

Complications of Fractional CO₂ Laser Resurfacing: Four Cases

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Background and Objective: Fractional ablative laser therapy is a new modality which will likely be widely used due to its efficacy and limited side-effect profile. It is critical to recognize, characterize, and report complications in order to acknowledge the limits of therapeutic efficacy and to improve the safety of these devices.

Study Design/Materials and Methods: The photographs, treatment parameters, and clinical files of four female patients aged 54–67 who had scarring or ectropion after fractional CO₂ laser resurfacing on the face or neck were carefully reviewed to search for any possible linking factors.

Results: Patient 1 developed erosions and swelling of the right lower eyelid 2 days postoperatively, which developed into scarring and an ectropion. Patient 2 developed linear erosions and beefy red swelling on the right side of the neck which developed into a tender, band-like scar over 1-month. Patient 3 developed stinging and yellow exudate in multiple areas of the neck 3 days postoperatively. Cultures grew methicillin-resistant *Staphylococcus aureus*. Despite appropriate treatment, she developed multiple areas of irregular texture and linear streaking which developed into scars. Patient 4 developed an asymptomatic patchy, soft eschar with yellowish change on the left side of the neck. Azithromycin was started, however at 2-week follow-up she had fibrotic streaking which developed into horizontal scars and a vertical platysmal band. The treatment and final outcome of each patient are described.

Conclusion: Scarring after fractional CO₂ laser therapy may be due to overly aggressive treatments in sensitive areas (including excessive energy, density, or both), lack of technical finesse, associated infection, or idiopathic. Care should be taken when treating sensitive areas such as the eyelids, upper neck, and especially the lower neck and chest by using lower energy and density. Postoperative infections may lead to scarring and may be prevented by careful taking of history, vigilant postoperative monitoring and/or prophylactic antibiotics. *Lasers Surg. Med.* 41:179–184, 2009. © 2009 Wiley-Liss, Inc.

Key words: carbon dioxide; CO₂; complications; ectropion; fractional; laser; resurfacing; scarring

INTRODUCTION

Fractional ablative lasers deliver microscopic columns of energy which vaporize myriads of tiny holes covering only a

small to moderate percentage of the skin surface. The majority of the epidermis is left intact, allowing these microscopic lesions to heal very quickly and to limit complications. This modality is currently used for treatment of acne scarring, photoaging, and skin laxity, among other indications. In contrast, traditional laser resurfacing (with an ultra-pulsed CO₂ or Er:YAG laser) ablates 100% of the epidermal surface, which is associated with prolonged healing and an increased risk of scarring and infection. In addition, the fractional approach allows much deeper treatment (up to 1,500 μm) because of the extremely small beam diameter (100–300 μm) [1,2] This is dramatically different from traditional ablative procedures that ablate the entire surface to approximately 300–350 μm. Few complications have been reported with fractional ablative resurfacing, most likely because fractional CO₂ therapy is still in its infancy. It is important to recognize and characterize complications in order to appropriately define treatment parameters and improve efficacy and safety. We report four cases of scarring in patients treated by fractional CO₂ laser on the face or neck.

MATERIALS AND METHODS

Four patients who had scarring or ectropion after fractional CO₂ laser resurfacing were analyzed to determine the cause of the scarring. All patients had been treated with either the prototype or the trade version of the Fraxel Re:pair laser (Reliant Technologies, Inc., Mountain View, CA). The patients' photographs and clinical files were carefully reviewed to search for any possible linking factors that may have led to complications.

RESULTS

Case #1: Ectropion and Lower Eyelid Scarring After Fractional CO₂ Laser Treatment

A 57-year-old female presented for fractional CO₂ laser treatment of facial rhytids. She had no history of prior laser

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surgery, but reported having a face lift 15 years previously as well as botulinum toxin and various chemical peels. Her entire face was treated with a fractional CO₂ laser (Fraxel Re:pair laser, Reliant Technologies, Inc.) with settings of up to 70 mJ, 30% density, total of 12.34 kJ administered. Preoperative medications included a topical lidocaine and prilocaine cream, oral diazepam, lidocaine and epinephrine nerve blocks, and intramuscular Toradol. The patient tolerated the procedure well. Immediate postoperative treatment included topical use of zinc oxide, frequent vinegar soaks, Keflex 500 mg tid and Acyclovir 400 mg tid.

At the 2-day follow-up visit the patient complained of mild pruritus throughout her face. On exam swelling and serosanguinous oozing limited to the right lower eyelid and upper cheek. One month postoperatively she reported thickening and drooping of the R lower eyelid starting 3 weeks previously (1-week postoperatively). Clinical examination revealed a 1 cm firm, scar-like tightening of the right central lower eyelid, with a visible ectropion that was accentuated when the patient looked up and opened her mouth (Figs. 1 and 2). This was injected intralesionally with 0.1 ml of a 5 mg/ml triamcinolone acetone solution. She was instructed to use lubricating eyedrops multiple times per day. At her follow-up appointment at 2 months this problem had almost completely resolved, with just a very small area in the medial lower lid being thickened, and with no persistence of ectropion. Overall the patient regarded the procedure as a success, thought she looked very rejuvenated, and desired treatment of her neck and chest.

Case #2: Scarring Band on the Neck After Fractional CO₂ Laser Treatment

A 67-year-old female with facial rhytids and neck laxity presented for laser therapy. Her prior cosmetic procedures included a face lift and facial liposuction 5 years prior to her treatment. Preoperative topical 4% lidocaine cream (LMX, Ferndale Laboratories, Ferndale, MI), intramuscular Toradol, and sublingual Diazepam were administered for patient comfort. Her entire face and neck were treated with



Fig. 1. Patient 1. Ectropion and 1 cm scar on medial right lower eyelid 1-month after treatment. [Figure can be viewed in color online via www.interscience.wiley.com.]

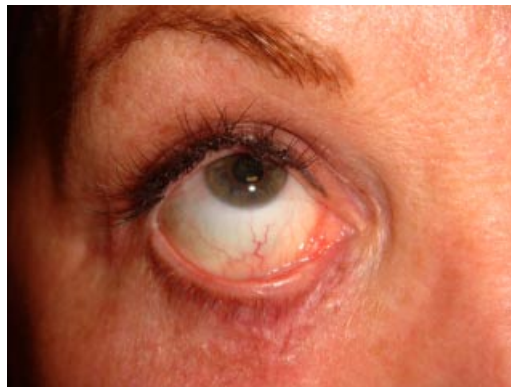


Fig. 2. Patient 1. Ectropion accentuated when the patient looks upward and opens her mouth. [Figure can be viewed in color online via www.interscience.wiley.com.]

the fractional CO₂ laser (Fraxel Re:pair laser) with settings of up to 70 mJ with 30% density on the face and up to 70 mJ with 20% density on the neck, and the patient was discharged on standard postoperative care including Keflex and Acyclovir.

At the 2-day follow-up appointment she reported moderate swelling and mild itching. On exam there was no exudation but moderate swelling diffusely of her face and neck bilaterally. At 1-week postoperatively linear erosions were noted on the right side of the neck, and beefy red swelling of the right neck and face were noted in comparison to the left (Fig. 3). Oral doxycycline and fluconazole were prescribed, and she was instructed to apply Bacitracin to the eroded areas. Cultures for bacteria, fungus, and virus were obtained, all of which were negative except for light growth of pan-sensitive *Staphylococcus epidermidis*. At her 14-day postoperative visit the erosions and erythema were healed, but fullness and edema of the right side of her neck and face were still present. One month



Fig. 3. Patient 2. Erosion and crusting on right lateral neck 1-week postoperatively. [Figure can be viewed in color online via www.interscience.wiley.com.]

later (6 weeks postoperatively) the patient presented with a tender, erythematous 5 cm × 1 cm band of thickened tissue on the right anterior neck which appeared to be overlying a platysmal band. This band was injected with 1.7 ml of a 10 mg/ml triamcinolone acetonide solution and she was instructed to use 0.1% triamcinolone cream on the region. At an 8-week follow-up visit she reported continued tightening and soreness in the neck. Exam revealed a 5 cm × 1 cm white and erythematous scar with banding of the right side of the neck (Fig. 4). Patient was not interested in surgical lengthening of the scar to relax the band, and wished to have more conservative treatment, such as repeated steroid injections. Injections of 20 mg/ml triamcinolone acetonide solution were administered into the band at intervals of 1–4 weeks with improvement. At her most recent visit, botulinum toxin were injected into the superficial dermis over the scar with the goal of releasing any muscular tension that may have a contributory role in inducing scarring in this patient.

Case #3: Scarring on the Neck Associated With *Staphylococcus aureus* Infection After Fractional CO₂ Laser Treatment

A 54-year-old female with phototype II skin presented for improvement of photoaged skin, including irregular texture, dyschromia, freckling, tissue laxity of the cheeks and neck, and deep rhytids on the forehead, periorbital area, and medial cheeks. She had no history of prior cosmetic procedures. She was treated with a fractional CO₂ laser (prototype of the Fraxel re:pair) with settings of 15 mJ on the neck and eyelids and 30 mJ on the face, 40–45% density in all areas treated.

At a 3-day postoperative visit she reported stinging and burning, and a yellow exudate with surrounding redness



Fig. 4. Patient 2. Long-term follow-up: Scarring and platysmal banding of the right neck. [Figure can be viewed in color online via www.interscience.wiley.com.]



Fig. 5. Patient 3. Yellow exudate with surrounding erythema on postoperative day 3. [Figure can be viewed in color online via www.interscience.wiley.com.]

was noted in multiple areas of the neck (Fig. 5) suggestive of a bacterial infection, and she was given levofloxacin. When culture grew methicillin-resistant *Staphylococcus aureus* (MRSA) sensitive only to sulfamethoxazole and rifampin, the patient was prescribed Bactrim DS and fluconazole 100 mg once daily. On postoperative day 10 she was feeling and looking better, but forehead erosions with white exudates were seen on exam, which grew MRSA and *Candida albicans* on culture. Bactrim DS was continued, fluconazole was increased to 100 mg twice daily, and naftifine gel was initiated. Three days later (postoperative day 13) her face appeared much improved, but an area of possible early scarring was seen on her neck. She initiated clobetasol cream. One week after starting Bactrim DS, she developed urticaria which was thought to be a sulfa allergy, and kenalog 40 mg was given intramuscularly and Bactrim DS was discontinued. A follow-up exam on postoperative day 19 revealed irregular texture and linear streaking on the lower anterior neck which was diagnosed as early scarring (Fig. 6). These areas were treated over a 5-month period with repeated 595 nm pulsed dye laser treatments and intralesional injections of a solution of 5-fluorouracil 50 mg/cm³ and triamcinolone acetonide 1 mg/cm³ (total of 16 injections and 10 laser treatments) with moderate improvement in erythema and scars. Although the patient continued to have MRSA abscesses and candidal infections in groin, these infections did not affect her face or neck. Finally, the patient had six treatments with a fractional 1550 nm laser on her neck (30–50 mJ, 32% density), which blended in the scarred areas with her normal skin (Fig. 7).

Case #4: Scarring on the Neck and Platysmal Banding in a Patient Treated for Melasma With Fractional CO₂ Laser

A 61-year-old female with phototype IV skin with a complicated history of recurrent melasma was initially



Fig. 6. Patient 3. Linear streaking on the lower neck suggestive of scarring. Postoperative day 19. [Figure can be viewed in color online via www.interscience.wiley.com.]



Fig. 7. Patient 3. Long-term follow-up: After multiple laser and injectable treatments, the scarred areas blended into normal skin. [Figure can be viewed in color online via www.interscience.wiley.com.]

treated with ultrapulsed CO₂ laser with excellent cosmetic improvement, however she was left with a line of demarcation and persistent melasma on the upper lateral neck. She was treated extensively by multiple modalities over a 5-year period, including a 755 nm alexandrite laser, intense-pulsed light, Jessner's peels, Erbium:YAG laser treatments (settings of 30 μ m ablation and 25 μ m coagulation per pulse) fractional 1550 nm laser, and topical tretinoin and hydroquinone. Her melasma improved with many of these therapies but continued to recur. She underwent fractional CO₂ laser therapy of her neck with settings of 30 mJ, 35% density on her upper neck and 25% density on her lower neck with a total of 4.93 kJ delivered. Her preoperative medications included clobetasol cream twice daily on day prior to treatment to reduce histamine release and swelling.

An examination the day after the procedure was unremarkable, however on postoperative day number 6 a patchy, soft eschar with yellowish change was noted which was nonpainful but suspicious for infection (Fig. 8). Unfortunately, no culture was performed, but azithromycin was started. One week later she had fibrotic streaking on the left neck, and fluticasone propionate 0.05% ointment was prescribed. On postoperative day 19 examination revealed definite areas of likely scarring in horizontal wrinkle lines and a platysmal band on the left anterior neck (Fig. 9). One milliliter of a 5-fluorouracil 50 mg/cm³ and triamcinolone acetonide 1 mg/cm³ solution was injected into these scarred areas. Similar injections were repeated seven times over the next 30 days, and all areas of scarring resolved except the platysmal band (Fig. 10), which is much improved and continues to be treated.



Fig. 8. Patient 4. Patchy, soft eschar with yellow exudate on the left neck on postoperative day 3. [Figure can be viewed in color online via www.interscience.wiley.com.]



Fig. 9. Patient 4. Scarring in horizontal wrinkle lines and a vertical scarred platysmal band. Postoperative day 19. [Figure can be viewed in color online via www.interscience.wiley.com.]



Fig. 10. Patient 4. After multiple treatments, most of scarr-ed areas have resolved with residual hyperpigmentation and hypopigmentation. The vertical platysmal band is persistent. [Figure can be viewed in color online via www.interscience.wiley.com.]

DISCUSSION

We believe that these cases of neck-banding and ectropion represent scarring processes caused by fractional carbon dioxide laser therapy. While scarring and cicatricial ectropion are known complications of ablative therapies such as chemical peels [3], dermabrasion [4], and traditional CO₂ laser resurfacing [5], these complications have not been reported with fractional CO₂ laser therapy.

For better or worse, these represent the first cases of scarring seen with fractional CO₂ laser therapy in over 650 treatments administered by the authors for either acne scarring, dyspigmentation, or facial rejuvenation. The settings used in these patients were not different from those used in other patients, with the exception of patient 3.

The reason for scarring in these patients is unclear, but may be related to site-specific tissue characteristics, overly aggressive treatment, or infection. The skin of both the neck and the eyelid is characterized by a very thin epidermis and dermis. The underlying platysma and orbicularis oculi in the neck and eyelid, respectively, run superficially underneath the skin. It is possible that this fractional laser, which penetrates much more deeply than the traditional CO₂ laser, affected the underlying structures such as muscle, which may have led to greater tissue contraction and scarring. Thin skin may not be able to tolerate the same energy or density of microablative zones than the adjacent skin on the face. In addition, patients should be questioned preoperatively about any history of abnormal scarring.

Cases 2–4 demonstrate that great care should be used when treating the neck. Patient 3 was treated with a density of 40–45% on the neck, which is much higher than is recommended with the current treatment protocols. The other patients were treated at the upper limit of recommended densities on the neck. In the authors' experience

the lower neck is more problematic than the upper neck. Appropriate maximum treatment densities may be 35% for the upper neck and 20% for the lower neck.

Infection may have also played a role in stimulating the inflammatory processes that led to scarring in these patients. Patient 3 had a documented *S. aureus* infection, and patient 4 had a suspected infection. While our cultures were negative in patient 2, it is possible that bacterial, viral, or fungal infection were nevertheless responsible for the scarring. While the use of prophylactic antiviral agents is well-established, the use of prophylactic systemic antibacterial and antifungal is controversial. One of the authors gives these agents to all patients undergoing fractional CO₂ laser therapy over large areas or whenever using a high density of microablative zones, while another uses them only when treating a density of 20% or greater. In addition, laser surgeons should have a low threshold for culturing postoperative wounds in these patients. Documentation of the causative organisms is important in this era of MRSA infections. In fact, it is wise to assume that any infection is MRSA until proven otherwise.

Interestingly, both patient 1 and 2 had a prior face lift procedure in the remote past (5 and 15 years). The relation between a prior face lift and scarring from the fractional laser is difficult to assess in a series of only a few cases, but may be a subject of further scrutiny.

These cases also highlight the importance of close follow-up in the first few days and weeks after treatment. Each patient developed an abnormality in the first 2 days to 1-week after therapy. Patients 1 and 2 had long intervals between follow-up visits relatively early in their postoperative course. It may be necessary to see patients multiple times in the first 1–2 weeks to detect and treat infections or early scarring. It is also critical to initiate anti-scarring therapies as early as possible in order to reverse or minimize scarring. These therapies include potent topical steroids, intralesional steroids and anti-proliferative drugs, vascular lasers, and nonablative lasers.

In summary, fractional ablative laser therapy is a relatively new therapeutic modality which will likely be widely used because of its efficacy and limited side-effect profile. It is critical to recognize, characterize, and report complications in order to recognize the limits of therapeutic efficiency, and to improve the patient safety of these devices. Infectious complications may lead to scarring in patients with fractional CO₂ laser treatment and may be prevented by prophylactic antibiotics and vigilant postoperative monitoring. Care should be taken when treating areas of thin skin such as the eyelids, upper neck and especially the lower neck, probably by decreasing the energy, the density, or both.

REFERENCES

1. Hantash BM, Bedi VP, Kapadia B, Rahman Z, Jiang K, Tanner H, Chan KF, Zachary CB. In vivo histological evaluation of a novel ablative fractional resurfacing device. *Lasers Surg Med* 2007;39:96–107.
2. Hantash BM, Bedi VP, Chan KF, Zachary CB. Ex vivo histological characterization of a novel ablative fractional resurfacing device. *Lasers Surg Med* 2007;39:87–95.

3. Daily RA, Gray JF, Rubin MG, Hildebrand PL, Swanson NA, Wobig JL, Wilson DJ, Speelman P. Histopathologic changes of the eyelid skin following trichloroacetic acid chemical peel. *Ophthal Plast Reconstr Surg* 1998;14:9-12.
4. Ragland HP, McBurney E. Complications of resurfacing. *Semin Cutan Med Surg* 1996;15:200-207.
5. Nanni CA, Alster TS. Complications of carbon dioxide laser resurfacing. An evaluation of 500 patients. *Dermatol Surg* 1998;24:315-320.