ORIGINAL ARTICLE

Preliminary Comparison of Fractional Laser with Fractional Laser Plus Radiofrequency for the Treatment of Acne Scars and Photoaging

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BACKGROUND The therapeutic approach to the treatment of acne scars and photoaging varies according to the type of lesion. Traditional carbon dioxide (CO_2) laser is associated with long healing times, persistent erythema, and high risk of post-inflammatory hyperpigmentation. Fractional laser technology, which involves the application of microscopic beams of pixilated light inducing focal zones of tissue injury surrounded by normal tissue, is currently used for the treatment of acne scars and photoaging.

OBJECTIVE To compare the results obtained using CO_2 fractional laser with those obtained using CO_2 fractional laser plus radiofrequency for the treatment of atrophic acne scars and photoaging by means of clinical evaluation and confocal laser.

MATERIALS AND METHODS Ten patients with photoaging and acne scars underwent a single treatment using both technologies. Investigators and patients evaluated the clinical effect of the treatments using digital photographs, dermatoscopy, and in vivo reflectance confocal microscopy before and immediately, 1 week, and 3 months after treatment.

RESULTS AND CONCLUSION Our results underlined the high efficacy of combining CO_2 laser and radiofrequency, producing better results with fewer sessions, lower risks, and fewer side effects.

The authors have indicated no significant interest with commercial supporters.

Targeted and innovative techniques and protocols are increasingly used in the treatment of acne scars and photoaging, with the aim of achieving the best results and reducing side effects. An effective treatment for acne scars should be selected in relation to scar characteristics in terms of shape and depth. Specifically, the laser technique is the most-appropriate treatment for boxcar or rolling scars, whereas ice-pick scars need higher energy and more-intense ablation, which may require more-complex operating techniques.[1,2]

Laser treatment is also indicated for skin imperfections resulting from photoaging such as wrinkles and loss of skin suppleness. A new physics-based principle has recently been introduced as an alternative to traditional laser resurfacing in the field of laser technologies used for the treatment of these skin conditions.

Specifically, excellent clinical results have been obtained in the treatment of skin texture, wrinkles, flabby skin, and scars using carbon dioxide (CO_2) or erbium laser resurfacing, although they also entail lengthy postoperative healing times because of persistent erythema (up to 3 months), edema, and the risk of post-inflammatory hyperpigmentation and superinfections. Therefore, recent studies have focused on methods and technologies capable of obtaining similar results but with a reduction in healing time and associated side effects. Fractional CO_2 laser combines the "concept" of fractional

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photothermolysis with an ablative wavelength of 10,600 mm, successfully treating photoaging, acne scars, and skin flabbiness with minimal postoperative risks and discomfort.[3]

The implementation of a device that introduces new laser pulse emission methods represents a new technological frontier of this innovative laser technique. This method modulates the ablative and coagulative effects, as well as a bipolar radiofrequency source. The latter is an additional system for heating the dermis in depth that exploits nonablative bipolar radiofrequency electrodes to reach the target skin layers of the various problems to be treated.

Radiofrequency effect is due to the passage of electromagnetic waves through the upper dermal layers. Radiofrequency causes an increase in temperature of the top skin layers with a subsequent firming, compacting effect when combined with CO_2 laser treatment. Two phenomena occur when the top skin layers are heated; the first entails shrinkage of collagen due to its helical structure, compacting and firming skin tissues; the second, which has a long-term effect, is based on the activation of fibroblasts.[4]

In this study, we used clinical analyses and in vivo reflectance confocal microscopy (RCM) to compare the effects on acne scars and photoaging of fractional laser treatment alone with those of fractional laser treatment plus radiofrequency.

Materials and Methods

Patients

Ten subjects (7 female, 3 male) with Fitzpatrick phototypes II and III were enrolled in the study after signing an informed consent form. Patients were aged 28 to 55 (mean age 39.2). Four had clinical photoaging symptoms (wrinkles and skin flabbiness), and six had acne scars (of the superficial boxcar and rolling type). Exclusion criteria were deep boxcar and ice-pick acne scars, active acne, keloids and hypertrophic scars, cancer lesions, warts or skin infections in the area to be treated, viral herpes infections during the previous 6 months, collagen disease, and autoimmune disease. Individuals who had taken systemic isotretinoin during the previous 12 months; had used nonreabsorbable fillers; were undergoing treatment with antineoplastics, corticosteroids, or anticoagulants; or were diabetic, pregnant, or breastfeeding were excluded.

The Laser

A fractional CO_2 laser was used, which combines a scanning system to produce thermal effects in microareas with the emission of a bipolar radiofrequency (SmartXide2, DEKA M.E.L.A., Calenzano, Italy).

The system generates perfectly controlled energy pulses (microthermal zones called DOTs) by managing the energy per pulse parameter and the DOT spacing between two microscopic wounds. This technology also offers different pulse shapes (such as the S-pulse, D-pulse, and H-pulse), which play an important role in ensuring superficial ablation of the epidermis and the release of heat deeper down in the dermis. Finally a 500-MHz bipolar radiofrequency (managing power and time parameters) can be added simultaneously to the fractional CO_2 laser emission to achieve greater therapeutic efficacy because of the synergy of the two methods. The laser settings were 30 mJ per DOT with 500 μm of spacing and D-pulse. The therapeutic sessions entailed the effects of radiofrequency and laser applied simultaneously. The bipolar radiofrequency settings were 20 W and 2 seconds.

Treatment Protocol

All patients were treated in a single session using both technologies; in each patient, the left side of the face was treated with fractional laser plus radiofrequency. After treatment, an emollient cream was applied, and the patients continued to apply it at home for the next 5 to 6 days. The use of antibiotic creams or oral administration of nonsteroidal anti-inflammatory treatment was also considered in the case of intense erythema or edema.

The principles of the 1975 Declaration of Helsinki were followed.

Clinical Evaluation

Investigators and patients evaluated the clinical effect of treatment (4-point scale: excellent, good, sufficient, insufficient) by taking digital photographs and using dermatoscopy and in vivo RCM in the areas of treatment before and immediately, 1 week, and 3 months after treatment.

In vivo RCM

In vivo RCM is a relatively new, noninvasive technology that enables real-time viewing of the microscopy with resolution similar to that of classical histology. This technology has been used successfully to evaluate several neoplastic skin diseases (melanoma, carcinoma) and inflammatory skin conditions (e.g., psoriasis, allergic dermatitis, erythematous skin lupus, alopecia, vitiligo, melasma,).

The horizontal microscopic layer-by-layer view of tissue (starting from the stratum corneum and reaching the superficial dermis at ~250 μm of depth) make it possible to obtain useful information for assessment of the efficacy and biological effects of laser treatment on wrinkles. Advantages are absence of tissue damage, in vivo execution, and the possibility of dynamic microscopic monitoring changes in the same skin site.

Results

All subjects enrolled completed the study. Seven of 10 patients evaluated tolerability of treatment as good. In patients reporting a burning sensation, a compress soaked in cool saline solution was placed on the area after treatment for approximately 10 minutes, before application of the emollient cream.

Patients reported a prolonged burning sensation on skin treated using radiofrequency, although this did not make the tolerability of treatment significantly different from that of laser treatment alone. The post-treatment erythema and edema were slightly less visible on the side of the face treated using the laser–radiofrequency combination. No other complications were observed in any of the 10 patients treated.

Three months after treatment, patients treated for acne scars showed clinical improvement of the boxcar and rolling scars in terms of depth and tissue remodelling that was more evident on the side of the face treated using fractional laser plus radiofrequency (excellent 50%, good 50%, sufficient 0%) (Figure 1A,B) than on the side treated with laser alone (30% excellent, 40% good, 30% sufficient) (Figures 2A and 3A,B). The side treated with fractional laser plus radiofrequency also healed more quickly (excellent 33%, good 50%, sufficient 17%)

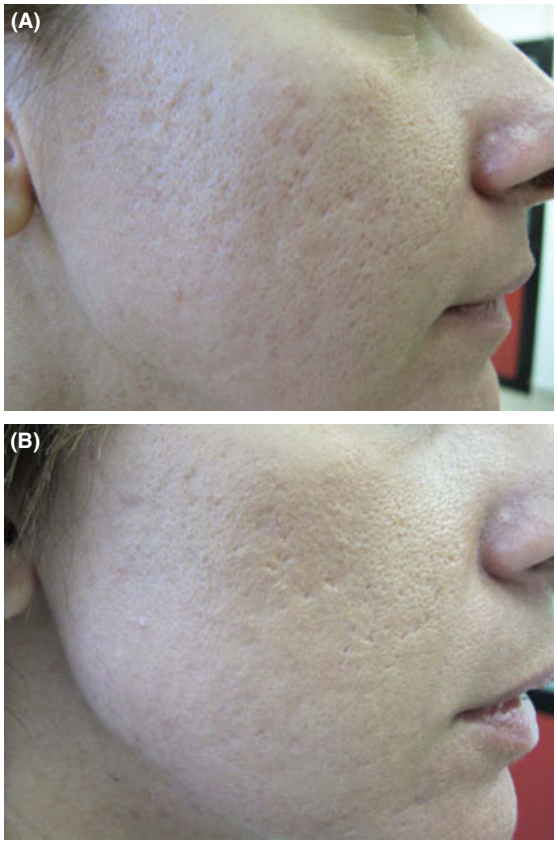

Figure 1. Acne scars in a 36-year-old woman (A) before and (B) after carbon dioxide (CO_2) laser treatment plus radiofrequency.

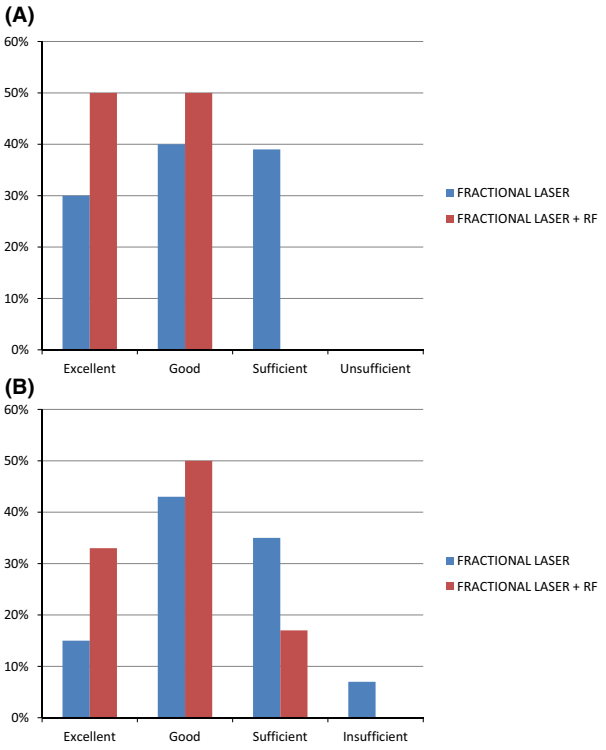

Figure 2. Physician evaluation of (A) clinical improvement of acne scars 3 months after treatment and (B) healing time of acne scars treatment.

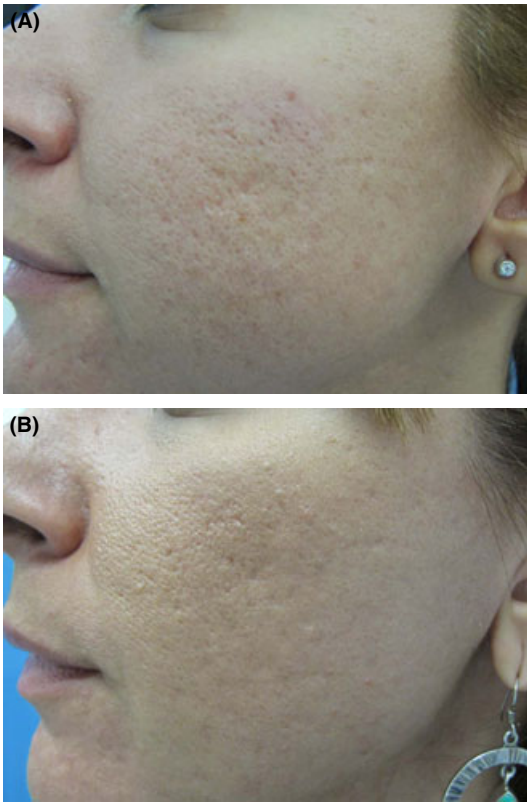

Figure 3. (A) Acne scars in a 36-year-old woman (A) before and (B) after treatment with carbon dioxide (CO_2) laser alone.

than the side of the face treated with fractional laser alone (Figure 2B).

Patient evaluation of the clinical outcome was better for the side treated using fractional laser plus radiofrequency (40% excellent, 50% good, 10% sufficient) than for the side treated using fractional laser alone (25% excellent, 40% good, 34% sufficient, 1% insufficient) (Figure 4A). Healing was faster on the side treated using fractional laser plus radiofrequency (30% excellent, 40% good, 22% sufficient, 8% insufficient) (Figure 4B).

In terms of skin aging, the results evaluated by the physician were better on the side of the skin treated using fractional laser plus radiofrequency (excellent 75%, good 25%, sufficient 0%) (Figure 5A,B) and followed by more rapid healing than the skin treated with fractional laser only (excellent 25%, good 75%, sufficient 0%). Patient evaluation also showed better outcomes for the side treated with fractional laser plus radiofrequency (Figure 6A,B).

Significant improvement of skin areas treated with the new laser emission method was also assessed using in vivo microscopic analysis with RCM. Specifically, this method allowed noninvasive, real-time visualization of the coagulative effects of laser beam treatment, providing semiquantitative information on the spot size and effects on the surrounding tissues in terms of inflammation, keratinocytes, and dermal damage. Limited effects on the tissue surrounding the spot were evident using RCM, with no significant stratum corneum or spinous layer keratinocyte alteration. Shrinkage of the tunnel crater was visible from the stratum corneum to the upper dermis using RCM planar microtomography. The tunnel had well-defined, circular margins.

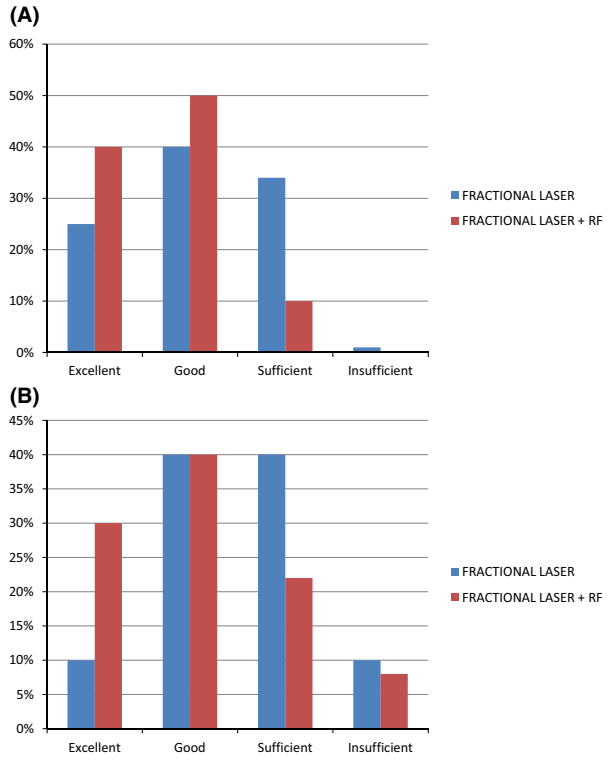

Figure 4. Patient evaluation of (A) clinical improvement of acne scars 3 months after treatment and (B) healing time of acne scars treatment.

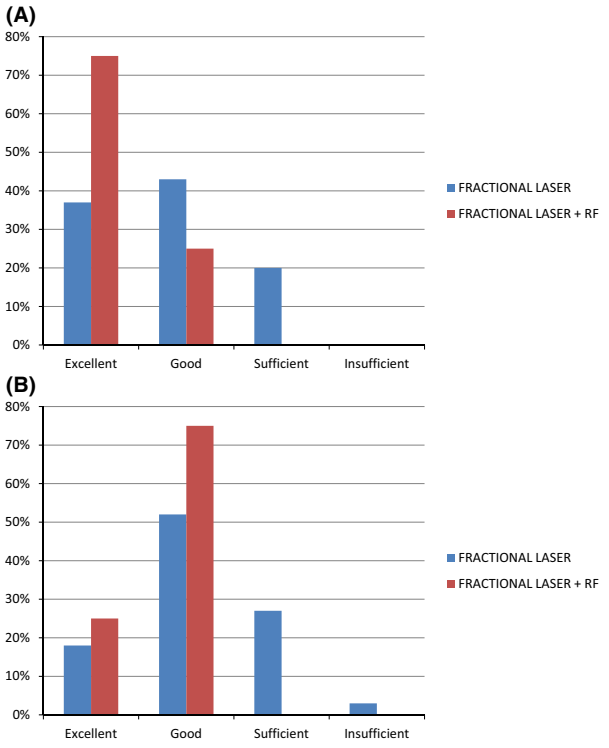

Figure 5. Physician evaluation of (A) clinical improvement of skin aging 3 months after the treatment and (B) healing time of skin aging treatment.

Comparing fractional CO_2 laser treatment plus radiofrequency with fractional CO_2 laser treatment only, treatment tunnel margins were seen to be less defined and characterized by larger peripheral areas with signs of thermal tissue damage in the areas treated using fractional CO_2 laser only.

With regard to the inflammatory effect of laser treatment, infiltrated and dilated vessels in the upper dermis and microscopic signs of inflammation were assessed using RCM monitoring of the presence of inflammatory cells. One week after treatment, complete physiologic healing of the tissues was clinically and confocally evident. After 1 week, in the site of laser plus radiofrequency treatment, microcolumns had completely disappeared, as had any features of inflammation or vasodilatation around the spot. Improvement of dermal fibers was also evident with RCM (Figures 7 and 8).

During follow-up, clinical assessment, dermatoscopy (Figures 9 and 10), and RCM (Figures 11 and 12) revealed progressive improvements of the scars, with significant and progressive reduction in the diameter and depth.

After treatment with both methods, patients with wrinkles, spots, and flabby skin caused by photo-induced aging also showed features of significant improvement, clinically and instrumentally. The classification of patients with photoaging was made according to dyschromic features and texture aspects. Specifically, radiofrequency action is predictable and has no effect on the dyschromic component, for which the ablative effect of the laser prevails.

Discussion

Acne scars are classified as atrophic, hypertrophic, and keloidal. Atrophic scars are divided, according to American classification, into ice-pick, rolling, and

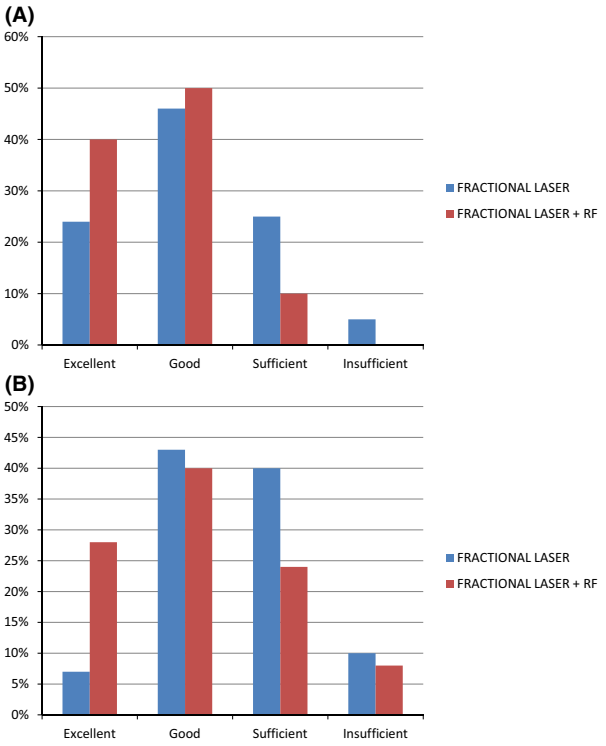

Figure 6. Patient evaluation of (A) clinical improvement of skin aging 3 months after the treatment and (B) healing time of skin aging treatment.

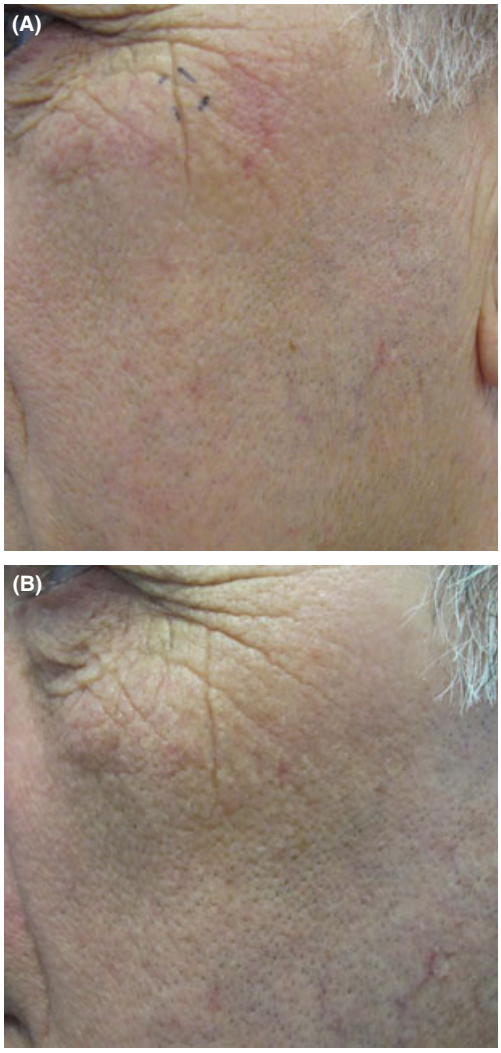

Figure 7. (A) Skin aging in a 55-year-old man (A) before and (B) after carbon dioxide (CO_2) laser treatment plus radiofrequency.

boxcar scars (with craters). The choice of treatment must take into account the clinical features of the scars, time of onset, and patient expectations. There are multiple therapeutic options: chemical peeling, skin needling, dermabrasion, surgery, injections of autologous fat, fillers, and laser treatment. Therapeutic techniques available for treating wrinkles, spots, and flabby skin in the field of photoaging include noninvasive topical treatments as well as the increasingly more-frequent ablative methods such as laser treatment. The best results can often be obtained by combining treatments (laser, radiofrequency, and cosmetics) able to alleviate the immediate sense of burning caused by laser treatment, determining a reduction in the side effects, and enhancing restoration of the correct barrier function.

In recent years, bipolar radiofrequency currents for skin rejuvenation and skin tone have been successfully used in medical treatments in hundreds of patients.[5–7] Radiofrequency energy offers an alternative treatment that has been proven to promote collagen contraction and remodelling and is not scattered by epidermal constituents. Bipolar radiofrequency devices have proven to be effective and noninvasive. Improvement of treated areas is progressive and continues to be evident several months after the last session. Other technologies reported in the literature for the treatment of skin aging combine radiofrequency energy with optical infrared energy,[7] pulsed light, and diode laser.[8] This combined use makes it possible to use lower energies for both forms of energy and reduces the risk of side

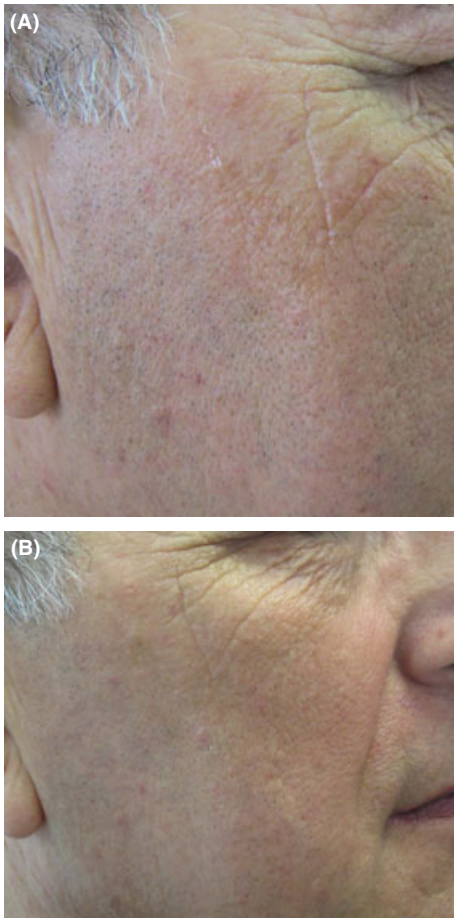

Figure 8. (A) Skin aging in a 55-year-old man (A) before and (B) after treatment with carbon dioxide (CO_2) laser alone.

effects associated with optical or radiofrequency treatment alone.

Light and radiofrequency energy has been used to treat acne in selected patients,[9,10] leading to greater clinical improvement than radiofrequency alone. Moreover, the combination of diode laser and a bipolar radiofrequency energy device has been reported to be a highly effective treatment for acne scars.[11]

There are no other reported combinations of fractional CO_2 resurfacing lasers that use radiofrequency simultaneously. Use of these two different types of energy for the treatment of skin aging and acne scars together might be better than one based on radiofrequency only.

Figure 9. Dermatoscopy of acne scars before treatment.

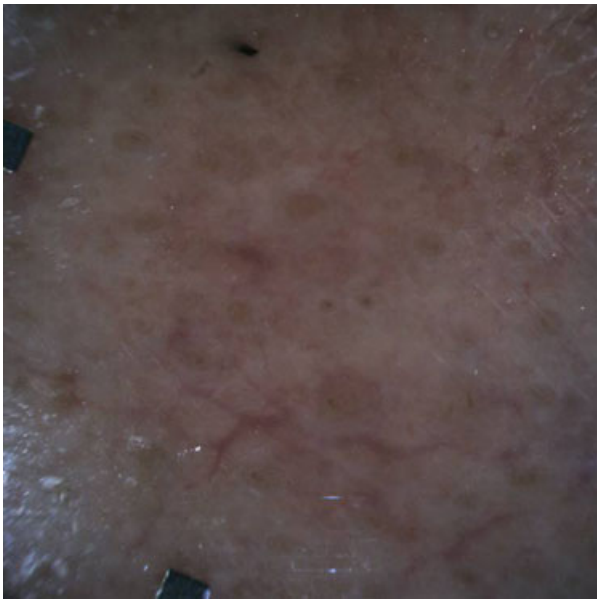

Figure 10. Dermatoscopy of acne scars after treatment with carbon dioxide laser plus radiofrequency.

Weakness of the Current Study

The lack of blinded reviewers, the mixing of treatment objectives (anti-aging and acne scars), the small number of patients, and the no-randomization of the right and left are limitations of this study.

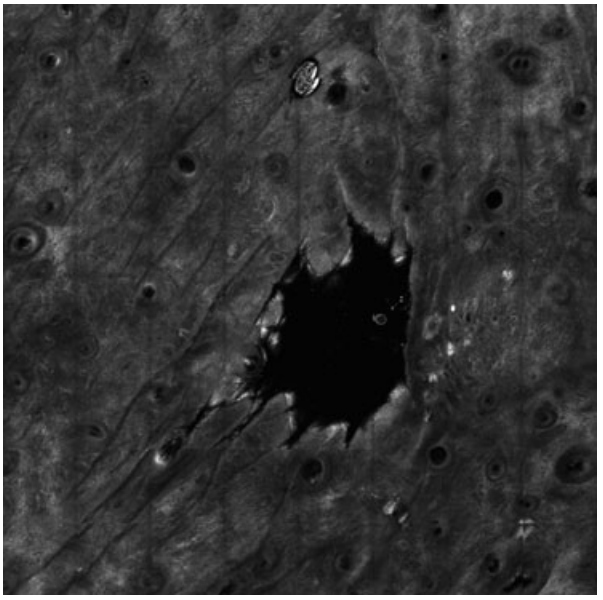

Figure 11. Confocal microscopy of acne scars before treatment.

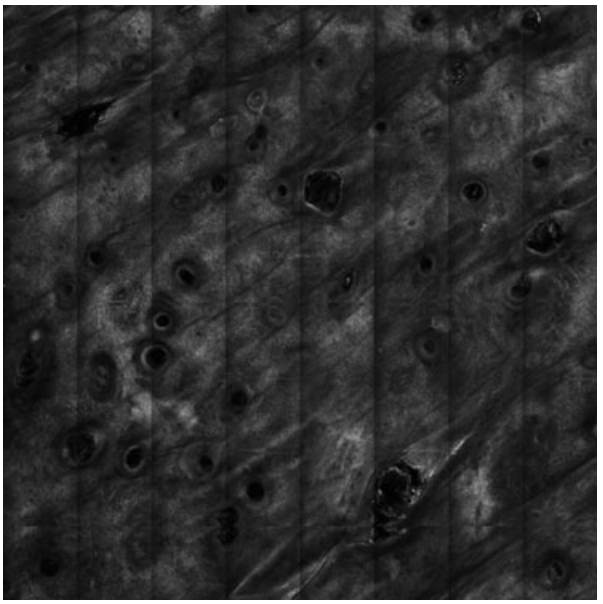

Figure 12. Confocal microscopy of acne scars after treatment with carbon dioxide laser plus radiofrequency.

Conclusions

This study compared the effectiveness and tolerability of fractional CO_2 laser treatment with and without the synergic combination of bipolar radiofrequency using clinical, dermoscopic, and in particular RCM assessment.

Specifically, RCM showed the possibility of noninvasive, real-time monitoring of the response to laser treatment, enabling its modulation and helping prevent side effects from the treatment.

Noninvasiveness and real-time use of RCM to monitor and evaluate macroscopic changes are characteristics that give this relatively new technology the prospective possibility of application in all aesthetic conditions involving the upper skin as a useful tool for therapeutic follow-up and management.

Our results underline the extreme efficacy of combining CO_2 laser and radiofrequency; this new fractional device generated various biologic effects ranging from dermal stimulation for new collagen production to regeneration of tissue texture capable of increasing the smoothness and tone of the skin more than fractional CO_2 laser alone. Fewer side effects and shorter healing times were also evident. Therefore, combination of the two methods seems to intensify the thermal effects on treated tissues, producing better results in less time and with fewer sessions without increasing the risks or side effects.

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