Non-ablative skin rejuvenation utilizing a combination of Q-switched and long -pulse Nd:YAG laser, assisted with a topically applied carbon photoenhancer in lotion form.

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Abstract

Objective: The purpose of this clinical study was to determine the efficacy of a non-ablative facial rejuvenation process using a dual pulsed (Q-switched and 300 μs pulsed) Nd:YAG laser and carbon based photoenhancer lotion, focusing on skin texture improvement and pore size reduction.

Subjects and Methods: Fifty-eight human subjects, skin types III to IV, aged from their 30's to their 50's with enlarged facial pores were treated with three to five laser sessions at our clinic. Cosmetic skin rejuvenation was accomplished using a wavelength of 1064 nm, fluence of 1.8 to 2.3 J/cm^2, a pulse duration of 300 μs (long pulse) and 5 ns (Q-switched), a pulse repetition rate of 10 Hz and a fixed beam diameter of 7 mm. The treatment involved applying a lotion with carbon in suspension to the skin surface of the full face as a photoenhancer and irradiating the lotion-treated areas with the Nd:YAG laser, first in long pulse mode followed by Q-switch mode. Treatment sites were evaluated compared with the baseline (pretreatment) regarding the skin texture, pore size, fine wrinkles and spotty pigments.

Results: At 8 months follow-up the investigators reported improvement in skin texture, pore size, fine wrinkles and spotty pigments compared with the baseline values.

Conclusions: Nd:YAG laser treatment combining long pulse and Q-switched mode, and assisted with a topical carbon suspension, offers a safe cosmetic method of improving skin texture, especially pore size reduction.

Introduction

Laser resurfacing with the microsecond-domain high fluence computer pattern generator, collimated beam CO_2 laser has been proven to be efficacious in improving photodamaged skin and acne scarring[1-3]. Unfortunately, prolonged erythema and delayed wound healing are common adverse sequelae, which require intensive patient education and intervention [4-6]. These adverse effects may be due to the degree of nonspecific thermal damage present after resurfacing with the CO_2 laser. 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, in the present study, melanin [7]. Selective damage also requires delivering energy in a time period equal to or less than the thermal relaxation time (TRT) of the chromophore. TRT is defined as the time needed for an object to cool after absorbing heat [8]. If heat is delivered faster than the chromophore can cool, the substance becomes hot relative to its environment and is destroyed. Conversely, if heat is delivered slower than the target can cool, heat is transferred to the surrounding environment. Recent studies suggest that the longer wavelength of the Nd:YAG laser, with its decreased absorptive affinity for epidermal melanin, may provide the advantage of deeper penetration into the dermis [9]. The purpose of this clinical study was to determine the effectiveness of non-ablative facial rejuvenation process using a dual pulsed (Q-switched and 300 μs pulsed) YAG laser in combination with a carbon based lotion as a photoenhancer, focusing on skin texture improvement and pore size reduction.

Subjects and Methods

58 human subjects ,skin types 3 to 4 , Ages 30's to 50's with enlarged facial pores were treated with three to five laser sessions at our clinic. The laser used was a Spectra VRM Nd:YAG laser (Max Engineering Limited, Seoul, Korea). Cosmetic skin rejuvenation was performed using a wavelength of 1064 nm, fluence of 1.8 to 2.3 J/cm^2, a pulse duration of 300μs (long pulse) and 5 ns (Q-switch), a pulse repetition rate of 10 Hz and a fixed beam diameter of 7mm. These parameters were considered as low, medium, and high settings, respectively. The treatment involved applying a lotion with carbon suspension to the skin surface and irradiating Nd:YAG laser over the entire lotion-covered area, first in the long pulse mode followed by the Q-switched mode. Treatment sites were evaluated at the baseline regarding skin texture, pore size, fine wrinkles and spotty pigments. One laser treatment session was performed and evaluations were undertaken at 3 months (3M) and 8 months (8M) after treatment. The patient and physician assessed the skin at the follow-up points using the following scale: 0 =worse, 1 =No change, 2 = Slightly improved, 3 = Improved 4=excellent. Digital photography was used to compare images at baseline and at all follow-up intervals.

Results

In 58 patients, 29 required 3 treatments, 17 required 4 and 12 needed 5 treatments. Treatment efficacy was assessed by the patient and clinician immediately, 3 months and 6 months after treatment using the grading system already explained above, and the results are shown in Table 1. Regarding skin texture, the patient assessment gave an efficacy rate (sum of those grading 2 or more on the scale) of 71% compared with the clinician assessment of 74%, showing a high satisfaction rate and good correlation between the clinician and patient assessments. As for pore size, 62% was the patient efficacy rate compared with 79% from the clinician, so in this case the clinician assessment was significantly higher than that of the patient, but even the latter was still acceptable. In the assessment of improvement of the inhomogeneity of pigmentation, Patient and clinician efficacy rates were 71% and 77%, respectively, high satisfaction and high correlation. On the other hand, when assessing improvement in fine wrinkles, the patient efficacy rate was 66% but that of the clinician was only 48%, the lowest of all the scores and the one with the least correlation between the subjective patient and objective clinician efficacy rates.
Figure 1 shows the histological findings of the skin before and after treatment, from which improvement posttreatment can be observed. Figure 2 shows the pre-and post-therapy findings in a 29-year-old female from the three-treatment group: Improvement in both skin texture and pore size can be observed. The 49-year-old female in Figure 4 shows good improvement on both pore configuration and pigment after 4 treatments.

Discussion

The goal of laser resurfacing is to replace the photodamaged epidermis and superficial dermis with fresh, 'young' cells and an undamaged dermal extracellular matrix cells. This technique has also been demonstrated to result in both a contraction of existing collagen fibers[10], as well as formation of new dermal collagen [11,12]. Unfortunately, many patients experience prolonged erythema, pigmentary changes, and delayed healing. The present study has shown that the beneficial effects of laser resurfacing can be maintained with a reduction of adverse sequelae through minimizing the extent of nonspecific thermal damage.

The first reports on the efficacy of the comparatively low-fluence Q-switched Nd:YAG laser in improving skin texture cane from Goldberg and colleagues [13], and these groups also reported on the efficacy of this treatment approach for correcting inhomogeneity of pigment[14,15]. In the present study, we found the lowest efficacy scores from both patient and clinician assessment in the improvement of fine wrinkles, however, our fluence was much lower than that of Goldberg and colleagues and other researchers who were using the Q-switched Nd:YAG at a fluence of 7 J/cm^2 and a 3 mm spot size [16]. Just the decreased spot size alone would result in an increase of the power density (irradiance) by more than 4-fold, so that there was a definite thermally mediated change in the immediately post-treatment histology, but on the other hand there was improvement in the fine wrinkles.

In general, since the usual Nd:YAG beam is delivered in Gaussian mode, with a peak 'hot spot' in the center of the beam, pinpoint hemorrhage can be seen as a side effect, which can in turn adversely affect the wound healing process (17). The beam mode of the double pulse Nd:YAG used in the study is the 'top hat' mode, however, in which an even power density, and hence energy density, is homogeneously delivered throughout the whole spot. This even energy distribution realizes treatment with a lower risk of complications at optimal fluence settings (Figure 4).

In laser peel treatment we utilize both the 5 ns Q switched pulse and the 300 μs quasi-long pulse. The latter pulse is used for the 1st pass aimed to induce a thermal effect into the skin. The 5ns Q-switch mode is used for the 2nd and 3rd passes. The second pass causes destruction of the carbon particles in the topically-applied lotion to get mechanical peeling of superficial layers. The carbon particles act as a photoenhancer, concentrating the thermal energy transfer of the beam into the particles, thus preventing deeper secondary thermal damage.. At the third pass, the majority of the carbon particles have already been blasted away in the plume from the second pass, so the laser energy penetrates deeper into dermal layer delivering an even but gentle heating effect. Figure 5 shows the different reactions of carbon particles when irradiated with long pulse and Q-switch pulse [18]. The tissue containing the carbon particles will explode when irradiated with the ultra-high energy, ultra-short pulse 5 ns Q-switched beam. Because the pulse width is much shorter than the thermal relaxation time of the tissue, the incident energy is totally expended in that first reaction and there is no time for the heat to diffuse to the surrounding and underlying tissues. When the carbon particles are irradiated with the 300 μs pulse which exceeds its thermal relaxation time, there is plenty of time for the heat to diffuse to the surrounding tissues. Thus the skin will be heated up deliberately by the thermal effect thus created.

Conclusion

Topical carbon suspension assisted Nd:YAG laser treatment combining long pulse and Q-switched mode offers a safe cosmetic method of improving skin texture, especially pore size reduction.

T. Fujimoto, MD., Ph.D. has indicated no significant interest with commercial supporters.

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Figure Legends

Figure 1

A) Photomicrographs before treatment with a Q-switched and long pulse Nd:YAGl aser.

B) Improvement of skin texture 1week after a treatment with Q-switched and long pulse Nd:YAG laser.

Figure 2

A) Pore size before treatment with Q-swiched and long pulse Nd:YAG laser.

B)Pore size of skin texture 2 weeks after 3 treatment sessions.

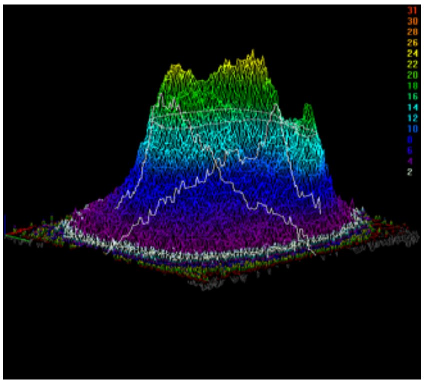
Figure 3

A) Belt-type pore before treatment with Q-switched and long pulse Nd:YAG laser.

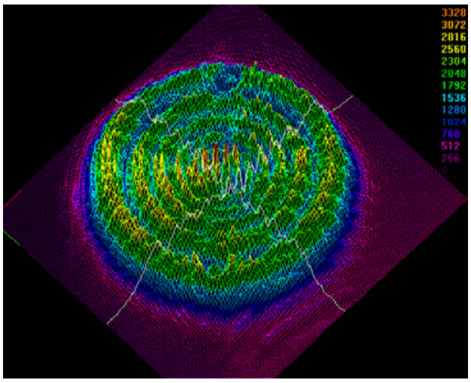
B) Improvement of skin texture 2 weeks after 4 treatment sessions.

Figure 4

Beam mode



A) Gaussian Mode – the peak power density in the middle of the beam can lead to the risk of transient hyperpigmentation or other side effects.



B) Top-hat Mode – in this mode, the beam energy is evenly distributed over the entire spot.

Figure 5

The different reactions of carbon particles when irradiated with a long pulse and Q-switched pulse.