

Treatment of Complications of Laser Skin Resurfacing

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During the past decade, cutaneous laser resurfacing has evolved into a primary treatment modality for photoinduced facial rhytides, lentigines, facial dyschromias, and atrophic scars.¹⁻¹¹ Major advances in laser technology during the past 15 years have made possible the ability to perform safe and reliable laser resurfacing of facial skin. In fact, cutaneous laser resurfacing has become so popular in North America that more than 150 000 procedures were performed in 1999 alone. Fortunately, most adverse reactions associated with laser resurfacing are mild and, when recognized early, are easily treated. Serious complications may result after laser resurfacing, however, and may be due to various factors, including surgeon inexperience, inappropriate or inadequate postoperative wound management, and individual patient characteristics (skin phototype, UV light exposure, and postoperative compliance). For these reasons, laser surgeons must be aware of all potential adverse effects associated with cutaneous laser resurfacing, so that when one does occur, appropriate interventions can be promptly initiated to prevent further cutaneous damage.

The incidence and severity of complications associated with cutaneous laser resurfacing depend on the type of laser system used. Several different high-energy, pulsed and scanned carbon dioxide (CO₂) and erbium (Er):YAG laser systems are most commonly used for cutaneous resurfacing, with the CO₂ laser considered the gold standard because of its ability to produce the most dramatic long-term clinical improvement. Early laser systems involved continuous-wave CO₂ laser technology for resurfacing, which effected gross lesional destruction, but were unable to reliably produce fine tissue ablation due to the excessive delivery of laser energy, resulting in large zones of thermal necrosis being produced with high incidences of scarring.^{12,13} It was not until the high-energy, short-pulsed lasers became available in the mid-1990s that controlled ablation of facial skin became possible. These latter lasers operate based on the theory of selective photothermolysis,¹⁴ with the CO₂

and the Er:YAG laser systems targeting epidermal and dermal water. The ability to deliver high fluences of energy to the skin in extremely short pulses leads to effective cutaneous ablation with minimal surrounding collateral tissue damage. As such, the earlier continuous-wave laser systems have been totally abandoned as resurfacing tools—the high-energy, pulsed and scanned systems exclusively being used for skin resurfacing, with consistently low complication rates reported.

The risk of developing complications after a cutaneous laser resurfacing procedure is influenced by the number of laser passes performed, the energy densities used, the degree of pulse or scan overlap, the preoperative skin condition, and the anatomic areas to be resurfaced. The physician and the patient must be cognizant of the normal healing process and that some degree of postoperative morbidity is normal and unavoidable. Virtually all patients who undergo laser resurfacing will initially experience intense erythema, edema, serous discharge, and crusting. These cutaneous

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effects are more intense and prolonged after CO₂ laser resurfacing because of the slower rate of reepithelialization (8.5 vs 5.5 days, CO₂ vs Er:YAG laser) associated with the slightly increased residual thermal necrosis produced on CO₂ laser irradiation of skin. Postoperative erythema seen after CO₂ laser treatment averages 3 to 6 months in duration, compared with 2 to 4 weeks for Er:YAG laser-treated patients. Because the amount of residual thermal damage correlates directly with the degree of erythema produced, multiple passes of the Er:YAG laser may also result in prolonged erythema comparable to that of the CO₂ laser.

COMPLICATIONS OF CUTANEOUS LASER RESURFACING

Proper wound management during the immediate postoperative period is vital to the success of a cutaneous laser resurfacing procedure. Appropriate wound care leads to rapid healing and resolution of minor symptoms. The short-term recovery process may be hastened by using either an open or a closed wound dressing. The open technique involves the frequent application of thick, healing ointments (Aquaphor, Catrix-10, Recovery Hydra balm, or plain petrolatum) to the resurfaced skin with cold, wet compresses and ice packs several times daily for the first 72 hours. This open system allows for direct visualization of the healing skin for early signs of infection or scar formation, but may be associated with increased postoperative discomfort and requires greater effort and cooperation by the patient. The closed technique typically involves the application of a biosynthetic semioclusive dressing (Flexzan, Second Skin, Silon TSR, or Vigilon) that is left intact on the wound for 1 or more days in an effort to aid reepithelialization and decrease patient discomfort. These dressings offer improved patient compliance because of their "hands off" nature, but are often difficult to keep intact. Their use also contributes to poor wound visualization, with potential delays in diagnosing infection or scar development, and may actually be responsible for the development of infections due to wound maceration.¹⁵ Thus, a combined approach using a closed technique for the first couple of postoperative days followed by an open technique is advocated by some practitioners in an effort to improve initial patient discomfort without significantly increasing the risk of infection. Regardless of whether an open or a closed technique is used, thorough preoperative patient education and close postoperative follow-up are necessary to ensure the most successful surgical outcome—one with minimal morbidity and fast epithelial recovery.

Adverse effects and complications of cutaneous laser resurfacing range in severity from mild to severe.¹⁶ Mild reactions include prolonged erythema, acne or milia formation, contact dermatitis, and pruritus. Moderate complications include viral, bacterial, or fungal infections; postinflammatory hyperpigmentation; and delayed-onset hypopigmentation. The most serious complications and, fortunately, the most rare include hypertrophic scarring, ectropion formation, and disseminated infection.

Erythema and Edema

Erythema and edema are the most common adverse effects experienced by patients who undergo resurfacing with either CO₂ or Er:YAG lasers.¹⁶⁻²¹ These reactions are normal consequences of laser-induced tissue injury and are only considered abnormal if they persist for an extended period. Persistent erythema, lasting up to 6 months or more, is most commonly seen after resurfacing with the CO₂ laser because of the more extensive residual thermal necrosis it produces in the dermis. Multiple laser passes, inadvertent pulse stacking, or aggressive intraoperative rubbing of the skin to remove partially desiccated tissue after each pass can also worsen persistent, intense erythema. Patients who regularly use tretinoin or glycolic acid compounds or who have a history of rosacea are also predisposed to persistent postoperative erythema.²¹⁻²³

Focal areas of intense erythema that develop after laser resurfacing may signify impending scar formation and should be treated aggressively with strong class 1 topical corticosteroids. Persistent erythema may also be due to contact sensitization to a topical compound applied during the recovery process. If contact allergy is suspected, all topical medicaments should be discontinued and topical corticosteroids applied in an effort to hasten recovery and prevent scarring. Because topical corticosteroids have not been shown to reduce normal postlaser erythema, they should not routinely be added to the recovery regimen unless dermatitis or early scarring is suspected.

On the other hand, the addition of topical ascorbic acid during the postoperative period decreases erythema, presumably because of its anti-inflammatory tissue effect. Topical vitamin C should only be used once complete reepithelialization has occurred since it can serve as an irritant to the newly resurfaced skin and further contribute to erythema.²⁴

Acne and Milia Formation

Acne flares are relatively common after cutaneous laser resurfacing because of the application of highly occlusive healing ointments and dressings during the short-term recovery process, particularly in patients who are acne prone.¹⁶⁻²⁰ In addition, aberrant follicular epithelialization following laser-induced injury of the pilosebaceous apparatus may lead to exacerbation of acne, milia, or both, regardless of acne history. In most cases, no treatment is necessary, as the eruptions are usually mild and resolve once the thicker healing ointments and occlusive dressings are discontinued and/or replaced by cream-based compounds. If needed, a course of oral tetracycline or minocycline can be prescribed.

Acne flares tend to develop within the first few weeks following cutaneous laser resurfacing in patients with a strong history of acne, and after 6 or more weeks in those without a strong history of acne.² If acne lesions persist despite the cessation of occlusive ointments or dressings, then topical antibiotics can also be used. Topical erythromycin, clindamycin, tretinoin, glycolic acid, or azelaic acid compounds are beneficial once the short-

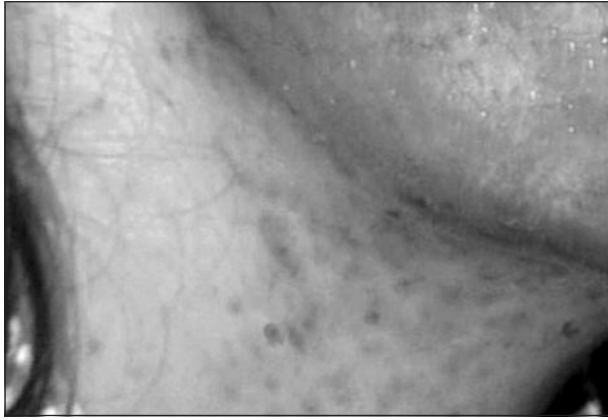


Figure 1. Increased redness with development of pruritic and erythematous papules on the resurfaced facial and adjacent (untreated) neck skin appeared 5 days after laser treatment because of the application of neomycin sulfate-containing topical antibiotics. Cessation of the offending agent, followed by the use of topical corticosteroids and cool compresses, usually provides rapid resolution of the problem.

term healing process is complete (typically 1 month). Milia are usually superficial and resolve without specific treatment. If treatment is necessary, tretinoin or glycolic acid preparations may be used or lesions can be manually extracted after the first postoperative month.

Allergic and Irritant Contact Dermatitis

Postoperative contact dermatitis is usually irritant in nature and has been reported to occur in as many as 65% of all patients treated.^{1,2,18,20} Although rare, type IV allergic reactions have also been reported. Newly resurfaced skin is particularly vulnerable to irritation from topically applied substances because of the lack of a protective epidermal barrier. Patients may react to various potential irritants and allergens contained within topically prescribed ointments, including preservatives, chemical sunscreens, and fragrances. Because topical antibiotics (bacitracin zinc, neomycin sulfate, and polymyxin B sulfate combination [Neosporin]; bacitracin zinc and polymyxin B sulfate combination [Polysporin]; or bacitracin) are common causes of contact dermatitis after resurfacing, their use in the immediate postoperative period should be avoided. Many patients are tempted to self-prescribe various topical herbal and vitamin remedies, including vitamin E or aloe-containing compounds, in an attempt to speed their recovery; these self-prescribed remedies may actually contribute to the problem.

Irritant or allergic contact dermatitis should be suspected whenever a patient exhibits worsening erythema or pruritus after resurfacing (**Figure 1**). In an effort to decrease this risk, only bland emollients (eg, Aquaphor ointment, plain petrolatum, or Recovery Hydra balm) should be used and patients should be warned against applying any “home remedies” or herbal preparations to newly resurfaced skin. When contact dermatitis develops, all topical agents should be discontinued and mild topical corticosteroids and cool, wet compresses regularly applied to alleviate pruritus and discomfort. In severe cases, oral antihistamines or short courses of oral corticosteroids may be necessary to control cutaneous inflammation and decrease the risk of fibrosis.



Figure 2. Grouped vesicles on an erythematous base are the distinguishing hallmarks of a herpes simplex virus (HSV) infection. If an HSV outbreak occurs before reepithelialization has been completed, erosions (rather than intact vesicles) may be evident. Appropriate oral antiviral treatment should be initiated, with aggressive wound care.

Infection

Viral, bacterial, and fungal infections can develop after cutaneous laser resurfacing, usually during the first postoperative week during the reepithelialization process. The most frequent infectious complication associated with resurfacing is a reactivation of the herpes simplex virus (HSV) (**Figure 2**).²⁰ It is suspected that direct laser trauma to the skin leads to latent viral activation and shedding. Herpetic outbreaks are experienced by roughly 2% to 7% of all laser-treated patients despite antiviral prophylaxis.^{20,25,26} In addition, due to the high incidence of latent HSV infection, any patient (regardless of prior HSV history) planning to undergo full-face or perioral resurfacing should be given oral antiviral prophylaxis in an effort to reduce viral reactivation, which could subsequently lead to scarring.

Early postlaser detection of HSV is often difficult because there is no intact epithelium and, rather than the characteristic grouped vesicles or pustules, infection is manifested by small, superficial erosions. Symptoms of HSV reactivation include tingling, burning, or discharge from isolated foci within the treated areas. Extensive eruptions can result in disseminated infection and atrophic scarring and, therefore, must be recognized early and treated aggressively. Oral antiviral agents, such as acyclovir, famciclovir, or valacyclovir, are routinely administered 1 to 2 days before the laser resurfacing procedure and continued for another 7 to 10 days until reepithelialization is complete. Famciclovir and valacyclovir are commonly used because of their favorable twice-daily dosing schedules, which lead to enhanced patient compliance. A recent study²⁵ demonstrated the efficacy of famciclovir, 250 mg, given twice daily for patients without a history of HSV and of famciclovir, 500 mg, given twice daily for patients with a history of HSV for 10 days as adequate prophylaxis in most cases. If a herpetic outbreak occurs despite prophylaxis, patients should either be switched to a different antiviral agent or have their dosage increased to maximal herpes zoster doses (acyclovir, 800 mg, given 5 times daily; or famciclovir or valacyclovir, 500 mg, given 3 times daily). If dissemination



Figure 3. Increased pain, discharge, and crusting are indicative of bacterial infection. Bacterial cultures should be obtained from a wound swab, and the patient given appropriate oral antibiotics.

of HSV occurs, hospitalization with administration of intravenous antiviral therapy may become necessary.²⁵

Superficial bacterial and fungal wound infections can also occur after cutaneous laser ablation. The moist environment of newly resurfaced skin is an ideal medium for contamination by or overgrowth of opportunistic pathogens. Although bacterial infections are usually due to streptococcal or staphylococcal species, *Pseudomonas aeruginosa* may also contaminate the wound (**Figure 3**).^{1,2,16-20} Cutaneous candidiasis may be difficult to diagnose since it can resemble acne or milia in the postoperative period. Persons at increased risk of candidal infection include those with diabetes, angular cheilitis, immunosuppression, or vaginal candidiasis.

If cutaneous infection is suspected clinically, wound cultures should be obtained for appropriate oral antibiotic or antifungal agents to be initiated. Prevention of infection is the primary goal, and such measures as frequent dressing changes and dilute acetic acid soaks during the initial recovery period are of great benefit. Patients must also be instructed to follow postoperative wound care instructions, carefully using sanitary measures such as thorough hand washing before dressing changes, frequent wound cleansing, and strict avoidance of washcloth or dressing reuse during the healing process. The use of prophylactic antibiotics during the postoperative recovery process is unclear. Many laser surgeons routinely prescribe oral antibiotics as part of the perioperative regimen despite convincing proof of their benefit. A recently published study²⁷ failed to demonstrate any advantage for the routine administration of antibiotics after cutaneous laser resurfacing—with their indiscriminate use actually favoring drug resistance and promoting superinfection by other opportunistic organisms. Pain, increased erythema, purulent discharge, crusting, or delayed wound healing should alert the physician to the possibility of a superficial cutaneous infection. Superficial bacterial and fungal infections that develop as a result of laser ablation must be aggressively treated because dissemination could lead to significant morbidity or result in permanent scarring.



Figure 4. Hyperpigmented square laser scan patterns are evident approximately 1 month postoperatively in a patient with skin phototype III. Topical application of various mild peeling and skin bleaching agents and avoidance of sun exposure can help speed resolution.

Postinflammatory Hyperpigmentation

Transient postinflammatory hyperpigmentation is the most common adverse effect of cutaneous laser resurfacing, occurring in approximately 33% of all patients treated and in virtually 100% of those with darker skin phototypes (Fitzpatrick stages IV-VI).^{1,2,16-20} Hyperpigmentation usually manifests within the first month following treatment, and spontaneously resolves during the next several months. Since this cutaneous reaction pattern is often so conspicuous, many patients seek medical intervention to speed its resolution (**Figure 4**). Topical agents, including retinoic, azelaic, or glycolic acid compounds, hydroquinone-containing preparations, or light glycolic acid peels (30%-40%), may be initiated after the first postoperative month.^{28,29} Hydroquinone and retinoic acid may be particularly irritating to the skin and, therefore, should be combined with mild topical corticosteroids for maximum benefit. Broad-spectrum sunscreens with sun protection factors of 20 or higher are also mandatory during this period to prevent worsening of the hyperpigmentation. Treatment must not be overly aggressive, to avoid skin irritation and further postinflammatory hyperpigmentation.

The incidence of postoperative hyperpigmentation has not been shown to be prevented nor reduced in intensity by the use of any pretreatment topical regimen. A recently published study³⁰ failed to demonstrate a lower rate of hyperpigmentation despite the preoperative use of topical tretinoin, hydroquinone, or glycolic acid. It has been postulated that the effect of these topical agents is superficial, failing to reach deeply situated dermal melanocytes that are primarily responsible for the potentiation of hyperpigmentation. In addition, while it was



Figure 5. The development of hypopigmentation is often delayed for several months after laser resurfacing. Skin typically appears pale relative to the adjacent untreated skin, rather than truly hypopigmented.

initially proposed that Er:YAG laser resurfacing would result in a decreased incidence of hyperpigmentation (due to less residual thermal damage in treated tissue), the rates of hyperpigmentation after CO₂ and Er:YAG laser irradiation are comparable, given their similar tissue vaporization effects. Early intervention for observed hyperpigmentation appears to be the best and most efficient way to decrease the severity and duration of this most common surgical sequela.³¹

Hypopigmentation

Delayed-onset hypopigmentation is a potentially serious, and permanent, complication of laser resurfacing. Hypopigmentation does not usually become manifest until 6 to 12 months after resurfacing, once residual traces of erythema and hyperpigmentation have completely faded.^{1,2,16-20} Relative hypopigmentation is more commonly observed in areas adjacent to photodamaged skin (eg, the mandible), since ablative lasers remove traces of mottled pigmentation (**Figure 5**). True hypopigmentation, however, is rare and occurs most frequently in those who have undergone previous dermabrasion or phenol peeling or in aggressively treated areas. Glycolic acid peels (30%-40%) or light trichloroacetic acid peels (15%) may be used to decrease the surrounding skin's relative hyperpigmentation in an attempt to blend the marked contrasts in pigmentation. Application of opaque makeup can also be used to camouflage the hypopigmented areas.

Hypertrophic Scarring

Hypertrophic scarring is another uncommon complication of cutaneous laser resurfacing (**Figure 6**).^{1,2,16-20} Many factors influence the risk of scar development, including poor intraoperative technique with use of inappropriate laser parameters, pulse stacking or scan overlap, and/or an excessive number of laser passes. Certain anatomic locations, such as the infraorbital region, mandible, and anterior neck, are also more susceptible to scar



Figure 6. Hypertrophic scars are preceded by focal areas of intense erythema and induration that never resolve. Pulsed-dye laser irradiation has been shown to improve these hypertrophic burn scars.

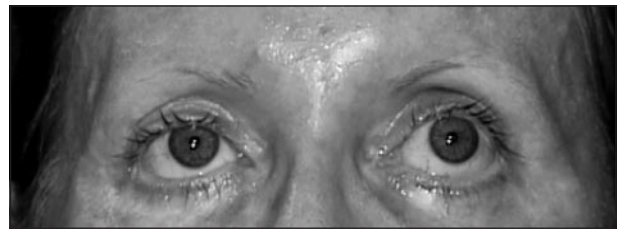


Figure 7. Ectropion formation may be seen in patients with infraorbital laxity or in those who have undergone prior lower blepharoplasty, particularly when aggressive periocular laser resurfacing has been performed. Surgical correction may be necessary.

formation and should be treated more cautiously.^{16,32} Postoperative wound infection or contact dermatitis may also eventuate in scarring. In addition, recent use of isotretinoin, previous radiation therapy, and a history of keloid formation increase a patient's risk of scarring.³³

Focal areas of intense erythema and induration are the first signs of impending scar formation and must be recognized early and treated promptly to avoid permanent sequelae. Strong class 1 topical corticosteroids should be prescribed in an effort to halt the progression of scar formation. Intralesional corticosteroid injections or silicone gel sheeting are other effective methods of scar reduction. The use of a 585-nm pulsed-dye laser has been proved to be particularly effective in treating erythematous and hypertrophic burn scars.³⁴ Laser irradiation not only decreases scar tissue bulk but it also improves scar erythema and alleviates symptoms of pruritus or dysesthesia. Pulsed-dye laser treatments are delivered at 6- to 8-week intervals using parameters identical to those suggested for vascular lesions. Typically, 2 or 3 treatments are necessary to effect significant scar improvement.

Ectropion Formation

Ectropion of the lower eyelid is a serious complication of cutaneous laser resurfacing and usually requires surgical intervention for correction (**Figure 7**).^{1,2,16-20} Patients who have undergone previous lower blepharoplasty are at increased risk and, thus, should be evaluated

preoperatively with a skin “snap test” to determine the risk of eyelid eversion. If the lower eyelid skin does not briskly return to its normal resting position within 3 seconds after its release from a manual downward pull, then laser resurfacing near the lower eyelid margin should be avoided. In general, conservative laser settings and fewer laser passes should be performed in the periorbital region because of the thin nature of the skin in this cosmetic area. Although topical corticosteroid application and massage can be used to improve lower eyelid retraction, surgical correction is often necessary.

CONCLUSIONS

Cutaneous laser resurfacing with high-energy, pulsed or scanned CO₂ and Er:YAG lasers has revolutionized the field of aesthetic surgery. Lasers are capable of recontouring photodamaged skin with relative ease and few complications. Since it has become increasingly common for physicians across a broad range of specialties to use ablative lasers for resurfacing, it is critical that all potential adverse effects and their appropriate management are fully understood. Although facial resurfacing has been made relatively safe with this newer laser technology, complications are still possible and can be devastating at times. Prevention of complications is best managed by pretreatment patient education coupled with a proper intraoperative technique and a closely supervised postoperative recovery. When complications do arise, physicians must be able to readily identify their cause and treat expeditiously to prevent permanent sequelae. Knowledge of the typical healing process is also necessary, as erythema, edema, and crusting are normal consequences of laser resurfacing and do not require specific treatment above and beyond that typically prescribed. Mild complications associated with laser resurfacing include acne and milia formation, contact dermatitis, and pruritus. Reactivation of HSV, superficial cutaneous superinfections, and pigmentary alterations are moderately severe complications of resurfacing. The most serious complications include hypertrophic scarring, ectropion formation, and disseminated infection. The success of any laser resurfacing procedure, therefore, relies on several factors, including an appropriately educated and well-informed patient, a well-trained and experienced physician, the use of an excellent intraoperative technique, and a carefully executed postoperative recovery regimen.

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