Nonablative Facial Skin Tightening

Last Updated: October 31, 2005

Synonyms and related keywords: non-ablative facial skin tightening, nonablative facial resurfacing, nonablative procedure, skin rejuvenation, dermabrasion, chemical peels, resurfacing lasers, nonablative laser rejuvenation, mid-laser, intense pulsed light, Fitzpatrick skin type IV, Fitzpatrick skin type V, erbium:yttrium-aluminum-garnet laser, Er: neodymium:yttrium-aluminum-garnet laser, Nd:YAG, rhytid, rhytid reduction, rhytidosis, skin laxity, facial appearance, wrinkle reduction, nonablative facial skin tightening

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Disclosure

INTRODUCTION

Reduction of rhytids and skin laxity can significantly contribute to improving overall facial appearance. Dermabrasion, chemical peels, and resurfacing lasers (e.g., carbon dioxide laser, erbium:yttrium aluminum-garnet [Er:YAG] laser) are the current mainstays of ablative facial resurfacing. Durin ablative facial resurfacing process, the epidermis is denuded to a certain depth by the direct photothermal injury. The ablative cutaneous injury induces a healing response, resulting in the deposition of a new skin matrix with improved characteristics. During the healing process, skin rejuvenation occurs by a proliferation of fibroblast activity, the action of inflammatory mediators, and a deposition of new collagen and other dermal matrix proteins.

Despite achieving appreciable clinical results, the adverse effects of ablative resurfacing mode can result in significant edema and erythema that last for several weeks. The potential for impo clinical improvements must be balanced against well-described morbidities (e.g., protracted edema, erythema), long-term sequelae (e.g., pigmentary changes), and potential complications (e.g., scarring). As such, the typical prolonged recovery times and the potential problems associated with the ablative modalities may also limit their use in patients who desire a rejuvenation procedure with reduced downtime and a minimal risk profile.

NONABLATIVE REJUVENATION

In contrast to ablative rejuvenation procedures, nonablative laser rejuvenation procedures induce a dermal healing response without notable injury to the epidermis. Improving the appearance of skin without injury to the epidermis is a hallmark of nonablative skin rejuvenation. The exact mechanism of nonablative dermal remodeling is under investigation; however, a subthreshold laser-induced injury to the dermis and/or the dermal vasculature theoretically results in a wound repair response, fibroblast stimulation, and collagen reformation.

Currently, the main nonablative laser rejuvenation modalities involve the application of mid-infrared lasers. Certain visible light lasers (VLLs), such as the pulse dye laser or the intense pulsed light have been shown to induce dermal remodeling in patients with lighter skin tones. These lasers are discussed for historical purposes in a later section of this article.

An increasing body of evidence suggests that lasers in the mid-infrared range may be the best for safe nonablative resurfacing on a wide range of skin types. This article focuses on the following mid-infrared lasers: the 1320-nm neodymium:yttrium-aluminum-garnet (Nd:YAG) laser (Cool Touch Corp, Roseville, Calif) and the 1064-nm Nd:YAG laser (Lyra, Laserscope, San Jose, Calif).

BASIC TENETS
The ideal nonsurgical rejuvenation method for the aging face is dependent on each patient's rejuvenation goals, recovery time priorities, threshold for complications, and esthetic expectations. Influencing these important factors is the physician's experience and familiarity with a particular rejuvenation modality. An ideal rejuvenation modality induces an improvement in the skin without causing injury to the epidermis.

**HISTORY OF NONABLATIVE RESURFACING USING LASERS**

Early reports in the mid to late 1990s demonstrated clinical improvement in the appearance of stretch marks treated with VLLs without significant ablation of the epidermis. Such improvement was histologic evidence of decreased coarse collagen fibers and increased elastin formation in biopsies.

Clinical and histologic improvement in the appearance of scars prompted investigators to evaluate the effect of VLLs on reducing actinically induced facial rhytids. In 1999, Zelickson noted an improvement in 9 out of 10 patients with moderate-to-severe scars treated with VLLs.

Corresponding histologic observations showed an increase in epidermal thickness and superficial elastin content. Other studies with VLLs also demonstrated clinical improvements in dyspigmentation and dermal texture. Despite achieving appreciable clinical improvement, the reported adverse effects of VLLs were uncommon, with bruising and swelling that lasted up to 2 weeks. Additionally, the affinity of VLLs for melanin linings was noted in tanned patients.

Intense pulsed light (IPL) sources were initially successful in treating solar-induced changes or skin rejuvenation effects. Some improvement at 6-month follow-up in the quality of the skin in 25 out of 30 (83%) patients with a 645-nm cutoff filter. However, blistering occurred in 3 out of 30 (10%) patients with a 532-nm cutoff filter.

In his treatment of patients with photodamaged skin, Bitter reported a success rate of greater than 75% improvement in superficial irregular pigmentation, telangiectasias, and fine wrinkles. He treated patients using a shortened wavelength (using a 550-nm cutoff filter), a short pulse width (creating less epidermal damage), and fine wrinkles. Upon histologic evaluation of skin sections, he noted formation in both the papillary dermis and the reticular dermis. Bitter also reported a high rate of improvement with no incidences of purpura; he described this finding as one of the advantages of using IPL lasers.

Despite the encouraging findings of such reports, a number of limitations exist. The disadvantages include
include the absence of an inherent skin-cooling protective mechanism, the need to learn specifically or avoid epidermal injury, and the large size of the IPL device. Most importantly, the designate strongly attracted to melanin, limiting its use in darker-skinned patients and increasing the risk of patients.

ND:YAG LASERS (MID-INFRARED RANGE LASERS)

Laser energy in the near- and mid-infrared locations on the spectrum is weakly attracted to melanin and is bypassed more efficiently, patients with all skin types can be treated with reduced risk of wavelength of the selected laser to the infrared and mid-infrared areas, deeper energy penetrates the laser energy can be delivered to the dermis. The epidermis is bypassed, and the heat that is partially nonselectively deposited in the dermis. Theoretically, heat-induced dermal injury eventually results in dermal fibroblasts and the induction of a healing response. An inflammatory response within the generated heat hypothetically initiates a reaction that leads to collagen remodeling and an improvement of facial rhytids.

Early studies with the 1320-nm Nd:YAG laser demonstrated histologic evidence of dermal collagen indicating the occurrence of a degree of dermal remodeling. However, the use of the 1320-nm cooling device produced discouraging clinical results. Moreover, the clinical risk profile of this and hyperpigmentation that occurred at a rate of 30% and 40%, respectively.

SKIN-COOLING TECHNIQUES COUPLED WITH ND:YAG LASERS

Coupling the 1320-nm Nd:YAG laser handpiece with a thermal sensor and a cooling cryogen to better control the surface temperature of the skin. The laser is able to induce greater thermal changes to fibroblasts within the papillary dermis and the mid-dermal dermis, while cooling the epidermis to reduce thermal injury.

Cooling the skin and delivering the laser pulse can be coordinated in numerous theoretical ways during, or immediately after laser pulse delivery to optimize treatment. In this manner, the temperature can increase to 60-70°C, while the temperature of the epidermal surface can be safely maintained. Clinically, effective cooling of the skin can minimize the risks of scarring and hyperpigmentation. If the surface temperature, the risk of pigment change seems to be averted, even in Fitzpatrick types.

Kelly et al were among the first to publish their experience in treating facial rhytids with the 1320-nm laser with a cryogen spray. This initial study demonstrated statistically significant improvement at 3-month follow-up, only patients with severe rhytids retained their previously observed improvements.

Pham applied the 1320-nm Nd:YAG laser with a thermal sensor and a cryogen cooling spray to skin types (Fitzpatrick skin types III, IV, and V) in Asian patients. Pham noted an improvement at 6-month follow-up in all (of 4) patients who had undergone serial (multiple) treatments. He also noted no side effects, except for transient erythema. Clinical observation did not reveal any cases of hyperpigmentation. Evaluation of biopsy specimens taken 2 weeks after treatment did not show any increase in melanin.

Pham's experience highlighted the need for a multiple treatment regimen. Of those who were treated (25%) patients demonstrated an improvement at 6-month follow-up; even the improvements of
not found to be statistically significant.

The extended pulse 1064-nm Nd:YAG laser is a safe and proven technology that has been effective in patients of all skin types and colors. Similar to the 1320-nm Nd:YAG laser, the 1064-nm wavelength is absorbed into the dermis with a minimal affinity for melanin. The advantages of this modality for wrinkle reduction are related to their technical ease of performing the procedure, minimal to no patient discomfort, and the ability to avoid the risk of epidermal injury.

Goldberg's side-by-side comparisons of perioral rhytids treated with an IPL source and the 1064-nm Nd:YAG laser showed similar improvement in rhytid reduction, with the Nd:YAG laser being better tolerated by patients. Statistically significant, patients who were treated with the Nd:YAG laser subjectively described the improvement in dermal elasticity that lasted up to 24 weeks following their final treatment.

In a recent study by Dayan et al involving 51 patients over a 4-month period, treatment with the 1064-nm Nd:YAG laser coupled to a cooling handpiece produced improvement in several skin quality parameters. This was achieved with a minimum of 7 treatments, which were spaced in 1- to 4-week intervals, with the favored interval being 7-10.

Treatments were initiated using a 10-mm handpiece at a setting of 22 J/cm^2, a 50-millisecond pulse of 2 pulses per second. These settings were chosen based on the following theoretical rationale. A threshold level for melanin follicular damage, the pulse width was extended beyond the thermal threshold for melanin (3-10 milliseconds), and the overall energy would produce enough heat for a subthreshold dermis.

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12/11/2007
Blinded physician analysis based on pretreatment and posttreatment photographs demonstrated significant decreases in coarse wrinkles, skin laxity, and overall improvement scores. Patient scores declined after 6 treatments in relation to coarse wrinkles, skin laxity, and overall improvement scores; complications were encountered, the anesthetic needs of the patients were minimal to nonexistent, and the subjects described a shallow learning curve. While improvements in photodamaged skin were subtle and not always tolerated by patients of all skin types, anesthesia requirements for the patients were minimal, with no pharmacologic intervention.

Although not part of this study, the authors reported no blister formation, prolonged erythema, or any major adverse reactions in over 500 facial treatments using the 1064-nm Nd:YAG laser. The cooling handpiece was well suited for patients who request facial rejuvenation treatments with minimal pain.

CONCLUSION

Nonablative resurfacing techniques are well suited for patients who request rejuvenating treatments. Regardless of the laser type, improvements in fine lines, wrinkles, and photodamaged skin are many and different lasers and nonlaser light sources are being investigated in an attempt to identify extended pulse Nd:YAG lasers provide particular benefits. However, both the 1320-nm Nd:YA Nd:YAG laser when coupled with a skin-cooling device are unique in that they are well tolerated. Furthermore, at this time, these treatments have been found to be safe.

Nonablative laser treatments, while desirable, have yet to replace proven resurfacing techniques and procedures for facial rejuvenation. Patients with moderate-to-severe rhytides still need surgical procedures for appreciable facial rejuvenation. Further studies and histologic evaluations are at the ideal settings to achieve long-term benefits and to minimize possible sequelae of these new modalities. Nevertheless, nonablative rejuvenation may provide an attractive alternative for those who afford the downtime of more aggressive procedures and is dissatisfied with the minimal gains of chemical peels and microdermabrasion.

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