Early Improvement in Rhytides and Skin Laxity Following Treatment With a Combination Fractional Laser Emitting Two Wavelengths Sequentially

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Abstract

Background: Carbon dioxide laser resurfacing remains the gold standard for the treatment of photoaged skin. Today, however, fewer patients will tolerate the postoperative downtime associated with the use of this device. Fractional photothermolysis was designed to overcome the disadvantages associated with ablative resurfacing. Prototype fractional lasers (Fraxel®, Reliant Technologies Inc.) have required the use of blue tracking dye to give evenly spaced microtreatment zones, and treatments are associated with moderate levels of discomfort because of microtreatment zone depths reaching nearly 1000 μm. Newer technologies have evolved that do not require tracking dye, and are less painful than older prototypes because microtreatment zones are more superficial (100 to 300 μm) than that of the Fraxel laser. Newer devices offer advances in treating facial rhytides and skin laxity through the use of 2 laser wavelengths (1320 nm/1440 nm) emitted sequentially through a specialized diffractive lens array that produces high-intensity microtreatment zones surrounded by deeper low level heating.

Observations: One to 3 treatments with this combination fractional laser device were performed on 16 Caucasian females with static periocular rhytides or skin laxity affecting the nasolabial crease. There was a 3-week period between treatments. Improvement was noted in both areas after a small number of treatments.

Conclusion: The technology behind fractional lasers is rapidly evolving, and new devices offer significant advances over older prototypes.

Introduction

Laser skin resurfacing using the 10 600-nm carbon dioxide (CO_2) laser is considered the gold standard in treating severely photodamaged facial skin. The CO_2 laser ablates the entire epidermis, part of the superficial dermis, and imparts varying depths of coagulative thermal necrosis, reaching depths of approximately 150 μm. In doing so, this laser consistently provides remarkable improvements in the appearance of photoaged skin. Epidermal ablation typically requires 7 to 10 days for re-epithelialization, and thermal damage to the dermis initiates a wound healing response that affects tissue tightening and stimulation of neocollagenesis. Despite its potential benefits, CO_2 resurfacing can result in a prolonged postoperative recovery and potentially permanent adverse sequelae,[1] including postoperative edema, erythema, burning, crusting, and permanent hypopigmentation. While the erythema typically resolves after 6 weeks, it may last for up to 6 months, and pigmentary changes, acne flares, herpes simplex virus reactivation, scars, milia formation, bacterial and fungal infection, and allergic contact dermatitis may also occur.[2]

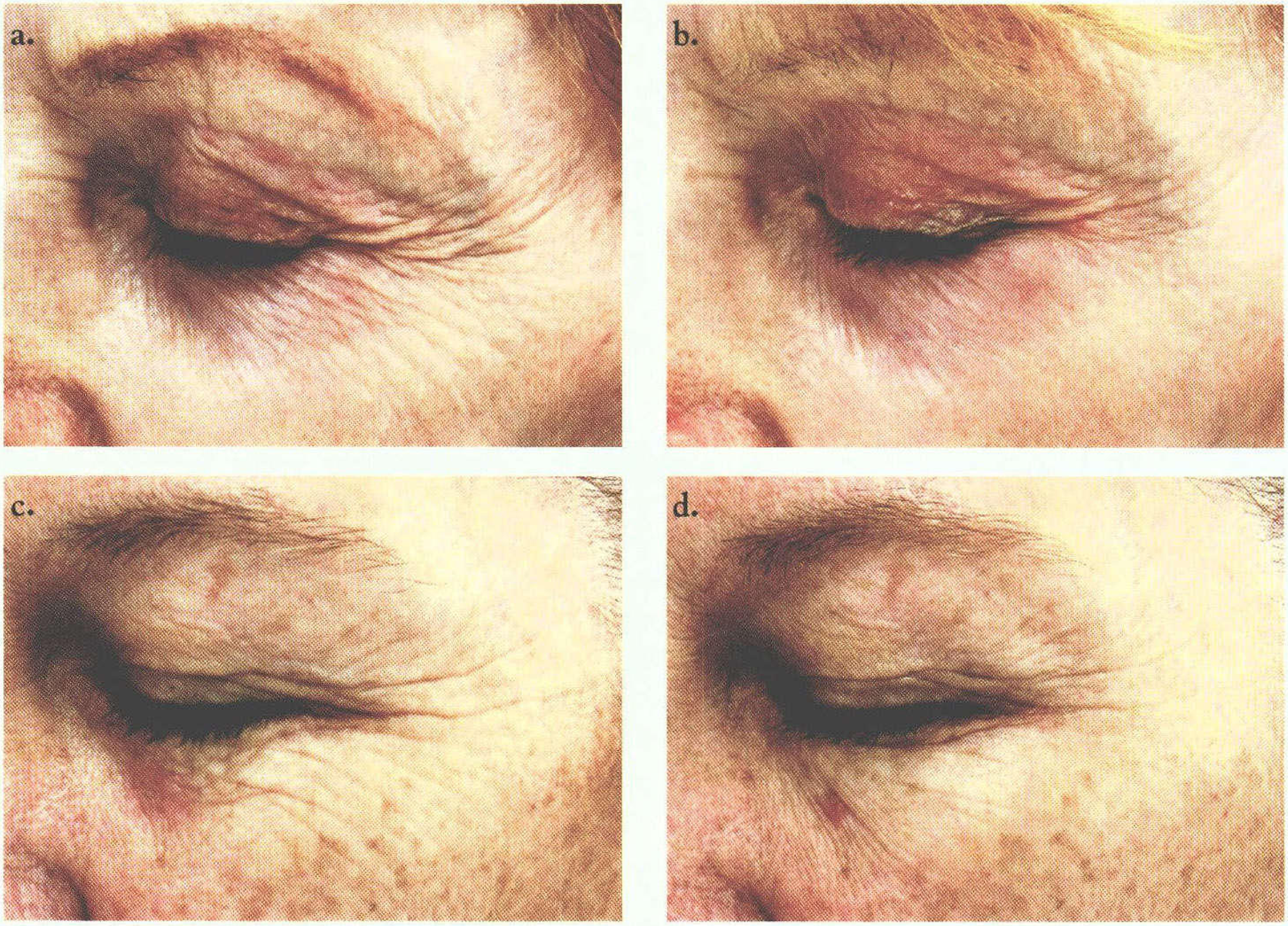
A majority of patients will not tolerate the postoperative "downtime" that accompanies use of the CO_2 laser, and fractional photothermolyis was designed as a way to overcome the disadvantages associated with ablative resurfacing. The first fractional laser, Fraxel® (Reliant Technologies Inc., Mountain View, CA), is a 30 watt, diode-pumped, 1550-nm erbium fiber laser that targets water as its chromophore. This device produces microscopic treatment zones (MTZs) 70 to 100 μm wide and up to 1000 μm deep. No tissue vaporization occurs, and the stratum corneum is not removed. Following treatment, coagulated epidermal tissue is expelled and replaced by keratinocyte migration. When the basement membrane zone is damaged, dermal contents and melanin are also expelled as microscopic epidermal and dermal necrotic debris (MEND). Zones of collagen denaturation in the dermis cause upregulation of the inflammatory cascade, which leads to collagen remodeling and new collagen formation. Fraxel currently has FDA clearance for the treatment of periorbital rhytides, pigmented lesions, melasma, skin resurfacing, acne scars, and surgical scars.[3] Clinically, Fraxel treatments are well tolerated, with side effects including a transient posttreatment erythema (100%), facial edema (82%), dry skin (87%), flaking (60%), small superficial scratches (47%), pruritus (37%), bronzing (27%), transient increased sensitivity (10%), and acneiform eruption (10%).[4] Treatments are moderately painful, and this drawback has been addressed by pretreatment with compounded high concentration topical anesthetics available from specialized pharmacies (eg, 30% lidocaine gel),[5] forced air cooling, and oral anxiolytics in certain cases. Prototype devices require the use of a blue tracking dye to ensure an even MTZ spot pattern that is independent of handpiece velocity.

The optimal depth of MTZ penetration required to induce remodeling and improvement in rhytides is an area of ongoing debate. Some investigators believe that older fractional technologies, eg, Fraxel or StarLux® (Palomar Medical Technologies Inc., Burlington, MA) with depths of penetration that achieve 1000 μm, are adequate for this purpose. Others believe that the relatively deep MTZ penetration of these fractional prototypes induces unnecessary wounding, and a more superficial injury that resembles that of the CO_2 laser (100 to 200 μm) is sufficient to adequately treat photoaged skin.

Since its introduction, the Fraxel laser has evolved significantly and more recent models have optimized delivery systems that no longer require the use of tracking dye. Still newer fractional technologies have advantages over the Fraxel. One such device, Affirm™ with MultiPlex™ (Cynosure, Westford, MA), is a combination Nd:YAG laser emitting 1320-nm and 1440-nm wavelengths in sequential 3 ms pulses comprised of 1000 microbeams per 10 mm spot. The 1440-nm wavelength exerts its effects more superficially, targeting superficial rhytides and pigmentation, while the 1320-nm wavelength has deeper effects, stimulating neocollagenesis and thereby improving skin laxity. A novel diffractive lens, a proprietary technology termed Combined Apex Pulse (CAP) by the manufacturer, produces varying levels of heat distribution in the treated area. The CAPs create high intensity, uniform MTZs (1000 per cm^2) resulting in collagen remodeling, and low-level heating surrounds the CAPs inciting neocollagenesis and tissue tightening.

The intensity of the initial emission, the 1320-nm pulse, is redistributed by the diffractive lens into apex high fluence areas producing an MTZ approximately 150 μm in diameter and separated by 350 μm. Optical scattering within the dermis causes intermixing of the high fluence areas, such that at depths of 1 to 3 mm, the fluence distribution of the 1320-nm pulse is uniform throughout the treatment area.[6] After the delivery of the 1320-nm pulse and a short delay to permit full epidermal cooling, the 1440-nm pulse is delivered and redistributed by the diffractive lens into areas of high fluence.

Figure 1. Softening of static periocular rhytides following treatment with a combination fractional laser device 1320 nm/1440 nm. Appearance of periocular skin in a 74-year-old female patient before treatment **a)** and after 3 treatments **b)**. Appearance of periocular skin in a 55-year-old female patient before treatment **c)** and after 2 treatments **d)**.



This redistribution occurs more superficially with a lower fluence background absorption that coincides with the apex high fluence areas created by the 1320-nm pulse. Acting in concert, the apex high-fluence areas resulting from the sequential pulses of both wavelengths produce zones of injury that reach a depth of about 100 to 300 µm, a depth of penetration that is more superficial than that of the Fraxel and StarLux lasers, which may reach up to 1000 µm.[7]

From a practical standpoint, this combination device is easy to use, has only a 5 minute warm-up time, does not require a cryogen canister, a tracking dye, nor a specially compounded high concentration topical anesthetics (eg, 30% lidocaine gel).[5] Cooling occurs primarily by cold air flow delivered by a Zimmer Cryo5 (Elektromedizin Corp, Irvine, CA) or SmartCool® (Cynosure, Westford, MA) and secondarily by direct skin contact with the cooled treatment tip. The disposable tip has a finite lifetime of 6000 pulses (each combination pulse counts as only a single pulse) and retails for approximately $750 per unit. It takes approximately 250 pulses to cover the entire face, so a single tip may be good for over 20 full-face treatments. This is in contrast to the Fraxel laser, where each disposable tip supports only 4 to 5 full-face treatments.[8] Treatment of the entire face can be completed in 15 to 20 minutes. A facial treatment series is generally started with the following settings: fluence of 8 J/cm^2 for 1320-nm wavelength or fluence of 2.0 J/cm^2 for 1440-nm wavelength, 14 mm spot, and 0.5 Hz. It is also important to inform the patient that at least 4 to 5 treatments will be necessary to see significant improvements. Forced air cooling is delivered to the entire treatment area for 1 to 2 minutes before and after each treatment.

The authors have used the combination device approximately 800 times with 300 patients, and the only complications that have been encountered were mild blistering in 7 patients for unknown reasons. The blisters were superficial, did not result in scarring in any of the cases, manifested 2 to 3 days after treatment, and resolved completely within 1 week. Possible etiologies could have been the inadvertent use of repetition rates of 2 Hz, rather than 0.5 to 0.7 Hz or inadequate cooling. Transient wheal-like erythema of the treated area that resolved uniformly in 10 to 24 hours was observed in all patients. A recall phenomenon of the reappearance of erythematous treatment spots after prior disappearance was observed in 1 patient and was precipitated by a hot shower within 2 to 3 days of treatment. The manufacturer also reports that the recall phenomenon can be precipitated by exposure to prolonged direct sunlight. No bronzing, hypopigmentation, or hyperpigmentation has been observed, even in Fitzpatrick type 4 or 5 skin.

Case Reports

While long-term controlled trials testing the efficacy of this combination device in the treatment of facial rhytides and laxity are being initiated, improvement has been noted in several patients prior to completing the recommended 4 to 5 treatments. These improvements are particularly notable in the periocular region (Figure 1) and nasolabial crease (Figure 2) after only 1 to 3 treatments and are typical of the improvements seen in most patients similarly treated. From an ongoing trial of 16 patients, this trial included 4 Caucasian patients, aged 55 to 74 years. Treatments occurred between June 20, 2007 and August 20, 2007, and were separated by 3 weeks. Patients were photographed prior to beginning treatment and 3 weeks after the last treatment. The treatments were well tolerated, and no untoward side effects or adverse events were observed. All patients were treated with the same device and settings (Affirm with MultiPlex, fluence of 8 J/cm^2 for wavelength 1320 nm or 1.5-2.0 J/cm^2 for wavelength 1440 nm, 14 mm spot, and 0.5 Hz), and direct and forced air cooling for 1 minute prior to, during, and for 1 minute after treatment were used in each case.

Figure 2 (a and b). Softening of the nasolabial crease following treatment with a combination fractional laser device 1320 nm/1440 nm. Appearance of nasolabial skin in a 62-year-old female patient before treatment **a)** and after 2 treatments **b)**.

Figure 2 (c and d). Softening of the nasolabial crease following treatment with a combination fractional laser device 1320 nm/1440 nm (Affirm with Multiplex). Appearance of nasolabial skin in a 56-year-old female patient before treatment **c)** and after 2 treatments **d).**

Discussion and Conclusion

The technology behind fractional lasers is evolving rapidly. The Affirm with MultiPlex is a next-generation fractional laser that employs a combination of wavelengths emitted through a novel diffractive lens. The tightening effect of the 1320-nm wavelength along with the resurfacing effect of the 1440-nm wavelength are distinct technological advances when compared to the prototype fractional lasers: other advantages include less downtime, results comparable to or better than prototype fractional devices, less pain and swelling, use without the need for tracking dyes or specially compounded high-concentration topical anesthetics, and a more cost-effective disposable tip. While this work constitutes a report of several cases demonstrating the potential of this new device, it falls short of providing a head-to-head comparison to the Fraxel or StarLux laser, and does not provide analysis of any long-term improvements. Future studies will focus on the limits of improvement in photodamaged skin of the eyelid, neck, cheek, and forehead following treatment with this laser, the optimal treatment parameters for these sites, and a comparative assessment of this laser to other fractional technologies.

Disclosure

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References

1. Lupton JR, Williams CM, Alster TS. Nonablative laser skin resurfacing using a 1540 nm erbium glass laser: a clinical and histologic analysis. *Dermatol Surg.* 2002;28:833-835.
2. Geronemus RG. Fractional photothermolysis: current and future applications. *Lasers Surg Med.* 2006;38:169-176.
3. Rahman Z, Alam M, Dover JS. Fractional Laser treatment for pigmentation and texture improvement. *Skin Therapy Lett.* 2006;11: 7-11.
4. Fisher GH, Geronemus RG. Short-term side effects of fractional photothermolysis. *Dermatol Surg.* 2005;31:1245-1249.
5. Marra DE, Yip D, Fincher EF, Moy RL. Systemic toxicity from topically applied lidocaine in conjunction with fractional photothermolysis. *Arch Dermatol.* 2006;142:1024-1026.
6. Sierra RA, Mirkov M. *Technical Report: Affirm™: Combining Single and Sequential Emission of Wavelengths for the Treatment of Photoaged Skin.* Westford, MA: Cynosure; 2007.
7. Bedi VP, Chan KF, Sink RK, et al. The effects of pulse energy variations on the dimensions of microscopic thermal treatment zones in nonablative fractional resurfacing. *Lasers Surg Med.* 2007;39:145-155.
8. Kaufman J, Narurkar VA. Fractional resurfacing: myriad uses, faster healing, reduced downtime, fewer complications driving success. *Dermatology Times.* January 1, 2007 (Article 29).

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