

# The Case for Nonablative Laser Resurfacing

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**T**raditionally, wrinkles could be improved using cosmeceuticals, retinoids, chemical peels, dermapeels, botulinum toxin (best for kinetic wrinkles), dermabrasion, Er:YAG, and CO<sub>2</sub> resurfacing (the gold standard). The recent advent of nonablative lasers adds a new medium for wrinkle treatment. The idea behind their use is a good one: improve the dermis, which serves as the scaffolding for the epidermis, and that in turn will translate into a smoother surface. To understand how the nonablative lasers claim to work, we must first understand the effects of aging on the dermis.

## The Effects of Aging on the Dermis

In a recent article, we reviewed the effects of intrinsic aging and photoaging on the skin and the various treatment modalities to fight the aging process.<sup>1</sup> In order to understand how and why the nonablative lasers would work, we need to examine what transpires in the dermis as we age, on the molecular level, and how that leads to wrinkle formation. We can then ask ourselves if these changes can be targeted and improved by these lasers.

The most significant changes seen with aging occur in the dermis. The dermis provides elasticity, pliability, and tensile support to the skin. The 3 most important components in the dermis allowing it to maintain its function are collagen, comprising about 75% of the skin's dry weight, the elastic fibers found around adnexal structures and permeating the dermis from the dermal-epidermal junction (DEJ) to the hypodermis, and glycosaminoglycans and proteoglycans forming a gel-like sponge attracting water and providing the dermal "ground substance."<sup>2</sup>

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## Collagen

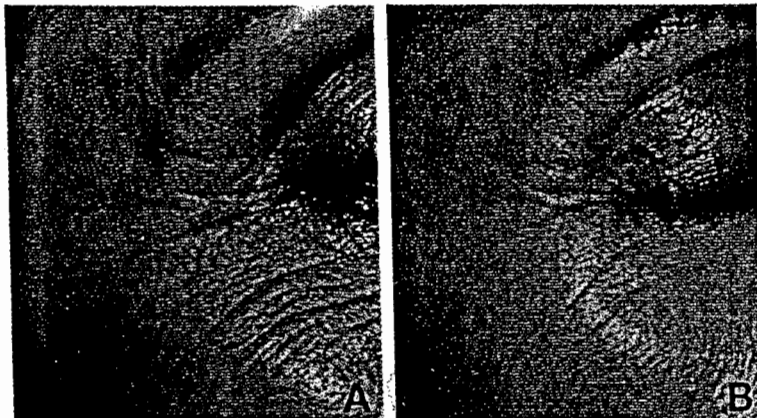
As we age, each year we lose about 1% of our dermal collagen. The most common collagen type in the dermis is type I — 80%, followed by type III — 10%.<sup>2,3</sup> After collagen is synthesized by fibroblasts and excreted into the extracellular space, the carboxy and hydroxy terminals are cleaved off, the molecules then spontaneously aggregate into fibers which then undergo covalent cross-linking. The cross-linked collagen is functionally mature collagen. It is degraded by collagenases. Collagenases are stimulated to break down the collagen primarily by ultraviolet radiation (UVA). Other important collagenase activators include sulfhydryl agents; a variety of proteolytic activators; IL-1 and other monocyte activators. Collagenases can be inhibited by calcium chelators, corticosteroids, and retinoids (inhibit collagenase synthesis).<sup>3,4</sup> Anchoring fibrils are decreased in photodamaged skin, and their decrease is hypothesized to be responsible for increased wrinkle formation; an effect partially reversed with retinoids.<sup>3,4</sup>

## Elastic Fibers

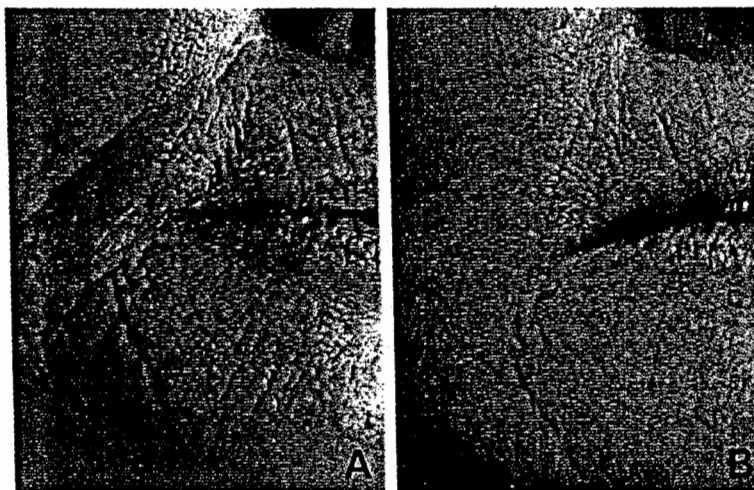
Elastic fibers are first synthesized into a microfibrillar framework onto which further elastin is deposited. It comprises 2% of the total protein in the dermis. These fibers help the skin return rapidly to its normal configuration after being stretched or deformed, thus explaining why sagging, fine wrinkling, and skin laxity become more pronounced with age. Elastic fibers usually undergo a slow turnover. This turnover can be accelerated by ultraviolet radiation (UVA and UVB) through the induced increased synthesis of elastin.<sup>2,4</sup>

The third component is the glycosaminoglycans and proteoglycans. These can bind up to a thousand times their volume in water. They thus help regulate the dermal water binding capacity and thereby its volume and compressibility. They are involved in mediating cell adhesion, migration, development, and differentiation.<sup>2</sup> As we age, there is a decrease in synthesis of these components which results in decreased water content in the dermis, accentuating the lustless appearance of aged skin.<sup>4</sup>

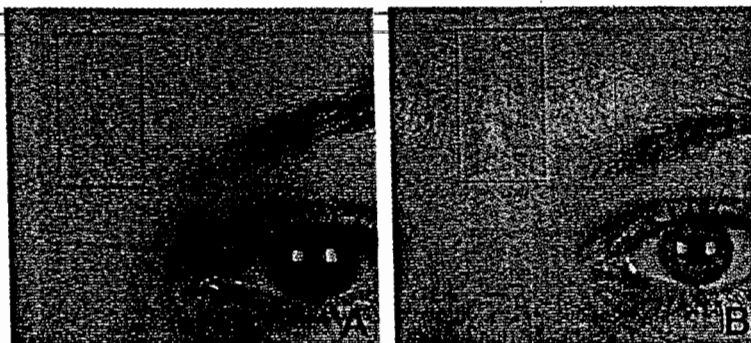
The cells that help produce the earlier mentioned substances are the fibroblasts. Unfortunately, the number of



**Figure 1.** A) Pretreatment. Notice the depth and extension of this patient's crows feet. B) Two months after a single treatment with NLite nonablative laser. The wrinkles are less deep and disappear beyond the orbital rim.



**Figure 2.** A) Pretreatment. B) Three months post single treatment with NLite nonablative laser. Many of the smaller wrinkles have softened in depth and are smoother in appearance.



**Figure 3.** A) Pretreatment. Notice the depth of a glabellar scar line from trauma. B) One month post single treatment with NLite laser. An improvement is noted in the depth and texture of the scar (subjectively softer). All photos courtesy of NLite.

fibroblasts decreases with age. As they age they become senescent and have been shown to underexpress procollagen, overexpress collagenase, and undersynthesize elastin. These effects of intrinsic aging hurried by photoag-

ing result in increased collagen degradation and decreased elastin production, culminating in the clinical and histological signs of aging.<sup>2</sup>

### Dermal Injury

We know that the best way to stimulate healing is to cause an injury. To allow for a nonablative injury to take place, one must injure the dermis while sparing the epidermis. For this to occur a chromophore not found in the epidermis must be targeted (such as hemoglobin) or the epidermal chromophore must be somehow shielded from the effects of the incident light (eg, epidermal cooling); in essence allowing the laser light to "skip" the epidermal chromophore and stimulate a controlled injury in the dermis through absorption by the dermal chromophore (eg, water targeted by the long pulse Nd:YAG 1320 nm Cooltouch, the IPL has a nonspecific target and is believed to try to exert its effects through the 1320 nm or 585 nm, or both wavelengths).

The 585-nm Pulsed Dye Laser (PDL) has long been used to treat keloids, hypertrophic scars, and burn scars.<sup>5</sup> It was discovered that the scars improved more when a lower fluence was used, and so an attempt was made to garnish all the parameters in that laser that mediates the observed improvement, discard the unnecessary additions, and make a simple "leaner and meaner" scar/wrinkle fighter, ie, the NLite.

A similar fortuitous observation was noted during hair removal using the long pulse Nd:YAG and for poikiloderma and melasma with the intense pulse light (IPL). The NLite is a PDL with a 585-nm wavelength with its parameters changed to include a shorter pulse duration (350  $\mu$ sec as opposed to 450  $\mu$ sec with the regular PDL), lower fluence, and different pulse shape; all manipulated with the idea to injure—without destroying—smaller blood vessels in the papillary dermis.

This injury in turn is believed to result in the local release of inflammatory mediators, which stimulate the surrounding fibroblasts to produce collagen (Figure 1–3).

The Nd:YAG laser emits at 532 nm (frequency doubled), 1064 nm, and at 1320 nm. The 1320-nm Nd:YAG has been introduced as Cooltouch (Cooltouch NS130; Laser Esthetics Inc., Auburn, California) and recently modified with a higher fluence and larger spot size. It is believed to work by targeting water in the dermis, thus heating

the surrounding dermal collagen with resultant injury to the collagen that in turn stimulates collagen remodeling. The absorption of the 1320-nm wavelength by water in the dermis is based on the wavelength nonselective tissue absorption, along with its strong scattering in all directions.

The epidermis is spared through epidermal cooling with a cryospray that has been made simple by self-programming its duration and lag period in relation to the laser pulse. The laser handpiece in contact with the skin has an infrared sensor giving real time skin surface temperature reading.

Normal body temperature is up to 37°C. The cryogen spray is programmed to allow each pulse to result in maximal epidermal temperature that does not exceed 40°C (to avoid epidermal injury), while allowing the dermis from the papillary layer to the "mid-dermal" layer to heat to about 70°C. For reference values, it is important to note that 57°C is the minimum temperature needed for direct collagen stimulation, at 65°C protein degeneration takes place. The latter temperature is believed to stimulate new collagen formation and remodeling, a threshold also known as controlled residual thermal damage (RTD).

### Biochemical Studies

An experiment designed to test the NLite theory was devised with 10 volunteers having 2 areas treated with the NLite laser. One area had a single treatment, the other had 2 treatments 5 minutes apart. A nontreated area served as the control. Suction blisters were raised 3 days later and the fluid in the subepidermal bullae was examined for the presence of the N terminal propeptide (an indirect measure quantifying the amount of collagen produced by fibroblasts).<sup>6</sup> The result showed an 84% increase in collagen production at the site treated once and only 50% increase at the site treated twice, as compared to the nontreated control. It was thus decided that pulse overlap is counter-productive and currently a retreatment, when done, is performed at a 2-week interval.<sup>5</sup>

### Clinical Studies of Cosmetic Efficacy

The next logical step is to put the tool to the clinical test. A silicone imprinting, coupled with a profilometry assessment of wrinkles on a patient's face, was taken before treatment. During the treatment, the surface temperature at the epidermis was recorded and found to be at 36°C, far below the temperature needed to cause epidermal injury.

At 6 months after the treatment, the silicone imprint was repeated and compared to the original. A 55% reduction in the depth of the original wrinkles was noted.<sup>6</sup> A similar study performed with the Cooltouch showed no improvement following 1 treatment and some minimal improvement 2 months following the second treatment.<sup>7</sup>

Another study was done where blinded observers were shown photographs of patients before and 6 months after

either NLite or CO<sub>2</sub> resurfacing and asked to rank the degree of wrinkle reduction. The CO<sub>2</sub> to NLite improvement in the mild, moderate, and severe wrinkle groups was 1.57 to 0.8, 2.57 to 2.29, and 2.25 to 1.88, respectively. It was thus concluded that the NLite improvement is most noticeable in patients with moderate wrinkles where the improvement was 89% of that seen with the CO<sub>2</sub> resurfacing.<sup>6</sup>

While multiple questions remain unanswered regarding this and other studies, many of which are sponsored by the companies selling the lasers, one important question is: what are the long-lasting results and were the patients satisfied? Some physicians report dissatisfied patients and doctors.<sup>8</sup> These frustrations may be due to a myriad of reasons. Since improvement with all the nonablative lasers is continuous but subtle, the gradual improvement that occurs over a 6- and even 9-month period following each treatment is harder to appreciate when compared to the quick response seen following CO<sub>2</sub> laser resurfacing or Botox. The laser companies will also blame patient dissatisfaction on using the "older generation" laser, with an "older" protocol, or on the patient population selected, and on a lack of "good" pretreatment photographs. Still, it is possible that the dissatisfaction stems from the disparity between the expected results and the achieved results, the cost-to-benefit ratio observed by the patient and doctor, and maybe the lasers simply don't work as well as they are claimed to work.

### Consultation and Physical Exam

A detailed examination of the area of interest for the patient is done. Specific notations on the different locations and changes of both intrinsic aging and photoaging must be recorded.<sup>1</sup> A sense must be established as to the cosmetic goals of the patient. Different treatment options can be used to target various aspects of aging.<sup>1</sup> This should be reviewed with the patient as it relates to the cost and expected improvements. Risks of the procedures, their limitations, and alternatives should be outlined. Once realistic expectations are established and the treatment modality best fitting the desired outcome and anticipated downtime is selected, a thorough history and physical exam should be performed to assess for any risks or contraindications to the procedure. Relative contraindications for IPL treatment would be hyperpigmentation at the treatment area or patient with skin type IV or higher. Both NLite and the newer version of the 1320-nm Nd:YAG (Cooltouch II) are presumably safe and have no contraindications.

### Operative Technique

The patient is asked to remove any makeup gently with a nonalcohol-based cleanser in order to avoid epidermal inflammation. Polaroid pictures and/or digital pictures of the

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treatment areas are taken. The skin changes to be targeted are then outlined. The selected skin area is then treated with the nonablative modality chosen. When using the NLite, a test spot preauricularly with 3 J/cm<sup>2</sup> and 2.8 J/cm<sup>2</sup> is first performed. The test spot is assessed 1 to 2 minutes later for the presence of purpura, which reflects unwanted vascular damage. The higher fluence that doesn't cause purpura is then selected for the skin treatment. When treating the face, a 1 mm to 0.5 mm space between spots is maintained in order to avoid overlap. The entire face can be treated in 3 minutes. The most the patient feels is a warm sensation. The Cooltouch II does not require a test spot but is more painful (the patient senses a sharp prick or sting-like sensation with each pulse); this sensation can be ameliorated with the use of prior local or topical anesthesia. The IPL has a mild warm to slight stinging sensation (depending on the fluence used) and takes about 20 minutes to treat the entire face. The side effects for the newer NLite are none; literally the worst you can end up with is purpura (if the fluence is inappropriately selected, see test spot above).

The NLite machine is easy to operate, especially for anyone who used any laser before. While the older Cooltouch had reports of skin crusting even in skin types not higher than III,<sup>7</sup> the newer Cooltouch II is reportedly safe for all skin types. One has to be sure that the cryogen spray and the skin temperature sensors do not malfunction, as this may result in scarring.<sup>7</sup> The Cooltouch II is easy to operate but takes about 4 times as long as the NLite to treat an area. The IPL should be used with a cooling gel and or topical numbing to make the procedure more comfortable for the patient, as well as to decrease the chance of epidermal sloughing. For best results, a 550-nm cutoff filter, shorter pulses, and lower fluence are recommended.<sup>9</sup> The older IPL machine was very complicated with many parameters to maneuver, which made it highly operator-dependent with a high chance for variability in efficacy. It has since been modified and is currently marketed in the more predictable/user friendly mode (the light source and the filters have not been changed).<sup>9,10</sup> There are no postoperative instructions with the NLite and Cooltouch II, and patients can immediately apply their makeup and go on their usual business. Depending on the parameters used with the IPL, more caution is advised to prevent postinflammatory changes and epidermal sloughing.

## Discussion

The nonablative laser wrinkle reduction systems have tapped into an important need in our baby boomers by offering minimal to no downtime. Still, their advertised improvement that claims to rival that of CO<sub>2</sub> resurfacing is found desperately wanting. While some results can be seen after 3 to 6 months, in most cases one needs to examine the earlier photographs to appreciate the changes, which are usually very subtle. If one decides to use the nonablative

lasers for wrinkle reduction, it is our opinion that the NLite and the Cooltouch II work better than the IPL in achieving it. The treatment—when performed—is best appreciated when done in conjunction with a superficial epidermal peeling such as microdermabrasion<sup>11</sup> or superficial chemical peel<sup>12</sup> and Botox. When one examines the pathophysiology of aging, it is true that collagen is extremely important in the scheme of wrinkle production, but it is only one part in a larger picture which one cannot justify simplifying. Even if these lasers would be able to stimulate extra collagen production, their improvement also depends on the degree of fibroblast senescence, and the concentration of proteoglycans, glycosaminoglycans, and elastin in the skin. To better assess these factors and the reported efficacy of the various lasers, more studies should be performed comparing the lasers to each other and their action in different age groups, and on the different components of the dermis.

As we continue to take brave strides into a new and uncharted era, we will encounter new treatments for cosmetic problems. It is important to maintain our image as trustworthy pioneers rather than eager marketers, as the public's trust is hard to gain but easy to lose. We must scrutinize the data provided before we rush to embrace new technology, separating science from fiction; and if it sounds too good to be true... it probably is.

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