

# PERSPECTIVES in Plastic Surgery

VOLUME THIRTEEN · NUMBER ONE

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## Complications in Laser Skin Resurfacing: A Review of the Recent Literature

MARTIN J. MOSKOVITZ, M.D.

**ABSTRACT** Laser skin resurfacing has gained wide popularity in a short time. As with all new technologies, however, there is a learning curve with inherent complications and normal side effects. It is incumbent upon practitioners of laser resurfacing to understand the principles behind laser surgery and to properly prepare their patients for treatment. Skin care in the postoperative period is extremely important to the success of the procedure and physicians must be aware of normal and abnormal sequelae. This paper examines laser resurfacing complications as presented in the recent literature, and distills a reasonable treatment plan for the common conditions encountered.

**Keywords** Erbium, laser, skin, therapy, complications

Driven by patients, physicians, and industry, laser skin resurfacing has rapidly attained wide popularity. Patients have become more aware of their choices and better educated regarding the risks and benefits of medical procedures. They often expend significant time and effort searching the Internet, medical journals, and the lay press to better understand the therapies offered to them. Physicians attend meetings and seminars to learn new technologies and treatments. Industry, a key player in the medical-laser arena, advertises new machines, touting improved results with added safety. This triumvirate has turned laser skin resurfacing from theory to multi-million dollar enterprise in less than a decade. New lasers spawn a frenzy of interest and purchasing with the possibility of improved results in a safer environment. Plastic surgeons

must understand the technology behind the lasers they use and acknowledge their potential for harm. Industry driven enthusiasm should not be a substitute for research and medical dialogue. This was seen in the general surgical arena when lasers were used in place of electrocoagulation in endoscopic procedures. These lasers proved to be extremely dangerous as they misfired in the abdomen causing common bile duct strictures and other injuries. High tech answers are not always the best for our patients.

Lasers skin rejuvenation has, however, been proven effective. The carbon dioxide (CO<sub>2</sub>) and erbium YAG lasers are currently the two most popular lasers in skin resurfacing. The CO<sub>2</sub> laser employs a wavelength of 10,600 nm with water as its target chromophore. It is currently used in a pulsed fashion rather than a continuous wave in order to decrease local tissue damage by keeping the tissue dwell time under the thermal relaxation time. The principles of selective photothermolysis state that laser energy be directed at a specific target chromophore and applied in amounts that will not cause damage to the surrounding tissues. This damage is avoided by applying the energy in short bursts which allow the target tissues to react but prevent heat exchange to the surrounding, non-target, tissues. Most CO<sub>2</sub> laser beams in use are collimated thereby freeing the operator from using a fixed distance to the target. Computerized scanning devices have also become common on most CO<sub>2</sub> lasers.

The Erbium:YAG laser operates at a wavelength of 2940 nm with water as its chromophore. Note, however, that at this wavelength the laser's affinity for water is roughly 10 times greater than that of the CO<sub>2</sub> laser. Pulse widths are short at 250 to 350 µsec. Early erbium laser beams were not collimated and often had no scanning devices. Newer units, however, offer collimated beams and contain scanning options. Among the differences between the two resurfacing modalities, depth of penetration and collateral thermal injury, are the two most striking. Erbium laser energy, with its higher water affinity, will be absorbed more rapidly, penetrate less deeply, and allow less collateral heating. Both lasers, however, have similar potential complications and routine use of either laser can result in similar complications. It is interesting to note that CO<sub>2</sub> skin resurfacing has been in use for roughly two decades, though reports of CO<sub>2</sub> laser complications have surfaced only in the past decade. Erbium skin lasers have been in use for less than ten years and communications regarding its complications number two, both published this year.

## COMPLICATIONS

### Erythema

It is debatable as to whether erythema constitutes a complication or a normal aspect of the healing process. Most clinicians would probably agree, however, that there is a postlaser period of normal redness, after which erythema would be considered a complication.

Nanni and Alster<sup>1</sup> report an average length of postlaser erythema of 4.5 months utilizing a pulsed CO<sub>2</sub> system while Goodman<sup>2</sup> noted that 14% of patients complained of erythema lasting greater than 3 months. Bass<sup>3</sup> reported erythema abatement at  $4.25 \pm 1.5$  weeks on average with an erbium laser. Weinstein<sup>4</sup> also noted a relatively short erythema time of 3.6 weeks with the erbium laser and comments that stronger postlaser hydroquinones tended to lengthen the erythematous phase as do glycolic, retinoic, and lactic acid containing moisturizers.

Most authors comment that erythema is proportional to depth of laser injury and that deeper penetration with an erbium laser will indeed lead to longer postlaser erythema. The final cosmetic outcome will most likely diminish with decreasing laser depth, proving a "no pain (redness), no gain (effect)" theory. Perez, however, comments that histology of erbium treated skin shows less hair follicle damage than comparable CO<sub>2</sub> treated skin and may provide another reason for more rapid healing.<sup>5</sup> There is no known technique to avoid erythema other than decreasing the depth of the laser interaction. Fulton<sup>6</sup> believes that occlusive dressings and lower fluences tend to decrease redness, though recent studies<sup>7</sup> have shown no difference in erythema based on dressing methodology.

As far as erythema treatment, many physicians<sup>4,5</sup> use topical steroid creams on their longstanding erythema patients. Weinstein<sup>8</sup> prefers 1% hydrocortisone cream. Ointment based steroids may lead to milia; fluorinated compounds may cause skin atrophy and telangiectasias; and either one may cause acne. In any case, physicians should always be vigilant in the face of erythema since it may herald postlaser hypertrophic scarring.

## Scarring

Scarring is probably the most feared complication in laser skin resurfacing. It can appear without warning in erythematous skin, or it can follow full thickness tissue loss. In either case, scarring is difficult to treat and an acceptable aesthetic result is often unattainable. In their series of 500 patients Nanni and Alster<sup>1</sup> reported no hypertrophic scars. Goodman<sup>2</sup> reported two cases in a series of 100, both, he felt, due to an occlusive dressing which was left unchanged for the first 48 hours and became incorporated into the wound. A case of scarring was reported<sup>4</sup> after erbium laser resurfacing of a neck in a patient who suffered a Staphylococcal infection postlaser, though the author notes that the total fluence of 20 J/cm<sup>2</sup> may have been a contributing factor.

Grossman<sup>9</sup> relates his burn center's experience with referred patients after laser resurfacing.

This article serves as a sobering reminder of the power of the laser. Twenty consecutive patients were reported over an 18-month period. Thirteen patients presented to this center with hypertrophic scars. Two patients had microstomia secondary to peri-oral scarring. Three patients had steroid precipitate plaques

due to over injection of steroids in an effort to treat the scarring. Two people had full thickness skin loss, one of which required grafting. Note that these last two patients were lasered immediately after facelift procedures. The photos in this communication are vivid reminders of what can go wrong in laser skin resurfacing and should be kept in mind at all times.

Fulton notes that a persisting erythematous streak is a harbinger of scar<sup>6</sup> and that silicone gel sheeting should be administered. If the scar continues to thicken, intralesional steroids (triamcinolone hexacetonide) should be injected. Overall, judicious total fluence with either the erbium or CO<sub>2</sub> laser system should provide a good margin of safety to avoid scarring. This is particularly true over the lower mandibular border, which has been implicated in a higher rate of scar formation. In addition, any prior treatments, which may have decreased the number of skin adnexal structures, must be noted and considered during treatment. Radiation for cancer of acne should be a strong contraindication to facial resurfacing since it can permanently destroy adnexal structures. Recent isotretinoin (Accutane) use is likewise a contraindication. The timeframe for this hazard is unproven, but a buffer of 6 to 24 months off medication prior to laser treatment seems a reasonable window of safety.<sup>1</sup> Finally, a history of keloid formation should serve as a caution to resurfacing and fluence needs to be decreased properly.

A subset of scarring is ectropion. The thermal shrinkage of the thin lower eyelid tissue can overcome the lower lid's resistance, especially if actual scarring takes place. The exact incidence is not known, but if it lasts more than several weeks it often requires surgical correction for satisfactory outcome.<sup>1</sup> Grossman reports two cases of ectropion that presented to his burn center, one of which underwent standard lower lid blepharoplasty immediately prior to resurfacing. Weinstein<sup>4</sup> reports two erbium treated patients who developed a transient ectropion, which corrected spontaneously within two weeks and Goodman<sup>2</sup> relates a 5% incidence of transient ectropion after CO<sub>2</sub> laser resurfacing. He cautions physicians to keep passes and fluences low in this area. Fulton<sup>6</sup> experienced one ectropion after CO<sub>2</sub> laser therapy. He started the patient on blinking exercises, massage, and steri-strip taping on the lid, and obtained resolution in three months.

It is vital for surgeons to exercise the same caution with lower lid laser therapy that they do with lower lid blepharoplasty. Careful lower lid testing as described by Jelks<sup>10</sup> needs to be performed. Lower lid snap and lift tests, as well as vector analysis, are vital. If needed, tarsal support in the form of canthopexy or canthoplasty should be performed prior to laser treatment.

## Pigment Changes

While most patients understand that erythema is a normal consequence of laser resurfacing and may tolerate several months of redness, the average

patient is often less informed of pigment changes and becomes upset should it occur. The reported incidence of postlaser hyperpigmentation is high. Nanni and Alster<sup>1</sup> note a 37% incidence, with most cases becoming evident at one month and lasting an average of 112 days. In that study, all Fitzpatrick type IV-V suffered hyperpigmentation, as did 53% of type III; 38% of type II; and 17% of type I patients. Weinstein, however, noted mild hyperpigmentation in only 11 of 141 patients treated (7.8%), though 57 of these patients were Fitzpatrick type V.<sup>4</sup> In addition, the problem was very transient, lasting 2.3 weeks on average. A possible difference between the two outcomes is that most of Alster's patients were treated for rhytids while many (67) of Weinstein's patients were treated for pigment problems. Goodman<sup>2</sup> notes an 18% incidence of transient dyschromia utilizing a CO<sub>2</sub> laser, while Bass reports a 24% incidence in his series with erbium. Most authors note that time, bleaching creams (hydroquinones), and acid peels (glycolic), constitute the basic treatment of postlaser hyperpigmentation. Time is the most important factor. Most physicians place their postlaser patients on a hydroquinone cream starting at two weeks posttreatment and continuing for 4 to 6 weeks.

Many physicians also pre-treat their patients with tretinoin and hydroquinones though the use of these agents may be unnecessary and without scientific basis.<sup>8</sup> Tretinoin was originally used to thin the epidermis prior to chemical peeling—an effect not needed in laser surgery. Hydroquinones principally act upon the superficial melanocytes that will be removed by the laser. The deeper melanocytes which cause postlaser pigmentation are unaffected by this pre-treatment.

Sunscreens are important in the prevention of hyperpigmentation. Bass<sup>3</sup> notes that all of his severely hyperpigmented patients were not sunscreen compliant. While most physicians prescribe standard sunscreens with an SPF rating of 15 to 40, Weinstein<sup>8</sup> points out that the SPF rating pertains to sunburn prevention which is a function of UVB radiation. Pigment change, however, is a predominantly UVA function and not inhibited by standard sunscreens. She recommends a pigmented, silicon based, titanium dioxide or zinc oxide sunscreen for true pigment protection. Her choice of sunscreen may be another reason for her previously noted low incidence of hyperpigmentation. I recommend this paper be read in its entirety to gain insights and guidance into many of our postlaser treatment regimens.

Hypopigmentation is a less frequent, but more permanent problem. Bass<sup>3</sup> notes a 12% incidence of mild hypopigmentation status posterbium resurfacing. Nanni and Alster<sup>1</sup> report a 5% incidence with most cases becoming evident at six to seven months posttreatment. They note that the pigment loss is permanent and irreversible. A recent case report<sup>11</sup> notes that immunohistochemical staining of hypopigmented postlaser skin demonstrated a normal number of melanocytes but a decreased amount of expressed melanin. This is a finding similar to that of a phenol chemical peeling in which case experience

has proven that permanence is the rule. No predisposing condition has been linked to this finding though darker skin colors may be more predisposed. It is important that patients understand that this complication can occur and that it is permanent in nature.

## Infection

Viral, bacterial, and fungal infection are potential complications of laser resurfacing. Viral infection, however, has received the greatest attention due to its higher incidence. Recent studies report a 2 to 7% incidence with no ability to accurately predict which patient will be affected.<sup>1,2,4</sup> A prior history of cold sores does not appear to have significant prognostic value.<sup>1</sup> Review of the literature, however, shows that nearly all physicians do prescribe some form of oral antiviral prophylaxis (acyclovir, famcyclovir). It should be noted that there is no FDA approval for prophylactic use nor are there clinical studies demonstrating a beneficial effect in laser resurfacing. The use of antiviral medications is justified, however, within the wider medical literature and has had proven prophylactic and moderating effects in such areas as organ transplantation and laboratory research.<sup>12,13</sup>

Bacterial infection is a much less common problem with all previously cited articles quoting rates less than 1%. Historically, however, rates have been seen up to 47%.<sup>1</sup> The evolution of careful postoperative wound management has been the key in reducing the infection rate. The use of an oral first generation cephalosporin (cephalexin) starting the morning of the procedure gives reasonable gram positive prophylaxis and is the most common regimen seen.

Candidal infections are likewise rare with rates less than 1%. They are best treated with improved wound care, oral antifungal agents (itraconazole), and topical antifungal agents if tolerated. A higher incidence of both bacterial and fungal infection has been reported when using the closed wound care method. This increase, however, is quite small given the above quoted incidences and should probably not be a substantial reason to choose one method over another provided careful wound supervision is provided to all patients.

## Acne and Milia

These entities comprise a common and rather innocuous pair of complications. Acne has been reported in 10 to 17%<sup>1,4,8</sup> of patients and milia occurs at a similar rate. The most common cause of either condition seems to be the prolonged use of heavy, petroleum based, wound dressings. Changing the wound dressing protocol is the best treatment for either condition. Acne, which is a more common finding with patients with prior acne problems and can flare several weeks posttreatment, can be prevented/treated with oral

tetracycline. Glycolic acid topical treatment can also aid in comedolysis and potentially avoid acne outbreaks.<sup>8</sup>

### Contact Dermatitis

Dermatitis is due to the skin's increased sensitivity to antigens<sup>14</sup> in conjunction with the application of an antigenic substance such as antibiotic containing ointment (Bacitracin) or fragrances. Changing to more bland emollients (Catix) is the best treatment. Topical steroids can be added if needed. Fulton<sup>6</sup> advises changing ointments every 4 to 5 days to avoid sensitization and subsequent reactions.

### Pruritis

Itching is a frequent postlaser complaint and most likely due to dry skin. Frequent moisturizers are the best treatment, though persistent itching should be carefully monitored to prevent scratching and subsequent excoriation. Stronger medications such as benadryl and even fluoxetine (Prozac) may be needed.<sup>6</sup> Obsessive patients can often pick at their healing wounds and may benefit from fluoxetine use.<sup>6</sup>

### CONCLUSION

Laser skin resurfacing is undoubtedly a useful modality in skin care and aesthetic surgery. It is incumbent upon physicians to be familiar with the normal sequellae of laser treatment as well as the complications. We must be acquainted with accepted laser parameters and normal postoperative care. Proper use of lasers, combined with careful postlaser care, can provide our patients with predictable, safe, and efficacious results.

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