

Long Pulsed Nd:YAG 1064-Nm Laser in Treatment of Onychomycosis

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Abstract

Onychomycosis is a common nail disease, especially in older patients. Various treatment options are currently available for onychomycosis; however, their limitations include high failure rates, time-consuming nature, high cost, and high risk of drug interactions. Objective: To evaluate the efficacy of onychomycosis treatment with a long-pulsed 1064-nm Nd:YAG laser. Patients and Methods: ten patients were assessed. The study involved treatment with a long-pulsed 1064-nm Nd:YAG laser in two sessions at 4-week intervals. Fungal culture at two media sabourauds dextrose agar with cycloheximide and without cycloheximide and microscopic examination were performed at the start and then one-month after the second session. Results: After two sessions, the mycological test results were negative in eight 80%. The result showed that the mean improvement percentage was 60.50 %. Side effects were mild and limited to mild pain and delayed nail growth after the laser procedure. Conclusions: Long-pulsed 1064-nm Nd:YAG laser therapy is safe and effective for treating onychomycosis.

Keywords: Onychomycosis, Long-pulsed laser, Fungal culture

Introduction

Onychomycosis is a common fungal infection of the nails. Its incidence is 2 to 13% in the general population and 14 to 28% in the older population (1, 2). In more than 90% of patients, onychomycosis is caused by a dermatophyte infection from the genera

Trichophyton (most commonly *T. rubrum* and *T. mentagrophytes*), Epidermophyton, or Microsporum (3). In rare cases, non dermatophyte molds (e.g., *Aspergillus niger* or *Scytalidium dimidiatum*) and yeasts (e.g.,

Candida albicans) can also cause onychomycosis (4).

Nail discoloration is one of the most common symptoms of onychomycosis. If not treated, onychomycosis can lead to nail thickening, distortion, nail bed detachment, and irregular nail surface modifications, causing pressure, irritation, and pain (5). Onychomycosis represents more of a psychosocial concern than a medical problem because it can negatively affect the patient's quality of life. Patients with onychomycosis frequently report decreased self-esteem, no self confidence and avoid social interaction (6).

Various treatment options are available for onychomycosis; however, their limitations include high failure rates, time-consuming nature, high cost, and high risk of drug interactions. Conventional treatment approaches include topical or systemic oral antifungal agents and surgical treatment involving fingernail and toenail removal (7). Oral antifungal agents are the most effective treatment and represent the gold standard of onychomycosis management (8). However, it is often associated with the need for long-term therapy, various adverse effects, possible drug interactions, and high recurrence rates (9).

Promising laser-based treatments for onychomycosis have been reported in recent years. Such therapies include Nd:YAG laser treatment (7) and diode lasers with wavelengths of 870/930 nm (10). The Nd:YAG laser with 1064-nm wavelength penetrates through the nail plate and produces heat (43–51°C) deep within the dermis and nail tissue, superheating the fungal material. Exposure of fungi to increased temperatures causes cell damage and death, resulting in the fungicidal effect of this laser treatment (11).

Therefore, we conducted the present study to evaluate the efficacy of the mycological results and side effects of onychomycosis treatment with long-pulsed 1064-nm Nd:YAG laser.

Patient and methods

This is a prospective cohort study processed between March 2021 and April 2022. This study was carried out on ten patients in Benha University hospitals, at Dermatology, Venereology, and Andrology Department outpatient clinics. The local ethics committee approved the study on research involving human subjects of Benha Faculty of Medicine (MS:19-8-2020). Informed consent was obtained from all patients before participating in the study. Ten patients with

onychomycosis received two sessions of 4 weeks intervals using long-pulsed Nd: YAG (1064 nm). The study enrolled patients with different types of onychomycosis.

The exclusion criteria were, concomitant nail disorders such as nail psoriasis, lichen planus, atopic dermatitis, bacterial nail infection, subungual hematoma, and nevoid formation, using topical or systemic antifungal therapy or other drugs which could affect therapy during the treatment, using nail coloring dyes, polishes, or Henna.

All included patients were subjected to complete history taking, including age, onset, course, duration, prior treatment, type of the current job and family history, general examination, dermatological examination regarding other diseases, and the presence of other fungal infection as tinea pedis and /or tinea manuum, inspection of all fingers and toes for onychomycosis type and the number of affected nails. Then each patient was subjected to a direct microscopic examination and culture of affected nails at the start and then one-month after the second session.

Examination of the nails to detect the diseased nails clinically and scoring the severity of affection. Onychomycosis severity index (OSI), Nail scraping and subungual debris from all cases were

collected from the proximal border of the onycholytic area with a surgical blade after cleaning the affected area with 70% alcohol to remove bacteria and debris.

Part of the prepared specimen was processed by direct microscopic examination using 40% KOH with subsequent analysis by optical microscopy at 100-400x magnification (4).

Fungal culture was also done to identify the species of organism. Two types of growth media were used, one with cycloheximide; this was processed by seeding the samples in Sabouraud dextrose agar with the addition of 500 mg actidion (cyclohexamide) dissolved in 10 ml acetone to suppress the growth of non-dermatophyte molds and facilitate the isolation of dermatophytes (8).

The other growth media was sabouraud dextrose agar (SDA) without cycloheximide to isolate yeasts and non-dermatophyte molds. Chloramphenicol was added to both culture plates to inhibit bacterial growth. Cultures were incubated at 25°C for up to 30 days with daily observations to check fungal growth (1). The identification of the fungal species was performed by observing both macroscopic (macromorphology) and micromorphological aspects of isolated colonies.

The therapy consists of two sessions. Topical anesthesia was added before the session. Patients were treated with long-pulsed 1,064-nm Nd: YAG laser (*Cynosure Elite*®) every month with the following parameters: fluence: 35 J/cm², pulse duration: 25 milliseconds, spot size: 5 mm, frequency: 1 Hz, and the cooling system was stopped. Two passes were done in a 1-minute interval. Two sessions were done for every patient. Photographed images were taken for every participant before and after every session with standard passion and good illumination. Adverse effects were also evaluated during and after sessions, pain, discoloration, paronychia, and slow of growth.

Grading of improvement according to patients' response to treatment. Excellent improvement (normal appearing nail from 81 to 100%), Good improvement (normal appearing nail compared with the area of the initially infected nail from 61 to 80%), moderate improvement (31-60% normal appearing nail) and Mild improvement (less than 30% normal appearing nail) (*12*).

Data were fed to the computer and analyzed using IBM SPSS software version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using numbers and percentages. The Kolmogorov-Smirnov test //

Shapiro-Wilk test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR). The obtained results' significance was judged at $p \leq .05$ at the 5% level.

Results

Ten patients with microbiologically and clinically diagnosed onychomycosis were included in this study. The patients comprised eight women and two men ranging in age from 21 to 70 years (mean age, 40.2 years; standard deviation, 15.85 years). Six patients lived in rural areas, while four lived in urban areas. The disease duration among patients ranged from 1 to 5 years (Table 1).

Four patients (40%) presented with multiple fingernail affection, while three patients (30%) had one fingernail affection. Also, three (30%) patients had multiple toenails affected.

The improvement was variable 2 (20%) patients had excellent improvement, 5(50%) had good improvement, and 3 (30%) had mild improvement. The mean of improvement was $60.50 \pm 26.08\%$ (Figure 1,2).

The treatment was well tolerated by almost all the patients as nine patients (90%) complained of mild to moderate heat sensation causing pain and slow growth of nails in 1 (10%) patient.

In the beginning, mycological clearance was achieved in 20% but at the end of the sessions; mycological clearance was achieved in 80%.

Table 1. Patient characteristics.

History		Long – pulsed (n= 10)	
		No.	%
Demographic data	Sex		
	Male	2	20.0
	Female	8	80.0
	Age (years)		
	Min. – Max.	21.0 – 70.0	
	Mean ± SD.	40.20 ± 15.85	
	Median (IQR)	37.50 (29.0 – 42.0)	
	Address		
	Urban	4	40.0
	Rural	6	60.0
Clinical data	Positive family history	4	40.0
	Onset (Gradual)	10	100.0
	Course (Progressive)	10	100.0
	Duration (years)		
	Min. – Max.	1.0 – 5.0	
	Mean ± SD.	3.0 ± 1.41	
	Median (IQR)	3.0 (2.0 – 4.0)	

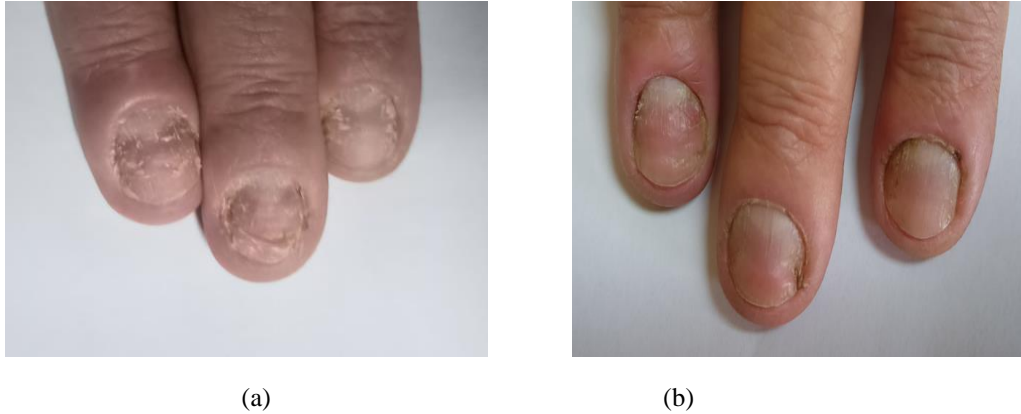


Fig. 1: (a) 59-year-old female patient with onychomycosis before treatment (b) After treatment with long- pulsed Nd:YAG 1,064 nm, with good improvement 70%.



Fig. 2: (a) 35-year-old female patient with onychomycosis before treatment. (b) After treatment with long-pulsed Nd:YAG 1,064 nm, with good improvement 65%.

Discussion

Onychomycosis is a fungal infection of the nail that expands slowly and, if left untreated, leads to the destruction of the nail plate; it can be dermatophytic (99%) and/or nondermatophytic (1%) infections of the nail plate. The Nd: YAG laser is such a device with a wavelength (1064 nm) that passes through the nail plate and into the nail bed,

resulting in superheating of the fungal material. Exposure of fungi to high temperatures inhibits their growth as well as causes cell damage and death (10).

The present study, found that onychomycosis incidence was more in females (80%) than males (20%) in a ratio of 8:2. A similar female predominance was reported in a

previous study (13) that included 35 patients with 18 females and 17males. This female predominance was further reported in another study (14) . According to this study, onychomycosis was more common in housewives which matches with the study of **Singal, Khanna (15)**. Females (specially housewives) are more exposed to household activities like cleaning, washing, etc. Subsequently, their hands and feet are more immersed in water, detergents and chemicals, therefore they are more liable to nail trauma. They are also more concerned about their cosmetic appearance than males.

In the present study, onychomycosis was more common in patients living in rural areas (60%) than in urban areas (40%). These findings go in hand with Ma et al., (16), who reported that 94.12% of their patients lived in rural areas.

In the current study, after the end of the session, the result revealed mycological clearance by culture in 80%, while 20% of patients were still mycologically positive by culture. These results agree with another study [12] on 25 nails of 14 patients who used long pulsed Nd: YAG 1064 nm for four sessions at a one-week interval. They reported a response rate of 63.5% one month after treatment. This is because the amount of

laser energy that can deactivate 80-90% of the organisms in an affected nail does not instantly kill the fungal colonies but limits their ability to replicate or survive (14).

In the current study, at the end of sessions, the result showed a mean improvement percentage of 60.50 %. This result agrees with two studies (13,17), which recorded a mean improvement of 57.50% and 73.3%, respectively.

According to side effects and complaints from the treatment in this study, 90% of patients complained of mild to moderate pain during the laser session and slow growth of nails in 1 patient. Side effects were reported by another researchers (11); they showed that 46% had mild pain , while 28% had moderate pain that decreases every session.

Also, discoloration of the affected nail was reported as a common side effect of the procedure. The limitations of this study include the short follow-up period and patient dropout.

Conclusion

The present study has demonstrated that long-pulsed 1064-nm Nd:YAG laser therapy is a safer and effective choice in treating onychomycosis; it also allows for shorter

treatment duration. Nd:YAG laser treatment is not associated with systemic antifungal drugs' systemic adverse effects or drug interactions.

References

1. Dembskey N, Abrahamse H. The Efficacy of Phototherapy for the Treatment of Onychomycosis: An Observational Study. *Photonics* 2021, 8, 350. s Note: MDPI stays neutral with regard to jurisdictional claims in ...; 2021.
2. El Saftawy E, Sarhan R, Hamed A, Elhawary E, Sameh A. Lasers for cutaneous lesions: An update. *Dermatologic Therapy*. 2022:e15647.
3. Falotico JM, Lapides R, Lipner SR. Combination Therapy Should Be Reserved as Second-Line Treatment of Onychomycosis: A Systematic Review of Onychomycosis Clinical Trials. *Journal of Fungi*. 2022;8(3):279.
4. Gupta AK, Venkataraman M, Quinlan EM. Efficacy of lasers for the management of dermatophyte toenail onychomycosis. *Journal of the American Podiatric Medical Association*. 2022;112(1).
5. Zhang J, Lin P, Li J, Guo C, Zhai J, Zhang Y. Efficacy of laser therapy combined with topical antifungal agents for onychomycosis: a systematic review and meta-analysis of randomised controlled trials. *Lasers in Medical Science*. 2022:1-13.
6. Rhee Y-H, Ryu H-Y, Ahn J-C, Chung P-S. Evaluation of the safety and efficacy of long pulsed Nd: YAG laser in the treatment of vascular lesions in vivo. *Journal of Cosmetic and Laser Therapy*. 2022:1-8.
7. Paasch U. Laser-Assisted Photodynamic Therapy. *Energy for the Skin*: Springer; 2022. p. 203-19.
8. Ricardo JW, Lipner SR. Novel and emerging pharmacotherapy and device-based treatments for onychomycosis. *Nail Therapies: Current Clinical Practice*. 2021:37-48.
9. Gupta A, Stec N, Summerbell R, Shear N, Piguet V, Tosti A, et al. Onychomycosis: a review. *Journal of the European Academy of Dermatology and Venereology*. 2020;34(9):1972-90.
10. Kandpal R, Arora S, Arora D. A study of Q-switched Nd: YAG laser versus itraconazole in management of onychomycosis. *Journal of Cutaneous and Aesthetic Surgery*. 2021;14(1):93.
11. de Mattos Milman L, Reinehr CPH, Chaves CRP. Q-Switched and Drug Delivery. *Drug Delivery in Dermatology: Fundamental and Practical Applications*. 2021:97.
12. Elmorsy EH, Abou Khadr NA, Taha AA, Abdel Aziz DMJLis, medicine. Long-pulsed Nd: YAG (1,064 nm) laser versus Q-switched Nd: YAG (1,064 nm) laser for treatment of onychomycosis. 2020;52(7):621-6.
13. Wanitphakdeedecha R. Treatment of onychomycosis with a long-pulsed Nd: YAG laser. *J Laser Health Acad*. 2011;8:1.
14. Zhang R-n, Zhuo F-l, Wang D-k, Ma L-z, Zhao J-y, Li L-f. Different Numbers of Long-Pulse 1064-nm Nd-YAG Laser Treatments for Onychomycosis: A Pilot Study. *BioMed Research International*. 2020;2020.
15. Singal A, Khanna DJJoDV, Leprology. Onychomycosis: Diagnosis and management. 2011;77(6):659.
16. Ma W, Si C, Carrero LMK, Liu H-F, Yin X-F, Liu J, et al. Laser treatment for onychomycosis: A systematic review and meta-analysis. 2019;98(48).
17. Helou J, Maatouk I, Hajjar M, Moutran R. Evaluation of Nd: YAG laser device efficacy on onychomycosis: a case series of 30 patients. *Mycoses*. 2016;59(1):7-11.

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