Single-pass CO_2-laser skin resurfacing in combination with cold air cooling. Efficacy and patient satisfaction of a prospective side-by-side study

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Abstract:

Objective:

Ablative laser skin resurfacing via CO_2 and/or Er:YAG lasers is still considered the gold standard for treating rhytids, photodamage and acne scars. However, the prolonged down times and undesired concomitant effects involved have sent dermatologists looking for less invasive non-ablative laser technologies to rejuvenate skin. Our goal was to combine cold-air cooling with a single-pass CO_2 laser skin resurfacing to generate as high an efficacy as possible while minimizing the spectrum of side effects.

Study design / material and methods:

This prospective study examined the efficacy of single-pass CO_2-laser skin resurfacing (UltraPulse 5000C) on perioral and periorbital wrinkles in a follow-up period of 6 months. In a side-by-side comparison, we also studied the influence of simultaneous cold-air cooling on concomitant effects, pain tolerance, therapeutic success and patient satisfaction. Eight patients with perioral and/or periorbital wrinkles underwent single-pass CO_2 laser skin resurfacing. During laser treatment, only the right half of each face was cooled using a cold-air system (Cryo 5).

Results:

Six months post treatment, a mild to moderate improvement of the wrinkles was observed in all cases. Seven of eight patients reported a conspicuous tightening of the skin. Using 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 abbreviated the recovery period from 3.9 +/- 1.5 to 3.5 +/-1.4 days and helped post-operative erythema fade more quickly, from an average of 21.3 +/- 17.9 to 11.7 +/- 3.9 days. The reduction of pain was significant, which led to a much higher level of patient acceptance: on a numerical analog scale of 1-10, the rate fell from an average 6.8 +/- 1.8 to 3.6 +/- 1.7 ($p=0.006$).

Conclusion:

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 to both conventional resurfacing as well as subsurfacing. The use of cold air cooling not only minimizes intra- and post-operative adverse effects, it also contributes strongly to patient satisfaction.

Key words: lasers, cooling, cold air cooling, skin resurfacing, CO_2 lasers

Introduction:

In the past, laser skin resurfacing by means of ablative technologies which use CO_2 and Erbium:YAG lasers have proven to be a promising therapeutic option for treating cutaneous photodamage, perioral and periorbital wrinkles, and acne scars [1, 2, 3, 4]. Heating dermal collagen has been demonstrated to induce collagen shrinkage and reactive dermal neocollagen formation [5, 6, 7]. In spite of excellent results, the major disadvantage of ablative treatment methods is the large surface erosions they cause, which can lead to downtime of up to two weeks and long-lasting postoperative erythema [8, 9]. For several years, researchers have been looking for minimally invasive alternatives which will yield similar success rates. These include both subsurfacing via non-ablative lasers and IPL systems, approaches whose efficacy have never been completely convincing, especially with regard to reduction of wrinkles only [4, 10, 11]. Another strategy is single- or double-pass CO_2 laser resurfacing, which has been discussed many times. It is said to bring about more rapid reepithelialization, fewer and less severe adverse effects, and good prospects of success [12, 13, 14, 15, 16].

In dealing with patient satisfaction, not only the postoperative adverse effects of ablative wrinkle treatment are important; preventing intra-operative pain is also a major factor. In our experience, effective procedures included systemic analgesics, topical treatments of lidocaine-prilocaine (Emla® creme) and infiltration anesthesia, nerve blocks and tumescent anesthesia; the greatest success, however, comes from using a cold-air system, which has a pain-killing 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, 18, 19, 20].

It is not yet clear, however, to what extent the cooling process can affect the therapeutic success of ablative laser treatment of wrinkles.

This is why we conducted a side-by-side prospective comparison study of single-pass CO_2 laser skin resurfacing with and without cold-air cooling. The clinical success, concomitant effects and patient satisfaction were evaluated during a follow-up period of six months.

Materials and Methods:

A total of eight patients (all female) between ages 34 and 58 (average age 46) with Fitzpatrick skin type 1-2 were included in the prospective study for a defined period between November 2002 and March 2003. Two patients had perioral wrinkles, five had periorbital ones and one patient had both. Patients with a history of recurrent herpes simplex were given Aciclovir 200 mg (Aciclostad®) every four hours for five days; the first dose was administered 24 hours before treatment. In terms of adverse effects and concomitant effects, all patients specifically requested a mild treatment that would allow them to return to work as soon as possible.

We used the Lumenis UltraPulse 5000C (Lumenis Ltd., Yokneam, Israel) with a computer pattern generation unit. A general single pass was done over the entire region with 350 mJ/cm^2 using the collimated handpiece with 5-10 pulses per minute. The margin was treated at 250 mJ/cm^2 to blend it with the surrounding skin. Appropriate laser goggles were used as protective eyewear (GPT™ Glendale, Dalloz Safety, Lakeland, Florida, USA). In each case, the right side of the patient's face was concomitantly treated with cooled air, while the left side remained untreated. For cooling we used the "Cryo 5" cold air machine (Zimmer Elektromedizin, Ulm, Germany) at a cooling level of 3-4. 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 500-1000 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 area was covered with a thick layer of petroleum jelly. Post-operative treatment (petroleum jelly, tea compresses, ice packs) took place until the crusting healed. Post-operative administration of analgesics was not needed in any case. Photodocumentation was performed routinely before the operation as well as one and six months post treatment (camera: Canon EOS 100, Film: Agfa CTX 100). The post-operative healing process was assessed in terms of the length of time needed until the crusting healed and the erythema faded. Each individual assessment of intra-operative pain within the cooled and uncooled areas was performed using a numeric analog scale (NAS) of 0 (no pain) to 10 (intolerable pain). Three independent evaluators determined the success of the treatment by analyzing the clinical findings and the photodocumentation.

Post-operative evaluation also included the patients' individual assessments of the therapeutic success and a comparison of the two sides (whether clearance without

cooling was better / worse / the same) and their personal satisfaction with the results of the treatment (very good / good / moderate / not satisfied).

Results:

The average interval until the crusting healed completely was 3.5 +/- 1.4 days with cooling and 3.9 +/- 1.5 days without. In the cooled areas, an average of 11.7 +/-3.9 days passed before the erythema resolved, compared to 21.32 +/- 17.9 days for the uncooled areas. One patient reported erythema of up to two months in an uncooled area and resolution of erythema in the cooled area after only two weeks (see Table).

A significant reduction ($p=0.006$) of the average pain level was also seen during laser treatment. Patients stated that this was 3.6 +/- 1.7 with concomitant cooling and 6.7 +/- 1.8 without (see table). No post-operative analgesic treatment was needed beyond application of petroleum jelly and compresses of ice or tea.

All patients showed mildly improved 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 were absent from work for more than eight days after the procedure.

Overall, seven of eight patients were satisfied with the success of the treatment as far as the initial findings and the concomitant effects were concerned. They reported a general tightening and revitalization of the skin. Only one patient with perioral rhytids 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 side of the face in terms of rhytid clearance and acne scarring. The patients were unanimous in stating that laser treatment was much more pleasant with cooling than without.

Discussion:

To date, various studies have proven the efficacy of single-pass CO_2 skin resurfacing for slight to moderate rhytids with regard to mild concomitant effects and a down-time that is tolerable for the patient.

In two studies, David and Ruiz-Esparza used an ultrapulsed CO_2 laser to treat their patients with variable degrees of actinic damage. Two to four passes were done focally over the shoulders of rhytids (200-300 mJ/cm^2). A general single pass was then done over the entire face (200-250 mJ/cm^2). The recovery period for all patients lasted between six and seven days, and no post-operative analgesics were needed. After an average of one week, the patients could resume their everyday work. Post-operative wound treatment consisted of topically administered substances. Six months after the procedure, there was clear dermal tightening which also lasted 18 months post treatment. 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 post-operative analgesics, greater patient acceptance and satisfactory cosmetic results [12, 14].

In their study, Khosh et al. performed single-pass CO_2-laser skin resurfacing on the entire facial area of 30 patients. Their histological studies showed that a single pass at 17 J/cm^2 led to comparable thermal damage in the reticular dermis and entailed much shorter post-operative erythema than two or more passes at 9 J/cm^2 in the comparison group [13].

Ross et al. and Tanzi et al. both compared single-pass CO_2 to multiple-pass Er:YAG laser skin resurfacing in their respective side-by-side studies. Ross et al. treated 13 patients with perioral and periorbital wrinkles with a pulsed CO_2 laser (10 J/cm^2) and a pulsed Er:YAG laser (5 J/cm^2); for the purposes of the histological examination, the postauricular region was also treated. The evaluation of the results showed that the CO_2 laser treated site had comparable immediate post-operative histological results and cosmetic improvement with milder post-operative erythema and less invasiveness [15].

Tanzi et al. did a retrospective comparison of post-operative 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 Er:YAG-laser (22.5 J/cm^2) resurfacing for photodamage, rhytids and atrophic scarring. The clinical evaluation of the results

demonstrated comparable post-operative healing intervals and concomitant effects [16].

The findings of our study on single-pass CO_2 laser skin resurfacing make it clear that a moderate improvement of wrinkles and a noticeable tightening of the skin can be achieved with single-pass CO_2 laser skin resurfacing of the perioral and periorbital rhytids.

In comparing the two sides of the face, the use of concurrent intra-operative cold-air cooling yielded little to no difference in terms of the efficacy of the laser treatment and the resolution of the crusting. By contrast, the post-operative erythema on the cooled side of the face had a clear tendency to resolve more quickly, although a statistical significance cannot be claimed here without a larger sample group.

The most important advantage to this technique with cold-air cooling, however, is definitely the reduction of the intra-operative pain that the patient undergoes during laser treatment. There was a statistically significant reduction in individual pain perception from 6.7 +/- 1.8 points (NAS) on the uncooled side to 3.6 +/- 1.7 with cooling. Other comparable studies primarily used regional nerve blocks and intravenous anesthesia to this end; doing so may not only necessitate the presence of an anesthesiologist, but also entails a procedure that is also rather painful itself [14, 15, 16]

Interestingly, during histological examinations of dermal collagen Majaron et al. observed that the depth of coagulation decreased after Er:YAG laser skin resurfacing when cryogen spray cooling was applied during laser treatment [21]. By contrast, in our study, absolutely no clinical difference could be observed between the cooled and uncooled areas in terms of wrinkle reduction or improvement of the dermal structure. This might be due to the different extents to which dermal collagen is denaturalized by CO_2 and Er:YAG lasers, but more likely it is because of the different methods of cooling.

In spite of the advantages of single-pass CO_2 laser skin resurfacing — much shorter post-operative downtimes and healing periods — in our opinion, treating age and sun-related facial rhytids with conventional ablative skin resurfacing via CO_2 and/or Er:YAG laser still remains the gold standard among the therapeutical options that exist [4, 22]. If, however, the patients' greatest wish is as short a downtime as possible with satisfactory reduction of rhytids, the method we present of combining single-pass CO_2 laser skin resurfacing with cold air cooling is to be preferred and will

maximize patient acceptance. In terms of therapeutic success, this method is to be positioned somewhere between the process known as non-ablative subsurfacing and conventional ablative skin resurfacing, although subsurfacing is most commonly used as a means of preventing rhytids and general treatment of the face, including essential telangiectasias and epidermal lentigines. Its efficacy is currently the focus of heated debate among some authors, however [4, 10, 23, 24].

In summary, the method we introduce of using air cooling parallel to single-pass CO_2 laser skin resurfacing presents an effective mechanism that can be ranked between conventional 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 lowers intra-operative pain and post-operative adverse effects to an easily tolerated minimum. All patients whose wrinkles were treated were able to return to work completely after an average of 8 days. Additional post-operative painkillers were usually not necessary. Without exception, all patients felt that the treatment on the side which was cooled with air was much more pleasant.

Table: Results of treatment and statistical assessment

	Healing of crusting (in days)	Fading of erythema (in days)	Painfulness of treatment (1-10)
Without cooling	Ø 3.875 +/-1.485	Ø 21.286 +/-17.905	Ø 6.750 +/-1.826
With cooling	Ø 3.500 +/- 1.414	Ø 11.714 +/-3.946	Ø 3.625 +/-1.718
Significance	**no**	**no**	**yes**: **p = 0.006**

Fig. 1: 63-year-old female patient with perioral wrinkles before treatment

Fig. 2: Status 5 days after single-pass CO_2 laser skin resurfacing: individual crusting sites visible on the upper lip.

Fig. 3: Status 6 months after single-pass CO_2 laser skin resurfacing (cooling on the right side): moderate improvement of perioral wrinkles, no difference visible between clearance on different sides

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