STUDY

Single-Pass Carbon Dioxide Laser Skin Resurfacing Combined With Cold-Air Cooling

Efficacy and Patient Satisfaction of a Prospective Side-by-Side Study

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Background: Ablative skin resurfacing with carbon dioxide (CO_2) and erbium:YAG lasers is still considered the gold standard for treating rhytides, photodamage, and acne scars. However, the prolonged downtime and undesired concomitant effects that are involved have sent dermatologists looking for less invasive nonablative laser techniques to rejuvenate skin.

Objective: To combine cold-air cooling with single-pass CO_2 laser skin resurfacing to generate as much benefit as possible while minimizing the spectrum of adverse effects.

Study Design: The efficacy of single-pass CO_2 laser skin resurfacing on perioral and periorbital wrinkles was examined prospectively during a 6-month follow-up period. In a side-by-side comparison, the influence of simultaneous cold-air cooling on concomitant effects, pain tolerance, therapeutic success, and patient satisfaction was also studied. Eight patients with perioral and/or periorbital wrinkles underwent the procedure. During laser treatment, only the right half of each face was cooled using a cold-air system.

Results: Six months after treatment, a mild improvement of the wrinkles was observed in all cases. The use of cold-air cooling did not have any impact on the long-term results, although in a direct comparison between sides, it was observed that cooling reduced the recovery period from 3.9±1.5 (mean ± SD) days to 3.5±1.4 days (P=.09) and helped postoperative erythema fade more quickly, from an average of 21.3±17.9 days to 11.7±3.9 days (P=.17). The reduction of pain was significant, which led to a much higher level of patient acceptance: on a numerical analog scale of 1 to 10, the rate decreased from an average of 6.8±1.8 (mean ± SD) to 3.6±1.7 (P=.006).

Conclusions: Given the clear decline in demand for invasive laser technologies, single-pass CO_2 laser skin resurfacing in conjunction with cold-air cooling is a worthwhile alternative both to conventional resurfacing and to conventional subsurfacing. The use of cold-air cooling not only minimizes intraoperative and postoperative adverse effects, it also contributes strongly to patient satisfaction.

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IN THE PAST, LASER SKIN RESURFACing by means of ablative techniques that use carbon dioxide (CO_2) and erbium:YAG lasers has proved to be a promising therapeutic option for treating cutaneous photodamage, perioral and periorbital wrinkles, and acne scars.[1-4] Heating dermal collagen has been shown to induce collagen shrinkage and reactive dermal neocollagen formation.[5-7] Despite excellent results, the major disadvantage of ablative treatment methods is that they can cause large surface erosions, which can lead to downtime of up to 2 weeks as well as long-lasting postoperative erythema.[8,9] For several years, researchers have been looking for minimally invasive alternatives that will yield similar success rates. These include subsurfacing with both nonablative lasers and intense pulsed light systems, approaches whose efficacy has never been completely convincing, especially with regard to reduction of wrinkles alone.[4,10,11] Another strategy is single- or double-pass CO_2 laser resurfacing, which has been reported to result in more rapid reepithelialization, fewer and less severe adverse effects, and good prospects of success.[12-16]

See also pages 1373 and 1379

The postoperative adverse effects of ablative wrinkle treatment are not the only important consideration in regard to patient satisfaction; preventing intraoperative pain is also a major factor. In our experience, treatment with systemic analgesics, anesthesia with topical lidocaine-prilocaine cream, infiltration anesthesia, nerve blocks, and tumescent anesthesia has been effective. The greatest success, however, has come from using a cold-air system, which has an analgesic

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Figure 1. A 63-year-old female patient with perioral wrinkles before treatment.

Figure 2. Photograph taken 5 days after single-pass carbon dioxide laser skin resurfacing; individual crusting sites are visible on the upper lip.

effect. Previous studies have shown that sufficient air cooling during laser treatment not only dramatically decreases pain levels and thus increases patient tolerability, it also greatly diminishes the postoperative adverse effects.[17-20] It is not yet clear, however, to what extent the cooling process can affect the therapeutic success of ablative laser treatment of wrinkles.

Therefore, we conducted a side-by-side prospective comparison study of single-pass CO_2 laser skin resurfacing with and without cold-air cooling to examine the potential effect that cooling has on the efficacy of this method of treating wrinkles. A secondary end point of this study was the assessment of effects of cooling on concomitant reactions as well as patient satisfaction during a 6-month follow-up period.

METHODS

A total of 8 patients (all female) between the ages of 34 and 58 years (average age, 46 years) with Fitzpatrick skin types I and II were included in the prospective study for a defined period between November 2002 and March 2003. All patients had class I or II wrinkles (Fitzpatrick wrinkle classification system). Two patients had perioral wrinkles (**Figure 1**), 5 patients had periorbital wrinkles, and 1 patient had both. Patients with a history of recurrent herpes simplex were given 200 mg of acyclovir (Aciclostad; STADA Arzneimittel AG, Bad Vilbel, Germany) every 4 hours for 5 days; the first dose was administered 24 hours before treatment. Patients were excluded if they were pregnant, were prone to hypertrophic scars or keloids, had undergone facial laser resurfacing, had received collagen or botulinum toxin injections, or had taken oral retinoids in the past 12 months. Approximately 30 minutes before beginning the session, the patients received a single 25-mg dose of dexketoprofen (Sympal; Berlin-Chemie AG, Berlin, Germany) by mouth as a general analgesic. All patients specifically requested a mild treatment that would allow them to return to work as soon as possible.

We used the short-pulsed CO_2 laser (UltraPulse 5000C; Lumenis Ltd, Yokneam, Israel) with a collimated handpiece (3 mm; pulse duration, <1 millisecond) and an approximate pulse overlap of 10%. A general single pass was made over the entire region with 350 mJ/cm^2 and 5 to 10 pulses per second. The margin was treated at 250 mJ/cm^2 to blend it with the surrounding skin. Appropriate laser goggles were used as protective eyewear (SpectraShield; Dalloz Safety, Lakeland, Fla). In each case, the left, noncooled side of the patient's face was always treated first, while the right side was always treated second, along with air cooling. This sequence was always strictly observed so that the perception of pain on the uncooled side was not influenced or enhanced by the previous use of cooling on the other side. Despite this procedure, the uncooled side was always covered with a thick layer of petroleum jelly during the treatment of the right side to avoid any unnecessary effects from the cold-air flow. We used a commercially available cold-air machine (Cryo 5; Zimmer Elektromedizin, Ulm, Germany) at a cooling level of 3 to 4 for all treatments. This machine works with a compressor system like those in refrigerators and uses ambient air to generate a permanent stream of cold air with a flow of 500 to 1000 L/min and a temperature as low as –30°C, depending on the cooling delivery system and the desired cooling level (range, 1-6). The treated areas were then covered with a thick layer of petroleum jelly. The postoperative treatment (petroleum jelly, tea compresses, and ice packs) lasted until the crusting healed. There was no need for the postoperative administration of analgesics in any case. Photodocumentation was performed routinely before the operation as well as 1 and 6 months after treatment using a 35-mm single-lens reflex camera (EOS 100; Canon Deutschland GmbH, Krefeld, Germany) and analog film (American Standards Association 100 CTX; Agfa Deutschland VGmgH & Cie KG, Köln, Germany). We used a single lot of film and rolls processed in a single bath. The patients were clinically evaluated for healing of crusting and fading of erythema by 3 independent investigators daily in the first week after the treatment (**Figure 2**) and at 2 weeks, 1 month, 3 months, and 6 months after the treatment. The final objective assessment was made 6 months after the treatment (**Figure 3**). Each individual assessment of intraoperative pain within the cooled and uncooled areas was performed twice (during and after the treatment) using a numerical analog scale of 0 (no pain) to 10 (intolerable pain), and the average of both figures was calculated. For statistical analysis of all data, the differences between the pretreatment and posttreatment scores were then determined and a paired *t* test was performed (**Table**). Two additional independent evaluators who were blinded to the treatment method determined the success of the treatment by analyzing the photodocumentation and the clinical findings before and 6 months after treatment. The degree of wrinkle improvement was divided into 4 categories: no improvement, mild improvement, moderate improvement, and substantial improvement. Postoperative evaluation also included the patients' individual assessments of the therapeutic success and a comparison of the 2 sides (whether wrinkle reduction without cooling was better, worse, or the same) and their personal satisfaction with the wrinkle reduction (satisfied or not satisfied).

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Figure 3. Photograph taken 6 months after single-pass carbon dioxide laser skin resurfacing (cooling on the right side); moderate improvement of perioral wrinkles; no difference is visible between clearance on different sides.

Table. Results of Treatment and Statistical Assessment

Variable	Mean ± SD: Without Cooling	Mean ± SD: With Cooling	*P* Value
Healing of crusting, d	3.88 ± 1.48	3.50 ± 1.41	.09
Fading of erythema, d	21.29 ± 17.91	11.71 ± 3.95	.17
Painfulness of treatment (1-10)	6.75 ± 1.83	3.62 ± 1.72	.006

RESULTS

The average interval until the crusting healed completely was 3.5±1.4 (mean ± SD) days with cooling and 3.9±1.5 days without (P=.09). In the cooled areas, an average of 11.7±3.9 days passed before the erythema resolved, compared with 21.29±17.9 days in the uncooled areas (P=.17). One patient reported erythema of up to 2 months in an uncooled area and resolution of erythema in the cooled area after only 2 weeks (Table). A significant reduction (P=.006) in the average pain level was also seen during laser treatment. The pain level was 3.6±1.7 (mean±SD) in the cooled areas and 6.7±1.8 in the uncooled areas (Table). No postoperative analgesic treatment was needed beyond application of petroleum jelly and compresses of ice or tea.

All patients showed mild improvement of wrinkles in the clinical evaluation of therapeutic success 6 months after treatment. No difference was observed with regard to the cooling used on one side during treatment. None of the patients was absent from work for more than 8 days after the procedure. Overall, 7 of 8 patients were satisfied with the success of the treatment as far as the initial findings and the concomitant effects were concerned. Only 1 patient with perioral rhytides stated that she was not satisfied with the outcome.

Even after the subjective assessment by the patients, no difference was detected between the cooled and the uncooled sides of the face in terms of rhytid clearance. The patients were unanimous in stating that laser treatment was much more pleasant with cooling than without.

COMMENT

To date, various studies have proved the efficacy of single-pass CO_2 skin resurfacing for slight to moderate rhytides with regard to mild concomitant effects and a downtime that is tolerable for the patient. In 2 studies, David[12] and Ruiz-Esparza and Gomez[14] used an ultrapulsed CO_2 laser to treat their patients with variable degrees of actinic damage. Two to 4 passes were made focally over the shoulders of rhytides (200-300 mJ/cm^2). A general single pass was then made over the entire face (200-250 mJ/cm^2). The recovery period for all patients lasted between 6 and 7 days, and no postoperative analgesics were needed. After an average of 1 week, the patients were able to resume their everyday work. Postoperative wound treatment consisted of topically administered substances. In comparison to conventional laser skin resurfacing, a more rapid process of reepithelialization has been observed, along with fewer complications, less need for operative and postoperative analgesics, greater patient acceptance, and satisfactory cosmetic results.[12,14]

In one study, Khosh et al[13] performed single-pass CO_2 laser skin resurfacing on the entire facial area of 30 patients. Their histologic studies showed that a single pass at 17 J/cm^2 led to comparable thermal damage in the reticular dermis and entailed much shorter postoperative erythema than 2 or more passes at 9 J/cm^2 in the comparison group.[13] Ross et al[15] and Tanzi et al[16] compared single-pass CO_2 laser resurfacing with multiple-pass erbium:YAG laser resurfacing in their respective side-by-side studies. Ross and colleagues treated 13 patients with perioral and periorbital wrinkles with a pulsed CO_2 laser (10 J/cm^2) and a pulsed erbium:YAG laser (5 J/cm^2). The evaluation of the results showed that the CO_2 laser–treated site had comparable immediate postoperative cosmetic improvement with milder postoperative erythema and less invasiveness. Tanzi and colleagues did a retrospective comparison of postoperative wound healing and short- and long-term adverse effects of both laser systems in 100 patients who underwent laser skin resurfacing with single-pass CO_2 (UltraPulse 5000C; 300-500 mJ/cm^2) or multiple-pass, long-pulsed erbium:YAG (22.5 J/cm^2) laser resurfacing for photodamage, rhytides, and atrophic scarring. The clinical evaluation of the results demonstrated comparable postoperative healing intervals and concomitant effects.[16]

The findings of our study on single-pass CO_2 laser skin resurfacing make it clear that a mild improvement of wrinkles can be achieved with single-pass CO_2 laser skin resurfacing of perioral and periorbital rhytides. In comparing the cooled and noncooled treatment areas, there was no statistically significant difference in efficacy in terms of wrinkle reduction, resolution of crusting (P=.09), or resolution of postoperative erythema (P=.17).

The most important advantage of the cold-air technique, however, is the reduction of the intraoperative pain that the patient undergoes during laser treatment. In the present study, we found that there was a statistically significant reduction in individual pain perception on the

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cooled side ($P = .006$). Other comparable studies have primarily used regional nerve blocks and intravenous anesthesia to reduce pain; such methods may not only necessitate the presence of an anesthesiologist, but they may also involve a procedure that in itself is rather painful.[14-16] The acceptance of cold-air therapy is very high among patients and physicians. To avoid problems with treatment around the eyes and nostrils, the use of nose clips and protective goggles has been shown to be extremely beneficial in terms of patient acceptance. Since the air stream is very gentle, the degree of tissue distortion is minimal. The minor disadvantage of this procedure is the additional space that is required for the cooling unit; there is also a certain amount of noise and heat produced in the laser room.[17]

Despite the advantages of single-pass CO_2 laser skin resurfacing—much shorter postoperative downtimes and healing periods—in our opinion, treating age- and sun-related facial rhytides with conventional ablative skin resurfacing with the CO_2 and/or erbium:YAG laser still remains the gold standard among the therapeutic options that are available today.[4,21] However, if the patient's greatest wish is as short a downtime as possible, with satisfactory reduction of rhytides, we believe that the combination of single-pass CO_2 laser skin resurfacing and cold-air cooling is the most effective method and that it also will maximize patient acceptance. In terms of therapeutic success, this method is somewhere between nonablative subsurfacing and conventional multiple-pass ablative CO_2 or erbium:YAG laser skin resurfacing, although subsurfacing is most commonly used as a means of preventing rhytides and general treatment of the face, including essential telangiectasias and epidermal lentigines. Its efficacy, however, is currently the focus of heated debate among some authors.[4,10,22,23]

In summary, the present method of using air cooling along with single-pass CO_2 laser skin resurfacing is an effective technique that can be ranked between multiple-pass ablative CO_2 or erbium:YAG laser skin resurfacing and subsurfacing in treating incipient and light perioral and periorbital wrinkles. Unlike conventional skin resurfacing and single-pass resurfacing with alternative forms of analgesics, our procedure clearly reduces intraoperative pain and postoperative adverse effects to an easily tolerated level. All of our patients were able to return to work after an average of 8 days. The use of additional postoperative analgesics was usually unnecessary. Without exception, all patients felt that the treatment on the side that was cooled with air was much more pleasant.

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