

1,927-nm Fractional Thulium Fiber Laser for the Treatment of Nonfacial Photodamage: A Pilot Study

KRISTEL D. POLDER, MD,*† APRIL HARRISON, PA-C,† LEIGH ELLEN EUBANKS, MD,† AND SUZANNE BRUCE, MD†

BACKGROUND A 1,927-nm wavelength was recently added to the 1,550-nm erbium-doped fiber laser. This wavelength possesses a higher absorption coefficient for water than the 1,550-nm, conferring greater ability to target epidermal processes.

OBJECTIVE To evaluate the efficacy and safety of a novel 1,927-nm fractional thulium fiber laser in the treatment of nonfacial photodamage.

METHODS Nine participants with nonfacial photodamage underwent three laser treatments (at 3- to 4-week intervals) at pulse energies of 10 to 20 mJ and 30% to 55% surface area coverage (4–8 passes) with a 1,927-nm thulium fiber laser. A blinded assessor and participants evaluated clinical improvement of treatment areas at 1-month follow-up using a quartile grading scale (0–4).

RESULTS Nine participants with a total of 12 treatment areas completed three treatments and the 1-month follow-up visit. At follow-up, a blinded assessor rated mean improvement in photodamage as 3.25 ± 1.0 and lentiginos as 3.33 ± 0.9 on a scale of 0 to 4 (0 = none, 1 = 1–25%, 2 = 26–50%, 3 = 51–75%, and 4 = 76–100% improvement). Skin responses observed after treatment were moderate erythema, mild edema, itching, and desquamation. No scarring or postinflammatory hyper- or hypopigmentation was observed.

CONCLUSION The 1,927-nm fractional thulium fiber laser is a safe, effective treatment for nonfacial photodamage.

Dr. Polder is a principal investigator and Dr. Suzanne Bruce is a consultant for Solta Medical.

The demand for safe and effective treatment of photodamaged skin has steadily risen over the last several decades with a growing aging population. The traditional criterion standard for photorejuvenation has been ablative resurfacing with carbon dioxide (CO₂, 10,600-nm) or erbium yttrium aluminum garnet (Er:YAG, 2,940-nm) lasers,¹ but complete epidermal ablation results in greater risk of infection, scarring, and posttreatment pigmentary changes. Furthermore, this modality is limited to lighter Fitzpatrick skin types and predominantly facial skin.¹ Less-invasive methods such as nonablative fractional photothermolysis allow for controlled dermal thermal injury, which leads to neocollagenesis.² This fractional approach creates microscopic columns of thermal injury, called

microscopic treatment zones. These precise columns of thermal injury permit rapid healing and less downtime, because tissue surrounding each column is left intact.^{2–5} In addition, fractional photothermolysis can be safely used in nonfacial sites.^{6–8}

A new addition to the 1,550-nm erbium-doped fractional device using the novel 1,927-nm wavelength (Fraxel re:store DUAL, Solta Medical, Hayward, CA) was introduced in October 2009. This wavelength has a higher absorption coefficient for water than the fractional 1,550-nm erbium-doped fiber laser (Fraxel re:store, Solta Medical), conferring a greater ability to target epidermal processes such as pigmentation and dyschromia. The other characteristic of this wavelength that makes it well

*Department of Dermatology, University of Texas, Houston, Texas; †Suzanne Bruce and Associates, Houston, Texas

suited for superficial epidermal indications is its maximum depth of penetration of 300 μm , compared with 1,400-1,500 μm for the 1,550-nm wavelength. The 1,927-nm thulium fiber laser was selected to investigate the efficacy and safety in the clearance of photodamage in nonfacial areas (neck, chest, forearms, dorsal hands) at a private dermatologic laser center. This report represents interim data from a pilot study with 1 month of follow-up. Data collection is ongoing, with 6 months of follow-up planned.

Methods

This study was performed under BioMed Institutional Review Board (San Diego, CA) approval at a private dermatology practice in Houston, Texas. Nine participants underwent an initial screening visit and, based on inclusion and exclusion criteria, were enrolled in the study after informed consent was obtained. All participants were aged 30 to 75 and had clinically evident diffuse nonfacial photodamage as evidenced by diffuse solar lentigines, fine wrinkling, coarse wrinkling, mottled hyperpigmentation, and textural irregularities. Only Fitzpatrick skin types I to IV were included in the study. Up to two areas per participant could be included in this study. An area was defined as the neck, chest, bilateral dorsal hands, or bilateral circumferential forearms. For instance, the bilateral hands qualified as one treatment area. For the forearm treatments, the entire circumference of the forearms from the wrist to the elbow was treated. Participants did not receive treatment for their diffuse photodamage for at least 1 month before enrolling in the study, including treatment with liquid nitrogen, curettage, laser treatments, chemical peels, or keratolytics. Additionally, participants had not used topical steroids or retinoids on the treatment area during the 3 months before enrolling in the study. Participants agreed to discontinue any topical agents or cosmeceutical agents on the treatment area(s) during the course of the study unless the study investigators instructed them to do so. Additional exclusion criteria were active localized or systemic infections; cigarette smoking; pregnancy;

allergies to lidocaine; compromised ability for wound healing; and a personal history of malignant melanoma, keloid scars, psoriasis, or systemic diseases that would preclude the use of topical anesthesia.

Participants

Nine participants (8 women, 1 man) with moderate to severe cutaneous photodamage were included in this study. All participants completed the three treatment sessions and the 1-month follow-up. Participants' ages ranged from 47 to 70 (mean 58 ± 8.1). Three participants were Fitzpatrick skin type I, five Fitzpatrick skin type II, and one Fitzpatrick skin type III.

Treatments

The device used in this study was a 1,927-nm fractionated thulium fiber laser (Fraxel re:store DUAL). The area was cleansed before treatment with a mild cleanser (Cetaphil Gentle Skin Cleanser, Galderma Laboratories, LP, Fort Worth, TX). A compounded double anesthetic ointment (23% lidocaine/7% tetracaine) was applied to the treatment area for 1 hour before treatment.

Participants underwent three treatment sessions at 3- to 4-week intervals. Treatments were performed at energies ranging from 10 to 20 mJ (Table 1). Four to eight passes at the aforementioned settings were performed at each treatment with 30% to 55% surface area coverage. A cooling device (Zimmer Elektromedizin Cryo 5 device, Zimmer Medizin Systems, Irvine, CA) was used to mitigate participant discomfort (fan power 5-7; integrated into hand piece). After each laser treatment, the degree of erythema, edema, and other post-treatment responses were recorded. Participants were asked to score pain immediately after treatment based on a visual analog scale of 0 (no pain) to 10 (worst pain).

Participants were advised to avoid sun exposure for 7 to 10 days after the laser treatment and to use daily broad-spectrum sunscreen with ultraviolet A and B

TABLE 1. Treatment Parameters

<i>Patient</i>	<i>Treatment Location</i>	<i>Energy (mJ)</i>	<i>Total treatment density/pass (MTZ/cm²)</i>	<i>Total passes performed</i>	<i>Coverage (%)</i>
1	Forearms	10/15/15	488/384/448	8/8/8	35/40/45
2	Hands	10/15/20	408/324/288	8/6/6	30/35/40
2	Forearms	10/15/20	408/324/288	8/6/6	30/35/40
3	Hands	15/15/15	328/328/328	8/8/8	35/35/35
4	Neck	10/10/10	408/408/408	8/8/8	30/30/30
4	Chest	10/10/10	408/408/408	8/8/8	30/30/30
5	Hands	10/10/20	488/672/440	8/8/8	35/45/55
6	Hands	10/15/15	408/324/384	8/8/8	30/35/40
7	Hands	15/15/15	320/324/378	4/6/6	35/35/40
8	Hands	10/10/15	576/776/520	8/8/8	40/50/50
9	Forearms	15/15/20	510/582/448	6/6/8	50/55/55
9	Hands	15/15/20	510/582/448	6/6/8	50/55/55

All treatment parameters are listed for treatment 1/treatment 2/treatment 3.

protection (minimum SPF 30) on the treated areas. For wound care, participants were given a prescription for Biafine topical emulsion (OrthoNeutrogena, Titusville, NJ) to use on treated areas at least three times daily for 7 to 10 days after treatment.

Photographic documentation using identical camera settings (Nikon D70, Canfield Imaging Systems, Fairfield, NJ), lighting, and positioning of the participant were obtained at the screening visit, baseline evaluation, all three treatment visits (before treatment), and all follow-up visits. The same blinded assessor assessed clinical improvement of treatment areas using a quartile grading scale (0 = no improvement, 1 = 1–25% (minor), 2 = 26–50% (moderate), 3 = 51–75% (marked), 4 = 76–100% (very significant)). The masked assessor was a non-treating board-certified dermatologist (LEE) who independently reviewed and scored the before and after photographs at the 1-month follow-up. Photographs were randomized before assessor viewing. Other attributes assessed were fine wrinkling, coarse wrinkling, lentigines, mottled hyperpigmentation, and sallowness. Participants were given a satisfaction survey on which they could grade their level of improvement on each of the aforementioned parameters plus overall improvement in photodamage, as well as any side effects after laser treatment.

Results

All nine participants completed the 1-month follow-up visit, with a total of 12 treatment areas evaluated by the masked assessor and participants. The treatment areas were four bilateral circumferential forearms (Figure 1), six bilateral dorsal hands (Figure 2), one neck (Figure 3), and one chest (Figure 4). At the 1-month follow-up visit, the mean level of improvement in photodamage was graded as 3.25 ± 0.97 on a scale of 0 to 4 based on review of randomized baseline and 1-month follow-up digital photographs. Eight of 12 treatment areas demonstrated at least

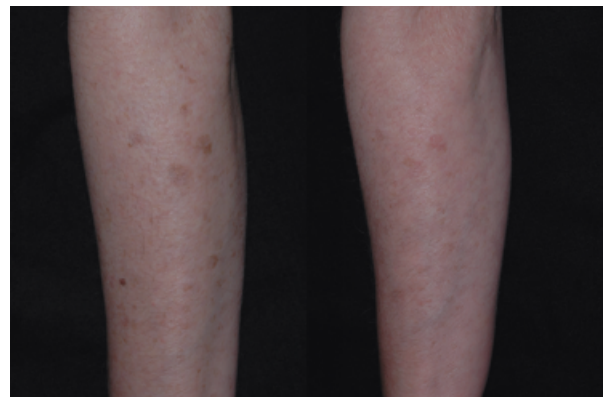


Figure 1. 49 year-old participant's left forearm at baseline (left) and at 1-month follow-up (right) after three laser treatments.



Figure 2. 62 year-old female participant's left hand at baseline (left) and at 1-month follow-up (right) after three laser treatments.

51% to 75% improvement in overall photodamage at the 1-month follow-up. Four treatment sites (3 sets of forearms, 1 set of dorsal hands) attained 26%

to 50% improvement. Investigators rated improvement in lentigines as 3.33 ± 0.89 , fine wrinkling as 1.75 ± 1.06 , and mottled hyperpigmentation as 3.33 ± 0.89 (Table 2). At 1-month follow-up, participants rated mean level of improvement in sun freckling as 2.71 ± 0.82 and overall improvement in sun damage as 2.00 ± 0.85 . Participant assessments of other parameters such as skin tone, reduction of wrinkles, and skin texture are listed in Table 3.

One month after the final laser treatment, participants rated their level of erythema as 1.57 ± 0.78 (0 = no redness, 1 = minor, 2 = moderate, 3 = severe), peeling of the skin as 0.28 ± 0.48 , and itching as 0.57 ± 0.78 (Table 4). In the investigator clinical assessments before each laser treatment and at the 1-month follow-up visit, investigators did

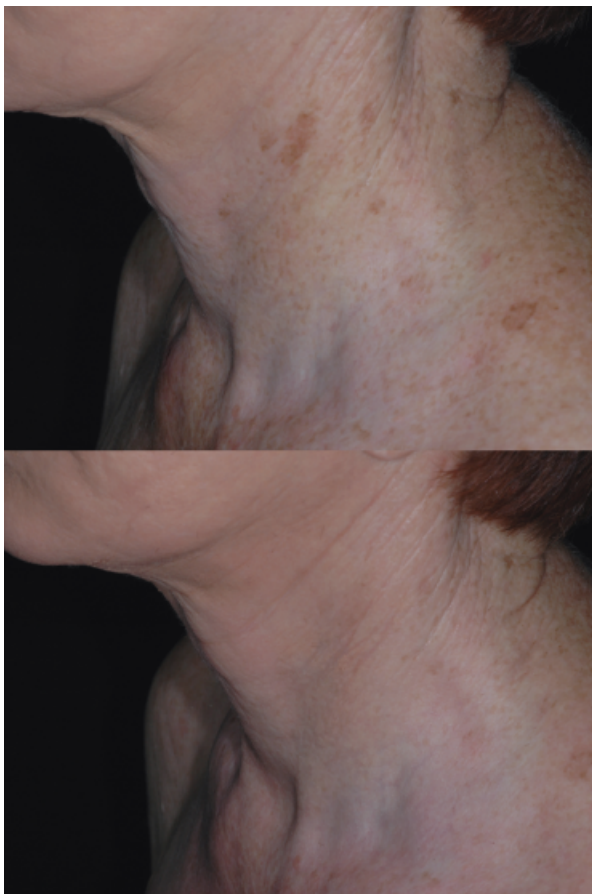


Figure 3. Side view of the left neck of a 70 year-old female participant at baseline (above) and at 1-month follow-up (below) after three laser treatments.



Figure 4. 70-year-old female participant at baseline (above) and at 1-month follow-up (below) after three laser treatments on the chest.

TABLE 2. Blinded Evaluator Assessment of Improvement: 1-Month Follow-Up

<i>Parameter Assessed</i>	<i>Mean Score ± Standard Deviation (all treatment sites)</i>
Overall photodamage	3.25 ± 0.97
Fine wrinkling	1.75 ± 1.06
Coarse wrinkling	1.14 ± 0.69
Lentigines	3.33 ± 0.89
Mottled hyperpigmentation	3.33 ± 0.89
Sallowness	3.1 ± 1.24

0 = none, 1 = 1–25%, 2 = 26–50%, 3 = 51–75%, 4 = 76–100% improvement.

not note any incidence of scarring or hypo- or hyperpigmentation. During the first treatment, participants reported a mean pain score of 3.61 ± 1.9 on a visual analog scale of 0 to 10. Parameters for the first laser treatment were less aggressive than at subsequent visits, in which pulse energy and treatment level were increased as tolerated. For the first treatment, most participants were started at 10 mJ and 30% to 35% surface area coverage. Mean pain scores were 3.27 ± 2.6 for the second treatment and 4.00 ± 3.16 for the third treatment. Participants also rated the degree of erythema and edema immediately after treatment (Table 4). Occasional minor itching and peeling were also reported as side effects (Table 4).

TABLE 3. Patient Assessment of Improvement: 1-Month Follow-Up

<i>Parameter Assessed</i>	<i>Mean Score ± Standard Deviation (all treatment sites)</i>
Overall sun damage	2.00 ± 0.85
Sun freckling	2.71 ± 0.82
Reduction of wrinkles	0.83 ± 0.93
Reduction of discoloration	1.71 ± 1.02
Skin texture	1.43 ± 1.11
Skin tone	1.43 ± 1.03

0 = none, 1 = 1–25%, 2 = 26–50%, 3 = 51–75%, 4 = 76–100% improvement.

Discussion

This data demonstrates the safety and efficacy of the 1,927-nm fractional thulium fiber laser in the treatment of nonfacial photodamage. At 1-month follow-up, eight of 12 nonfacial treatment sites scored at least 51% to 75% improvement in photodamage according to a masked assessor. These results are consistent with previous reports using fractional resurfacing for photodamage.^{5–8} Wanner and colleagues treated 20 patients on nonfacial skin for three treatment sessions (3- to 4-week intervals) using the 1,550-nm erbium-doped fiber laser and found that 55% of patients had at least 51% to 75% improvement in photodamage at 9-month follow-up.⁸ They also concluded that maximum clinical improvement was seen at 3 months after the final laser treatment. Given similar wavelength and the same fractional pattern of thermal injury, there may be further improvement in the treated areas at longer follow-up visits with the 1,927-nm thulium device. Combination treatments using the 1,550- and 1,927-nm wavelengths were not performed in this study but may enhance therapeutic results.

The 1,927-nm wavelength has a higher absorption coefficient for water, and this device can achieve greater surface area coverage per treatment than the 1,550-nm erbium-doped fiber laser. At maximum settings, the 1,927-nm thulium fiber laser can attain up to 70% surface area coverage per treatment. The mechanism by which lentigines and dyspigmentation is improved using fractional photothermolysis is through the shuttling of melanin in columns of microscopic epidermal necrotic debris created by fractional photothermolysis. The extraneous pigment is then exfoliated.^{3,5}

Post-treatment responses were moderate erythema, mild edema, itching, and desquamation. There was no evidence of scarring, erosions, or postinflammatory hyper- or hypopigmentation throughout the course of this study. Previous reports have demonstrated the safety of the 1,550-nm erbium-doped fiber laser.^{4,7–10} Our study demonstrated a similar

TABLE 4. Side Effects

Visit	<i>Mean ± Standard Deviation</i>			
	<i>Erythema</i>	<i>Edema</i>	<i>Itching</i>	<i>Peeling</i>
Treatment 1	1.75 ± 0.46	0.75 ± 0.46	0	0
Treatment 2	2.0 ± 0.5	1.22 ± 0.66	0.44 ± 1.01	0.11 ± 0.33
Treatment 3	2.42 ± 0.53	1.0 ± 0.53	0.37 ± 0.51	0.12 ± 0.35
1-month follow-up	1.57 ± 0.78	0.71 ± 1.11	0.57 ± 0.78	0.28 ± 0.48

0 = none, 1 = minor, 2 = moderate, 3 = severe. No scarring, erosions, or postinflammatory hypo- or hyperpigmentation was observed.

safety profile. Initially, conservative settings were used in this study given the nonfacial treatment sites. Treatment levels and energies were increased on subsequent laser treatment visits. We found greater erythema and edema when more-aggressive settings were used. Erythema resolved in many participants by 7 to 10 days, although it persisted longer when aggressive settings were used in these nonfacial sites, especially the dorsal hands. This trial took place during the spring and summer in Texas, so frequent re-application of sun protection and sun avoidance in this area may have been difficult.

The small sample size limited this study; larger scale trials are needed to define optimal settings and to capture additional unreported side effects. Six-month follow-up is planned in this study. Participants were not shown photographs before filling out the satisfaction questionnaire. Allowing patients to review before-and-after photographs may alter their scoring.

Conclusion

Studies have demonstrated the safety and efficacy of the 1,550-nm fractional erbium-doped fiber laser for skin rejuvenation.^{6,8-10} The novel 1,927-nm fractional thulium fiber laser represents a new addition to the fractional photothermolysis armamentarium. This pilot study, which includes 1-month follow-up data of 12 nonfacial treatment sites, demonstrates a mean improvement in photodamage score of 3.25 ± 0.97 and lentiginos as 3.33 ± 0.89 at 1-month follow-up after a series of three laser treatments. Treatment areas represented in this study

were the dorsal hands, bilateral circumferential forearms, neck, and chest. At the 1-month follow-up, participants rated sun freckling and overall sun damage as the highest areas of subjective improvement. Post-treatment responses were moderate erythema, mild edema, itching, and desquamation. There was no evidence of scarring, erosions, or postinflammatory hyper- or hypopigmentation throughout the course of this study. Large-scale studies using the 1,927-nm thulium fiber laser alone, as well as combination treatments with the 1,927-nm and 1,550-nm wavelengths, are warranted to further define and optimize treatment parameters for nonfacial treatments.

References

1. Alster TS. Cutaneous resurfacing with CO₂ and Erbium:YAG lasers: preoperative, intraoperative, and postoperative considerations. *Plast Reconstr Surg* 1999;103:619-32.
2. Laubach HJ, Tannous Z, Anderson RR, Manstein D. A histological evaluation of the dermal effects after fractional photothermolysis treatment. *Lasers Surg Med* 2005;36(S17):86.
3. Hantash B, Bedi V, Sudireddy V, et al. Laser-induced transepidermal elimination of dermal content by fractional photothermolysis. *J Biomed Opt* 2006;11:041115.
4. Laubach H, Tannous Z, Anderson R, Manstein D. Skin responses to fractional photothermolysis. *Lasers Surg Med* 2006;38:142-9.
5. Manstein D, Herron GS, Sink RK, Tanner H. Fractional photothermolysis: a new concept for cutaneous remodeling using microscopic patterns of thermal injury. *Lasers Surg Med* 2004;34:426-38.
6. Geronemus R. Fractional photothermolysis: current and future applications. *Lasers in Surg Med* 2006;38:169-76.
7. Sherling M, Friedman PM, Adrian R, et al. Consensus recommendations on the use of an erbium-doped 1,550-nm fractionated laser and its applications in dermatologic laser surgery. 2010;36:461-9.

8. 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.
9. Graber EM, Tanzi EL, Alster TA. Side effects and complications of fractional laser photothermolysis: experience with 961 treatments. *Dermatol Surg* 2008;34:301–7.
10. Metelitsa AI, Alster TS. Fractionated laser skin resurfacing treatment complications: a review. *Dermatol Surg* 2010;36:307–8.

Address correspondence and reprint requests to: Kristel D. Polder, MD, The Center for Cosmetic Dermatology, 1900 St. James Place Suite 650, Houston, TX 77056, or e-mail: kristelpolder@hotmail.com