Low Risk of Postinflammatory Hyperpigmentation in Skin Types 4 and 5 After Treatment With Fractional CO2 Laser Device

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ABSTRACT

Background/Objective: Hyperpigmentation occurs in more than 37% of dark-skinned subjects treated with a fully ablative CO2 laser device. This study assessed the risk of postinflammatory hyperpigmentation (PIH) in skin types 4 and 5 subjects treated once with a specific protocol of treatment using a fractional CO2 laser.

Methods: Seven subjects with photodamaged skin received a single facial treatment using a fractional CO2 laser. Anesthesia was limited to a lidocaine and prilocaine cream for 1 hour before single-pass treatment. Subjects were evaluated for improvement and PIH on alternate days for 14 days and at 1 month, 3 months, and 6 months after treatment.

Results: All subjects achieved improvement in their specific skin conditions and in skin texture. PIH was not observed in any subject. Four subjects experienced no pain during treatment while 3 reported mild pain. Recovery was associated with minimal pain and itching.

Conclusion: In dark-skinned subjects, fractional CO2 laser treatment and topical anesthesia subjectively improves common skin conditions without PIH.

INTRODUCTION

Postinflammatory hyperpigmentation (PIH) is a frequent adverse effect in Asians who undergo ablative laser resurfacing.[1] Temporary hyperpigmentation has been reported in more than 37% of dark-skinned patients treated with a CO_2 laser.[2] Postinflammatory hyperpigmentation, along with the extended recovery time associated with ablative CO_2 treatment, has led to the development of nonablative laser devices and cooling techniques for the treatment of photodamaged skin. However, clinical improvement with these modalities is limited.[3,4]

Both ablative and nonablative laser devices deliver energy in pulses to take advantage of selective photothermolysis,[5] in which laser-induced heat is confined to the target and does not diffuse into surrounding tissue. Manstein and colleagues[6] recently introduced fractional photothermolysis (FP), in which a laser beam produces a pattern of microscopic thermal wounds, called microscopic treatment zones (MTZs), at certain depths of skin without injuring the surrounding tissue. Unlike conventional lasers in which irradiation produces a layer of thermally damaged tissue, FP laser devices produce a pattern of tiny columnar wounds that extend into the dermis. Since each tiny MTZ is surrounded by a large area of undamaged tissue, healing is quick due to a short keratinocyte migration time.[1,7]

The purpose of this study was to conduct a preliminary assessment of the risk of PIH in skin types 4 and 5 subjects treated once with an ablative fractional CO_2 laser device. This CO_2 laser device ablates the tissue in the fractional column rather than just causing injury.

METHODS

Seven subjects (4 women and 3 men, ages 47.0±15.6 years) with skin types 4 and 5) with photodamaged skin were enrolled in the study. Exclusion criteria included cosmetic medical treatment of the face during the past 6 months, isotretinoin therapy, immunosuppressant therapy, connective tissue disease, dermatitis, skin malignancy, and history of keloids. All subjects provided signed informed consent to participation.

Each subject received a single facial treatment with a fractional CO_2 laser handpiece held perpendicular to the skin. The treatment procedure followed a specific protocol (ActiveFX™) for superficial resurfacing with a new nonsequential fractional CO_2 laser device (UltraPulse® Encore™; Lumenis Inc, Santa Clara, CA) with a new computer pattern generator (CPG). This laser device differs from its predecessors in several important respects. First, the spot diameter is 1.30 mm rather than 2.50 mm, changing the treated area from 3.97 mm^2 to 1.30 mm^2. The advantage of the smaller spot size and treated area is that less heat builds

up around each tiny wound, which reduces posttreatment erythema. The second advantage is that energy emission is nonsequential; the spots are laid down within the pattern, one after another, but not adjacent to one another. Such random placement permits thermal relaxation of each spot before the next spot is placed. The result is less thermal injury, erythema, and edema[8] than when spots are laid down closer to one another. Nonsequential fractional CPG delivery is illustrated in Figure 1.

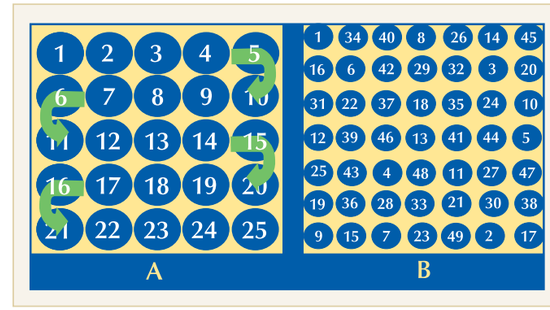

FIGURE 1. a) Sequential spot delivery with an earlier computer pattern generator (CPG) handpiece and b) nonsequential spot delivery with the new CPG. Although spot diameters (and treatment areas) are reduced, spots can be placed more rapidly with the new CPG handpiece. It is also not necessary to remove the small eschars because they serve as natural bandages.[8]

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Faces were cleaned and covered with a topical anaesthetic of lidocaine and prilocaine (Emla® cream) 1 hour before treatment. The shape, size, and density of the fractional light beam can be adjusted on the CPG handpiece. Treatment settings were 60 mj energy, shape 3, size 3, and density 1. At a density setting of 1, approximately 60% of the facial skin surface was ablated. Treatment consisted of a single pass without cooling and the same operator administered all treatments. Treatment duration was approximately 20 minutes, less time than the 25 minutes previously reported.[8] Progress during treatment was monitored by noting the appearance of a stippled gray factional epidermolysis pattern on the treated areas.

Subjects returned on alternate days for 14 days and at 1 month, 3 months, and 6 months after treatment for evaluation of improvement and PIH. Subjects agreed to avoid sun exposure for 3 months, remain indoors for 7 days, wash their faces with normal saline and apply petroleum jelly twice each day for 3 days after treatment, hydroquinone 4% in the mornings, tretinoin 0.05% (Retin-A®) in the evenings of days 3 through 14, and sunblock (SPF 30+) from day 14 to 3 months after treatment. Subjects were photographed (3.2 megapixel digital camera DSC-505V, Sony, Tokyo, Japan) before and immediately after treatment, and on days 2, 4, 8, 15, 30, and 40 after treatment.

Subjects were asked to evaluate pain, the duration of pain, other sensations and their duration, and overall improvement. Subjects also asked if they would undergo a second treatment and if other people noticed their improvement.

METHODS

The results of treatment are shown in Figures 2 and 3. All subjects achieved subjective improvement in their specific skin condition (s) and in skin texture. Treatment-induced hyperpigmentation was not observed in any subject. Mild hypopigmentation that appeared on day 15 in 1 subject was attributed to the prophylactic use of tretinoin and hydroquinone. Hypopigmentation improved when medications were discontinued. Photographs of one subject were not included due to background lighting differences in the before and after images.

Subjects completed a questionnaire to evaluate pain during and after treatment on a 5-point scale of 1 (painless) to 5 (very painful). Pain during treatment was rated as a 1 by 4 subjects and a 2 by 3 subjects, while pain after treatment was rated as a 2 by all subjects. Pain lasted 1 day after treatment for 1 subject and 2 days after treatment for 6 subjects. Six subjects noted itching that persisted 1 to 2 days in 5 of these subjects and 15 days in 1 subject. No other sensations were reported. All 7 subjects noted improvement after treatment, would consent to another treatment, and said that other people had noticed their improvement.

DISCUSSION

The aim of skin resurfacing is to remove sun and age-damaged skin and to allow the regeneration of new skin. CO_2 laser energy has been considered the gold standard treatment for this purpose. The results of this study suggest that PIH does not occur in dark-skinned subjects treated with a single-pass fractional CO_2 laser device. Treatment was associated with minimal patient discomfort during and after treatment.

The 10 600-nm beam is highly absorbed by water and thermal injury is limited to the site of the laser wound.[9] Spot size can be varied and the concentration of the applied energy raised or lowered by changing the spot size.[10] Superpulsed CO_2 lasers minimize thermal damage by applying short-duration pulses of high irradiance without heating surrounding tissue.[11] The addition of CPGs to the fractional CO_2 laser has eliminated the need for manual delivery of laser impacts.[12] The CPG offers a variety of advantages; it reduces the treatment time, permits more uni-

form delivery of pulses, and promotes more uniform healing of the treated area. Computer pattern generators also permit the user to select pattern shapes, density, and size of the pattern. The low-density setting has no overlap and the high-density setting has more overlap. The larger the size of the pattern, the more laser impacts delivered. [12]

Traditional CO_2 laser treatment is also associated with long recovery times and significant adverse effects;[8] the high incidence of PIH exceeds that of Er:YAG laser treatment and strong anesthesia such as intravenous sedation may be required. Yet, although the Er:YAG laser offers more superficial ablation and quicker healing time, the clinical benefits are less than those achieved with the fully ablative CO_2 laser.[13] To address the need for both higher efficacy and fewer adverse effects, FP laser devices that produce a pattern of tiny columnar wounds surrounded by large areas of undamaged tissue were developed.[8]

The fractional CO_2 laser combines the advantages of the CO_2 laser and fractional photothermolysis. Clinical trials with the ActiveFX treatment have shown its efficacy in the treatment of dyschromia, rhytids, and skin laxity.[14] In a recent 55-patient study of patients (skin types 2 and 3) receiving a full-face, single-pass session (using the same ActiveFX protocol) reported good improvement in fine lines, mottled hyperpigmentation, sallow complexion, tactile roughness, and global score.[8] Transitory PIH reported in 1 case was attributed to misuse of a prescribed sun protection product.

In this study, skin conditions improved with a similar protocol. Subjects with skin types 4 and 5 received a single facial ActiveFX treatment with the UltraPulse Encore, a fractional CO_2 laser device. The use of topical Emla Cream avoided the risk of intravenous sedation. Four subjects experienced no pain during treatment while 3 noted only mild pain. Postinflammatory hyperpigmentation was not observed in any subject. (This study was limited to 7 subjects because of an initial concern the PIH might occur.) Mild hypopigmentation in 1 subject due to the prophylactic use of tretinoin and hydroquinone was improved when both agents were withdrawn. Recovery was uneventful and associated with minimal pain and itching.

CONCLUSION

ActiveFX treatment with the UltraPulse Encore and topical anesthesia subjectively improves common skin conditions without PIH in Asian skin. Results presented here warrant additional studies with larger sample sizes.

DISCLOSURE

Dr. Tan and Ms. Kurniawati report no financial relationships with Lumenis Inc. The study was funded by Dr. Tan. Dr. Gold is a Lumenis stockholder and performs research for Lumenis. He is also a funded speaker and consultant for Lumenis.

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FIGURE 2. A 54-year-old man with a burn scar **a)** before and **b)** 40 days after a single fractional CO_2 laser treatment. Treatment resulted in softer skin and improvement of the burn scar, particularly below the lower lip. The greater range of skin movement permitted the patient to more easily open his mouth. Skin surface irregularities and the dark pigment around the borders of the scars were also reduced. Hyperpigmentation was not observed.

FIGURE 3. A 67-year-old woman with photodamage, solar keratoses, and lentigines a) before and b) 40 days after a single fractional CO2 laser treatment of the forehead and zygomatic areas. Treatment lightened lentigines and in the zygomatic area, improved crow's feet, removed solar keratoses, and improved skin texture. Hyperpigmentation was not observed.

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