Nonablative Laser Resurfacing Using the Long-Pulse (1064-nm) Nd:YAG Laser

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**Background:** Lasers with infrared wavelength ranges have been used in nonablative rejuvenation of skin. In this process, cooling of the epidermis allows for laser energy heat-induced injury to the dermis without ablation of the epidermal layer. This dermal injury is theorized to produce improvements in skin quality. In addition, long-pulse Nd:YAG lasers target melanin less efficiently, allowing safer treatment of patients with all skin types. In this study, we evaluate the use of the 1064-nm Nd:YAG laser for the purpose of rejuvenating the aging face.

**Materials and Methods:** Fifty-one patients were enrolled in the study. Patients with Fitzpatrick skin types I through V were included. Standard photographs were taken before the first and after the last treatment. The Nd:YAG laser treatments were initiated with a chilled tip-cooling device. At each treatment session, patients were given self-assessment questionnaires. At completion of the study, 3 physicians performed masked evaluations of patient pre-treatment and posttreatment photographs.

**Results:** Thirty-four of 51 patients completed at least 7 treatments, had posttreatment photographs, and were entered into the study. Follow-up ranged from 1 to 6 months. No adverse events were noted. Masked analysis and patient subjective scores demonstrated a subtle improvement in several skin variables. Patient-assigned Fitzpatrick Scale scores declined after 6 treatments for coarse wrinkles (−22.3%; \( P < .01 \)), skin laxity (−36.3%; \( P < .01 \)), and overall improvement (−40.6%; \( P < .01 \)). Physician-graded scores demonstrated decreases in coarse wrinkles (−11.9%; \( P < .01 \)), skin laxity (−17.3%; \( P < .01 \)), and overall improvement (−20.0%; \( P < .01 \)).

**Conclusions:** Nonablative resurfacing techniques are well suited for patients requesting rejuvenating treatments of the aging face with minimal downtime. Although improvements in photodamaged skin are subtle and gradual, the 1064-nm Nd:YAG laser was well tolerated by patients of all skin types.

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Improving the appearance of aging skin by reducing wrinkles and skin laxity has long been a goal. Carbon-dioxide and erbium-YAG lasers and various chemical peels have become the mainstays of ablative facial resurfacing. During such ablative processes, the epidermis is denuded by the chemical or the thermal injury to the skin. Despite achievement of an appreciable clinical improvement, adverse effects of ablative resurfacing modalities can result in significant edema and erythema lasting for several weeks. Moreover, well-known morbidities, long-term sequelae, and potential complications have all been well documented. The typical prolonged recovery times and potential complications associated with these modalities may limit their use in patients who desire a rejuvenation procedure with reduced downtime and minimal risk.

In contrast to ablative rejuvenation procedures, nonablative laser rejuvenation procedures attempt to achieve a dermal injury response without injuring the epidermis. Improving the appearance of skin without injury to the epidermis is a hallmark of nonablative laser rejuvenation. The mechanism of nonablative dermal remodeling is still under investigation. It is theorized that laser-induced subthreshold injury to the dermis and/or vasculature results in a wound repair response, stimulation of fibroblast activity, and collagen reformation.

Laser energy in the near- and mid-infrared areas of the electromagnetic spectrum has longer wavelengths and is weakly attracted to melanin. This translates into less melanin chromophore absorption and deeper energy transmission through the skin. Laser energy is delivered to the dermis where heat is nonselectively deposited. This heat-induced damage has also been hypothesized to result in activation of dermal fibroblast and induction of a healing response. Others have reported im-
proven to improve the regional appearance of fine lines and wrinkles using near- and mid-infrared lasers. An additional benefit of this wavelength range is that patients with all skin types (including darker-skinned or actively tanning patients) may be treated with less risk. With such encouraging preliminary reports, we decided to evaluate the applicability of the 1064-nm Nd:YAG laser in nonablative rejuvenation of the aging face.

Fifty-one patients were enrolled after institutional review board approval and detailed consultation, physical examination, and informed consent. Thirty-four patients completed at least 7 treatments, had final posttreatment photographs, and were entered into the study. Patients with Fitzpatrick skin types 1 through 5 were included. Exclusion criteria included vitiligo, pregnancy, lactation, previous electrolysis, and use of isotretinoin, anisatil or other photosensitizing medications. Patients were not permitted to undergo concomitant chemical peels, topical tretinoin treatment, or microdermabrasion. Home skin care regimens were evaluated and standardized to eliminate potentially confounding factors. Patients were given samples of gentle moisturizers and sunscreens (Maroque; MD Aesthetics, Northbrook, Ill).

Standardized full-face, oblique, and lateral view photographs were taken before beginning treatment and after the last treatment using a 35-mm format camera (Nikon N60; Nikon Inc USA, Melville, Ky) equipped with a 105-mm macro lens. Before treatment sessions, all makeup was removed and laser safety precautions were exercised.

Treatments were initiated with the 1064-nm Nd:YAG laser (Lyra; Laserscope, San Jose, Calif) using a 10-mm hand piece at a setting of 22 J/cm², a 50-millisecond pulse width, and a frequency of 2 pulses per second. A skin-cooling device (Thermodotek, Carrollton, Tex) was used and controlled to 1.5°C. Clear refrigerated ultrasound gel was used to facilitate hand-piece movement.

Three passes were performed in a painting motion over the area extending from the nasolabial fold medially, preauricular crease laterally, mandibular border inferiorly, and orbital rim superiorly. Topical anesthesia of the skin was not necessary. Patients underwent weekly treatment and evaluation for 8 weeks. Patients were instructed to avoid makeup for at least 1 hour after the procedure.

Each participant was required to perform a subjective self-evaluation before each treatment and after completion of the study. Patients rated the following variables on a 9-point scale, with 9 being the most severe: fine wrinkles, coarse wrinkles, skin roughness, uneven pigmentation, skin laxity, and overall improvement.

Analysis of patient photographs was performed by a dermatologist (G.M.) and 2 facial plastic surgeons (S.H.D. and S.R.M.). The physician graders were masked to the preoperative and postoperative status of the photographs. Posttreatment photographs were obtained from 1 to 4 months after the last treatment. Using a 9-point grading system, the graders reviewed the following variables: fine wrinkles, coarse wrinkles, skin laxity, pigmentation, and overall rating. Preoperative and posttreatment scores in each category were compared. A 1-tailed, paired comparative statistical analysis of the 2 groups was conducted using the t test.

Results

Thirty-four of 51 patients completed the entire course of 7 treatments. Another 11 patients completed at least 5 treatments. Six completed fewer than 5 treatment sessions. Patient ages ranged from 35 to 62 years, with a mean age of 41 years. Follow-up after the final treatment session ranged from 1 to 6 months (average, 4.5 months). Most patients experienced mild erythema lasting less than 15 minutes after the procedure. Anesthesia requirements of the patients were minimal and did not require any pharmacological intervention. No significant adverse events were noted, including blistering, prolonged erythema, severe pain, scarring, hypopigmentation, or hyperpigmentation.

Subjective Patient Analysis

Participants’ subjective self-evaluations were recorded before each treatment session. These subjective self-assigned Fitzpatrick Scale scores were recorded for fine wrinkles, coarse wrinkles, skin roughness, uneven pigmentation, skin laxity, and overall improvement. We analyzed the difference between patients’ pretreatment and treatment 6 scores. The scores from treatment 6 (1 treatment before the final session) were used in an effort to minimize any placebo-type effects of the final patient evaluation of the treatment regimen. Statistically significant (P<.01) reductions in Fitzpatrick Scale scores were observed in all the categories (Figure 1). Patient-assigned Fitzpatrick Scale scores continued to decline on the seventh or final treatment and evaluation session in all categories (Figure 2).

Masked Physician Analysis

Masked objective analysis by the 3 physicians using a 9-point grading system of rhytids (Fitzpatrick Scale scores, Table 1) was undertaken on the basis of frontal and lateral view close-up photographs. Pretreatment photographs were compared with photographs from treatment 6 (Figure 3 and Figure 4). In all patients, statistically significant (P<.01) improvements were noted in coarse wrinkles, fine wrinkles, skin laxity, and overall improvement scores (Table 2). When scores from patients with pretreatment class I Fitzpatrick Scale score were excluded, similar improvements in physician-graded scores were noted (Table 2). No statistically significant changes in skin pigmentation scores were noted.

Table 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Pretreatment Score</th>
<th>Treatment 6 Score</th>
<th>% Reduction</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Wrinkles</td>
<td>3.7</td>
<td>2.5</td>
<td>-36.3%</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Coarse Wrinkles</td>
<td>2.8</td>
<td>1.4</td>
<td>-47.5%</td>
<td>&lt;.01</td>
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<tr>
<td>Roughness</td>
<td>3.2</td>
<td>1.8</td>
<td>-40.6%</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Uneven Pigmentation</td>
<td>2.9</td>
<td>1.6</td>
<td>-41.2%</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Skin Laxity</td>
<td>3.1</td>
<td>2.1</td>
<td>-34.5%</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Overall Improvement</td>
<td>2.7</td>
<td>1.3</td>
<td>-52.4%</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>
Nonablative laser resurfacing using the 1320-nm Nd:YAG laser has been shown to produce subtle positive results in patients with minimal downtime and complications.\(^{12,13}\) Similar to the 1320-nm Nd:YAG laser, the 1064-nm Nd:YAG laser is not efficient at targeting melanin chromophores and hence at facilitating deeper nonselective energy transmission into the dermis. The addition of a skin-cooling device in both lasers serves to further protect the epidermis from potential thermal injury.\(^\)
The extended-pulse 1064-nm Nd:YAG laser has been demonstrated as safe and effective for laser epilation in patients of all skin types.\textsuperscript{15-17} A side-by-side comparison of perioral rhytids treated with an intense pulse light device and the 1064-nm Nd:YAG laser demonstrated similar improvement in rhytid reduction, whereas the 1064-nm Nd:YAG laser was associated with fewer complications and better patient tolerance.\textsuperscript{9} Although not statistically significant, patients treated with the 1064-nm Nd:YAG laser subjectively identified increased rhytid reduction lasting up to 24 weeks after their final treatment.\textsuperscript{9} Advantages of the 1064-nm Nd:YAG laser for wrinkle reduction include the technical ease of performing the procedure, minimal to no patient discomfort, and the ability to treat all skin types with little risk of epidermal injury.

In this pilot clinical study, we treated 51 patients during a 4-month period. Thirty-four patients completed a minimum of 7 treatments and had final photographs after treatment 6. Treatments were spaced out from 1 to 4 weeks apart, with the favored interval being every 2 weeks. Treatments were initiated using a 10-mm hand piece at a setting of 22 J/cm\textsuperscript{2}, 50-millisecond pulse width, and a frequency of 2 pulses per second. These settings were chosen on the basis of the following theoretical reasons: (1) the energy level was below the threshold for melanin follicular damage; (2) the pulse width was extended beyond the thermal relaxation time of skin melanin (3-10 milliseconds); and (3) the overall energy would produce heat for a subthreshold injury to the surrounding dermis.

No patients reported blister formation, prolonged erythema, scarring, or dyspigmentation, regardless of skin type. Including other patients that we have treated (not enrolled in this study), we have not seen any major adverse reactions in more than 500 facial laser treatments. A review of patient anesthetic requirements was quite favorable. In our initial days of using this laser, the patients underwent pretreatment with topical anesthetic lidocaine-prilocaine cream (2.5% prilocaine, 2.5% lidocaine; EMLA; AstraZeneca Pharmaceuticals LP, Wilmington, Del) and received posttreatment topically applied chilled packs. This practice was discontinued as the patients reported minimal to no discomfort during laser treatments.

Patient satisfaction was high on the commentary section of the treatment evaluation forms. Patients commented favorably in regard to the short duration of the procedure (which takes only minutes), observed skin improvements, and the ability to be treated in an office setting.

The subjective patient-reported scores (Figure 1) demonstrated the following decreases in Fitzpatrick Scale scores: −35.8\% in fine lines, −36.3\% in skin laxity, and −40.6\% overall improvement in facial appearance. These figures compare favorably with those of a previous study involving microdermabrasion results that showed a −19.8\% improvement in fine wrinkles, −13\% improvement in skin laxity, and −16.5\% overall improvement.\textsuperscript{18}

Judging by physician-graded scores, patients demonstrated improvements in all categories evaluated (Figure 5). When patients with pretreatment class I
wrinkle classification were eliminated, evidence of slightly greater improvement was noted in those who began with more severe pretreatment wrinkles (Table 2). This finding was consistent with observations in which patients with worse pretreatment skin experienced more dramatic improvements. As others have also indicated, we recognize that full-face and multiple treatments are necessary to appreciate subtle gains by means of nonablative modalities.9,10,12,13 Most patients identified little or no change after the first 2 treatments. Usually, at the 6-week measurement, after the third treatment, patients began to observe an improvement in their skin texture. After the fourth treatment, patients recognized a visible difference in their overall skin appearance, which continued into the final treatment sessions.

An interesting discrepancy between patient-assigned self-scores and physician-graded scores were observed in all categories (Table 2 and Figure 2). We ascribe these to several factors. First, the presence of a placebo-type effect should be considered. Placebo and halo effects may account for more than half of the good to excellent outcomes seen in some medical and surgical case

Table 2. Changes in Physician-Graded Scores From Pretreatment to Final Photographs*  

<table>
<thead>
<tr>
<th></th>
<th>% of Change (P Value)</th>
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<tbody>
<tr>
<td></td>
<td>All Classes (n = 34)</td>
<td>Classes II and III (n = 30)</td>
<td></td>
</tr>
<tr>
<td>Coarse wrinkles</td>
<td>−11.9 (&lt;.01)</td>
<td>−14.1 (&lt;.01)</td>
<td></td>
</tr>
<tr>
<td>Fine wrinkles</td>
<td>−10.7 (&lt;.01)</td>
<td>−13.1 (&lt;.01)</td>
<td></td>
</tr>
<tr>
<td>Skin laxity</td>
<td>−17.3 (&lt;.01)</td>
<td>−18.1 (&lt;.01)</td>
<td></td>
</tr>
<tr>
<td>Uneven pigmentation</td>
<td>−0.7 (.50)</td>
<td>−2.19 (.38)</td>
<td></td>
</tr>
<tr>
<td>Overall improvement</td>
<td>−20 (&lt;.01)</td>
<td>−23.3 (&lt;.01)</td>
<td></td>
</tr>
</tbody>
</table>

*Final photographs were obtained after 6 treatments. Classes are described in Table 1.
series. Second, although standardized photographs were used, the 2-dimensional aspect of still photography may obscure subtle skin changes. An in-person analysis of the face may better highlight cutaneous changes analyzed in this study, but this would have unmasked the physician grading process. Perhaps physician-graded scores also reflect a more conservative or underestimated interpretation of observed changes. Third, the patient’s ability to distinguish the different categories of skin changes may not be as well developed as that of the physician. More specifically, the similarity in subjective scores for improvements in skin roughness, uneven pigmentation, and coarse wrinkles (26.4%, 25.5%, and 22.3%, respectively), and the fine wrinkles and skin laxity scores (33.8% and 36.3%, respectively) may point out some of the limitations of the subjective scores. To the layperson, these categories may seem similar enough, creating confusion and interpretational overlap. This may also explain the significant difference between physician- and patient-assigned scores of the uneven skin pigmentation category.

In this category, the physician-graded scores did not demonstrate a statistically significant change (0.7%; P = .50), whereas patient-graded scores indicated notable change (25.5%; P < .01). We question whether the patient’s interpretation of uneven skin pigmentationary changes may have been generalized to include changes in skin hue and tone and consistency of skin quality.

Overall, our data and observations point to a measurable degree of improvement in fine wrinkles, coarse wrinkles, skin roughness, skin laxity, and global improvement in skin appearance.

Although results demonstrate changes that are statistically significant, it is important to communicate that observed clinical results were subtle and gradual. Clearly, patient satisfaction can depend on the patient’s expectations. Patient education and consultation need to be in-depth, complete, and honest. Expectations must be realistic and tempered by the lack of long-term results.

CONCLUSIONS

Nonablative resurfacing techniques are well suited for patients requesting rejuvenating treatments of the aging face. Although many different laser and nonlaser light sources are being investigated in an attempt to identify the favored modality, the long-pulse Nd:YAG laser provides particular benefits. Similar to other techniques, improvement in fine lines, wrinkles, and photodamaged skin are subtle and gradual. However, the 1064-nm Nd:YAG laser is unique in that it is well tolerated by patients of all skin types. Furthermore, at this point in our investigations, the treatments have been found to be safe. Nonablative laser treatments, although desirable, have yet to replace proven resurfacing techniques or standard surgical procedures for facial rejuvenation. Further studies and histological evaluations are necessary to determine the ideal settings and long-term benefits and possible sequelae of this treatment modality. For the person unable to afford the downtime of more aggressive procedures or dissatisfied with the minimal gains achieved from superficial peels and microdermabrasion, the 1064-nm Nd:YAG laser may provide an attractive alternative.

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REFERENCES


