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ORIGINAL CONTRIBUTION

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A combination of 1064 nm Q-switched fractional ND-YAG laser with a nonfractional microsecond pulsed technology has a synergistic effect for nonablative facial rejuvenation

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Abstract

Background: Non-ablative fractionated lasers for facial rejuvenation are increasingly preferred over ablative lasers due to their minimal downtime and fewer adverse events. The synergistic effect of the Q-switched fractional (QSF) 1064-nm neodymium-doped yttrium aluminum garnet (Nd:YAG) laser, in combination with the non-fractional microsecond pulsed technology has yet to be fully evaluated.

Aim: Our objective was to determine the safety and efficacy of this combination treatment for skin rejuvenation.

Methods: Patients who underwent treatment using the QSF-Nd:YAG laser, followed by the non-fractional microsecond pulsed Nd:YAG were evaluated retrospectively using a novel 3D imaging modality for degree of facial erythema, wrinkles surface area, and wrinkle depth. Pain perception, adverse effects, and patient satisfaction were assessed at the 2-month post-treatment follow-up visit, graded on a scale of 1- 5 (1 = not satisfied, 5 = very satisfied).

Results: Ten female patients' ages 44-67 (mean 55 years) completed both treatment and follow-up period, with an overall mild improvement in facial erythema and wrinkle surface area (mean improvement of 18% and 19.5% accordingly), as well as a mild improvement in overall wrinkle depth. Pain and adverse effects were mild and transient. Patients' satisfaction was high.

Conclusion: The combination of the QSF-Nd:YAG laser and non-fractional microsecond pulsed technology, using a single Nd:YAG 1064 nm laser platform, was found safe and effective as a non-ablative modality for facial rejuvenation, as demonstrated by a novel 3D imaging modality.

KEYWORDS

facial erythema, fractional laser, Nd:YAG; skin rejuvenation, wrinkles

1 | INTRODUCTION

Skin aging is influenced by multiple genetic and environmental factors that can manifest in the form of wrinkles, pigmentation, skin laxity, dullness, and telangiectasia. Skin rejuvenation is effectively treated by ablative laser procedures but at the price of patient discomfort, substantial downtime, and adverse events.[1] Alternative treatments using non-ablative fractionated laser for facial resurfacing are increasingly preferred due to their minimal downtime and fewer adverse events.[1-3] Depending on the technology,

non-ablative laser treatments may minimize the appearance of finer wrinkles in the skin, improve tone and texture and reduce enlarged pores. Compared with ablative lasers, non-ablative treatments are less aggressive modalities and require little to no downtime, although often require several treatments and produce more moderate results.[1,2]

The 1064 nm Nd:YAG laser in both its long pulsed and q-switched modes has been widely used in cosmetic laser dermatology for the removal of unwanted hair, tattoos, pigmented and vascular lesions and more recently in dermal remodeling for treatment of wrinkles.[3-5] Laser light at a wavelength of 1064 nm has a relatively low absorption in melanin and a deeper penetration into the skin. This allows safe delivery of thermal damage resulting in the activation of fibroblasts and the induction of a wound healing response. Treatments with 1064 nm lasers have been associated with increased collagen deposition in the papillary and upper reticular dermis and dermal remodeling.[5,7]

Studies performed with fractional Q-switched 1064-nm laser for the treatment of photo-aged skin demonstrated a safe and effective treatment for skin photorejuvenation, treatment of skin laxity, attenuation of fine lines and superficial wrinkles, treatment of stretch marks and superficial scars, and treatment of hyperpigmentation.[6,7] It is suggested that micro-injuries are also generated by a photoacoustic effect from the nanosecond pulses, triggering neocollagenesis.[7]

Quasi-long pulsed 1064 nm laser treatments have also been used in skin rejuvenation mainly in the treatment of small vessels and facial pore size reduction.[4,8-10] It is speculated that the relative longer pulse duration (microseconds) causes a photothermal effect which in turn induces dermal coagulation. Microsecond Nd:YAG lasers have been reported to induce new collagen formation in the papillary dermis.[8,9] Interestingly, one study showed microsecond and nanosecond 1064 nm pulses to be effective in reducing enlarged pore size, due to reduced sebum levels.[10]

There have been many studies reporting the safety and efficacy of minimally invasive photorejuvenation modalities; however, only few published reports are available regarding their combined use in one session.

This study aimed to explore the synergistic efficacy of a 1064 nm laser at two different pulse widths, triggering different mechanisms of actions, for the improvement of skin texture, erythema and wrinkles. A single Nd:YAG 1064 nm laser platform was used, providing a combination of non-ablative fractional Q-switched 1064 nm with focus depth controlled technology followed by a non-fractional microsecond pulsed technology. A novel 3D imaging modality was used to perform an accurate digital analysis of improvement.

2 | PATIENTS AND METHODS

2.1 | Patients

We performed a retrospective analysis of patients with mild to moderate facial aging who were treated in our clinic for facial rejuvenation. We excluded patients as following: (a) previously undergone a surgical facelift; (b) previously treated with ablative laser up to one year prior to treatment; (c) previously treated with any laser device up to three months prior to treatment; (d) applied any topical treatment up to 14 days prior to treatment; and (e) were obtaining oral retinoids during treatment. All patients signed an informed consent form for the treatment.

Standardized high-resolution digital photography of the treatment area was performed for each patient at baseline, before each treatment, on each visit, and at the 2-month follow-up visit, as well as a digital scan using a novel 3D skin vision imaging platform (*Cherry Imaging*). This handheld scanner is combined with a proprietary Trace™ software, capturing thousands of three-dimensional images of the face from multiple field views and wavelengths, providing a 100-micron accuracy level on the 3D model.[11]

2.2 | Treatment

2.2.1 | Laser device

A high power 1064 nm Q-switched Nd:YAG laser was used (Alma Q, Alma Lasers). This device can emit 1064 nm wavelength laser light at three different pulse widths: Q-switched (nanoseconds), quasi-long pulse (microseconds), and a long pulse millisecond range. The fractionated lenses pixelate the laser beam into microbeams arranged in a 7×7 pixel grid (1.1 cm^2), creating 49 microbeams. The depth of the pixelated beam can be adjusted by changing the focal point of the laser within the skin: The +2 and +1 focal depths are of superficial penetration; the 0 has medium penetration and the −1 and −2 exert a deeper effect.

2.2.2 | Treatment protocol

Treatment area was disinfected prior to each treatment. Protective eyewear was utilized during treatments and laser was applied, respecting all safety measures. Patients were treated using both laser modules during the same session. No anesthesia was necessary.

Laser treatments were performed with the non-ablative standalone 1064 nm Nd:YAG laser device, as previously mentioned. First, laser energy was delivered at 300 microseconds with a collimated 8 mm spot size, 7 J/cm^2 fluence at a 5 Hz. Treatment areas were divided into treatment grids (left and right cheeks) using a total of 5 passes. Immediately afterward, patients were treated with the Q-switch Pixel module at 25 mJ/pixel, double pulse mode, 10 Hz. Each treatment grid received an accumulated energy of 3000-4000 J. Patients were instructed to avoid direct sun exposure of the treated areas and apply daily sunscreen. Treatment sessions were 2 weeks apart and a follow-up visit was performed 8 weeks following final treatment session. The required number of treatment sessions was determined according to clinical improvement.

2.3 | Outcome measures

2.3.1 | Clinical evaluation

Digital scans using the 3D skin vision analysis platform (*Cherry Imaging*) with wrinkle and redness filter for quantitative analysis were taken at baseline, at each treatment session and 8 weeks following the last treatment. The overall "redness" filter as measured by the digital scanner ranges from 0 (no erythema) to 1 (most severe erythema). We extrapolated this to a scale of 0 to 10 (×10), for the convenience of better understanding the following grading of severity: 0-3 for mild erythema, 4-6 for moderate erythema, and 7-10 for severe erythema.

Pain level was evaluated by the patients after each treatment via a 10-point visual analogue scale (VAS 1 = no pain, 10 = worst pain ever felt). Patients were instructed to monitor for side effects or complications and to follow up during the post-treatment interval should any such events arise. Adverse events and downtime (time to return to work/study/normal routine) were recorded.

3 | RESULTS

Ten female patients, ages ranging from 44 to 67 years (mean 55) with a Fitzpatrick skin types I to III were included in our analysis. All patients were seeking to aesthetically improve their facial erythema and skin texture.

Patients had mild to moderate facial rhytids at baseline as measured by wrinkle surface area (6 cm^2 ± 4.1) and wrinkle depth (0.15 mm ± 0.018). Mild to moderate facial erythema was also measured at baseline (mean 4.65 ± 1.5, range 1 to 6). All patients completed both treatment and follow-up period (3-4 sessions, mean 3.2 ± 0.4).

Improvement in overall facial erythema, as measured by the digital scan analysis, was noted in 7 out of 10 patients (70%), resulting in an 18% decrease in mean erythema score (3.65 ± 1.4). Three patients did not demonstrate any measurable change in facial erythema. Wrinkle surface area (6 cm^2 ± 4.1) and wrinkle depth (0.15 mm ± 0.018) improved in 9 out of 10 patients (90%) by a mean rate of 19.5% (1.2 cm^2 ± 0.98) and 11% (0.017 mm ± 0.01) accordingly. Figures 1 and 2 portray representative cases. Patients' self-rated satisfaction ranged from 3 to 5 (mean 4.4 ± 0.7) at the 2-month follow-up visit. All adverse effects were mild and well tolerated by patients and included mild transient erythema, mild edema and mild to moderate pain (mean VAS 3.2 ± 1.6). No vesicles were noted. No adverse effects were noted at the follow-up visit. No downtime was reported following treatment by any of the patients.

4 | DISCUSSION

The Q-switched fractional (QSF) 1064-nm neodymium-doped yttrium aluminum garnet (Nd:YAG) laser is characterized by a short pulse duration, causing a photomechanical effect. The long wavelength allows deeper tissue penetration. This non-ablative modality

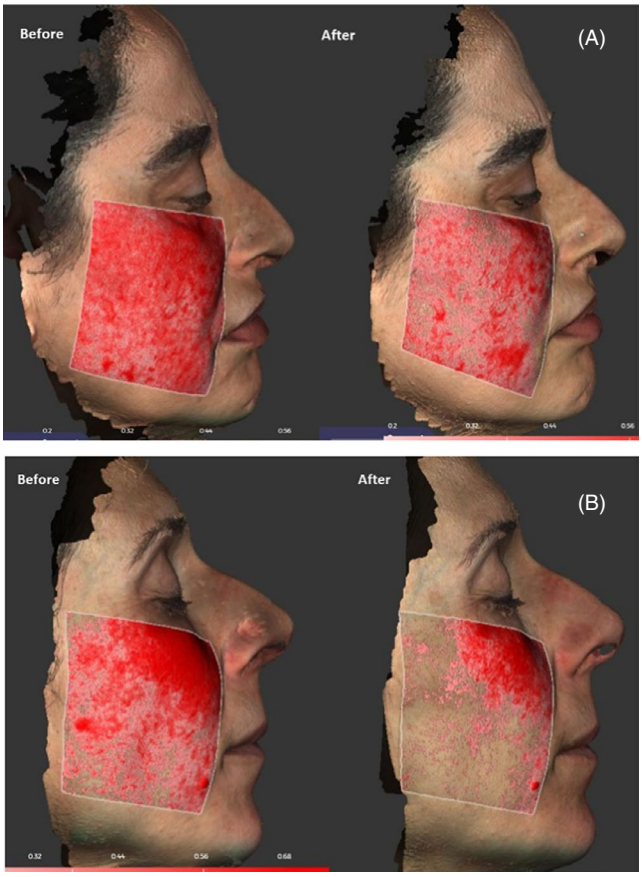

FIGURE 1 A + B: Before and after digital scan analysis of facial erythema—patients number 2,5 *(Cherry Imaging)*

allows minimal downtime and less discomfort to the patient, when compared to ablative lasers such as the CO2 laser, or to chemical peels, that carry a 7-10 days downtime, as well as higher incidence of dyspigmentation and associated infections.[1-4]

Our results demonstrate an average overall mild improvement in facial erythema and wrinkles, with high patient satisfaction 2 months following treatment, along with an excellent safety profile. Despite the fact that our results demonstrated mild improvement only, patient satisfaction was very high. This could be explained by the assumption that even a subtle change, as accurately measured in this patient population, has tremendous effect on patient self-esteem and subjective appearance. This could also be explained by the minimal recovery time.

The exact mechanism of the synergistic effect of both the 300 μs micropulsed and 7 ns Q-switched modes of the 1064 nm Nd:YAG laser on skin aging is not yet fully understood. At a 7 ns pulse width, the absorption of the laser light by the tissue causes a strong photoacoustic effect, while at the quasi-long pulse (300 msec) the effect in the dermis is photothermal.[3,4] The Q-switched nanosecond pulse module allows deep penetration with a rapid pulse delivery and without damaging the epidermis. Due to the nanosecond pulse delivery, the damage is limited and does not damage surrounding structures. The controlled microscopic thermal injuries initiate a wound healing response and subsequent neocollagenesis.[3-5]

Our study holds several limitations: primarily, the low number of participants, and secondly, its retrospective nature. However, the

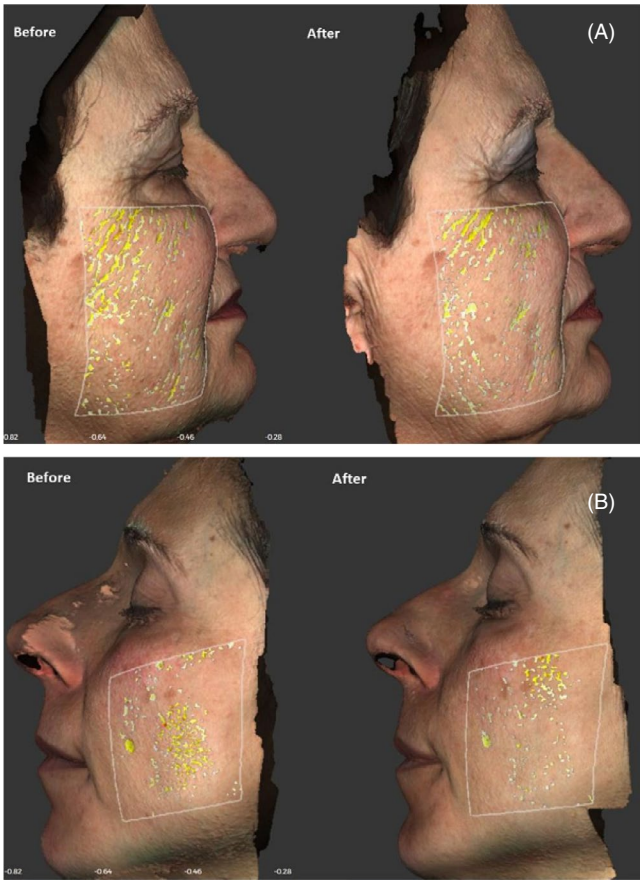

FIGURE 2 A + B: Before and after digital scan analysis of fine wrinkles—patients number 2, 6 (*Cherry Imaging*)

clinical response as well as an objective evaluation tool and improvement observed in most of our patients are promising.

In conclusion, our study demonstrates beneficial outcomes using the QSF-Nd:YAG laser in combination with non-fractional microsecond pulsed technology, using a single Nd:YAG 1064 nm laser platform for skin rejuvenation. This non-ablative high intensity platform can result in a better cosmesis with no downtime and minimal adverse effects.

CONFLICT OF INTEREST

None declared.

AUTHORS CONTRIBUTIONS

We hereby confirm the all authors in this article:

- Have made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; and
- Been involved in drafting the manuscript or revising it critically for important intellectual content; and
- Given final approval of the version to be published. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content; and
- Agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

ETHICAL APPROVAL

All patients included in this study have given informed consent to treatment and to usage of clinical photographs.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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