

Long-Pulsed 1064-nm Nd:YAG Laser for the Treatment of Onychomycosis

Domenico Piccolo, MD,¹ Dimitra Kostaki, MD,² Ester Del Duca, MD,³
Giovanni Cannarozzo, MD,⁴ Mario Sannino, MD,⁴ and Steven Nisticò, MD⁵

Abstract

Objective: The aim of this study is to evaluate the efficacy of long-pulsed 1064-nm Nd:YAG laser in penetrating tissue and targeting the fungal overgrowth in the nail plate. **Background:** Onychomycosis is the most frequent nail disorder. Current treatments include oral and topical antifungal agents, photodynamic therapy, and surgical approaches such as mechanical, chemical, or surgical nail avulsion. Moreover, the use of lasers to treat nail diseases has been approved in the United States by the Food and Drug Administration (FDA). Wide literature has been produced to assess the effectiveness of these devices, but, because the opposing results emerging from current studies, more data are still needed on the long-lasting efficacy and safety of this procedure. **Methods:** Twenty consecutive, unselected patients were enrolled in the study and treated, at intervals of 1 week, for a total of four sessions, using a long-pulsed 1064-nm Nd:YAG laser. In each session, three passages across each nail plate were performed with 1-min pause between each passage. A special lens for dermatoscopy, connected to a digital camera, was used for dermoscopic images. **Results:** In fourteen patients (70%; 12F; 3M), excellent results were obtained with an important reduction of chromonychia, onycholysis, opacity, longitudinal striae, and jagged proximal edge. Better results were observed in severe cases in the 2-month follow-up visit. **Conclusions:** Data for treating nail onychomycosis with laser and light therapy seem to be positive. The promising results of our study identify long-pulsed 1064-nm Nd:YAG laser as a possible alternative option for the treatment of onychomycosis. However, increasing subject data, improving study methodology, and output parameters may become an important next step of study in the treatment of nail onychomycosis.

Keywords: lasers, Nd:YAG, dermatology, laser therapy, onychomycosis

Introduction

ONYCHOMYCOSIS IS THE most frequently diagnosed nail disorder.¹ The prevalence of onychomycosis in the general population is between 2% and 28% with a higher incidence in elderly, diabetic, and chronically immunosuppressed patients. The most common causative pathogens are *Trichophyton rubrum* (71–87%) and *T. mentagrophytes* (9–22%) followed by *Candida* species (10–20%).²

Diagnosis of onychomycosis mainly relies on clinical features, KOH examination, and mycotic culture of the sample.³ However, in equivocal cases, dermatoscopy may be a useful tool to the clinical assessment of fungal nail infections. Recently, specific dermatoscopic patterns suggestive of ony-

chomycosis have been identified, including chromonychia, onycholysis, opacity, longitudinal striae, and jagged proximal edge with spikes.^{3,4} Current treatments available for onychomycosis include oral (terbinafine and itraconazole) and topical antifungal agents (ciclopirox and amorolfine), photodynamic therapy, surgical approaches such as mechanical, chemical, or surgical nail avulsion, as well as the use of several laser devices.⁵ Among the latter, the use of long-pulsed 1064-nm Nd:YAG laser (neodymium-doped yttrium aluminum garnet) for the treatment of onychomycosis has demonstrated promising results. Indeed, because of its longer wavelength, long-pulsed 1064-nm Nd:YAG laser is able to more deeply penetrate tissue and efficiently target fungal overgrowth in the nail plate.⁶ In the largest study using a long-pulsed 1064-nm

¹Italian Association Outpatient Dermatologists, Pescara, Italy.

²Skin Center Dermo-Aesthetic Lasers Centres, Pescara, Italy.

³Division of Dermatology, Department of Systems Medicine, University of Rome Tor Vergata, Rome, Italy.

⁴Lasers in Dermatology, University of Rome Tor Vergata, Rome, Italy.

⁵Department of Health Sciences, University of Catanzaro, Catanzaro, Italy.



FIG. 1. Clinical images and dermatoscopic features of onychomycosis treated with long-pulsed 1064-nm Nd:YAG laser. (A, B) Before treatment. (C, D) After treatment showing a significant reduction of chromonychia, opacity, and jagged proximal edge.

Nd: YAG laser for the treatment of onychomycosis, Kozarev et al. treated a total of 194 infected nails in 72 patients with 4-mm spot size, 30–40 J/cm² energy fluence, and 35 msec pulse duration in the presence of cold air cooling. Patients received four treatments with 1-week interval and they were, thereafter,

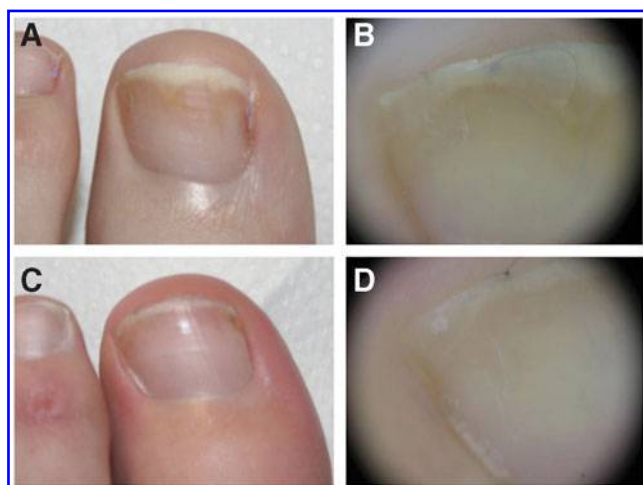


FIG. 2. Clinical and dermatoscopic features of onychomycosis treated with long-pulsed 1064-nm Nd:YAG laser. (A, B) Before treatment. (C, D) After treatment showing a significant reduction of opacity and onycholysis.

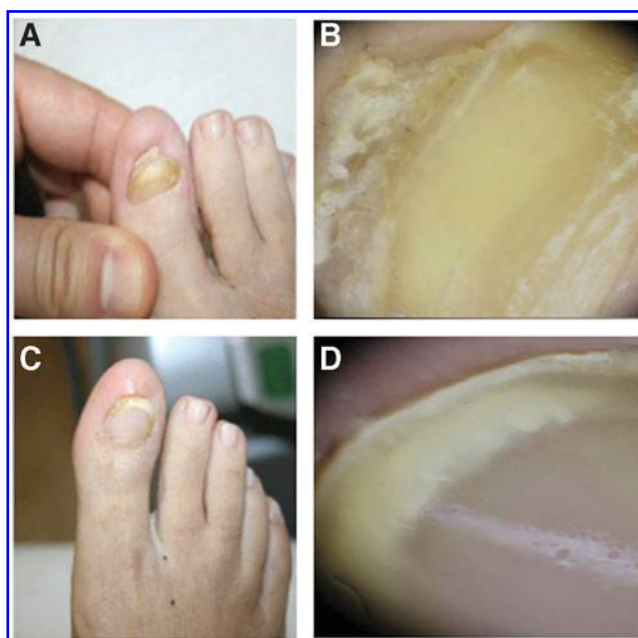


FIG. 3. Clinical and dermatoscopic features of onychomycosis treated with long-pulsed 1064-nm Nd:YAG laser: (A, B) Before treatment. (C, D) After treatment showing good improvement of opacity and onycholysis.

followed up for a period of 12–30 months. Their results showed a completely clear nail plate in 93.5% of patients.⁷ In general, laser systems in the near infrared spectrum (780–3000 nm wavelength) carry out their effect by direct heating of the target tissues.⁸ Moreover, by using pulsed light rays instead of continuous beam, they can deliver a “selective photothermolysis,” causing an immediate elevation in temperature into the defined target area. Sufficient intervals between pulses can allow tissue



FIG. 4. Clinical and dermatoscopic features of onychomycosis treated with long-pulsed 1064-nm Nd:YAG laser: (A, B) Before treatment. (C, D) After treatment showing no results.

relaxation and cooling, avoiding severe collateral damage to the surrounding structures.⁹

The use of lasers to treat nail diseases has been approved in the United States by the Food and Drug Administration (FDA). Wide literature has been produced to assess the effectiveness of these devices, but, because of the opposing results emerging from current studies, more data are still needed on the long-lasting efficacy and safety of this procedure.

Patients and Methods

This study aims to observe the effect of long-pulsed 1064-nm Nd:YAG laser on mycotic nail in terms of clinical cure using both clinical and dermoscopic pictures, before and after each treatment. Diagnosis was established in each patient on the basis of clinical findings, dermoscopic images, and mycological cultures. A long-pulsed 1064-nm Nd:YAG laser (DEKA M.E.L.A. Srl, Calenzano, Florence, Italy) was used and set to 4 mm spot size, 30 J/cm² fluence, 5 msec pulse duration, and 1 Hz repetition rate with epidermal cooling. Patients were treated at intervals of 1 week for a total of four sessions. In one session, three passages across each nail plate were performed with 1-min pause between each passage. Clinical and dermoscopic images were captured in all cases before each treatment and 2 months after the fourth session. A special lens for dermoscopy (DermLite Foto; 3Gen LLC, San Juan Capistrano, CA) connected to a digital camera (Canon PowerShot A360) was used for dermoscopic images.

Results

Twenty patients enrolled for the study (16 females and 4 males aged from 21 to 72; median: 42 years). Fourteen patients (70%; 12F; 3M) obtained excellent results with an important reduction of chromonychia, onycholysis, opacity, longitudinal striae, and jagged proximal edge (Figs. 1 and 2).

The results were already visible after the second session, especially in those patients who had mild mycotic involvement. All patients who claimed pain before treatment because of onychomycosis declared its complete disappearance after one or two treatments. Good results were obtained in four patients (20%; 4F). Fair-to-good reduction of chromonychia, onycholysis, opacity, longitudinal striae, and jagged proximal edge was achieved (Fig. 3). Two patients (10%; 1M and 1F) did not obtain results after treatments (Fig. 4). Interestingly, we noticed better results in severe cases in the 2-month follow-up visit. Although some patients reported mild pain and burning during the laser treatment, all patients underwent all three passages.

Conclusions

Laser therapy for onychomycosis is a new frontier of treatment, because of its fewer side effects. The number of professional lasers approved by the U.S. Food and Drug Administration is continually increasing, most of which are the long-pulsed Nd:YAG 1064-nm lasers.¹⁰ Many studies show that the laser treatment of onychomycosis is safe and effective.⁶ However, new studies¹¹ stated that the use of Nd:YAG 1064-nm laser is not a long-lasting treatment for onychomycosis.¹² For this reason, further study of the Nd:YAG 1064 method to treat onychomycosis is still needed

to assess the efficacy of the Nd:YAG 1064-nm laser therapy as a valid treatment for this frequent pathology.

Pivot studies on laser effects on onychomycosis show, in the laboratory, eradication of the common dermatophyte *T. rubrum*.¹³ The direct thermal killing effect on fungal mycelia was ensured, treatment temperatures exceeding 50° centigrade.¹⁴

Wide literature has been reviewed to assess the effectiveness of these devices¹⁵ and our experience confirms the possible key role that long-pulsed 1064-nm Nd:YAG laser might represent on treatment of onychomycosis.

The promising results identify long-pulsed 1064-nm Nd:YAG laser as a possible alternative option for the treatment of onychomycosis. Larger controlled studies may add new information about its efficacy and to would standardize the treatment regimen for the management of onychomycosis. With increased subject data, improved study methodology, and more precise output parameters, lasers may become an important, innovative modality in the treatment of nail onychomycosis.¹⁶

Author Disclosure Statement

No competing financial interests exist

References

- Gupta AK, Jain HC, Lynde CW, Macdonald P, Cooper EA, Summerbell RC. Prevalence and epidemiology of onychomycosis in patients visiting physicians' offices: a multicenter Canadian survey of 15,000 patients. *J Am Acad Dermatol* 2000;43:244–248.
- Lilly KK, Koshnick RL, Grill JP, Khalil ZM, Nelson DB, Warshaw EM. Cost-effectiveness of diagnostic tests for toenail onychomycosis: a repeated-measure, single-blinded, cross-sectional evaluation of 7 diagnostic tests. *J Am Acad Dermatol* 2006;55:620–626.
- Piraccini BM, Bruni F, Starace M. Dermoscopy of non-skin cancer nail disorders. *Dermatol Ther* 2012;25:594–602.
- Nakamura RC, Costa MC. Dermatoscopic findings in the most frequent onychopathies: descriptive analysis of 500 cases. *Int J Dermatol* 2012;51:483–485.
- Lecha M, Effendy I, Feuilhade de Chauvin M, Di Chiacchio N, Baran R; Taskforce on Onychomycosis Education. Treatment options—development of consensus guidelines. *J Eur Acad Dermatol Venereol* 2005;19 Suppl 1:25–33.
- Zhang RN, Wang DK, Zhuo FL, Duan XH, Zhang XY, Zhao JY. Long-pulse Nd:YAG 1064-nm laser treatment for onychomycosis. *Chin Med J (Engl)* 2012;125:3288–3291.
- Kozarev J, Vizintin Z. Novel lasers therapy in treatment of onychomycosis. *J Laser Health Acad* 2010;1:1–8.
- Nenoff P, Grunewald S, Paasch U. Laser therapy of onychomycosis. *J Dtsch Dermatol Ges* 2014;12:33–38.
- Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. *Science* 1983;220:524–527.
- Ledon JA, Savas J, Franca K, Chacon A, Nouri K. Laser and light therapy for onychomycosis: a systematic review. *Lasers Med Sci* 2014;29:823–829.
- Hollmig ST, Rahman Z, Henderson MT, Rotatori RM, Gladstone H, Tang JY. Lack of efficacy with 1064-nm neodymium:yttrium-aluminum-garnet laser for the treatment of onychomycosis: a randomized, controlled trial. *J Am Acad Dermatol* 2014;70:911–917.

12. Wiznia LE, Quatrano NA, Mu EW, et al. A clinical review of laser and light therapy for nail psoriasis and onychomycosis. *Dermatol Surg* 2016 [E-pub ahead of print]
13. Vural E, Winfield HL, Shingleton AW, et al. The effects of laser irradiation on *Trichophyton rubrum* growth. *Lasers Med Sci* 2008;23:349–353.
14. Paasch U, Mock A, Grunewald S, et al. Antifungal efficacy of lasers against dermatophytes and yeasts in vitro. *Int J Hyperthermia* 2013;29:544–550.
15. Gupta AK, Simpson F. Newly approved laser systems for onychomycosis. *J Am Podiatr Med Assoc* 2012;102:428–430.
16. Ortiz AE, Avram MM, Wanner MA. A review of lasers and light for the treatment of onychomycosis. *Lasers Surg Med* 2014;46:117–124.

Address correspondence to:

Ester Del Duca

Division of Dermatology

Department of Systems Medicine

University of Rome Tor Vergata

Viale Oxford, 81

Rome 00133

Italy

E-mail: ester.delduca@gmail.com

Received: June 12, 2016.

Accepted after revision: September 3, 2016.

Published online: December 30, 2016.