Long-term Results of Carbon Dioxide Laser Resurfacing of the Face

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Objective: To evaluate the long-term effectiveness of, and the complications associated with, carbon dioxide laser treatment of rhytidosis and solar aging.

Methods: This retrospective report describes our experience with 47 patients who underwent entire facial carbon dioxide laser resurfacing.

Results: The mean improvement in facial rhytid score at long-term follow-up was 45%. This improvement was consistent in all facial subsites. With the exception of 1 case of hyperpigmentation, which resolved within 2 years of treatment, hypopigmentation was the only long-term adverse effect. This complication was present in 6 patients (13%). The patients who developed hypopigmentation were more likely to have a greater response to treatment.

Conclusion: Our findings show that carbon dioxide laser resurfacing is a safe and effective treatment for facial rhytids.


The experience with carbon dioxide laser resurfacing at our institution indicates that nearly all patients experience some degree of hypopigmentation after laser resurfacing. However, the degree of postprocedure hypopigmentation is highly variable, as is the level of concern that this problem causes for patients. Hypopigmentation is thought to be related to the degree of thermal injury, a theory that is supported by the finding that hypopigmentation is associated with the degree of improvement in rhytidos.

Furthermore, hypopigmentation has also been associated with a greater degree of preprocedure rhytidos, perhaps suggesting that patients who receive more aggressive treatment are at increased risk of developing hypopigmentation.

The primary purpose of this study was to assess the long-term results after full-face carbon dioxide laser resurfacing. Long-term efficacy and complications were examined, with particular attention directed at determining the incidence of hypopigmentation that was evident on photographic review by an independent observer. The population of patients who developed hypopigmentation was further analyzed to determine whether there are any other factors that are associated with hypopigmentation.
METHODS

After written informed consent was obtained from the patients, all procedures were performed by the senior author (S.R.B.) using a commercially available carbon dioxide laser (Coherent UltraPulse; Coherent Inc, Santa Clara, California) between December 1996 and December 2004. The settings used for the resurfacing procedure were 300 mJ with a density of 5 to 6 for the facial skin and 250 mJ with a density of 5 for the eyelids. Three passes were used for the face and the eyelids. Care was taken not to use the laser in areas where skin vascularity was potentially at risk, such as on skin flaps elevated during concurrent rhytidectomy.

The patient’s sex, skin type, and age at the time of the procedure were all recorded. Any other procedures that the patient also underwent at the time of resurfacing were also documented. Preoperative and postoperative photographs were analyzed and graded to determine wrinkle scores before and after treatment. The scale used was described by Lemperle et al in 2001. It was initially designed and verified to be accurate for grading facial wrinkles before and after treatment with injectable fillers; however, it has since been demonstrated to be an effective method to use for grading facial rhytids that have been treated with the carbon dioxide laser. The glabellar, periorbital, and melolabial regions as well as the corners of the mouth and the upper lip were graded and assigned preprocedure and postprocedure scores. Also, the average score for the entire face was calculated using the scores for each of the 5 subsites. Improvement in rhytid score was calculated in relation to the preoperative rhytid score. The improvement in rhytid score was determined by calculating the ratio of the difference between the preprocedure and postprocedure scores and the preoperative score. Only the most recent photographs were used to determine the postoperative score. One-way analysis of variance was performed to assess any differences between the treated anatomical subsites.

All complications were recorded. The presence of hypopigmentation was determined by review of postoperative photographs. The characteristics of the patients who developed hypopigmentation were compared with those of the patients who did not develop hypopigmentation. The mean age, preoperative rhytid score, and percentage of improvement in rhytid score were all recorded and analyzed to determine any difference between the groups. One-way analysis of variance was again used to determine whether there was any statistical significance between the means of the parameters of the patients with hypopigmentation and those of the patients without hypopigmentation.

RESULTS

Sixty-two patients who underwent entire facial laser resurfacing were identified. Complete data were available in 47 cases. There were 42 women and 5 men, with a mean age of 52 years. All 47 patients had Fitzpatrick skin type I, II, or III, with the exception of 1 patient who had skin type IV. The mean and median duration of follow-up was 2.3 and 1.8 years, respectively (range, 0.2-8.1 years). Many patients underwent other procedures along with facial resurfacing, including dermabrasion, blepharoplasty, brow-lift, and rhytidectomy (Figure 4).

The mean improvement in facial rhytid score was 45% (95% confidence interval [CI], 40.6%-49.7%), and there was no difference in improvement between facial subsites (Figure 5). Complications encountered included milia or acne in 14 cases (30%), hyperpigmentation in

Figure 1. Patient who underwent carbon dioxide laser resurfacing because of concerns about her freckles. Patient’s appearance before (A) and 5 years after (B) the procedure.
At the long-term follow-up visit, most of the complications had resolved. The only complications present after 1 year were hypopigmentation and 1 instance of hyperpigmentation, which resolved by 2 years. Of the 14 patients with follow-up time of less than 1 year, 1 had hyperpigmentation that resolved after 5 months, and 3 had milia or acne flare-ups. None of the patients with follow-up of less than 1 year developed hypopigmentation. The patients with hypopigmentation had a mean age of 49.0 years (95% CI, 39.0-59.0) compared with a mean age of 52.7 years (95% CI, 48.7-56.7) in those without hypopigmentation (Figure 7). This difference was not statistically significant ($P_{} = .51$).

To determine whether the patient’s preoperative degree of rhytidosis may have led to a more aggressive treatment, the preoperative rhytid scores were calculated for patients who did and did not develop hypopigmentation (Figure 8). The average preoperative score for patients with hypopigmentation was 2.20 (95% CI, 1.23-3.17). The average preoperative score for patients without hypopigmentation was 2.15 (95% CI, 1.82-2.48). This difference was not significant ($P_{} = .92$).

The response to treatment was assessed by comparing the mean improvement in rhytid scores of the patients with and without hypopigmentation (Figure 9).
The patients with hypopigmentation had a greater response to treatment, with a 73.9% mean improvement (95% CI, 59.8%-88.0%), compared with a 41.8% mean improvement (95% CI, 33.9%-49.7%) in patients who did not develop hypopigmentation. This difference was significant ($P = .004$).

**COMMENT**

The efficacy of treating facial rhytids with the carbon dioxide laser is well established, and the short- and long-term utility of the carbon dioxide laser in treating solar facial aging has previously been documented.3,5-7 Our results verify those of previous studies that found that carbon dioxide laser resurfacing leads to long-term improvement in facial rhytidoses.1,3,5-7 The mean improvement in
rhytid score in the present study was 45%. This degree of improvement in facial rhytid score was consistent in all 5 anatomical subsites. Prior studies have documented decreased efficacy in the perioral region, presumably because of the increased muscular activity in this region.\(^1,3\) Although the perioral region demonstrated the least degree of improvement among the subsites in our study, the difference was not significant (\(P = .51\)).

The complications that were encountered in this study are similar to those described in previous studies. Milia and acne were the most frequent adverse effects, followed by hyperpigmentation, hypopigmentation, infection, and ectropion. Milia and acne flares, which are relatively common reactions, are thought to be caused by the use of postoperative dressings, ointments, and aberrant follicular epithelialization.\(^2\) Spontaneous resolution of acne is the typical course, although short courses of oral antibiotics or, if the skin has fully reepithelialized, topical antibiotics may be helpful. For milia, the use of retinoic acid can be helpful in accelerating resolution.

One patient developed a postoperative viral eruption, and 1 patient developed postoperative ectropion. The viral infection occurred despite the use of an antiviral agent before and after the procedure. Zoster-dose antiviral medications and supportive treatment were administered, and the patient had no further sequelae. The patient with ectropion was treated with eye lubricants and had complete resolution within 1 year.

The only complications present after 1 year were hyperpigmentation (1 patient) and hypopigmentation (6 patients). All 8 patients who had postprocedure hyperpigmentation were treated with topical hydroquinone, and 7 (88%) of them had resolution within 1 year. The patient with persistent hyperpigmentation at the 1-year follow-up visit had resolution within 2 years after the procedure. Our experience supports that of several previous studies in which hyperpigmentation occurred in 0% to 30% of patients but usually resolved within the first several months.\(^1,3,5-12\) The incidence of this complication, which is more common in patients with darker skin types, is decreased by avoidance of sun exposure for several weeks (at least 4) before the resurfacing procedure. Advising patients to continue sunscreen use postoperatively is also important to help prevent further pigmen
tary abnormalities.\(^2\) One month after the procedure, bleaching agents (eg, hydroquinone), retinoic acid, and glycolic acid peels may be used to hasten resolution of the pigmentary abnormalities.\(^2\)

Hypopigmentation was photographically evident at the long-term follow up visit in 6 of the 47 patients (13%). This rate compares favorably with the rates quoted in the literature, which range from 8% to 57%.\(^1,3,5,6\) The literature concerning hypopigmentation after laser resurfacing is somewhat difficult to interpret owing to the lack of a standard definition of hypopigmentation. Also, some authors make a distinction between true hypopigmentation and pseudohypopigmentation. True hypopigmentation, which refers to skin lightening due to decreased melanogenesis, is rare, whereas pseudohypopigmentation, which refers to areas of treated skin that are lighter than surrounding untreated skin,\(^3\) is much more common. The degree of hypopigmentation that occurs var-

ies from patient to patient, as does the degree of concern that this problem elicits. Dijkema and van der Lei\(^1\) found that 34% of patients who underwent laser resurfacing of the upper lip used some sort of camouflage to hide their hypopigmentation.

Our experience is that all patients who undergo carbon dioxide laser resurfacing with our protocol have some degree of hypopigmentation. We attempted to determine the incidence of hypopigmentation that was evident on photographic review. Previous authors have reported that the degree of thermal injury and the depth of penetration are directly related to the incidence of hypopigmentation.\(^1,3\) Patients who develop hypopigmentation have been shown to have a greater degree of solar damage before laser resurfacing as well as a greater improvement in rhytids.\(^3\) Our study did not note a greater degree of preprocedure rhytidosis in patients who developed hypopigmentation but did note a greater degree of improvement in rhytid score in these patients. An additional indicator of possible hypopigmentation development could be increasing patient age, with its resultant decrease in skin thickness. Our study did not note a difference in age between patients who did and did not develop hypopigmentation; however, our small sample size may have prevented us from finding a difference in age between the 2 groups.

For patients who develop hypopigmentation, chemical peels using glycolic acid or tricholoroacetic acid may be used to help blend the lines of demarcation between treated and untreated skin. Efforts to increase melanogenesis, such as limited exposure to UV light and application of methoxsalen, may also be helpful.\(^2\) The most important treatment, however, is prevention. The risk of developing hypopigmentation can be minimized by cautioning the patients to use sunscreen before and after the procedure and by treating all skin within cosmetic units to decrease the incidence of observable lines of demarcation.

In conclusion, carbon dioxide laser resurfacing is a safe and effective treatment for facial rhytidos
tis. The mean improvement in facial rhytid score was 45%. Complications encountered included hypopigmentation, milia, acne, hyperpigmentation, infection, and ectropion. All complications resolved in all patients by 1 year after the procedure, with the exception of 1 patient with hyperpigmentation and 6 patients with hypopigmentation. Some degree of hypopigmentation occurs in all patients who undergo carbon dioxide laser resurfacing with a protocol similar to that used in our study. Patients who experience a greater improvement in rhytidosis are more likely to develop hypopigmentation. Although increased age and preoperative level of rhytidosis were not found to be associated with increased hypopigmentation in our study, they are likely to be associated with an increased risk of hypopigmentation.

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REFERENCES


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