# A 1064-nm Neodymium-doped Yttrium Aluminum Garnet Picosecond Laser for the Treatment of Hyperpigmented Scars

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BACKGROUND Pigmentation is one of the few major characteristics according to which scars are evaluated. Data on the treatment of the hyperpigmented component of scars are sparse.

OBJECTIVE The authors aimed at evaluating the efficacy of the fractional 1,064-nm neodymium-doped yttrium aluminum garnet (Nd:YAG) picosecond laser in the treatment of the hyperpigmented component of scars.

METHODS Sixteen patients with hyperpigmented scars underwent 3 to 8 treatment sessions at 3- to 6-week intervals with the 1,064-nm Nd:YAG picosecond laser (PicoWay, Candela, Resolve handpiece). The treatment response was evaluated by 2 noninvolved dermatologists on a global assessment scale (GAS) of 1 to 4. A Mexameter quantitatively evaluated the melanin content of the scar before and after laser treatments.

RESULTS The average GAS score of the 2 noninvolved dermatologists was 3.31 ± 0.57. The patients assessed their level of tolerance as good or excellent and their satisfaction level as moderate or high. The Mexameter showed that the melanin index decreased considerably (by 39.11 ± 11.58%) in all patients after treatment.

CONCLUSION The fractionated nonablative picosecond Nd:YAG laser was effective for the treatment of the hyperpigmented component of scars.

*The authors have indicated no significant interest with commercial supporters. O. Artzi initiated the study and served as the principal investigator; A. Koren analyzed the data and wrote the manuscript. R. Niv and O. Artzi performed the treatments.*



Scars are a common complication of the wound healing process. They are associated with aesthetic, functional, and psychological morbidities.[1] The severity of scars is usually evaluated according to multiple characteristics, one of which is hyperpigmentation.[2,3] Numerous treatment modalities for the various scar components have been proposed, either alone or in combination. Each modality offers different biomechanisms, advantages, disadvantages, and contraindications. Laser therapy is currently one of the more commonly used technologies for scar remodeling.[4–6] The picosecond laser technology has been in clinical use for the treatment of tattoos and a variety of pigmentary disorders since 2012.[7–9] Its successful application for the treatment of acne scars was also reported.[10] To date, there have been no studies that evaluated picosecond laser for the indication of hyperpigmented scars. The authors report 16 patients whose hyperpigmented scars were successfully treated by a picosecond laser device as monotherapy.

## Methods

This is a case series of 16 patients (6 males and 10 females) with stable nonimproving hyperpigmented scars that were treated with a fractional PS 1,064-nm laser (Picoway; Syneron Candela, San Francisco Bay Area, CA) in the Dermatology Department of the Tel Aviv Medical Center between January 2015 and

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*ISSN: 1076-0512 • Dermatol Surg 2019;45:725–729 • DOI: 10.1097/DSS.0000000000001917*

**TABLE 1. Characteristics of the Study Patients, Scars, and Treatments**

| Pt # | Age, yrs | Sex | Skin Type (Fitzpatrick) | Scar Age | Etiology | Area | No. Treatments | Interval* (Wk) |
|---|---|---|---|---|---|---|---|---|
| 1 | 32 | M | 4 | 8 mo | Road accident | Face | 3 | 3 |
| 2 | 12 | F | 4 | 10 yrs | Leishmaniasis | Forehead | 3 | 4 |
| 3 | 48 | F | 6 | 25 yrs | Burn injury | Forehead | 4 | 4 |
| 4 | 27 | F | 2 | 10 mo | Burn injury | Arm | 4 | 4 |
| 5 | 45 | F | 3 | 8 mo | Burn injury | Shin | 4 | 4 |
| 6 | 34 | F | 2 | 10 mo | Road accident | Abdomen | 5 | 5 |
| 7 | 24 | M | 2 | 12 mo | Road accident | Forearm | 3 | 4 |
| 8 | 25 | M | 3 | 24 mo | Burn injury | Face | 4 | 6 |
| 9 | 37 | M | 4 | 17 mo | Road accident | Arm | 4 | 5 |
| 10 | 8 | F | 5 | 2 yrs | Road accident | Face | 5 | 5 |
| 11 | 35 | F | 2 | 2 yrs | Operation | Breast | 4 | 4 |
| 12 | 43 | F | 3 | 15 yrs | Road accident | Forehead | 5 | 6 |
| 13 | 66 | F | 4 | 2 yrs | Disease | Shin | 8 | 4 |
| 14 | 35 | F | 3 | 5 yrs | Operation | Shoulder | 3 | 5 |
| 15 | 23 | M | 2 | 3 yrs | Road accident | Face | 4 | 4 |
| 16 | 37 | M | 4 | 17 yrs | Road accident | Arm | 4 | 5 |

*Interval between treatments.

December 2017. The age of the participants ranged from 8 to 66 years (average 33.19 years). Five of them had Fitzpatrick skin Type II, 4 had Type III, 5 had Type IV, 1 had Type V, and 1 had Type VI. Demographic data, medical history, and clinical evaluation findings were recorded for all patients. Written consent was received from the participants or their surrogates before undergoing treatment.

The treatment was delivered with the 1,064-nm neodymium-doped yttrium aluminum garnet (Nd:YAG) picosecond laser (PicoWay, Candela) with the resolve 1,064-nm handpiece at an energy level of 1.7 to 2.5 mj/μbeam. Protective eyewear was used during all treatments. The patients were instructed not to undergo any other antiscarring or bleaching treatment until the last follow-up visit, as well as to avoid sun exposure and to apply sunscreen.

All patients were followed-up monthly for 6 months after the last treatment. Standardized photographs were obtained with a digital camera (Canon EOD 70D, Canon, Oita, Japan) using a 100-mm macro objective and a flash (Canon Macro 100 mm, Canon, Oita, Japan). Lighting conditions and patient positioning at baseline and at 6 months after the last treatment were identical. The pre-treatment and 6-month post-treatment photographs were compared for the improvement of hyperpigmented component of scar, by 2 noninvolved dermatologists who were unaware of the study design and treatment: they used a global assessment scale (GAS) where 1 = 0% to 25% = poor improvement, 2 = 25% to 50% = fair, 3 = 50% to 75% = good, and 4 = 75% to 100% = major change/excellent improvement. Six months after the end of treatment, the participants were also asked to rate their satisfaction on a 0 to 3 scale, where 0 = not at all satisfied, 1 = somewhat satisfied, 2 = moderately satisfied, and 3 = very satisfied. Finally, the patients rated their treatment tolerance on a scale from 1 to 4 where 1 = poor, 2 = fair, 3 = good, and 4 = excellent.

The narrow-band simple reflectance meter, Mexameter (MX18; Courage + Khazaka Electronic GmbH, Köln, Germany), was used to quantitatively to evaluate the melanin content of the scar before and after the laser treatments. This instrument uses arrays of light-emitting diodes that emit light at 3 defined wavelengths: 568 (green), 660 (red), and 880 nm (infrared). A melanin index is calculated from the intensities of the absorbed and the reflected light at 660 and 880 nm, respectively.[10,11]

**TABLE 2. Physician's and Patient's Assessments and Mexameter* Scores**

| | Ph1 | Ph2 | Ph | | | | | |
|---|---|---|---|---|---|---|---|---|
| # | GAS | GAS | Ave | Tolerance | Satisfaction | Mexa be | Mexa af | % |
| 1 | 4 | 3 | 3.5 | 4 | 3 | 320 | 180 | 43.75 |
| 2 | 3 | 3 | 3 | 3 | 3 | 330 | 212 | 35.75 |
| 3 | 4 | 4 | 4 | 4 | 2 | 222 | 99 | 55.4 |
| 4 | 3 | 3 | 3 | 4 | 3 | 272 | 132 | 51.47 |
| 5 | 3 | 4 | 3.5 | 3 | 3 | 343 | 232 | 32.36 |
| 6 | 4 | 3 | 3.5 | 4 | 2 | 275 | 142 | 48.36 |
| 7 | 3 | 3 | 3 | 4 | 3 | 312 | 132 | 57.69 |
| 8 | 4 | 4 | 4 | 4 | 2 | 260 | 200 | 23.07 |
| 9 | 4 | 4 | 4 | 4 | 3 | 290 | 159 | 45.17 |
| 10 | 3 | 3 | 3 | 4 | 3 | 253 | 141 | 44.26 |
| 11 | 3 | 4 | 3.5 | 3 | 2 | 331 | 220 | 33.53 |
| 12 | 4 | 4 | 4 | 3 | 2 | 250 | 210 | 16 |
| 13 | 2 | 3 | 2 | 4 | 3 | 232 | 150 | 35.34 |
| 14 | 3 | 4 | 2.5 | 4 | 2 | 220 | 149 | 32.27 |
| 15 | 4 | 3 | 3.5 | 3 | 3 | 290 | 184 | 36.55 |
| 16 | 3 | 4 | 3 | 4 | 3 | 230 | 132 | 42.6 |
| AVE | 3.37 | 3.5 | 3.31 | 3.68 | 2.6 | 276.8 | 167.1 | 39.6 |
| STD | 0.61 | 0.51 | 0.57 | 0.47 | 0.5 | 41.3 | 38.9 | 11.22 |

*Mexameter (MX18; Courage + Khazaka Electronic GmbH, Köln, Germany).
MI, melanin index as measured by Mexameter; Ph-GAS, physician global assessment scale.

## Results

All the study patients had a response to an average of 4.18 fractional picosecond laser treatments (range: 3–8) at an average of 4.5-week intervals (range: 3–6). Their demographic data are shown in Table 1. The average GAS score of the 2 independent dermatologists were 3.37 and 3.25. The average satisfaction rate was high (2.6), and the average patient tolerance level was good (3.7). The melanin content of the scar, as measured by the Mexameter, decreased by 39.11 ± 11.58% compared with pretreatment values. The physicians' and patients' assessments together with the Mexa* scores are shown in Table 2. There were no significant side effects reported by any of the patients.

## Discussion

Unsightly scars are a common complication of the wound healing process, affecting millions of people every year.[2] Apart from being aesthetically disturbing, scars may pose physical and psychosocial morbidities that lead people to seek treatment. Numerous treatment modalities have been proposed, among them corticosteroids, 5-fluorouracil, silicone gel sheeting, pressure therapy, radiation, cryotherapy, and surgery. A variety of lasers has also been evaluated for improving the appearance of scars.[4–6] Pulsed dye laser and fractional ablative and nonablative lasers in varied wavelengths and pulse durations are now considered an integral part of the treatment of scars. The best results can be achieved with a combination of treatment modalities suited to the characteristics of the scars, including their vascularity, texture, thickness, pliability, surface area, pain, pruritus, and pigmentation.[1,3] This study aimed to evaluate the value of picosecond laser in the treatment of the pigmented component of a scar.

Picosecond laser devices have been in clinical use since 2012, and they operate at a pulse duration in the subnanosecond range. Picosecond pulses target cutaneous pigmentation through selective photothermolysis. Moreover, they effectively confine the energy delivered to the target and produce considerable photomechanical effects with negligible undesirable heat diffusion into the surrounding structures. By

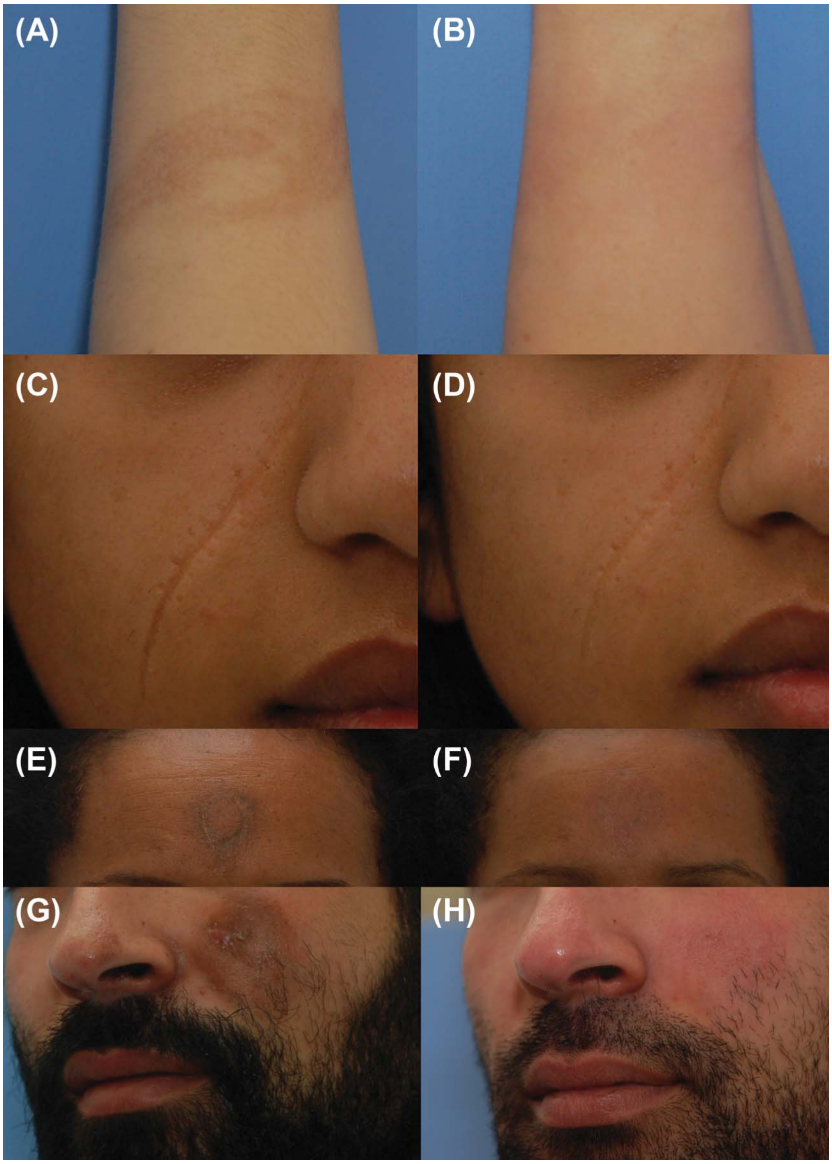


**Figure 1.** Photographs of patients # 7, 10, 3, and 1, taken before (A, C, E, G) and 6 months after (B, D, F, H) the course of laser treatments. The hyperpigmented component of the scar improved significantly after the treatments.

delivering picosecond pulses, effective treatment can be accomplished with lower fluences of energy, decreased epidermal injury, and lower risk of dyspigmentation.[12]

There is wide application for the picosecond laser systems, including multicolored tattoos, solar lentigines, dermal melanocytosis, nevus of Ota, minocycline-induced pigmentation, and photodamage/rhytids.[13–15] The successful use of the picosecond laser has also been described in the treatment of atrophic facial acne scars.[16]

The fractionated nonablative 1,064-nm Nd:YAG picosecond laser (PicoWay, Candela, Resolve handpiece) delivers 1,064-nm, 450-ps pulses with a maximum microbeam energy per pulse of 3 mJ. It delivers an array of 100 microbeams per $6 \times 6$ mm area using a holographic diffractive beam-splitter technology.[16]

In the current case series, the fractionated nonablative picosecond Nd:YAG laser was shown to be effective for the treatment of the hyperpigmented component of scars (Figure 1). To the best of the authors' knowledge, this is the first reported case series to demonstrate the clinical efficacy and safety of the picosecond laser for this indication.

This study has a number of limitations that future research could remedy. These include the small sample size, the lack of controls, and the relatively short follow-up time. The pre-treatment and 6-month post-treatment photographs were of sufficient quality but were not identical and might affect the comparison. In addition, this study only addresses the hyperpigmented component of the treated scar. A treatment combination using a picosecond laser with a pulsed dye and/or a fractional laser should be considered to address the different components of each scar. Furthermore, an holistic approach should be recommended in the treatment of hyperpigmented component of scars: The patient must first use photoprotection, including sunscreens and sun avoidance. These measures help to prevent further increase in melanin production and might promote spontaneous resolution. Effective treatment strategies include using topical depigmenting agents for few months as first-line treatment. If not improved, this can be followed by the use of fractional picosecond laser treatments.

*Acknowledgments* The authors thank Esther Eshkol for editorial assistance.

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