COMMENTARY

# Effects of Long-Pulsed 1,064-nm Neodymium-Doped Yttrium Aluminum Garnet Laser Therapy on Dermal Collagen Remodeling

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There is an ever-expanding body of clinically oriented literature that demonstrates the efficacy of photorejuvenation as a means of enhancing the appearance of skin.[1–5] From traditional fully ablative laser resurfacing to nonablative laser therapy to fractionated photothermolysis, there is substantial evidence of efficacy, including a number of randomized, controlled trials. There have also been several attempts to objectively measure the effects of laser therapy using tools such as ultrasound-based imaging, profilometry, histology, and three-dimensional imaging.[6–9]

Almost as important as proving that a specific treatment is clinically effective is to determine how that procedure brings about changes in the appearance of skin. Sophisticated cellular and molecular biology techniques including real-time polymerase chain reaction technology are now being applied to the study of the effects of laser therapy on photodamaged skin.[10–13] The value of taking such a mechanistic approach to studying photorejuvenation is at least twofold. First, the resulting quantitative data are a purely objective way to demonstrate and validate the notion that lasers bring about substantial changes in the structure and function of skin. This is perhaps most important with less-invasive procedures in which truly objective evidence of efficacy may be more powerful than purely clinical but often inherently subjective assessments. Second, studying the molecular mechanisms whereby lasers alter skin may serve as the basis for optimization of laser treatment parameters and protocols. Evaluating objective, quantitative data that measures molecular dermal and epidermal changes brought about by various different laser settings may suggest treatment protocols that bring about the greatest amount of clinical change possible with a given device. Given the plethora of programmable laser settings available with many of the most commonly employed devices, determining optimal treatment parameters is a daunting task indeed.

There have been some attempts over the past decade to delineate the mechanisms of photorejuvenation. Although that research is ongoing, an emerging paradigm suggests that, generally speaking, laser therapy results in an initial inflammatory stage marked by elevated levels of various cytokines, followed by dermal remodeling, including induction of several important matrix metalloproteinases, and finally upregulation of collagen.[10,13] The details of the timing and degree of these molecular events vary substantially between laser subtypes, but the basic framework of the controlled wound healing that results from photorejuvenation has been demonstrated to be fairly consistent across a variety of treatment techniques.[10–13]

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In this issue of *Dermatologic Surgery*, Lee and colleagues have reported on their examination of the molecular events that occur after long-pulsed neodymium-doped yttrium aluminum garnet (Nd:YAG) laser therapy.[14] Their study included quantification of matrix metalloproteinase-1 and transforming growth factor beta (TGF-β) levels and a semiquantitative assessment of dermal collagen induction. The authors are to be applauded for their attempt to further delineate the mechanisms involved with this type of photorejuvenation even as their study underscores many of the challenges inherent to this type of work. As noted, dermal remodeling is a dynamic process requiring evaluation at multiple timepoints to provide a clear picture of the mechanistic events involved. Thus, the results reported here simply provide a snapshot of dermal remodeling occurring at a particular moment (1 month) after treatment and may serve as the basis for additional work in this area. In addition, as the authors point out, it is unclear the degree to which their model for inducing photodamage using ultraviolet light exposure over a brief time mirrors the kinds of changes seen in chronically sun-exposed skin, nor is it possible to know at this point how well murine skin serves as a model for human skin in this context. Still, the finding of an association between TGF-β and collagen induction after exposure to this laser is in keeping with the idea that TGF-β may play a crucial role in laser-based dermal remodeling, as suggested by previous work.[10] Finally, the authors' evaluation of dermal remodeling after the use of varying fluences is precisely the type of approach that may one day help determine optimal treatment parameters with this laser system.

It is likely that laser therapy will continue to play an important role in the treatment of many of the clinical signs of photoaging in the years to come. As therapeutic options to improve the appearance of skin evolve, a great deal of clinical, basic, and translational research will be required to ensure that we are providing optimal treatments for our patients.

## References


1. Ratner D, Tse Y, Marchell N, Goldman MP, et al. Cutaneous laser resurfacing. J Am Acad Dermatol 1999;41:365–89.
2. Ciocon DH, Hussain M, Goldberg DJ. High-fluence and high-density treatment of perioral rhytides using a new, fractionated 2,790 nm ablative erbium-doped yttrium scadium, gallium garnet laser. Dermatol Surg 2011;37:776–81.
3. Alster TS, Tanzi EL, Lazarus M. The use of fractional laser photothermolysis for the treatment of atrophic scars. Dermatol Surg 2007;33:295–9.
4. Wanner M, Tanzi EL, Alster TS. Fractional photothermolysis: treatment of facial and nonfacial cutaneous photodamage with a 1,550-nm erbium-doped fiber laser. Dermatol Surg 2007;33:23–8.
5. Zelickson B, Kilmer S, Bernstein E. Pulsed dye laser therapy for sun damaged skin. Lasers Surg Med 1999;25:229–36.
6. Friedman P, Skover G, Payonk G, Geronemus RG. Quantitative evaluation of nonablative laser technology. Seminars in Cutan Med Surg 2002;21:266–73.
7. Moody B, McCarthy J, Hruza G. Collagen remodeling after 585-nm pulsed dye laser irradiation: an ultrasonographic analysis. Dermatol Surg 2003;29:997–1000.
8. Goldberg D, Tan M, Sarradet M, Gordon M. Nonablative dermal remodeling with a 585-nm, 350-μsec, flashlamp pulsed dye laser: clinical and ultrastructural analysis. Dermatol Surg 2003;29:161–4.
9. Goldman M, Rostan E, Payonk G. Quantitative assessment of rejuvenated skin using biomechanical characterization and three-dimensional microtopography. Lasers Surg Med 2001;28:30.
10. Orringer JS, Kang S, Johnson TM, Karimipour DJ, et al. Connective tissue remodeling induced by carbon dioxide laser resurfacing of photodamaged human skin. Arch Dermatol 2004;140:1326–32.
11. Orringer J, Voorhees J, Hamilton T, Hammerberg C, et al. Dermal matrix remodeling after nonablative laser therapy. J Am Acad Dermatol 2005;53:775–82.
12. Orringer JS, Hammerberg C, Hamilton T, Johnson TM, et al. Molecular effects of photodynamic therapy for photoaging. Arch Dermatol 2008;144:1296–302.
13. Orringer JS, Rittie L, Baker D, Voorhees JJ, et al. Molecular mechanisms of nonablative fractionated laser resurfacing. Br J Dermatol 2010;163:757–68.
14. Lee BY, Kang NH, Eun YS, Cheon MS, et al. Effects of long-pulsed 1,064-nm neodymium-doped yttrium aluminum garnet laser on dermal collagen remodeling in hairless mice. Dermatol Surg 2012;38:985–92.


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