Non-Ablative Wrinkle Reduction with the VersaPulse® Laser System

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ABSTRACT

Laser skin resurfacing has become a standard treatment for wrinkles and sun-damaged skin. This ablative treatment, however, is associated with undesirable complications and long recovery times. A growing body of evidence suggests that dermal inflammation and collagen formation can be stimulated without removal of the epidermis, raising the possibility of effective non-ablative wrinkle reduction. This study was performed to evaluate the use of the VersaPulse Aesthetic Laser System in the non-ablative treatment of wrinkles.

Patients with moderate-to-deep wrinkles were treated at 3-6 week intervals with the VersaPulse (532 nm wavelength, 4-6.5J/cm² fluence, 2 ms pulse width, 3 mm spot diameter) for a maximum of 6 treatments. Wrinkle severity as measured by patient self-evaluation was reduced in all of the patients treated (avg. 51.4%) with no significant side effects. These results demonstrate that non-ablative treatment with the VersaPulse may improve the appearance of facial wrinkles.

INTRODUCTION

Since the introduction of high-energy carbon dioxide lasers in dermatology in the mid-1990s, laser skin resurfacing has become a standard technique for the treatment of facial lines and wrinkles.[1,2] Lasers provide a consistency and level of control not possible with earlier skin resurfacing techniques such as dermabrasion or chemical peeling.[3] The result is often impressive improvement in the appearance of wrinkles and lines in sun-damaged or aging skin.[4-8]

These improvements, however, have come with a price.[8-11] Because ablative laser energy removes the epidermis (and a substantial part of the dermis) during skin resurfacing, a typical treatment requires the patient to receive intravenous sedation, with its attendant risks and complications.[11] After completion of treatment, the patient has a partial-thickness open wound that must heal by re-epthelialization, a process that may take up to two weeks for large treatment areas. For the first one to two weeks after treatment, the skin requires significant care and changing of dressings.[11] As the skin heals, erythema may continue for months, a time during which the patient must avoid direct exposure to sunlight. Patients may also experience hypo- or hyperpigmentation and other potential complications including infection and scarring.[8,9] Although CO_2 laser skin resurfacing remains the treatment of choice for severely photodamaged skin, non-ablative treatments that can improve the appearance of lines and wrinkles without the complications and long recovery time associated with ablative skin resurfacing are ideal for mild to moderate photodamage.

The actual mechanism by which laser skin resurfacing improves the appearance of wrinkles is not completely understood. Several lines of evidence suggest that optical absorption by targets in the epidermis and dermis stimulates the secretion of growth factors which induce the formation of dermal extracellular matrix[12]. If this evidence is correct, laser energy targeted at specific epidermal and dermal chromophores could stimulate the healing response and

achieve improvement of wrinkles. A careful choice of targets, and subsequently the laser parameters, will allow stimulation of the healing response while sparing the epidermis.

The 532 nm laser energy produced by the VersaPulse Aesthetic Laser System is selectively absorbed both by melanin in the epidermis and oxyhemoglobin in the blood. As the temperature of these chromophores increases, heat is transferred to vascular endothelia and epidermal keratinocytes. The objective of wrinkle treatment with the VersaPulse is to raise the temperature of these structures to a level that stimulates the healing response and the release of growth factors without permanently damaging them. This study was performed to determine the effect of these non-ablative treatments on subjective assessment of wrinkle production and assess the side-effect profile of selected treatment parameters.

STUDY DESIGN

Twelve patients with Fitzpatrick Skin Types I through IV and wrinkle severity from moderate to deep on the Fitzpatrick Wrinkle Scale[4] were included in the study (Table 1). One patient dropped out prior to initiation of the treatments. For each patient, the wrinkles on one half of the upper lip were treated; the other side of the lip was used as a control. The treatment side was randomized from patient to patient using a randomization table. Prior to treatment, any cosmetics the patient was wearing were removed. No other site preparation (such as the use of topical anesthetics, etc.) was performed.

The VersaPulse (frequency doubled Nd:YAG) was used at a wavelength of 532 nm, spot diameter of 3 mm, and a pulse width of 2 ms. No exogenous skin cooling was provided. The fluence was titrated to produce slight urticaria. The applied fluence averaged 5.7 J/cm^2 (range 4-6.5 J/cm^2). The patients received between 1 and 6 treatments (avg. 3.3 treatments) with a treatment interval of 3-6 weeks (avg. 4 weeks).

The patients were examined immediately postoperatively and one week after treatment for evaluation of treatment-related side effects. Patients performed a self-evaluation, and treatment results were calculated as percent improvement from baseline in wrinkle severity.

RESULTS

In this study, non-ablative treatment with the VersaPulse Aesthetic Laser System reduced the patient's subjective assessment of the severity of wrinkles in all patients without the complications and long recovery times associated with ablative skin resurfacing techniques. The average percent of reduction in wrinkle severity among all patients was 51.4% (range 10 to 85%, Table 1).

Typically photographs demonstrated little or no evidence of improvement. Figures 1 and 2 show evidence of minimal improvement of wrinkles. The wrinkles are shorter and shallower at the treated site.

No significant post-treatment pain, no wounding, and no other clinical signs of skin damage were observed after treatment. Immediately after treatment, at one week post-treatment, and at all other evaluation points, no hyperpigmentation, no hypopigmentation, no infection, and no scarring was observed during the study.

Despite the typical lack of photographic evidence of improvement, overall, patient satisfaction was high, both with the lack of side effects and with the reduction in severity of wrinkles.

DISCUSSION

Despite its potential complications, ablative laser resurfacing remains a popular cosmetic procedure for the treatment of wrinkles. More than 300,000 laser resurfacing operations were carried out in the US alone in 1999.[2] Demand for laser wrinkle reduction remains strong, but as importantly, it remains limited to a market of people who are willing and able to tolerate the long, often painful recovery period. It is reasonable to assume that the market for laser wrinkle reduction could be greatly expanded if a new approach was shown to be effective in improving the appearance of lines and wrinkles without the

Table 1: Improvement by Patient Self Evaluation

Patient Number	Total Treatments	Evaluation Length (weeks)	Average Fluence (J/cm^2)	Improvement % (from baseline)
1	4	8	5.8	75
2	3	5	5.5	30
3	5	2	6.2	50
4	6	5	5.7	70
5	4	5	5.9	70
6	2	7	5.3	50
7	3	4	5.7	85
8	1	27	5.0	35
9	4	5	5.8	70
10	3	8	5.5	10
11	1	4	6.5	20
Averages	3.3	7.3	5.7	51.4

complications and long recovery times associated with ablative skin resurfacing.

Many different approaches have been evaluated for non-ablative wrinkle treatment.[13] They fall into three general classes. The first uses lasers in the infrared or near-infrared portion of the spectrum. The energy produced is absorbed by water and heats both the epidermis and the dermis. The epidermis is protected by cooling the upper portion of the skin before the laser pulse so that only the dermis is heated sufficiently to create damage.[14-18] The second class of non-ablative wrinkle treatments are high-intensity, broad spectrum light sources.[19]

The third class, which includes the VersaPulse, consists of lasers in the visible portion of the spectrum. The light from these devices selectively heats the melanin in the epidermis and oxyhemoglobin in the capillaries and vessels of the dermis. In

addition to the VersaPulse, this class consists of pulsed dye lasers (585 nm). Two small studies have reported both clinically observable improvement and new extracellular matrix formation after pulsed dye laser treatment.[20,21] However, in one of the studies (in which fluences of 3.5 to 6.0 J/cm^2 were used), patients experienced purpura that lasted up to two weeks after the treatment, resulting in a period of cosmetic disability similar in length to that for ablative procedures.[20] The other study reported no such adverse pigmentary changes,[21] and its authors suggest that a smaller spot size and lower energy fluence (2 to 4 J/cm^2) may be responsible.[21] Purpura is a common complication of the use of pulsed dye lasers. These lasers are often utilized for the treatment of facial vascular lesions and port wine stains.

The long-pulse, frequency doubled Nd:YAG laser (VersaPulse) generates light at 532 nm. It has similar absorption in blood as the yellow light (585 nm) from the pulsed dye laser, but it is typically used with a longer pulse width. For example, the pulsed dye laser used in the Bjerring study used a pulse width of 250-400 µs compared to the 2 ms pulse width used by the VersaPulse[21]. A longer pulse width results in slower heating of the blood and avoids vessel wall rupture, reducing the risk of purpura.

Another advantage of the VersaPulse may be the preferential epidermal absorption of green(532 nm) light. Green light is more strongly absorbed by the epidermis than the yellow light produced by pulsed dye lasers. This increased epidermal absorption, although usually protected against by surface cooling, may result in better stimulation of growth factors that trigger collagen and elastin formation immediately below. The zone directly beneath the epidermis shows the greatest improvement after alpha-hydroxy acid, and retinoid treatment[12] (as well as carbon dioxide laser resurfacing[1]). This zone is where the bulk of the 532 nm energy emitted from the VersaPulse is deposited. Thus, 532 nm is maximally absorbed in the zone where other agents that rejuvenate photoaged skin exert their effect as compared to other wavelengths utilized by non-ablation skin rejuvenation. This superficial absorption also, in part, accounts for the low side effect profile.

Non-ablative laser wrinkle treatment is still in its early stages of development. Over time, treatment parameters will continue to be optimized to maximize wrinkle reduction and minimize side effects. This preliminary study demonstrates that non-ablative treatment with the VersaPulse may improve the appearance of facial wrinkles with no recovery time or significant side effects. Although the typical results with treatment appear to be difficult to measure with non standardized photography, patient satisfaction is high. This non-ablative approach is also very well tolerated, making repeat treatments possible, and opening the market to the large number of individuals who want wrinkle reduction but who may be apprehensive about the complications and long recovery time associated with ablative laser skin resurfacing. Ongoing studies utilizing standardized photography and optical profilometry of silicon skin moulds may quantify improvements in rhytids following non-ablative laser treatment.

REFERENCES

1. Bernstein EF, et al. Laser resurfacing for dermal photoaging. *Clinics in Plastic Surgery.* 27(2):221-40, 2000.
2. American College of Cosmetic Surgery. Cosmetic surgery: A comparison study of its growth in the 1990s www.cosmeticsurgery.org/Media_Center/media_center.html.
3. Rubach BW. Comparison of chemical peel and dermabrasion to carbon dioxide laser resurfacing. *Operative Techniques in Otolaryngology–Head and Neck Surgery.* 8(1):9-14, 1997.
4. Fitzpatrick RE, et al. Pulsed carbon dioxide laser resurfacing of photoaged facial skin. *Arch Dermatol.* 132:395-402, 1996.
5. Lowe NJ, et al. Skin resurfacing with the UltraPulse carbon dioxide laser: Observations on 100 patients. *Dermatol Surg.* 21:1025-9, 1995.
6. Alseter TS, et al. Treatment of facial rhytids with a high-energy pulsed carbon dioxide laser. *Plast Reconstr Surg.* 98:791-4, 1996.
7. Stuzin, et al. Histologic effects of the high-energy pulsed carbon dioxide laser on photoaged facial skin. *Plast Reconstr Surg.* 99(7):2036-50, 1996.
8. Manuskiatti W, Fitzpatrick RE, and Goldman MP. Long-term effectiveness and side effects of carbon dioxide laser resurfacing for photoaged facial skin. *J Am Acad Dermatol.* 40(3):401-11, 1999.
9. Nanni Ca, et al. Complications of carbon dioxide laser resurfacing. *Dermatol Surg.* 24:315-20, 1998.
10. Ruiz-Esparza J, et al. Erythema after laser skin resurfacing. *Dermatol Surg.* 24:31-4, 2000.
11. Sriprachya-Anunt S, Fitzpatrick RE, Goldman MP, Smith SR. Infections complicating pulsed carbon dioxide laser resurfacing for photoaged facial skin. *Dermatol Surg.* 23(7):527-35, 1997.
12. Ross EV, et al. Why does carbon dioxide resurfacing work? *Arch Dermatol.* 135:444-54, 1999.
13. Goldberg DJ. Subdermal resurfacing. *Operative Techniques in Oculoplastic, Orbital, and Reconstructive Surg.* 2(4):188-93., 1999.
14. Muccini JA, et al. Laser treatment of solar elastosis with epithelial preservation. *Lasers Surg Med.* 23:121-7, 1998.
15. Ross EV, et al. Nonablative skin remodeling: Selective dermal heating with a mid-infrared laser and contact cooling combination. *Lasers Surg Med.* 26:186-95, 2000.
16. Goldberg DJ, Non-ablative subsurface remodeling: Clinical and histologic evaluation of a 1320-nm Nd-YAG laser. *J Cut Laser Therapy.* 1:153-7, 1999.
17. Kelly KM, et al. Cryogen spray cooling in combination with nonablative laser treatment of facial rhytids. *Arch Dermatol.* 135:691-4, 2000.
18. Menaker GM, et al. Treatment of facial rhytids with a nonablative laser: A clinical and histological study. *Dermatol Surg.* 25:440-4, 1999.
19. Goldberg DJ. Nonablative treatment of rhytids with intense pulsed light. *Lasers Surg Med.* 26:196-200, 2000.
20. Zelickson BD, et al. Pulsed dye laser therapy for sun damaged skin. *Lasers Surg Med.* 25:229-36, 2000.
21. Bjerring P, et al. Selective non-ablative wrinkle reduction by laser. *J Cutan Laser Ther.* 2:9-15, 2000.