous glands causing thermal damage and acne clearance [13].

## Laser facial & Skin Whitening

In India and also in most parts of Asia, skin whitening and fairness is a huge cosmetic demand for most practitioners. Laser facial with low fluence, large spot size 1064 nm, is ideal for immediate skin lightening as well as hair reduction with minimum or no downtime. An immediate skin cooling and application of a facial peel off mask gives an immediate skin brightening and even skin tone. This procedure can be repeated once in 4-6 weeks for maintained results.

## Complications of QSNDYL Laser

Like any laser, use of QSNDYL too is haunted by few complications. However, most are transient reactions and do not require termination of treatment. These include erythema, physical urticaria, acneiform eruption, petechiae, whitening of fine hair and rebound hyperpigmentation. On the other hand, occurrence of mottled hypo/ hyperpigmentation, leukoderma, severe urticaria or acneiform eruption and activation of herpes simplex warrants modification of laser parameters and if required, even termination of therapy. Ghost shadows and scarring are adverse effects associated with tattoo removal at higher fluencies [14]. Recently, a Chinese study interpreted the factors inducing mottled hypopigmentation associated with QSNDYL laser toning done for melasma and skin rejuvenation. Low fluence, large spot size, frequent treatments i.e. weekly or fortnightly, done for longer periods of 1-2 years were deemed to be responsible. They further opined that this hypopigmentation doesn't respond well to treatment and persists for many

years. Hence, caution is advised. Indication, skin type, parameters and duration of therapy should be well considered before undertaking laser treatment [15].

## Conclusion

The QSNDDL is one of the most resourceful and versatile lasers in dermatology. No other laser provides such a wide spectrum of applications, that too without much downtime. However, complications like recurrence, post-inflammatory hyperpigmentation, mottled hypopigmentation and ghost shadows still limit its use in various conditions. It is a therapeutic gold standard for tattoo removal and pigmented lesions and many more of its utilities are either being studied or yet to be discovered. Furthermore, in today's day and age, the proactivity about delaying the natural aging process as well reversing, what can be reversed, of the existent damage has made QSNDDL a cosmetologists ace tool for treatment of skin pigmentation, photoaging, rhytides and dullness. Nonetheless, with so many effective anti-ageing modalities already present, it definitely also finds its place as a maintenance system. It is definitely a must for a cosmetic practice considering its multiple applications.

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