Complications of Carbon Dioxide Laser Resurfacing

An Evaluation of 500 Patients

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BACKGROUND. Cutaneous laser resurfacing with high-energy, pulsed and scanned carbon dioxide (CO₂) lasers has become popularized for the treatment of a variety of cutaneous indications, but potential complications and side effects remain a large concern. Despite the recent boom in cutaneous laser resurfacing procedures, there remains a relative paucity of written information documenting laser complication rates.

OBJECTIVE. The purpose of this study was to identify and report the complications that occurred after cutaneous CO₂ laser resurfacing within a large patient population.

METHODS. A retrospective analysis and chart review was performed in 500 consecutive patients who underwent cutaneous laser resurfacing of 1589 facial regions with the UltraPulse CO₂ laser by a single operator. Side effects and complications relating to infection, postoperative healing, pigmentedary changes, and scarring were tabulated.

RESULTS. The most common complication observed was postoperative erythema, which occurred in all patients, lasting an average of 4.5 months. Hyperpigmentation was seen in 37% of patients with a higher rate in darker skin phototypes. Acne flares, milia formation, and dermatitis occurred in 10–15% of patients. Postoperative infection with herpes simplex virus (HSV) was observed in 7.4% regardless of prior HSV history. Hypopigmentation, scarring, and other local or disseminated infections occurred in <1% of this study population.


Since the introduction of high-energy, pulsed and scanned carbon dioxide (CO₂) laser technology, there has been an explosion in the demand for cutaneous laser resurfacing. Although the success of these lasers has been reported frequently within the medical literature, comprehensive surveys of the side effect profile of CO₂ laser resurfacing are lacking. Knowledge of potential laser complications becomes particularly important to novice laser operators, who will experience a steep learning curve while they hone their surgical skills. It is important that the complications of resurfacing are accurately reported so that physicians are able to anticipate potential side effects and compare their own complication rates with those of other laser surgeons in the community.

Reported mild side effects of laser resurfacing include prolonged erythema, edema, milia formation, acne exacerbations, allergic or irritant contact dermatitis, burning discomfort, eczematization, and intermittent pruritus. Moderate complications such as local herpes simplex reactivation, transient posttreatment hyperpigmentation, and irregular delayed hypopigmentation have also been reported. The most severe complications of CO₂ cutaneous resurfacing include hypertrophic scarring, disseminated infection, and ectropion formation. The present study reviews the complications encountered after cutaneous resurfacing with a high-energy, pulsed CO₂ laser in 500 patients. Complication rates, patient characteristics, and long-term follow-up are reviewed.

Materials and Methods

Cutaneous laser resurfacing was performed on 500 consecutive patients (age, 19–79 years; skin types I–V) by a single operator and included a total of 1589 cosmetic facial units using a high-energy, pulsed CO₂ laser (UltraPulse 5000; Coherent Laser Corporation, Palo Alto, CA). Cosmetic facial units consisted of perioral, periorbital, forehead, cheek, and full face regions. Cases were evaluated by retrospective chart review.

Preoperatively, 70% of patients were placed on glycolic (GlyDerm; ICN Pharmaceuticals, Costa Mesa, CA) or retinoic acid (Retin A; Ortho Pharmaceuticals Corp, Raritan, NJ) creams nightly for at least 4–6 weeks prior to resurfacing. Lower eyelids were examined for evidence of excessive laxity or decreased tone using the "snap technique." In this technique, the lower lid was gently stretched downward and released with a normal brisk return of the lid to its resting position. The periorbital regions were not aggressively resurfaced if a delay in lid return or excessive separation of the lids upon eye closure was noted, in order to reduce the possibility of ectropion formation. Similarly, patients with histories of prior blepharoplasty were not generally treated with lower
energy fluences in the periorbital regions, but instead had fewer laser passes performed.

Laser operating protocol consisted of one to three laser passes using a 5–8-mm square computer pattern generator (CPG) scan at settings of 300 mJ, 60-W power, and a density of 6 to cover the entire cosmetic region. A 3-mm collimated spot calibrated to 500 mJ, and 7 W was then utilized to sculpt individual rhytides or scars using one to three additional passes. No feathering of the neck or hair line was performed. The laser margins coursing the inferior portion of the mandible were never extended beyond 1 cm onto the neck. Partially desiccated skin was removed with saline-soaked gauze between laser passes.

The majority of patients (85%) undergoing perioral or full facial resurfacing were placed on antiviral prophylaxis for herpes simplex infection whether or not a history of herpes simplex virus (HSV) was given. Patients were instructed to take the first dose of antiviral medication 24 hours prior to surgery and to continue the medication for 10 days. Ninety-two percent of patients were prescribed acyclovir (Zovirax; Burroughs Wellcome, NC) 400 mg po TID, and 8% of patients received famcyclovir (Famvir; SmithKline Beecham, Philadelphia, PA) at a dose of 500 mg po BID. Eighty-seven percent of patients undergoing full-facial resurfacing or resurfacing of more than one anatomic location received antibiotic prophylaxis with azithromycin (Zithromax; Pfizer Labs, NY, NY) 500 mg for the first day and 250 mg each postoperative day for 4 days. All patients undergoing full face resurfacing also received 1 g of intravenous cefazolin (Ancef; SmithKline Beecham, Pittsburgh, PA) intraoperatively. Any lesion suspicious for infection was examined microscopically and/or cultured for bacteria, yeast, and HSV. Negative laboratory results were occasionally superceded by clinical judgment, whereby patients were treated empirically for an infection without laboratory confirmation. A herpes infection was diagnosed when a positive viral culture or Tzanck smear was found or if the clinical suspicion was strong enough for oral antiviral intervention with subsequent clinical improvement.

Patients were instructed in postoperative care using an “open technique” that included frequent topical applications of Catrix-10 ointment (Donnell Inc., New York, NY), petrolatum (Vaseline), or Aquaphor (Beiersdorf Inc., Norwalk, CT) ointments as well as ice water soaks and compresses every 1–2 hours. On the third or fourth postoperative day, patients were evaluated and initiated a series of daily cleansing treatments consisting of gently facial steaming, dilute hydrogen peroxide debridement, and Catrix-10 ointment application for 1 week. After reepithelialization, patients were instructed to use a cream-based emollient such as Hydroton cream (ICN Pharmaceuticals, Costa Mesa, CA) twice daily in addition to a non–PABA-containing sunscreen.

Cases of scarring, erythema, dermatitis, ectropion, hypertrophic scarring, or cutaneous fibrosis were identified. Common complications and side effects from laser resurfacing included (Table 1) postoperative erythema, which occurred in 100% of patients with an average duration of 4.5 months. Hyperpigmentation was observed in 37% of all treated patients by an average of 32 days postoperatively, seen most commonly in darker skin types (Table 2), and lasted an average of 112 days. Hyperpigmentation developed in five cases with skin types I–IV represented. The appearance of hyperpigmentation was delayed and generally became noticeable after all residual erythema had resolved with an average time of onset of 7 months. Fifteen percent of patients developed postoperative acne lesions, with 92% of these patients having had a prior history of acne vulgaris. Milia formation was seen in 11% of patients and generally resolved spontaneously or with topical glycolic acid applications. Contact dermatitis was observed in 10% of patients and was attributed to the use of a topical antibiotic ointment or nonprescribed “home remedy” (eg, aloe vera gel) in the majority of cases. HSV infections occurred in 7.4% of patients undergoing peri- or full facial laser resurfacing. An equal number of patients with and without a prior history of perioral “cold sores” or “fever blisters” developed postoperative HSV (Table 3). Disseminated cutaneous HSV infection occurred in one patient with a strong history of oral

### Table 1. Incidence of Side Effects and Complications (n=500)

<table>
<thead>
<tr>
<th>Side Effect</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Erythema</td>
<td>100%</td>
</tr>
<tr>
<td>Hyperpigmentation</td>
<td>37%</td>
</tr>
<tr>
<td>Acne exacerbation</td>
<td>15%</td>
</tr>
<tr>
<td>Milia</td>
<td>11%</td>
</tr>
<tr>
<td>Contact dermatitis</td>
<td>10%</td>
</tr>
<tr>
<td>Herpes simplex infection</td>
<td>7.4%</td>
</tr>
<tr>
<td>Hypopigmentation</td>
<td>1%</td>
</tr>
<tr>
<td>Local candidiasis</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Hypertrophic scarring</td>
<td>0%</td>
</tr>
<tr>
<td>Ectropion</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Table 2. Distribution of Skin Types with Postoperative Hyperpigmentation

<table>
<thead>
<tr>
<th>Skin Type</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>17</td>
</tr>
<tr>
<td>II</td>
<td>38</td>
</tr>
<tr>
<td>III</td>
<td>53</td>
</tr>
<tr>
<td>IV</td>
<td>100</td>
</tr>
<tr>
<td>V</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table 3. Perioral HSV Infection

<table>
<thead>
<tr>
<th>Description</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>With history of HSV</td>
<td>7</td>
</tr>
<tr>
<td>Without history of HSV</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
</tr>
</tbody>
</table>

### Results

Five hundred patients who were resurfaced with a high-energy, pulsed CO2 laser were included in the study. No cases of hypertrophic scarring, bacterial in-
herpes labialis while on antiviral prophylaxis. Two cases of cutaneous candida infections were observed. Both patients developed increased erythema and perioral pustules on the sixth postoperative day while using petrolatum-based emollients.

Discussion

In a pulsed mode, CO₂ lasers utilize the theory of selective photothermolysis in order to ablate tissue with minimal char formation, collateral thermal diffusion, and injury. However, despite this new “pulsed” technology, CO₂ lasers are not entirely harmless. Scarring, textural changes, pigmentary alterations, infection, and many other complications may occur with the use of the pulsed CO₂ lasers, even in the hands of the most experienced operator.

In this patient population, post-laser erythema (Figure 1) was an expected outcome of cutaneous laser resurfacing lasting an average duration of 4.5 months. Although it is possible to decrease the intensity of erythema through the use of topical ascorbic acid or by using a laser system with a short pulse duration, average total duration of erythema is relatively constant. CO₂ lasers with the shortest pulse durations produce less residual thermal damage in treated skin resulting in decreased postoperative erythema.

Milia formation was documented in up to 11% of patients and 10% experienced acne exacerbation. Several patients who had never had significant acne prior to the resurfacing procedure experienced acne flares postoperatively. In anticipation of this potential flare, patients with even mild acne were often placed on oral antibiotics prior to resurfacing.

Posttreatment hyperpigmentation (Figure 2) is a relatively common complication of facial resurfacing, especially in people with darker skin types. The reported incidence of hyperpigmentation ranges from 5% in the periorbital regions to 17–83% when evaluating several different facial sites. Our 37% incidence of hyperpigmentation is relatively high and possibly relates to our diverse patient population, which includes many darker skin tones. Hyperpigmentation was typically observed by the fourth postoperative week and resolved with an average duration of 112 days. Treatment options for hyperpigmentation include office-based glycolic acid peels, hydroquinone-containing compounds, and topical azelaic, ascorbic, glycolic and retinoic acid–containing creams.

Contact dermatitis was experienced by 10% of our patients (Figure 3). Intermittent pruritus during the first few postoperative weeks due to dry skin and the normal healing process also occurred frequently. As the healing process continues, the skin will become dry and sensitive. This sensitivity may be exacerbated by exposure to sunlight or other irritants such as soap or detergents.
cutaneous surface is without an epidermal barrier for up to 7 days postoperatively, any potential sensitizer such as a fragrance, preservative, or antibiotic has a greater opportunity to interact with the cutaneous immune system to produce a Type IV allergic contact dermatitis. We avoid using topical antibiotics and prefer Catrix or plain petrolatum for wound care, which minimizes patient exposure to common antigens. Other reports in the literature document up to a 65% rate of contact dermatitis post-resurfacing. Many of these patients had been using bacitracin or other topical antibiotic ointments. No specific patch testing was performed in any of the patients with dermatitis due to the fact that patch testing for suspected allergens is often negative after cutaneous resurfacing, indicating that irritant reactions may also be common. There is an increased sensitivity to topical preparations post–laser resurfacing in which no common or uncommon sensitizers are identified.

Infection with HSV was the most common infection seen after resurfacing, occurring in 7.4% of patients (Figure 4). This rate is higher than other reports in the literature and may be due to the fact that any suspicious signs or symptoms of HSV were recorded as an HSV infection in this study with or without laboratory confirmation. Of significance was the fact that the development of postoperative HSV infection could not be predicted based upon a prior history of a “cold sore.” This finding supports the policy of prescribing antiviral prophylaxis for all patients regardless of past HSV history (Table 3). Perioral HSV reactivation from laser “trauma” usually became symptomatic by the sixth postoperative day. One case of disseminated cutaneous HSV occurred despite oral antiviral prophylaxis. Herpes simplex infections were defined clinically as an erosion or vesicular eruption. Although viral cultures and Tzanck smears were used to document the clinical diagnosis, lesions highly suspicious for HSV that subsequently improved on oral antiviral medications were included as positive cases of HSV despite negative laboratory evidence. The HSV rate may, therefore, have been falsely elevated in our series.

No cutaneous bacterial infections were found in this study population, although impetigo has been reported previously in patients who did not receive prophylactic antibiotics and aggressive wound care. Our use of an “open technique” utilizing bland emollients rather than the use of occlusive dressings, the close postoperative skin care protocol followed, and the judicious use of prophylactic antibiotics may have all contributed to our low rate of infection. In an open technique, the patient and physician are able to visually identify areas of infection in terms of purulent discharge, erythema, erosions, or delayed wound healing. Patients rinse their faces and gently debride the treated skin with application of compresses and soaks. Semiocclusive dressings render the newly resurfaced skin more difficult to assess. While they provide a moist environment for skin healing, their occlusive nature promotes the growth of bacteria and fungi.

Two cases of cutaneous yeast infection were observed (Figure 5). Perioral pustules developed in these patients during the first postoperative week and subsequently spread to adjacent facial areas. A potassium hydroxide examination of the pustules revealed numerous pseudohyphae. The patients were subsequently treated with topical antifungals and oral itraconazole. Both patients had predisposing risk factors, one patient with a history of perleche and the other with concomitant vaginal candidiasis.

Delayed hypopigmentation (Figure 6) is a relatively rare but serious complication of facial resurfacing. Although it has been an established complication of both phenol peels and dermabrasion, initial experience
with the CO₂ laser indicated that permanent hypo- or depigmentation was unlikely. However, delayed hypopigmentation was identified in a total of five of our patients. Although it occurred in several skin types, it was more prominent in individuals with darker skin tones. Despite gradual UV light exposure and glycolic acid peels to improve skin tone and color, the loss of pigment appears to be a permanent phenomenon. It could be hypothesized that irreversible melanocytic injury from laser-induced thermal damage occurs in predisposed individuals.

More severe complications such as focal atrophy and hypertrophic scarring (Figure 7) are rare but dreaded outcomes of CO₂ laser resurfacing. Facial areas such as the perioral, periorbital, chin, and neck regions are particularly prone to scar formation. Patient characteristics such as past or present isotretinoin use, prior cosmetic procedures, and individual tendency to form keloids may also serve as risk factors. Our experience in treating laser-induced scars from patients referred to us from around the country suggests that the mandibular region is particularly prone to injury. Extreme care should be exercised when determining the laser settings and executing the number of laser passes in this facial region.

Ectropion of the lower eyelid (Figure 8) is a severe complication that often requires surgical correction. The incidence of post-laser ectropion is not yet clear from the reported literature and we did not experience any periocular fibrosis or ectropion formation in our patient population. Although many patients who have had prior lower blepharoplasties have received laser resurfacing, treatment is typically delayed for several months after lid surgery and is only performed after appropriate tests have documented good eyelid tone.

Conclusions

CO₂ laser resurfacing is a relatively safe procedure with a low complication profile when proper treatment protocol and postoperative management is followed. This review of laser resurfacing of more than 1,500 facial regions is the most extensive report published to date. Side effects and complications of the procedure including infection, pigmentary alteration, dermatitis, and scarring have been shown to occur. Proper management of each of these conditions is discussed in order to minimize long-term sequelae.

References
