Single-Treatment Skin Tightening By Radiofrequency and Long-Pulsed, 1064-nm Nd: YAG Laser Compared

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Background and Objective: To compare single-treatment facial skin tightening achieved with the current radiofrequency (RF) protocol with single-treatment tightening achieved with the long-pulsed, 1064-nm Nd:YAG laser.
Study Design/Materials and Methods: A total of 12 patients were treated with RF energy on one side of the face and laser energy on the other. Results were evaluated on a numerical scale (0–12 with 12 = greatest enhancement) from pre- and posttreatment photographs by a blinded panel.
Results: Upper face improvement (posttreatment score minus pretreatment score) was essentially the same on both sides (30.2 and 31.3% improvement for laser and RF, respectively, $P = 0.89$). Lower face improvement was greater in the laser-treated side (35.7 and 23.8% improvement for laser and RF, respectively), but the difference was not significant ($P = 0.074$). Overall face improvement was significantly greater on the laser-treated side (47.5 and 29.8% improvement for laser and RF, respectively, $P = 0.028$).
Conclusion: A single high-fluence treatment with the long-pulse 1064-nm Nd:YAG laser may improve skin laxity more than a single treatment with the RF device. Further controlled split-face or very large non-self controlled studies are needed to conclusively determine the relative efficacies of the two technologies. Lasers Surg. Med. 39:169–175, 2007. © 2007 Wiley-Liss, Inc.

Key words: laxity; non-invasive; RF device; facial lifting; wrinkles

INTRODUCTION

Despite the dramatic improvements associated with surgical face-lifting, the recovery time and high expense remain significant drawbacks of these procedures. In the author's experience, patients seeking cosmetic improvement prefer procedures with little downtime yet are safe, effective, and inexpensive. If downtime is short, patients can receive these treatments without revealing to friends and associates that they have "had a procedure." Patients also prefer to avoid the risks of surgery, which are not limited to permanent nerve injury, skin flap necrosis, and permanent incisional scar visibility, and they know that cosmetic benefits, even from aggressive face-lifting procedures, are not necessarily permanent.

Non-surgical approaches to skin tightening have been the subject of intense investigation [1]. The first non-invasive device for skin tightening took advantage of the heat generated in tissue by radiofrequency (RF) energy [2–4]. Specifically, RF energy heats hydrodermal collagen while the skin is cooled, promoting both collagen remodeling [5] and skin tightening [6]. This "tightening response" was considered unique to RF until a split-face study [7] showed that facial skin tightening after a single treatment with RF was comparable to facial skin tightening after a single treatment with the long-pulse Nd:YAG 1064-nm laser (LP Nd:YAG). In this study, a 1-cm^2 fast tip was used in the RF treatment arm. Since the study was reported, new tips, settings, and RF protocols as well as new LP Nd:YAG protocols have become available that may increase the treatment safety, rapidity, cost effectiveness, and patient comfort [8]. Other devices investigated for skin tightening include a combination RF and diode laser [9] and a new broadband infrared light device [10].

The purpose of the present study was to compare single-treatment facial skin tightening achieved with the current recommended RF protocol (which includes skin-contact cooling) with single-treatment tightening achieved with the LP Nd:YAG laser equipped with a cooling device.

MATERIALS AND METHODS

Twelve patients seeking facial lifting and tightening participated in a split-face study. All were women with Fitzpatrick skin types I and II and mild to moderate gravitational skin laxity. All provided informed consent and were advised of the possible risk of adverse effects (e.g., scarring, sunken tissue) with RF treatment (ThermaCool TC, Thermage, Inc., Hayward, CA) treatment and the author's assumption (but not observation) that a similar risk might exist with long-pulsed, 1064-nm Nd:YAG laser (LPNYAG) (GentleYAG^{TM}, Candela Corporation,

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Wayland, MA) treatment. In 10 patients, the right side of the face and upper neck was treated with RF energy and the left side with laser energy. In the remaining two patients, opposite sides were treated by these respective modalities. The author treated the left facial sides of 10 participants with laser energy and the left sides of only 2 patients with RF energy.

RF Treatment

Each split-face patient received 450 pulses with a 1.0-cm^2 tip, the current RF protocol recommended by the manufacturer. Treatment settings were adjusted according to patient tolerance along x, y, and z facial vectors. Although the manufacturer recommends pulse stacking, the author treated each target zone repeatedly but without pulse stacking. Treatment parameters were the following: 450 repeat pulse pattern, several passes, 73–79 J (mean 75). Topical anesthetic cream (benzocaine 20%, lidocaine 10%, tetracaine 4%) was applied 20 minutes before RF treatment and removed immediately prior to treatment. No systemic sedatives were used.

Laser Treatment

Fluences for laser treatment were selected on the basis of patient tolerability. Topical anesthetic was applied as in RF treatment. Using a 10-mm spot size, 50-milliseconds pulse duration, and cooling device settings at 40/20/0 (Dynamic Cooling Device, Candela Corporation), the author tested the cheek of each patient with 50 J/cm^2 fluence, first as a

Fig. 1. Photographs showing wrinkles with cross shadowing (left) and without cross shadowing (right, full frontal flash technique). Both photographs are of the same patient without treatment. The left photograph shows the greater detail revealed by cross shadowing. The cross shadowing photographic technique was standardized and used throughout the study. For example, in the cross shadowing method, light was positioned identically in all pre- and posttreatment photographs. In the author's opinion, photographic technique must be standardized so that changes due to treatment are not confounded by changes due to variations in photographic technique.

TABLE 1. Blinded Panel Scores (Mean ± SD) for Faces Treated With RF on One Side and Laser on the Other Side

	Upper face				Lower face				Overall			
	Pre-Tx	Post-Tx	Ipvt (%)	*P*-value	Pre-Tx	Post-Tx	Ipvt (%)	*P*-value	Pre-Tx	Post-Tx	Ipvt (%)	*P*-value
RF	5.69 ± 1.87	7.47 ± 1.43	31.3	0.0002 (s)	5.92 ± 1.74	7.33 ± 1.41	23.8	0.005 (s)	5.67 ± 1.87	7.36 ± 1.35	29.8	0.0008 (s)
Laser	6.06 ± 1.83	7.89 ± 1.25	30.2	<0.0001 (s)	5.94 ± 1.97	8.06 ± 1.73	35.7	<0.0001 (s)	5.33 ± 1.99	7.86 ± 1.91	47.5	0.0002 (s)

RF = radiofrequency; Ipvt = improvement; Tx = treatment; s = significant; ns = not significant.

single pulse and second as two stacked pulses at 1.5 Hz. Patient responses indicated that the appropriate fluences were 40 J/cm^2 for the cheek and 20–30 J/cm^2 for the thinner-skinned forehead. Each facial target zone subsequently received three sets of two stacked pulses at 1.5 Hz applied in rotational fashion and without pulse overlap. Cheeks received approximately 300 J/cm^2 total fluence.

Two months after treatment, each of the 12 patients was permitted to choose a "crossover" treatment (e.g., if a patient felt that improvement on the left side of the face was greater than the improvement on the right side, the patient could choose to have the right side treated with the modality used to treat the left side).

Evaluation of Results

Improvement was assessed by a three-member lay panel blinded to the nature of the treatments and to the modality used on each facial side. Panelists compared front-view photographs taken before treatment and 2–4 months after treatment. They estimated improvements in forehead lines, brow positions, periorbital line positioning, and eyelid position in the upper face. In the lower face, they evaluated improvements in malar cheek and jowl positioning, nasolabial fold depth, and fold extension. Panelists also evaluated overall improvement in the upper face, lower face, and the entire face relative to age.

Panel members graded improvement on an A to F scale, which was considered intuitively simpler than a numerical scale. Each letter score could be designated plus or minus (e.g., B minus or C plus). Once obtained, letter scores were converted to a numerical scores (A = 12, B = 9, C = 6, D = 3, and F = 0) with 12 indicating the greatest enhancement. To assure consistent adherence to evaluation criteria, panelists graded improvements during a single session, using half-face photographs for facial sides and full-face photographs for overall enhancement. Scores were evaluated with Analyse-It for Microsoft Excel (Analyse-It Software, Ltd., UK) statistical software.

Photographs were taken with a fixed-plan Canfield photographic platform linked to Mirror™ (Omnia™ Imaging System with Mirror software, Canfield Scientific, Inc., Fairfield, NJ), which highlighted facial gravitational shadows and lines. Because full-face frontal flash photography tended to "burn out" shadowing, fixed 45-degree cross lightening was used. With this platform, panelists could view pre- and posttreatment images side by side. Figure 1 shows the superior enhancement of facial contours, texture, and lines obtained with the cross-shadowing technique.

Before patients could choose a crossover treatment, panelists scored improvement by viewing side-by-side photographs of the laser- and RF-treated sides and scored improvement on each side relative to baseline.

RESULTS

For both the RF and laser modalities, paired *t*-test comparisons (Table 1) showed that the mean posttreatment scores were significantly higher than the mean pretreatment scores for the upper face, lower face, and overall face. For the upper face, the mean score difference (posttreatment score minus pretreatment score) did not differ significantly between the RF- and laser-treated sides ($P = 0.89$, Table 2).

As shown in Table 2, for the lower face, the mean score difference was larger in the laser-treated side (2.11 vs. 1.39, or 35.7% vs. 23.8% improvement) although the difference did not reach statistical significance ($P = 0.074$). For the overall face, the mean score difference (2.53 vs. 1.69, or 47.5 vs. 29.8%) was significant ($P = 0.028$). The comparative overall improvements are shown in Figure 2.

As shown by the SD data (Table 1), the spread of patients' objectively judged results are roughly comparable between RF and LP Nd:YAG laser treatments. The data are shown graphically on Figures 3–5. Figures 6 and 7 show the facial halves of a patient treated with RF energy on the left side and laser energy on the right side. Additional split-face photographs of RF and laser treatments are shown in Figures 8–11.

Patients were asked to compare the improvement in their RF-treated sides (facial and abdominal) with the improvement in their laser-treated sides by looking in a handheld mirror. More than half of patients (58.3%) stated that improvement in the laser-treated side was greater, despite greater (temporary) discomfort during laser treatment. Panelists, who evaluated only photographs, showed a stronger preference (10 of 12 patients, or 83.3%) for the laser-treated side.

Adverse effects were not observed in any patient treated by either modality. Patients had no downtime with either RF or laser treatment. All patients experienced a tactile perception of tighter skin immediately after treatment by each modality. During laser treatment, all patients noted momentary discomfort which did not persist and did not

TABLE 2. Differences in Blinded Panel Scores (Mean ± SD) for Faces Treated With RF on One Side and Laser on the Other Side

Upper face			Lower face			Overall		
RF	Laser	*P*-value	RF	Laser	*P*-value	RF	Laser	*P*-value
1.78 ± 1.12	1.83 ± 1.05	0.89 (ns)	1.39 ± 1.46	2.11 ± 1.08	0.074 (ns)	1.69 ± 1.28	2.53 ± 1.58	0.028 (s)

Diff. = posttreatment score minus pretreatment score; RF = radiofrequency; Tx = treatment; s = significant; ns = not significant.

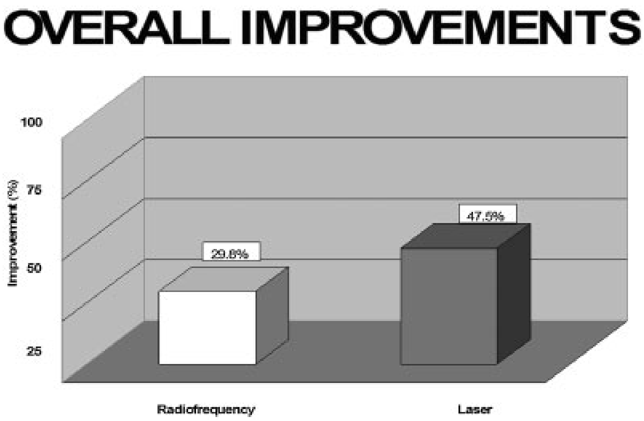

Fig. 2. Overall improvement after a single radiofrequency treatment (29.8%) and after a single laser treatment (47.5%).

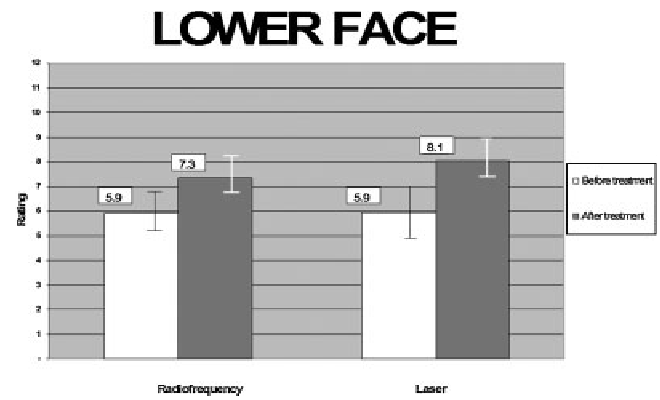

Fig. 4. Mean improvements of the lower face after a single radiofrequency treatment on one side and a single laser treatment on the other side. Radiofrequency treatment resulted in 23.8% mean improvement and laser treatment resulted in 35.7% mean improvement.

discourage them from choosing the laser as their crossover treatment.

DISCUSSION

In contrast to the present study, patients in earlier studies with the LP Nd:YAG laser [11,12] received multiple treatments at short intervals to improve skin quality. In a 50-patient study [11], Lee and colleagues reported 10–30% improvement in skin tone/tightening after 3–6 treatments with the 1064-nm laser alone. These authors administered treatment in "brush strokes" and single-pass patterns with surface cooling and a handpiece set at 30- to 65-milliseconds pulse widths and 24- to 30-J/cm^2 fluence. In a 51-patient study [12] in which 34 patients received seven treatments (1–4 weeks apart) with the LP Nd:YAG laser, Dayan and colleagues reported a 36.3% reduction in patient-assigned Fitzpatrick Scale scores for skin laxity without adverse events. The authors used a skin-cooling device and a 10-mm handpiece set at 22 J/cm^2, 50-ms pulse width, and 2 pulses per second.

The author of the present study relied on the accumulated fluence and higher tissue peak temperatures attained by pulse stacking during a single treatment with cryogen spray-linked cooling rather than single-pass multiple treatments spaced weeks apart. In previous studies of the RF device, authors gave patients a single RF treatment and evaluated the results. Using a prototypic RF device, Ruiz-Esparza and Gomez [2] found that 14 of 15 patients had up to 50% improvement in cheek contour, nasolabial fold softening, marionette lines, and mandibular lines. Patients had little discomfort during treatment and no downtime. In a 16-patient study [13], Hsu and Kaminer treated the upper neck, jaw line, cheeks, or combinations of these areas. Satisfaction was 36% in patients treated in all three areas compared to 25% in patients treated in fewer areas. Fitzpatrick et al. [3] performed periorbital tissue

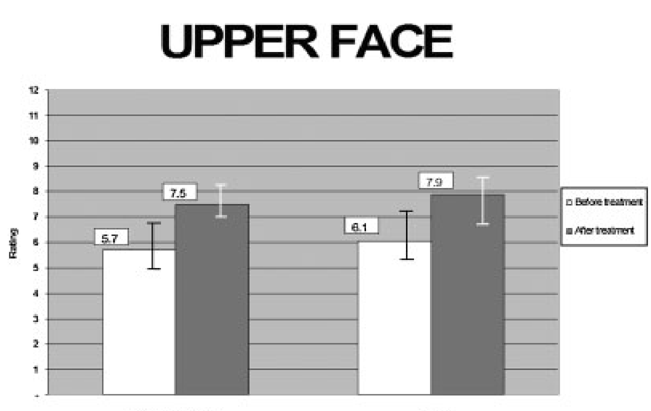

Fig. 3. Improvement of the upper face after a single radiofrequency treatment on one side and a single laser treatment on the other side.

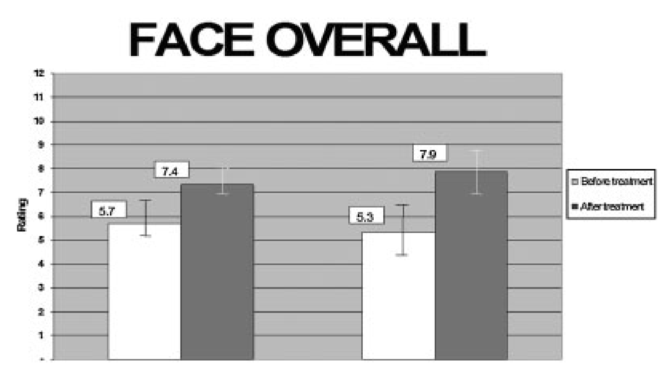

Fig. 5. Mean facial improvements after a single radiofrequency treatment on one side and a single laser treatment on the other side. Radiofrequency treatment resulted in 29.8% mean improvement and laser treatment resulted in 47.5% mean improvement.

Fig. 6. Tissue tightening by radiofrequency treatment of the right side of the face. The left photograph shows the face before treatment and the right photograph shows the face 14 weeks after a single treatment. The posttreatment photograph shows considerable residual laxity of jowl cheeks and little increase in jaw line definition. Volumetric suspension of the cheeks and nasolabial fold effacement are less than on the laser-treated side (Fig. 7).

tightening by RF in 86 patients. Fitzpatrick wrinkle score improvement (1 point or more) occurred in 83.2% of periorbital areas treated, improvement was observed in 28.9% of areas treated, and half of treated patients reported satisfaction with wrinkle reduction. Edema and erythema were lower than what normally occurred in ablative treatments. In a study of 50 patients with cheek and neck

Fig. 7. Tissue tightening by laser treatment of the left side of the face. The left photograph shows the face before treatment and the right photograph shows the face 14 weeks after a single treatment. Posttreatment photographs show greater effacement of jowl laxity and nasolabial fold, vertical volume suspension of the cheeks, jaw line definition, and lifting of the upper lip. Changes in brow and tissue redundancy are less pronounced.

Fig. 8. Tissue tightening by radiofrequency (RF) treatment of the right side of the face. The left photograph shows the face before treatment and the right photograph shows the face 12 weeks after a single RF treatment. The criteria for judging posttreatment tissue tightening were reduction in jowl soft-tissue laxity, upward displacement of the mid-malar cheek (giving the impression that the cheek is higher), reduced tissue draping of the upper eyelid, brow line reduction, upward displacement of the brow; and vertical resuspension of the ptotic lip (resulting in more fullness). The increased tightness of the cheek reduces gravitational redundancy of the nasolabial fold. (Fig. 9 shows the laser-treated left side of the face.)

laxity, Alster and Tanzi [14] reported mean clinical scores associated with (1) 25–50% improvement in mesolabial and nasolabial folds in cheeks in 93% of patients and (2) comparable improvement in upper neck and submandibular skin laxity in 85% of patients.

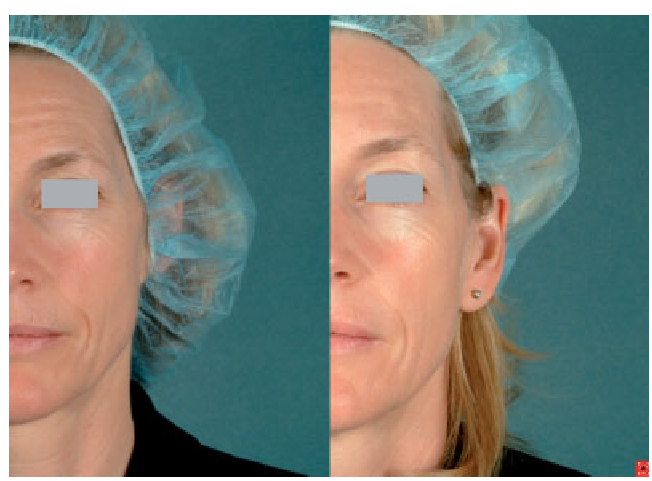

Fig. 9. Tissue tightening by laser treatment of the left side of the face. The left photograph shows the face before treatment on and the right photograph shows the face 12 weeks after a single treatment. The criteria presented in Figure 8 were used to judge posttreatment tissue tightening. (Fig. 8 shows the RF-treated right side of the face.)

Fig. 10. Tissue tightening by radiofrequency treatment of the right side of the face. The left photograph shows the face before treatment and the right photograph shows the face 16 weeks after a single treatment. Criteria of Figure 8 were used to judge improvement in skin tightening. Improvement in forehead and infrabrow is minimal.

The intent of the present evaluation was purposely different from that of these previous studies. Rather than to establish or confirm the efficacy of RF treatment, our intent was to compare the efficacy of RF treatment with that of an alternative method of volumetric thermally induced tissue tightening with the LP Nd:YAG laser. The author adhered to the manufacturer's current RF treatment algorithm which includes more passes at lower joules per pulse (for greater patient comfort) and higher cumulative fluence; 450 pulses applied to a half face with a 1.0-cm^2 tip would be equivalent to 900 pulses applied to the entire face with a 1.0-cm^2 tip.

Fig. 11. Tissue tightening by laser treatment of the left side of the face. The left photograph shows the face before treatment and the right photograph shows the face after a single treatment. Criteria of Figure 8 were used to judge improvement in skin tightening. Improvement in forehead and infrabrow is minimal. On the laser-treated side, the increased fullness and roundness of the cheek and vertical upward displacement of cheek soft-tissue volume indicated tissue tightening. The nasolabial fold and jowl cheek laxity is nearly gone, whereas on RF side (Fig. 10), virtually no change is apparent.

In the present study, both patients and blinded evaluators perceived that improvement was greater in the laser-treated side of the face than on the RF-treated side. Patients compared improvements with a handheld mirror while blinded panelists compared improvements by side-by-side visualizations made possible by our photography technique. The most dramatic differences in treatment results were in the overall face, in which 10 of 12 patients showed greater improvement with laser treatment as judged by blinded panelists. Overall perceived improvement was also far greater on the laser-treated side.

With the exception of two reports [7,8], the author is not aware of other split-face studies comparing RF and laser treatment modalities to tighten skin. The present split-face study is unique because it offers a head-to-head comparison of the efficacies of two methods for facial tissue tightening.

CONCLUSIONS

Our results suggest that in most patients, a single treatment with the LP Nd:YAG laser—at a higher fluence than used in multiple treatment studies—improves skin laxity more than a single treatment with the RF device. Comparative studies with more patients as well as further evaluations of the optimal use of cooling versus delivered laser fluences for skin tightening are warranted.

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