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

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Abstract

Onychomycosis is a common nail disease, especially among the elderly. There are now several treatment options for onychomycosis; however, they are restricted by high failure rates, time-consuming nature, high expense, and a significant risk of pharmaceutical 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 trial comprised treatment with a 1064-nm long-pulsed Nd:YAG laser in two sessions separated by four weeks. 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 80%. The result showed that the mean improvement percentage was 60.50%. Mild pain and delayed nail growth were noted after laser surgery. Conclusion: Long-pulsed Nd:YAG laser therapy at a wavelength of 1064 nm is effective and safe for onychomycosis treatment, according to the findings of this study.

Keywords: Onychomycosis, Long-pulsed laser, Fungal culture

Introduction

Onychomycosis is a frequent fungal infection of the nails. Approximately 2% to 13% of the population and 14% to 28% of the elderly population are afflicted by this condition (1, 2). In more than ninety percent of cases, Trichophyton, Epidermophyton, or Microsporum dermatophytes are responsible for onychomycosis (3). In very rare cases, non-dermatophyte fungi (e.g., Scytalidium dimidiatum or Aspergillus niger) and yeasts (such as Candida albicans) may also cause onychomycosis (4).
Nail discoloration is one of the most common symptoms of onychomycosis. Untreated onychomycosis may result in nail thickness, deformation, nail bed separation, and changes to the nail's uneven surface, causing pressure, irritation, and pain (5). Onychomycosis is more of a psychological concern than a medical one, since it may greatly affect the patient's quality of life. Onychomycosis sufferers often lack confidence, avoid social interaction, and have poor self-esteem (6).

Numerous therapy options exist for onychomycosis, but they are restricted by high failure rates, difficult procedures, high costs, and a substantial risk of adverse medication interactions. In addition to topical or oral systemic antifungal drugs and surgical removal of the diseased fingernail or toenail, typical treatment procedures include topical or oral systemic antifungal treatments (7). Oral antifungal medications are the usual and most successful therapy for onychomycosis (8). However, it is often accompanied by the necessity for long-term therapy, many unpleasant side effects, the possibility of drug combinations, and high recurrence rates (9).

In recent years, it has been reported that laser-based therapies for onychomycosis are quite promising. This category include Nd:YAG laser treatments (7) and diode lasers with 870/930 nm wavelengths (10). The Nd:YAG laser with a wavelength of 1064 nanometers penetrates the nail plate and generates heat (43-51°C) deep inside the dermis and nail tissue, superheating the fungus. This laser treatment is fungicidal because high temperatures harm and destroy fungal cells (11).

Therefore, we undertook this research to assess the effectiveness of the mycological outcomes and adverse effects of onychomycosis therapy with a 1064-nm Nd:YAG laser with long pulses.

**Patient and methods**

This prospective study was conducted on 10 patients attending Benha University hospitals, at Dermatology, Venereology, and Andrology Department outpatient clinics over a period of one year from March 2021 and April 2022. The local ethics committee approved the study on research involving human subjects of Benha Faculty of Medicine (MS:19-8-2020). A signed approval was obtained from all patients included. 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 lichen planus, nail psoriasis,
Atopic dermatitis, subungual hematoma, bacterial nail infection, and nevoid formation, using topical or systemic antifungal therapy or any drug affecting the therapy during the treatment, using nail coloring dyes, polishes, or Henna.

All patients were subjected to 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 by 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 ºC for up to 30 days, with daily monitoring of fungal development (1). Species may be recognized by studying the macroscopic (macromorphology) and microscopic (micromorphology) characteristics of fungal colonies that have been isolated.

The therapy consists of two sessions. Prior to the session, a local anesthetic was administered. Patients were treated monthly with a 1,064nm Nd: YAG laser (Cynosure Elite®) with the following parameters: Fluence: 35 J/cm2; Pulse Duration: 25 milliseconds; Spot Size: 5 millimeters; Frequency: 1 hertz; Cooling System: Stopped. Two passes were accomplished in under one minute. 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).

The data were imported into a computer and analyzed using version 20.0 of IBM SPSS software. For qualitative data, numerical and percentage descriptors were supplied. Using the Kolmogorov-Smirnov / Shapiro-Wilk test, the distribution's normality was determined. Quantitative data were defined by the range, mean, standard deviation, median, and interquartile range. At a significant threshold of 5%, p ≤ 0.05 was determined to be the significant level of the acquired findings.

Results

This research comprised ten cases with microbiologically and clinically diagnosed onychomycosis. 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 duration of disease varied from 1 to 5 years across the cases (Table 1).

Four patients (40%) were 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 ± 26.08% (Figure 1,2).
**Table 1:** Patients’ characteristics.

<table>
<thead>
<tr>
<th>History</th>
<th>Long–pulsed (n=10)</th>
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<tbody>
<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>Age (years)</td>
<td>Min. - Max.</td>
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<tr>
<td></td>
<td>Mean ± SD.</td>
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<td></td>
<td>Median (IQR)</td>
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<tr>
<td>Demographic data</td>
<td>Address</td>
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<tr>
<td>Urban</td>
<td>4</td>
</tr>
<tr>
<td>Rural</td>
<td>6</td>
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<tr>
<td>Positive family history</td>
<td>4</td>
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<tr>
<td>Onset (Gradual)</td>
<td>10</td>
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<tr>
<td>Course (Progressive)</td>
<td>10</td>
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<td>Duration (years)</td>
<td>Min. - Max.</td>
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<td>Mean ± SD.</td>
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<td>Median (IQR)</td>
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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%.

**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%.
Discussion
Onychomycosis is a nail infection that develops slowly and kills the nail plate if ignored; it may be dermatophytic (99%) or nondermatophytic (1%) infections of the nail plate. The Nd: YAG laser’s wavelength (1064 nm) penetrates the nail plate and nail bed, superheating the fungus. In addition to destroying and harming cells, high temperatures inhibit the growth of fungus (10).

In this study, the prevalence of onychomycosis was eight times higher in females (80%) than in men (20%). In a prior research (13) with 35 patients, 18 females and 17 males, the same female preponderance was seen by (14). Onychomycosis was more prevalent among housewives, consistent with the findings of Singal and Khanna (15). Females, particularly housewives, are more often exposed to household responsibilities such as cleaning, washing, etc. Consequently, their hands and feet are more often exposed to water, detergents, and chemicals, making them more prone to nail damage. In addition, women are more preoccupied about their beauty than males.

In the present study, onychomycosis was 60 percent more frequent in rural patients than in urban patients (40%). These findings align with those of Ma et al. (16), who discovered that 94.12% of their patients lived in rural areas.

80% of patients in the present research verified mycological clearance by culture at the end of the session, whereas 20 percent remained mycologically positive by culture. Comparable outcomes were seen in a previous research (12) in which 25 toenails from 14 individuals were treated with four sessions of long-pulsed Nd: YAG 1064 nm separated by one week. One month after therapy, they observed a 63.5% response rate. This is due to the fact that the amount of laser energy required to deactivate 80-90 percent of the organisms on a diseased nail does not immediately eradicate the fungal
colonies, but rather inhibits their capacity to proliferate or flourish (14).

The average percentage of improvement at the completion of sessions in this study was 60.50 percent. This result is congruent with the findings of two studies, which indicated a 57.50 percent and 73.3 percent average improvement, respectively (13 & 17).

Ninety percent of patients in this study had moderate to severe pain during laser treatment, and one patient's nail growth was reduced. Another research found that 46% of participants suffered moderate pain, while 28% experienced severe pain that diminished with each session (11).

In addition, discoloration of the nails was discovered as a usual side effect of the procedure. The limitation of this study include a short follow-up time and patient attrition.

**Conclusion**

The current study indicates that prolonged pulses of 1064 nm light inhibit DNA replication. Nd:YAG laser therapy is a safer, more effective, and shorter-lasting treatment option for onychomycosis. There is no link between Nd:YAG laser therapy and antifungal medicines' systemic side effects or drug interactions.

**References**

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