Rejuvenation of the Aging Face Using Fraxel Laser Treatment

According to the author, Fraxel laser treatment produces the resurfacing effects of tissue removal, treats pigmentary changes, improves rhytids, and stimulates tissue remodeling. Compared with other classical approaches, it has the advantages of no recovery time, no open wound, few nonresponders, few complications, and the ability to be used in all skin types. Data confirm that improvement with this treatment is substantial but is not yet well defined quantitatively in comparison with laser resurfacing. (*Aesthetic Surg J* 2005;25:307-309.)

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Fractional photothermolysis, a novel concept for treating the sequelae of cutaneous photoaging, creates a pattern of microscopic zones of tissue coagulation that heal over several weeks while the skin retains a normal appearance. Fraxel laser treatment (Reliant Technologies, Palo Alto, CA) uses fractional photothermolysis to achieve its clinical effect. Rather than creating a global tissue effect at the surface of the target tissue, or in the dermis alone, this treatment creates injury in a tiny fraction of the skin treated, coagulating multiple columns of tissue, 70 to 100 μm in diameter, extending through the epidermis and deeply into the dermis.

Even though the epidermis in these microthermal zones (MTZs) is coagulated, it remains intact, leaving no raw surface. The large volume of normal tissue surrounding the MTZ on all sides provides a generous reservoir of source cells for healing. Over several weeks the body extrudes the coagulated tissue, replacing it with new healing tissue. Since this process is invisible to the naked eye, there is no downtime. Over the course of multiple treatments, in a piecemeal fashion, most of the skin surface is replaced. The appearance of rhytids, scars, varied pigment irregularities, and vascular lesions is improved after each treatment with a Fraxel laser. Treatment is usually offered in a series of 4 weekly visits.

This fractional approach is a revolutionary means of effecting tissue removal without an open wound or recovery time. It produces the predictable resurfacing effects of tissue removal, treats pigmentary changes such as solar lentigines, improves rhytids, and stimulates tissue remodeling—all with no recovery time. Conceptually, this seems to be a safe, desirable approach to treating photodamaged skin. This rapidly evolving technology is claimed to produce a clearly visible clinical result without a significant number of nonresponders; preliminary clinical data confirm these results. The significance of this treatment can better be appreciated by understanding how it evolved (Table).

The Fraxel Laser

The Fraxel Laser is a 1540-nm glass fiber laser producing subablative pulses of light that range from 6 to 20 mJ. A computerized handpiece is used to scan the laser pulses across the treatment surface, depositing a fixed pattern of pulses, either 125 or 250 pulses per square centimeter in each pass. A tracking system follows the operator-directed motion of the handpiece over the skin and alters firing of the laser to maintain the desired pattern within a reasonable range of speed. The laser light is delivered to the handpiece through a metal-armored fiberoptic cable. A disposable tip is placed on the distal end of the handpiece, containing a sapphire window designed for contact with the skin. Each tip is programmed to allow 100 minutes of use to prevent degradation of the optical characteristics of the tip from repeated laser exposure or mechanical damage during skin contact.

The Tissue Effect

The 1530-nm wavelength is a mid-infrared wavelength of light, largely absorbed by intracellular and extracellular water in the skin, similar to the way that the light from resurfacing lasers is absorbed. This is not a wavelength at which there is high absorption of hemoglobin or

Background and history

Peels and dermabrasion

Classical approaches to the treatment of rhytids include chemical peels and dermabrasion, which remove the skin surface in the treated area. With these modalities, both the tissue removal and the healing response to the wound that is created contribute to the improvement.

Carbon dioxide laser

Carbon dioxide laser resurfacing provided greater predictability in the depth of tissue effect.[2] Refinements in the laser parameters and improved clinical management further reduced recovery time and healing complications.

Erbium: YAG

The subsequent introduction of Erbium:YAG (Er:YAG) resurfacing provided a more superficial peel. Based on the parameters that were initially used, Er:YAG resurfacing was almost completely ablative, having minimal underlying coagulated tissue compared with carbon dioxide laser resurfacing. Clinical observations indicated that although recovery time with Er:YAG was minimized, improvement in rhytids was significantly reduced. Higher energy Er:YAG treatments produced more thermal injury and a greater degree of clinical improvement, approaching that of CO_2 resurfacing.[3,4] Subsequent study revealed that a significant component of the mechanism of improvement in rhytid depth was the result of the healing response of the body to thermally altered collagen.[5,6]

Nonablative Laser

This "remodeling effect" was eagerly sought after, but without loss of epithelium and significant recovery time that occurred with laser resufacing. Strategies to heat the mid-dermis while cooling the epidermis with cryogen spray or contact cooling devices became known as nonablative laser remodeling, marketed as CoolTouch (CoolTouch, Roseville, CA) and Smoothbeam (Candela, Wayland, MA) among others.[7,8] The thermally damaged collagen stimulated a healing response and deposition of new collagen, with a remodeling effect on rhytids. This process required 1 or more treatments and a delay of several months before the clinical effect became apparent. It avoided downtime, there was no loss of epithelium (only mild erythema), and patients were able to immediately return to normal activities.

Nonablative remodeling was a triumph in that it avoided recovery time and the complications associated with laser resurfacing. Unfortunately, the degree of clinical improvement was modest and much less predictable than with laser resurfacing. The reason for this is not difficult to understand. Laser resurfacing or other peeling techniques have 2 components that contribute to clinical improvement: (1) tissue removal that occurs at the time of the treatment, and (2) the remodeling effect of the body's response to the wound. Tissue removal is predictable, with only minor variation from person to person, producing a clinical improvement that can be consistently generated with the same laser parameters. The remodeling response is not at all like this. A high degree of variation can be expected, depending on age, skin type, degree of pre-existing photodamage, and genetics. The delay in seeing the results of the treatment adds to the uncertainty, frustration, and difficulty in studying and refining these therapies. In addition, because tissue is not removed, epidermal pigment problems are not treated at all. Attempts to improve the degree and consistency of clinical response by increasing the amount of energy transferred into the skin did not amplify the clinical remodeling effect, but produced a higher incidence of complications.

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melanin (the other main chromophores targeted in other light-based skin therapies).

The penetration of light into the skin is much deeper than with carbon dioxide or Erbium:YAG (Er:YAG) laser wavelengths. Each pulse of laser light fired into the skin creates a column of coagulated tissue, extending from the surface of the epidermis into the dermis. The energies used in each pulse are below the threshold of ablation, creating no tissue vaporization. An exposure area of 50 to 70 μm results in an MTZ about 100 μm in diameter and extending to a depth of 350 to 750 μm, depending on the amount of energy used per pulse.

With multiple passes, the total number of MTZs produced can vary. For example, 2 horizontal and 2 vertical passes at 50% overlap will produce 2000 MTZ/cm^2 with a 250-MTZ/cm^2 treatment setting. This represents a total treatment area of about 17% of the skin. The MTZs are slowly extruded over a period of 2 to 3 weeks. This is replaced with healing tissue and new collagen.

Administering Fraxel Laser Treatment

Administer Fraxel laser treatment as a series of 4 to 6 treatments spaced at 1- to 2-week intervals. Exfoliate the area to be treated with an abrasive scrub, clean it with isopropyl alcohol, and stain it with the water-soluble blue dye furnished with the disposable handpiece tips. Then apply a nonaqueous topical anesthetic gel. After the interval recommended for the particular gel selected, perform the laser treatment through the topical gel.

Treatment of the face and neck requires about 15 minutes. The treatment sensation is one of warmth and prickling. Most patients are able to tolerate moderate energy treatments, such as 12 mJ/pulse, although anesthesia can be augmented with oral agents such as ketorolac, naproxen or oxycodone/acetaminophen. Following treatment, wash off the anesthetic gel and blue dye and apply a protective moisturizer.

Clinical Results

Patients have a sunburned appearance and experience the sensation of sunburn after the treatment; this sensation may persist up to several hours. Erythema abates within 24 hours, although in an occasional patient it may persist up to 2 to 3 days. Mild swelling or occasional petechiae may result at higher treatment settings, particularly in the periorbital areas. Clinical improvement can be assessed 3 weeks after the last treatment in the series. Anecdotal reports of skin tightening, manifesting over several months of subsequent recovery, have not yet been confirmed or quantified. Significant reduction in rhytid depth, pigmentary irregularities, and vascular lesions, such as rosacea and telangiectasias, are the anticipated results.

The most extensive study to date evaluated 30 patients who received 4 weekly treatments in the periorbital region.[1] An average improvement in wrinkle score of 18% was found comparing pre- and post-treatment photographs. Interestingly, 90% of patients had clearly visible improvement in the rhytids. All patients were able to return to work the day after the treatment. Mild erythema was seen for several days, but there was no scarring or blistering.

In my experience, rhytid improvement seems to be somewhat less than that obtained with a deep laser resurfacing, but improvement is enough to be clearly visible. I have not encountered nonresponders. As of this writing, additional work from a number of investigators is scheduled for presentation at national scientific forums. A number of new indications are being investigated, including melasma, which has been reported to respond to Fraxel laser treatment (R.R. Anderson, Director, Wellman Laser Laboratory, Massachusetts General Hospital, personal communication, January 2005).

Current Status of Fraxel Laser Treatment

The Fraxel laser is currently FDA-approved for the treatment of periorbital rhytids, photocoagulation of pigmented lesions (including but not limited to lentigos and dyschromias), and for dermatological procedures requiring soft tissue coagulation. Use of the laser for nonperiorbital rhytids is off label. A variety of additional indications, including melasma, rosacea, acne scars, large pores, active acne, and striae, are being investigated.

Despite the very recent introduction of Fraxel laser treatment, there are data confirming its ability to produce significant improvement that approaches, although currently does not match, that of laser resurfacing. Fraxel treatment eliminates an open wound, significant recovery time, and months of waiting for remodeling. There is also no significant incidence of nonresponders such as is seen with nonablative therapies. In addition, the ability to treat pigment and vascular conditions as well as rhytids makes fractional photothermolysis "one stop shopping" for reversal of facial photoaging. The low incidence of complications, including hyper- and hypo-pigmentation, allows use in all skin types and permits treatment of the neck, chest, and hands—areas that have responded poorly to resurfacing modalities. Further investigation and development will no doubt provide improvements in this fledgling technology, which will expand its capability and define its performance. Additional data are needed to corroborate currently available findings and to unlock the full potential of this emerging treatment modality. ■

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