NON ABLATIVE TREATMENT OF MELASMA UTILIZING A Q-SWITCHED Nd:YAG LASER PEEL ASSISTED WITH A TOPICAL CARBON PHOTOENHANCER LOTION, AND ADJUNCTIVE TREATMENT WITH 633 nm RED LED LIGHT

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Abstract

Objective: The purpose of this clinical study was to determine the effectiveness of treatment for melasma using combination therapy with a 633 nm red light emitting diode (LED)- based system and a Q-switched Nd:YAG laser with a topical carbon photoenhancer lotion.

Materials and Methods: Thirty-four human subjects with melasma, skin types III and IV and aged in their 30's to their 50's were treated with (experimental group) or without (controls) the Nd:YAG laser peel and 633 nm LED therapy over 4 sessions at our clinic. Initially cosmetic skin rejuvenation was accomplished using the topically applied lotion with carbon in suspension and the Nd:YAG laser at wavelength of 1064 nm, fluence of 1.8 - 2.3 J/cm^2, a pulse duration of 5 ns (Q-switched) with a fixed beam diameter of 7 mm, and patients were subsequently treated with 17 minutes of 633 nm LED phototherapy. As the post treatment protocol, all patients were given oral medicine and topical medication. Treatment sites were evaluated for melasma at the baseline.

Results: After a 2-month follow-up, the improvements were rated objectively by the investigators and subjectively by the patients. The investigators and patients reported improvements in melasma compared to the base line.

Conclusions: Combination therapy of using topical carbon suspension-assisted Nd:YAG laser and 633 nm LED therapy may offer a safe, non-ablative method to improve skin textures and treat melasma.

Introduction

Melasma is a common form of pigmentary disorder among Asian women and an acquired hyperpigmentation involving the cheeks, forehead, nose, and upper lip. It is a common complaint in patients with darker skin tones. Although the exact pathogenesis is unknown, melasma is believed to be associated with a multifactorial etiology. Genetics, ultraviolet radiation, pregnancy, hormone therapies, and phototoxic drugs have been implicated in the

pathogenesis of melasma [1,2]. In addition to routine usage of broad-spectrum sunscreens, bleaching agents, such as hydroquinone, tretinoin [2-4], and chemical peels [5,6], have shown satisfactory results for the patients with epidermal melasma. Nevertheless, patients with dermal or mixed-type melasma are therapeutically challenging. In the past, attempts to treat melasma with lasers that targeted melanin, such as the Q-switched ruby laser and Q-switched Nd:YAG laser, yielded disappointing results [7,8].

A single treatment alone may prove to be somewhat effective but combined therapy may compound effectiveness, whereby the total efficacy of the combination therapy yields an efficacy greater than the sum of the individual components. Visible red LED therapy as a spin-off from the US NASA Space Medicine Program has been reported by Whelan and colleagues as being effective clinically. The purpose of this clinical study was to determine the effectiveness of treatment for melasma using combination therapy with visible red (633 nm) LED therapy, Q-switched Nd: YAG laser assisted with a carbon photoenhancer lotion, together with oral and topical medication.

Subjects and Methods

34 human subjects with melasma, skin types 3 thru 4 and aged in their 30's to 50's were randomly allocated into two groups which were respectively treated with (experimental group) or without (control group) four LED and laser sessions at our clinic. Seventeen patients were treated with the carbon assisted Q-switched Nd:YAG laser (SpectraVRM, Max Engineering Limited ,Seoul, Korea) and visible red (633 nm) LED therapy (Omnilux Revive, Photo Therapeutics Limited of Altrincham, U.K.), during four sessions at 0, 1, 2, and 4 week intervals. Initially cosmetic skin rejuvenation was accomplished using a topically-applied lotion with carbon particles in suspension and the Nd:YAG laser at a wavelength of 1064 nm, fluence of 1.8 - 2.3 J/cm^2, a pulse duration of 5 ns (Q-switched), a pulse repetition rate of 10 Hz and a fixed beam of 7 mm in diameter. Laser spots were placed with approximately 30% overlap using an identical laser technique in each patient: (1) a vertical pass; (2) a horizontal pass; and (3) a diagonal pass (beginning superiorly on the forehead and moving down to the chin). Subsequently, the patients were treated with 17 minutes of red LED therapy (approximately 107 J/cm^2 per session). As the post treatment protocol, all patients were given oral medicine (250 mg of tranexamic acid and 1000 mg of ascorbic acid, tree times a day) and topical medication (0.1% tretinoin and 4% hydroquinone, twice per day). The control group received only the medication regimen without laser or LED therapy. The patients were evaluated at baseline and at 1, 2, 4, and 8 weeks postoperatively. Patients were also evaluated clinically using the Melasma Area and Severity Index (MASI) scoring system [9]. The face was divided into four areas: forehead, right malar region, left malar region, and chin, corresponding to 30%, 30%, 30%, and 10% of the total face, respectively.

The severity of the melasma in each of these four regions was assessed based on three variables: percentage of the total area involved (A), darkness (D), and homogeneity (H). A numerical value was assigned for the corresponding percentage area involved: 0 = no involvement; 1 = <10% involvement; 2 = 10–29% involvement; 3 = 30–49% involvement; 4 = 50–69% involvement; 5 = 70–89% involvement; and 6 = 90–100% involvement. The darkness of the melasma (D) compared to the normal skin and the homogeneity of the hyperpigmentation (H) were rated on a scale of 0 to 4 (0 = normal skin color without evidence of hyperpigmentation; 1 = barely visible hyperpigmentation/specks of involvement; 2 = mild hyperpigmentation/small patchy areas of involvement <1.5cm diameter; 3 = moderate hyperpigmentation/patches of involvement> 2cm diameter; 4 = severe hyperpigmentation/uniform skin involvement without any clear areas). To calculate the MASI score, the sum of the severity grade for darkness (D) and homogeneity (H) was multiplied by the numerical value of the areas (A) involved and by the percentages of the four facial areas (10–30%). These values were summated to obtain the total MASI score: Forehead 0.3 (D+H)A+ Right malar 0.3 (D+H)A+ Left malar 0.3 (D+H)A+ Chin 0.1 (D+H)A.

Results

Twenty-nine patients completed the study at Week 8. Two patients in the control group dropped out at Weeks 2 and 4 because they moved away. Three patients in the carbon suspension assisted Q-switched Nd:YAG and LED group failed to complete the Week 8 follow-up because they moved away. There were no significant differences in any variables such as age, duration of melasma, skin phototypes, and baseline MASI scores between the two groups ($p>0.05$) (Table 1).

In the carbon suspension assisted Q-switched Nd:YAG and LED group, the mean MASI score decreased from 19.55±3.87 at baseline to11.32±6.40 after only one session of Q-switched Nd:YAG and LED treatment at Week 1, representing a 40.0% change in pigmentation, which is statistically significant ($p<0.05$). Patients had further improvement in pigmentation with subsequent treatment sessions. After four sessions of Q-switched Nd:YAG and LED treatment, the mean MASI score decreased to 4.33±3.94 at Week 8, representing a 79.0% improvement compared to that of the baseline ($p<0.005$). The treatment efficacy did not correlate with any variables, such as age, duration of melasma, or skin phototypes. In the control group, the mean MASI score decreased from 21.48±3.31 at baseline to 13.47±4.02 at Week 8, representing a 38.3% change in pigment intensity. The difference in improvement rate between the two groups was also found to be significant ($p<0.05$), with a better response in the carbon suspension assisted Q-switched Nd:YAG and LED group. In the carbon assisted Q-switched Nd:YAG and LED group, 14.0% of the

patients assessed their improvement as satisfied, 43.0% as slightly satisfied, and 43.0% as unsatisfied. In the control group, 53% of the patients assessed their improvement as slightly satisfied and 47% as unsatisfied.

The increase in the MASI scores and melanin indices coincided with the development of post-inflammatory hyperpigmentation that was differentiated clinically from melasma by the involvement of additional facial areas than were observed originally. At the end of the study period, universal clinical improvement of pigmentation was observed (Figure 1). Figure2 shows standard digital photography at baseline (A) and Week 4 (B) of a 41-year-old woman in the treatment group.

Discussions

The management of melasma is a challenge. In spite of the various topical bleaching creams available, there still remains a subset of patients unresponsive to these therapies. In this study, we demonstrated that carbon suspension assisted Q-switched Nd:YAG and LED is a safe and effective treatment for melasma in Asian persons.

The Q-switched Nd:YAG laser has been widely used in cosmetic laser dermatology for the temporary removal of unwanted hair, tattoos, and pigmented and vascular lesions [11]. The majority of laser systems in use today employ the principle of selective thermolysis. This is the selective absorption of light of a particular wavelength by a specific substance referred to as a chromophore (photoacceptor), in this case, melanin [10]. With its ability to produce a nonspecific dermal wound, the Q-switched Nd:YAG laser may induce new collagen formation [12.13]. Recently a variety of LED-based phototherapeutic systems have been used as alternative methods in the treatment of photo-damaged skin [14]. One of the underlying mechanism for LEDs, particularly those in the red waveband such s the 633 nm LED panels used in the present study, is determined to be stimulation of mitochondrial cell organelles with the proper 'packets' of photons [16] and demonstrating global improvement of the patient's skin in facial texture, fine lines and pigmentation [17]. These techniques also all produce athermal dermal quasi-wounding without ablation. Combination treatments with standard photothermally-dependent non-ablative techniques such as intense pulsed light and diode lasers are being performed to determine whether LED therapy might enhance results after the deposition of photothermal damage by stimulating more collagen and producing less collagen degradation [17].

Most epidermal melasmas respond well to topical bleaching agents [2-4], a simpler and less expensive treatment. Chemical peels also show more benefits for epidermal melasma

than mixed type [5.6]. Sun protection was advised and 4% hydroquinone cream was applied throughout the study to prevent post inflammatory hyperpigmentation rather than treat melasma *per se*.

Er:YAG laser resurfacing, dermabrasion, and combined ultra-pulse CO_2 laser with Q-switched alexandrite laser were also reported to show benefits for refractory melasma [9-11]. Nevertheless, these methods are more invasive and post-treatment wound care is necessary. In addition, prolonged erythema, hyperpigmentation, hypopigmentation, infection, and hypertrophic scarring are potential side effects. Asian skin is prone to hyperpigmentation after even comparatively mild laser treatment [15]. The carbon suspension assisted Q-switched Nd:YAG may achieve selective photothermolysis of pigmented lesions hence the pulse duration is shorter than the thermal relaxation time of the melanosome (70-250 ns). The disappearance of the crusts led to the clinical improvement of the melasma. The pigments gradually reappeared, however, possibly because deeper pigment remained or repigmentation was induced by persistent trigger factors.

Conclusion

Combination therapy of using topical carbon suspension assisted Nd: YAG laser, visible red 633 nm LED therapy and topical and oral medicine may offer a safe, non-ablative method to treat melasma.

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Figure legend

Figure 1.
(not available)
Melasma Area and Severity Index (MASI) score for the Q-YAG& LED and control groups at different posttreatment intervals.

Figure 2.

Standard digital photography at baseline (A) and Week 4 (B) of a 41-year-old woman in the treatment group.