



# Fractional Resurfacing

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Traditional modalities for treating photoaging, such as ablative laser resurfacing and chemical peels, offer predictable and positive results when performed by experts; however, because of the significant cost and downtime associated with these procedures, less invasive approaches have become more common recently. Nonablative laser and light devices have often yielded inconsistent results. A new concept in skin rejuvenation—the Fraxel™ SR laser, which applies the concept of fractional resurfacing—was introduced in 2004. Dr. Rox Anderson, one of the creators of the Fraxel SR, describes the laser's performance as analogous to the repair of a digital photograph, pixel by pixel. Similar to the technique of editing a digital photograph composed of pixels, Fraxel laser treatment precisely produces thousands of tiny columns of treatment zones invisible to the naked eye that target flawed skin and leave surrounding healthy skin untouched (R.R. Anderson, oral communication, October 2001).

## How Fractional Resurfacing Works

Fractional resurfacing is a new approach using a near infrared light beam to deliver a high-energy, highly collimated spot through a fiber laser that produces a distinct column of tissue necrosis smaller than what is visible to the naked eye.<sup>1</sup> The Fraxel SR system uses a 1550-nm diode-pumped Erbium fiber laser delivered through an optically tracked microprocessor-controlled handpiece to produce an array of microscopic thermal zones. Each of these microscopic thermal zones is extremely thin (about 100  $\mu\text{m}$  in diameter) and 400 to 700  $\mu\text{m}$  deep. These precisely created wound columns produce localized epidermal necrosis and collagen denaturation. The optimal distance between individual lesions treated with Fraxel SR is 200 to 300  $\mu\text{m}$ , which minimizes injury because it permits survival of the stem cell–laden hair bulge at the preserved hair follicles. This bulge is where the cutaneous regeneration process begins.<sup>1</sup>

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The technique produces microscopic epidermal and dermal columns of thermal injury in microscopic thermal zones delivered densely in column-shaped lesions of small diameter.<sup>2</sup> While energy levels for the Fraxel SR system can range between 5 to 20  $\text{J}/\text{cm}^2$ , lower fluences of 1 to 3  $\text{J}/\text{cm}^2$  can be used for regeneration similar to what is seen with an Erbium:YAG laser. Initial investigations used a 1500-nm laser at pulse durations of 1.5 to 5.0 milliseconds and fluences of 1.5 to 3.0  $\text{J}/\text{cm}^2$  to lay down arrays of very small spots with spacing of 250  $\mu\text{m}$  in microscopic treatment zones. Reepithelialization was complete within one day. Immediate histological analysis revealed an intact stratum corneum overlying a column of necrotic debris adjacent to a column of completely uninterrupted untreated skin. Three months after treatment ended, histology revealed enhancement of the rete ridge pattern and increased dermal mucin suggestive of neocollagenesis.<sup>2</sup>

## Fractional Versus Traditional Resurfacing

Traditional resurfacing modalities ablate the entire skin surface. The entire epidermis is destroyed in the process and creates a denuded skin surface with the effect of impaired barrier skin function. Unlike  $\text{CO}_2$  laser skin resurfacing, in which the ablated epidermis and upper papillary dermis are removed yielding semi- to full-thickness wounds (which translates clinically to crusting, swelling, oozing, and erythema that last for 1 to 2 weeks), fractional resurfacing involves only erythema, and healing occurs in a matter of days rather than weeks.<sup>3</sup> The isolated noncontiguous microthermal wounds are surrounded by zones of viable untreated tissue, which facilitates quicker healing. The process requires some form of anesthetic; the degree of pain is directly proportional to the density of pulses and number of passes. Current protocols include pretreatment with benzodiazepines, intramuscular meperidine, and topical 30% lidocaine, as well as aggressive skin cooling.

Fractional resurfacing, by contrast to traditional methods, only treats a small part of the skin, leaving intact undamaged skin around each treated area to act as a barrier and a reservoir for rapid healing. Undamaged cells rapidly migrate to the microscopically damaged area and expedite healing of the wounded area. Histological



Patient with extensive actinic damage on the right side (A) and left side (B) of the face before treatment, and 14 days after 4 treatments with the Fraxel™ SR laser (C and D). Each treatment was spaced approximately 2 weeks apart. (Photographs courtesy of Roy Geronemus, MD, Laser & Skin Surgery Center of New York.)

examination has shown that the rapid process of epidermal healing is attributed to keratinocyte migration into the defect. The debris from the epidermal wound forms a column of microepidermal necrotic debris (MEND). During each treatment, millions of these microscopic MEND areas are created; however, because the bulk of the skin is undamaged, rapid healing can occur.

The Fraxel SR device targets water as a chromophore. As a result, the epidermis is protected because of its low water content. Clinically, the epidermis has a mildly bronzed appearance, although its barrier function is preserved. Healing of the dermal component seems to lack an inflammatory phase, especially at lower densities; however, histological examination supports mild collagen remodeling and skin tightening. Although the absorption of melanin by near and mid infrared laser wavelengths is poor, there seems to be

a controlled melanin release with resultant concentration of melanin in the MEND, which is subsequently shed. The exact mechanism of this “melanin shuttle” is unknown.

### Treatment Protocol

The Fraxel SR laser treats about 20% of the skin with each session. Additional treatments may be spaced as close as a week apart, for a total of 4 to 6 treatments (Figure). Further collagen remodeling and some skin tightening occur over the next 2 to 3 months.

### Indications

The Fraxel SR laser first received clearance from the US Food and Drug Administration (FDA) in 2003 for soft tissue coagulation and in 2004 for correction of periorbital

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wrinkles and pigmented lesions, including age spots, sun spots, and skin discoloration. Fraxel SR subsequently received FDA clearance for skin resurfacing earlier this year. Most recently, FDA approval has been granted for the treatment of melasma. Current applications under investigation include treatments for acne scarring, and anecdotal reports continue to describe novel applications for the technology including a number of uses on non-facial skin. Most reports show a side effect profile involving principally transient postinflammatory hyperpigmentation. All evidence, to no great surprise, suggests that most side effects are highly operator dependant.

## Comment

With the Fraxel SR, the laser surgeon has a new tool to address significant aesthetic skin concerns such as photoaging, actinic damage, and melasma. The Fraxel SR laser is not an ideal treatment for patients with strictly vascular issues such as diffuse erythema, rosacea, or telangiectases or for those with severe skin laxity. In these cases, treatment with a pulsed dye laser and/or intense pulsed light, as well as traditional face lifting techniques is more appropriate. Although work continues to be done to optimize efficacy, patient selection, and the most effective parameters (ie, settings, density, number of passes and treatments, and treatment intervals), the Fraxel SR laser is a truly novel and exciting addition to the laser surgeon's armamentarium.

## References

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## Suggested Readings

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