

Long-Term Experience with 1064-nm Nd: YAG Q-Switched Laser Treatment for Onychomycosis

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ABSTRACT

Introduction: laser treatment for onychomycosis has been described as an easy to perform and safe method.

Objective: to evaluate the efficacy and safety of 1064-nm neodymium-doped yttrium aluminum garnet (Nd:YAG) Q-switched laser for the treatment of onychomycosis. **Method:** This retrospective study included 700 patients with suggestive onychoscopy. KOH direct examination confirmed diagnosis of onychomycosis of patients who were treated with 1064-nm Nd:YAG Q-switched laser from April 2012 to December 2023. **Results:** Most of the patients required only 1 session (86%) and showed clinical response at 6 months while 14% required a second laser session. Clinical and mycological response was seen in 100% at 12 months. There were no documented side effects. **Conclusions:** Our long-term experience confirmed the efficacy and safety of Nd:YAG Q-switched laser treatment of onychomycosis.

Keywords: Onychomycosis, Nd:YAG laser.

INTRODUCTION

Onychomycosis is a common disease with a prevalence between 2% to 28% with high recurrence rates [1,2]. The most common pathogens are the dermatophytes *Trichophyton rubrum* (*T. rubrum*) and *T. mentagrophytes*, in 60%-90% of the cases, less common pathogens are other dermatophytes, molds and yeasts [1,2]. Onychomycosis affects fingernails and toenails; however, toenail involvement is more common. The clinical appearance is suggestive and can be supported by dermoscopy, an inexpensive and quick

tool. The dermoscopic features of onychomycosis are ruin appearance (ventral indentations of the nail plate caused by dermal debris), subungual hyperkeratosis, longitudinal striae, onycholysis, distal irregular termination (distal pulverization of the nail plate), chromonychia (multicolored pigmentation), leukonychia and melanonychia [3].

The diagnosis is not only clinical since mycologic laboratory testing is necessary. Direct examination with 5%-40% KOH is the preferred diagnostic tool, it has a sensitivity of 61% (44%-100%) and specificity of 95% (75%-100%) and the report takes only minutes to hours, with the disadvantages that it does not identify the pathogen and is operator dependent. Fungal culture has a sensitivity of 56% (29%-82%) and specificity of 99% (83%-100%) but takes two to four weeks to grow. Lastly, PCR has a sensitivity of 85-100% and specificity of 94%-100% with the disadvantage of higher cost [2].

Current treatments for onychomycosis comprehend topical or oral antifungal medication. Topical treatments have limited efficacy, and oral antifungals are highly effective due to their capability of penetration in nail plates, however they might cause adverse events such as hepatic and renal damage. Considering all this, other therapeutic options have been sought for [1,4].

Laser therapy was approved for onychomycosis in 2010 [1], its mechanism of action is thought to be by its activity on the pigment particles or chromophore groups of the fungal cells by increase of the temperature, thereby inhibiting their growth [5]. Furthermore, it has the benefit of causing few side effects, like mild and limited erythema and swelling after the procedure [6].

Objective

The objective of our study was to assess the effectiveness, time for resolution, minimum of sessions needed to achieve clinical and mycological clearance and safety of the 1064-nm Nd:YAG Q-switched laser treatment of onychomycosis.

METHODS

After searching through the database of the clinic, 700 patients were found and included in the study from April 2012 to December 2023. All patients had a KOH-confirmed diagnosis of onychomycosis. Patients of all ages who had not previously received any type of treatment were included, each patient signed a consent form allowing for clinical photographs of their nails to be taken before and after the laser therapy. Pregnant women, patients with subungual hematoma, taking photosensitizing drugs and those affected by psoriasis, lichen planus or atopic dermatitis with nail involvement were excluded.

Dermoscopy was performed in each patient. The most frequent signs were ruin appearance, longitudinal whitish striae, subungual hyperkeratosis, chromonychia and melanonychia (Figure 1). A direct microscopic test was performed with a mix of 25% KOH and 5% glycerol (1 hour at 51-54°C) for lipid emulsification, and mycological structures were identified under x3400 magnification. This test was performed at the beginning and at the end of the evaluation for each patient.

Laser therapy was performed with 1 of 3 1064-nm Nd:YAG Q-switched laser devices: 1) Monalisa Laser, Sincoheren Co., Xizhimen Beidajie, Beijing, China, 2) Q-Clear TM, Light Age, Inc., Somerset, NJ, USA, and 3) Discovery Pico Quanta System, Milano Italy. Laser settings were adjusted to deliver a fluency of 500-800 mJ/cm² (4-6 J/cm² equivalent) on a 3 mm spot at 5-10 Hz nanoseconds, in a single session. Three applications were performed on a square configuration across the entire ungual plate for each case. Immediate changes after laser light application were observed and determined as nail clearance. Treatment questionnaires and clinical revisions were scheduled at 3, 6, 9, 12 and 18 months after treatment.



Figure 1. Dermoscopic findings: ruin appearance and longitudinal striae.

RESULTS

Seven hundred patients were included in the clinical study, 670 adults and 30 children. Ages ranged between 6 and 79 years. A total of 2800 nails were treated: 2600 toenails and 200 fingernails; twenty patients had both toenails and fingernail involvement. Clinical response was seen in 84% of the patients within 3 months of the laser treatment with proximal healthy grow of the nail (Figure 2). At 6 months 86% showed clinical response and 14% required a second laser session considering the lack of visible proximal healthy grow. At 12 months, all the patients (100%) showed clinical and mycological response

with negative KOH test (Figure 3). There were no side effects at all.

During laser therapy, we observed near instantaneous "clearance" (change in the appearance from dark to clear) of the affected nails, particularly nails that showed melanonychia or dark green pigmentation. Additionally, as the clearance was evident the characteristic cracking sound of the fungus-affected areas of the ungual plate diminished until cessation, similar to what happened when laser treatment was administered to the nearby clinically healthy zones.



Figure 2. Clearance line response at 3 months after treatment.



Figure 3. (A, B) Comparison of toenails showing complete response after 12 months of treatment.

DISCUSSION

Cao Y, et al. [1], confirmed that long-pulsed 1064-nm Nd:YAG laser is effective for treating onychomycosis, and the energy irradiation can change cellular ultrastructure and inhibit colony growth of *T. rubrum* and *T. mentagrophytes*. The Nd:YAG Q-switched laser has been described under this name because it generates high-energy peaks at many repetitions. It produces energy that mechanically damages only the target of interest through selective photothermolysis on the pigment of fungi structures and it does not warm the tissue, so it does not elicit pain.

In a study of Meretsky CR, et al. [4], laser treatment was effective for onychomycosis compared to terbinafine and other antifungals, additionally, mycological cure rates were higher among participants receiving laser therapy as compared to terbinafine (OR = 3.19, 95% CI: 1.39-7.29; $p = 0.05$) with fewer adverse effects. However, the evidence was based on small comparative studies. In the present study a significant number of patients were treated with Nd:YAG Q-switched laser therapy alone showing efficacy at 12 months with both clinical and mycological cures.

Laser therapy has been compared with itraconazole pulses, with similar mycological and dermoscopic cure rate with no statistical difference [7]. A combination of long pulsed Nd:YAG laser and itraconazole pulse therapy gives best clinical results

when compared to itraconazole pulse therapy alone [8]. On the other hand, in the study conducted by Rovers JFJ, et al. [9], after 3 sessions with Nd:YAG laser 1064 nm, only 12.4% of patients had total clinical clearance, and the study conducted by Wanitphakdeedecha R, et al. [6], demonstrated mycological clearance in 40.7% after 1 month (4 sessions) of Nd:YAG. Nevertheless, and as stated in our results, longer follow up time is needed to assess both clinical and mycological cures and to determine if multiple sessions are required, since the nail plate of the toenails can take from months to over a year to fully grow new.

The greatest advantages of laser treatment for onychomycosis compared with traditional treatments such as oral or topical medications are the easy application, scarce contraindications and overall absence of side effects.

CONCLUSIONS

The present study confirmed the efficacy and safety of 1064-nm Nd:YAG Q-switched laser therapy as a sole and an uncomplicated treatment for onychomycosis.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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