

White Paper

Treatment of Pigmented Lesions with a Q-Switched 532nm Laser

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INTRODUCTION

Sun damaged skin, also referred to as photoaging, is a common condition for the current aging population. It is most prevalent in fair-skinned individuals (Fitzpatrick skin types I-III), in sunny geographic regions, among the 40 to 60-year-old age group. One of the consequences of chronic ultraviolet (UV) exposure is hyperpigmentation of the skin, which is commonly seen as benign pigmented lesions such as freckles (ephelides) and liver spots (solar lentiginosities).

Prior to the introduction of laser therapy, treatment regimes for photoaging included topical creams, dermabrasion, chemical peeling, and cryosurgery. During the past twenty years, light-based technology has emerged as a highly effective and target specific modality for the treatment of hyperpigmentation in photoaged skin.

The following case reports discuss the use of laser treatments for benign epidermal pigmentation conditions with the use of the RevLite® 532nm (1064nm frequency doubled) Q-Switched Nd:YAG laser.

PATHOGENESIS

Melanin is found in the lower level of the epidermis and has a functional role in the skin to protect cellular organelles and DNA from the harmful effects of ultraviolet radiation.²⁻⁵ Melanin is synthesized by melanocyte cells when the skin is exposed to UV radiation. Melanin is then packaged in melanosomes and distributed to keratinocytes, which migrate to the top of the epidermis, thus forming a protective layer of pigmentation. UVA (315-400nm) and UVB (295-315) wavelengths are highly absorbed by melanin.^{3,4}

However, chronic exposure to sunlight stimulates the epidermal melanocyte system, resulting in a dysfunctional interaction between melanocytes and keratinocytes.⁴ This is clinically evident as irregular pigmentation with areas of hypopigmentation and hyperpigmentation, such as darkened ephelides and lentiginosities.

BACKGROUND

Laser therapy for benign pigmented lesions has been studied over the past two decades. The ability to effectively and safely treat this condition has been a result of these studies and the improvements made in light-based technologies.⁵

Melanin as a chromophore is highly absorbed by the 532nm wavelength which makes the 532nm laser ideal for targeting melanin. For the removal of solar lentigines and ephelides, the objective is to deliver laser energy that is highly targeted and absorbed in a short pulse within the epidermis and to minimize thermal diffusion to surrounding tissue. This theory of selective photothermolysis, first discovered by Anderson and colleagues, stipulates that the pulse duration should be shorter than the thermal relaxation time of the targeted tissue. This ensures that the energy is delivered to the melanin in the targeted lesion only and has insufficient time to extend to the surrounding tissue.⁵ In addition to thermal injury, the Q-Switched laser also delivers photoacoustic energy with rapid nanosecond pulses, which further scatters and disrupts the pigment. For these reasons, the 532nm Q-Switched laser is an ideal wavelength for the treatment of benign epidermal pigmented skin lesions.

Several studies support the use of the Q-Switched 532nm laser in the treatment of epidermal lesions.⁶⁻¹⁰ Anderson and colleagues were the first to report the success of selective thermolysis for cutaneous pigmentation using a frequency-doubled Nd:YAG laser with the 532nm wavelength. In their study, irradiation of pigment on guinea pigs caused an immediate ash-white macule within the exposure area. At twenty-four hours, scattered dyskeratotic epidermal cells were noted, and on day eight, the regenerated epidermis demonstrated pigmentation similar to non-irradiated skin. These light microscopy findings demonstrated a marked reduction in lesional pigmentation without any effects on the epidermis.⁷

Following this study, Kilmer and colleagues performed a multi-center study on humans for the treatment of lentigines. Their objective was to deliver thermal damage to a specific target (lentigine) and minimize injury by selection of a wavelength that is well absorbed by the target, and delivered in a short nanosecond pulse; whereby the pulse duration is shorter than the thermal relaxation

time of the targeted tissue and thereby minimizes collateral damage to surrounding tissue. In the study, a frequency doubled Q-Switched Nd:YAG laser (ConBio, a Cynosure Company, Fremont, CA) using a 532nm wavelength was used and the lesions were irradiated with a single treatment delivered at 10 nanoseconds with a 2 mm spot size. They reported greater than 75% pigment removal in 60% of the lesions treated. No textural changes, scarring, or other side effects were reported.⁸

In 2010, Patel and colleagues completed a study to evaluate the use of both a short-pulse 532nm laser (10ns, 1 J/cm²) (ConBio, a Cynosure Company, Fremont, CA) and a long pulse 532nm laser (10ms, 1 J/cm²) (Laserscope, San Jose, CA) for the removal of freckles (ephelides) in patients with Fitzpatrick skin types I-IV.⁹ The study included 17 sets of freckles that underwent one treatment of laser irradiation. All of the lesions that were treated with the short-pulsed laser had immediate whitening, which turned to crusts the next day. None of the lesions treated with the long-pulsed laser developed immediate whitening or crusts. Patients that were treated with the short-pulse laser reported an average of 72.4% improvement, while only 20% improvement was reported in the long-pulse group. The study confirmed that when using the same energy settings, the short-pulse 532nm laser was more effective than the long-pulse 532nm laser for removal of ephelides, and these treatments have high tolerability with minimal side effects.

In addition, Ostovari and colleagues studied the use of the Q-Switched Nd:YAG laser (532nm and 1064nm) to reduce hyperpigmentation as a result of amyloidosis.¹⁰ Macular amyloidosis exhibits brown macules or poorly delineated, hyperpigmented, spotty patches on the skin. Amyloid material is deposited in the upper dermis and close to the basal cell layer of the epidermis, resulting from keratinocyte degeneration. Twenty subjects with a mean age of 47, and Fitzpatrick skin types of I-IV, with a pathology-proven diagnosis of macular amyloidosis, were treated with a Q-Switched 532nm laser in part of their plaques and a Q-Switched 1064nm Nd:YAG laser in another part of their plaques. A colorimetric assessment of the macular amyloidosis pigmented patches using a Mexameter and digital photographs were taken prior to treatment and eight weeks after

treatment. For each patient, one selected area was treated using the Q-Switched 532nm with a spot size of 3 mm, and fluence of 4.5 J/cm². A second area was treated using the Q-Switched 1064nm with a spot size of 3 mm and a fluence of 14 J/cm². No local anesthetic was used in either treatment. At eight weeks, the patient returned for follow-up evaluation and the treatment areas were photographed and scored calorimetrically. Photographic evaluation by two independent physicians reported very good or good response in 90% of the patients treated with the Q-Switched 532nm laser, while 60% of patients treated with the 1064nm Q-Switched laser had a very good or good response. The Mexameter data showed significantly greater reduction in pigmentation with the 532nm compared to the 1064nm Q-Switched lasers. Prior to treatment, the mean Mexameter score for macular amyloidosis was 408 and normal skin was 194. At eight weeks, the mean score for the area treated with the 532nm was 231 while the 1064nm score was 288. No signs of hypopigmentation or scar formation were observed in any of the treated sites.

METHODS

Prior to the procedure, the patients were instructed to avoid sun exposure for four weeks. On the day of treatment, an assessment was performed by the physician noting the presence of benign facial pigmented lesions (such as lentigines and ephelides) and Fitzpatrick skin type. The area was cleansed with an astringent toner. BLT ointment (20% benocaine, 6% lidocaine, and 4% tetracaine) was applied for anesthesia, if desired, for 45 minutes and removed prior to treatment.

Parameter settings were determined based on the patient's Fitzpatrick skin type, degree of skin lesional pigmentation, and clinical response to a test spot. The average treatment parameters used with the Q-switched 532nm were a 2-5 Hz, 0.6-1.0 joules, and a spot size of 6 mm for skin types I-III.

Test spots were performed in a linear strip of four to six pulses along the lateral jaw line prior to treatment, using a range of fluences. The test spots were evaluated after two to three minutes for the desired clinical end point of pigmented lesion whitening and signs of erythema, edema and petechiae. The test spot fluence resulting in pigmented lesion whitening with rare to no petechiae of the surrounding skin was selected as the treatment fluence.

Treatments were started on the lateral inferior cheeks and preceded medially and superiorly. The distance guide was in direct contact with the skin at all times and each spot had an overlap of 20% with the previously treated spot. The entire face (excluding upper and lower eyelids) was irradiated with one pass.

For post treatment care, patients were instructed to ice the area for a 10 minute period every hour on the day of treatment, or as needed for edema and erythema. Hydrocortisone 2.5% cream was applied two times per day for three to five days until erythema resolved, daily physical sunscreen with SPF > 30 and a hydrating cream at night (e.g. Epidermal Repair by SkinCeuticals).

Subject 1

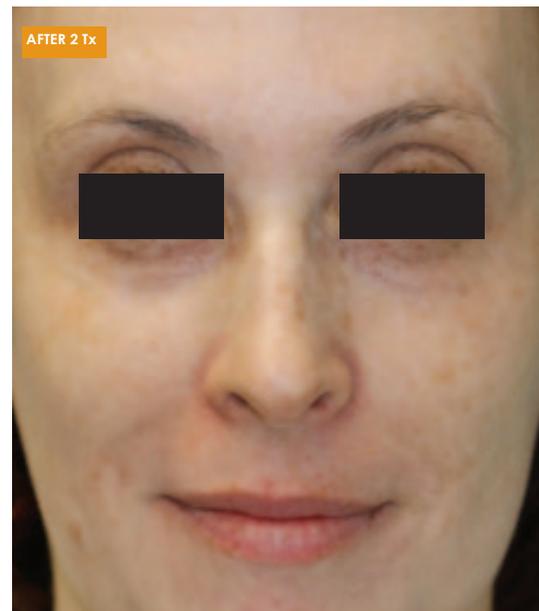
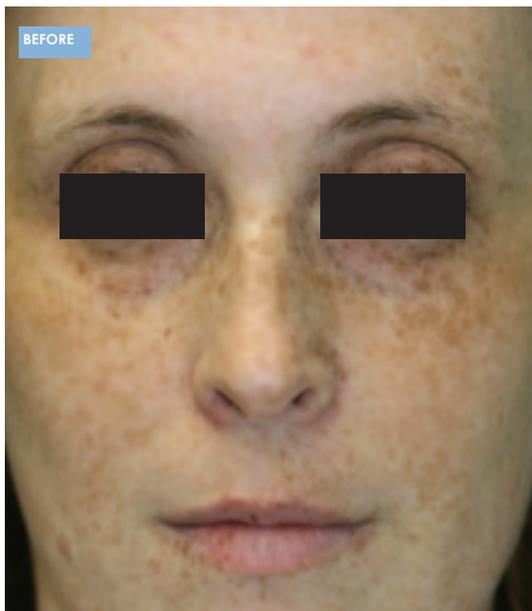
A 37-year-old female skin type II, presented with a history of freckles (ephelides) on the face.

The treatment was performed with laser parameters of 5 Hz and 0.6 joules with a spot size of 6 mm, with BLT used as a topical anesthetic. One year later, the patient returned for a repeat treatment to achieve further clearance. The patient requested no use of anesthesia and therefore the laser settings were reduced to 2 Hz and 0.6 joules with the same spot size (6 mm) to maintain comfort and efficacy. This patient was also prescribed Zyrtec 10 mg one tablet per day for two days for postprocedure hives.

RESULTS

The lesions darkened at the time of treatment and microcrusts flaked off over a period of seven to ten days. Post procedure erythema lasted four days. At one month, the physician assessed a 50-60% improvement from baseline with no side effects.

In the second treatment at the one-month follow-up, the physician assessed a 70-80% clearance of the lesions with no side effects. The patient rated satisfaction of the treatment as "very satisfied" and the treatment tolerability as fair without the use of a topical anesthetic.



Subject 2

A 50-year-old female skin Type II presented with a history of solar lentigines and fine lines on the face.

Topical anesthetic (BLT) was used prior to treatment. The laser was set to 5 Hz and 0.8 joules with a spot size of 6 mm.

Eighteen months later the patient returned for a repeat treatment to achieve further clearance and for treatment of fine lines. For the second treatment the laser settings were increased slightly to 5 Hz and 1.0 joules with a spot size of 6 mm.

Subject # 3



RESULTS

One day post procedure, moderate erythema, edema, and whitening of the sun spots were observed. At one month, the physician assessed the improvement as excellent with 100% clearance of the sunspots with no side effects, with one treatment. The patient rated the tolerability of the treatment as "very well" and rated the efficacy of treatment as "very satisfied."

RESULTS

On the first postoperative day, moderate erythema and mild edema were noted, which cleared after four days. Pigmentation turned a grey color and cleared by five days. At one month, the physician assessed a 40-50% improvement in pigmentation and fine lines when compared to baseline with no side effects.

At the second treatment at 18 months, post-op results were similar to the first treatment noting moderate edema and erythema with a grey color change to the pigmentation. One month following treatment, the patient achieved a 60-70% clearance of the lesions and fine lines with no side effects. The patient rated satisfaction of the treatment as "very satisfied" and the treatment tolerability as moderate.

Subject 3

A 48-year-old female skin type II presented with sunspots on the face.

Prior to the treatment, topical anesthetic (BLT) was applied. The treatment was then performed with two separate passes. The first pass covered the full face and the parameters were set at 1.2 J/cm² with a spot size of 6mm. The second pass was for treatment of the specific sunspots and the parameters were set at 0.9 J/cm² with a spot size of 4 mm.

DISCUSSION

Laser treatment of benign pigmented lesions has been studied for over twenty years with various wavelengths. In order to optimize the efficacy of treatment, three factors need to be considered when treating epidermal pigmented lesions.

Firstly, the target must be highly absorbed by the laser wavelength used. As previously discussed, melanin is highly absorbed by the 532nm wavelength. As the wavelength increases, melanin absorption declines.

Secondly, the depth of the lesions in tissue must correspond to the wavelength. Solar lentigines and ephelides are located very superficially in the epidermal layer. Therefore, these lesions are effectively targeted by shorter wavelengths, such as 532nm.

Lastly, the laser energy needs to be delivered in a short pulse with a high peak power because of rapid thermal relaxation by melanosomes. Q-switched technology provides high peak power pulses, which can be delivered in 10 nanoseconds, which is greater than the thermal relaxation of melanosomes.

As a result of combining these features, the RevLite Q-switched 532nm laser remains the gold standard for treatment of epidermal pigmented lesions such as lentigos and ephelides.

CONCLUSION

The RevLite Q-Switched 532nm is a highly effective and safe modality for the treatment of benign pigmented lesions in Fitzpatrick skin types I-III.

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