

Laser Treatment of Onychomycosis

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Background and Objectives: Onychomycosis is one of the most prevalent diseases in dermatological practice. Laser treatment of onychomycosis is the object of considerable interest. Laser therapy could be a safe and cost-effective treatment modality without the disadvantages of drugs. This study investigates the clinical effect of Q-Switched 1064/532 nm and Nd: YAG 1064 nm lasers.

Materials and Methods: A trial was carried out in 80 patients (aged 27-80) with the diagnosis of toenail onychomycosis confirmed by laboratory findings (microbiological and microscopic). Patients of the experimental group (N=40) received laser therapy as follows: 1 exposure every other week for 6 months, a total of 12 sessions. Controls received systemic antifungal itroconazole by the pulsed therapy protocol during 3 months.

Results: Clinical cure without side effects was attained in 90% of patients in the study group, vs. 85% patients in control group, with 7.5% patients (controls) developing side effects (nausea, vomiting, diarrhea).

Conclusions: This study indicates that Q-Switched 1064/532 nm and Nd: YAG 1064 nm laser therapy is comparable by efficiency and safety with systemic antifungals.

Key words: onychomycosis, laser therapy, Q-Switched 1064/532 nm laser, Nd:YAG 1064 nm laser

INTRODUCTION

In recent years onychomycosis prevalence in Europe and Russia has been increasing so fast that some experts talk about its epidemic. According to the latest epidemiologic research fungal infections affect between 7% and 15 % of adults. Onychomycosis incidence increases with age, fungal infections of the nail seldom affect children and widely affect adults, 50% of onychomycosis cases occur in patients of 70 years of age and older. [1] Vascular insufficiency (especially, diseases of lower extremity vessels), obesity, platypodia and other talipes play a big role in onychomycosis development. [2]

Onychomycosis is caused by different fungi, i.e. dermatophytes, yeasts, and molds, and the role of the latter is not quite clear. Dermatophytes account for about 90 % of all fungal infections of the nail. The dermatophytes that are typically responsible for onychomycosis are *Trichophyton rubrum* and *Trichophyton mentagrophytes*. [3]

Other dermatophytes are responsible for about 3% of onychomycosis cases. [4] Yeast fungi in the genus *Candida* are less common onychomycosis pathogens than dermatophytes. They mainly affect fingernails and account for 40-60% of all cases and are involved only in 5-10% of toenail onychomycosis cases. *Candida albicans* is the main causative organism of candidal onychomycosis (in more than 90% of cases). The infections caused by mold fungi are most commonly found in tropical and subtropical climates. *Scytalidium dimidiatum* (*Natrassia magniferae*) and *Scytalidium hyalinum* are the most prevalent mold fungi and as pathogenic as dermatophytes. In European countries various mold fungi such as *Scopulariopsis brevicaulis*, *Aspergillus* spp., *Fusarium* and *Acremonium* are described as the causative agents of onychomycosis. [5]

Onychomycosis is of great importance because it has a global distribution among the population and can be challenging to manage due to the anatomico-physiological characteristics of the nail. [6]

There has been a resurgence of interest in the potential of energy-delivery technologies such as lasers, for the local treatment of fungal nail infection. The term "laser" (from eng. Laser – Light Amplification by Stimulated Emission of Radiation) means light amplification by stimulated emission of radiation. [7] The rationale for using a laser source for the treatment of nail fungus stems from their thermocidal and bactericidal effects via localized photo-thermal or photo-chemical skin-nail interaction in the affected fungus nail. Laser therapy has become one of the most notable scientific achievements of the 20th century.

[8] There are 2 laser type modules that can be used on the Harmony XL (Alma Lasers Ltd.) multi-application platform (Figure 1) for the treatment of nail fungus: 1) Nd:YAG 1064-nm laser module; and 2) Q-switched Nd:YAG 1064-nm laser module. The Nd:YAG 1064-nm handpiece delivers high average power energy of up to 6W. Fluence (up to 200mJ/p) and repetition rate (up to 30Hz) are adjustable. The optical energy by the Nd:YAG lasers is aimed to 1) being absorbed in the region between the nail plate and the nail bed based on the principle of selective photo-thermolysis where the temperature is increased to thermally deactivate the unwanted organism without causing substantial unwanted injury or substantial permanent injury to surrounding tissue; 2) Non specific heat conduction is introduced by the laser beam where the unwanted organism is thermally deactivated as the target area absorbs the beam of radiation and transfers the thermal energy to the unwanted organism. There is supporting evidence of pigment-related photothermolysis of *T. rubrum* by the Q-Switched laser that are well absorbed by red and brown pigments rather than inhibition due to nonspecific thermal damage. Because of its xanthomegnin content the QSW Nd:YAG 1064-nm laser is well absorbed by the red pigment which is abundant in *T. rubrum*. Xanthomegnin is a diffusible pigment produced by *T. rubrum* which confers its prominent red pigment and melanin pigment both seen in *T. rubrum* culture. Although the wavelength of Nd:YAG 1,064 nm is beyond the absorption spectrum of xanthomegnin, inhibitory effects on the colonies treated with this wavelength might be due to melanin, as it is known that Trichophyton species contain melanin in their cell walls.

METHODS

In this observational trial 80 patients aged 27 to 80 with histologically verified toenail onychomycosis were included. The disease duration period ranged from 1 to 10 years.

The key inclusion criterion was a diagnosis of onychomycosis affecting fingernails and/or toenails by clinical nail morphology confirmed by positive fungal microscopy. Exclusion criteria were: patients with a history of keloid, localized bacterial infections, concomitant nail disease such as psoriasis, lichen planus or atopic dermatitis, or other skin diseases that may interfere with diagnosis and treatment; with allergy to drug used in the study; with heart, liver, kidney diseases, diabetes, or mental illness; had taken oral antifungal medication within the last 3 months or used topical antifungal medication within the last 2 weeks; had taken oral glucocorticoids or immunosuppressants within the last 3 months; with nail polish; and pregnant patients. Patients with negative fungal culture were not excluded if fungal microscopy was positive.

The experimental group consisted of 40 patients (12 male and 28 female) aged 32 to 80 (median 57.9 years) with laboratory verified diagnosis. In cultural study *Trichophyton rubrum* was found in 62% of patients, *Trichophyton mentagrophytes* var. *Interdigitale* in 33%, *Epidermophyton floccosum* in 2%, *Candida albicans* in 3%, Fungi in 2%. The inclusion criterion was as follows: the presence of 3 or more affected nail plates on both feet. The clinical appearance of the damaged nail plates in the experimental group was characterized by subungual hyperkeratosis; thickened, brittle, irregular and white to yellow/brown nail plates.

All patients received laser therapy with the following regimen: one procedure every 2 weeks during 6 months. We used Harmony PRO system (Alma Lasers) which combines 2 laser modules: Q-Switched double frequent 1064/532 nm (KTP) 3mm spot size and Nd: YAG 1064 nm 5mm spot size. Every procedure lasted from 20 to 30 minutes for 10 toenails. At first we treated nails with Q-Switched 1064/532 nm double frequent KTP 3mm tip, which targets mold spores shell. After that we treated with Nd: YAG: 1064 nm laser 5mm spot. This laser can increase the temperature of local nail and its underlying tissue up to 42 °C and at depth of 5-7 mm which warms up nail plate and nail bed, thus it plays a direct role in deactivating and killing the fungi in the laser-treated affected nail. Laser beam, penetrating into the nail and under the nail plate, has fungistatic and fungicidal effects on mycelia without damaging the tissue of the nail plate and under nail area itself. Every affected nail plate was exposed to influence of 2 lasers in vertical and horizontal lines covering the entire nail surface area.

There was no need to use anesthesia during the treatment. The main course consisted of 10 procedures in all patients regardless of damaged nails quantity.

The control group included 40 patients (17 male and 23 female) aged 27 to 70 (median 55 years) with laboratory confirmed toenail onychomycosis. In these patients using inoculation we found etiological agents as follows: *Trichophyton rubrum* in 54% of patients, *Trichophyton interdigitale* in 38% of patients, *Candida Albicans* in 5% of patients, Fungi in 3%. The clinical features were the same as in the experimental group. All patients took terbinafine 250 mg/day for 3 months.

Before the treatment we applied Mycospor on the nail plates to remove the damaged part of the nail plate in both groups. As topical therapy we administered Ciclopirox 8% nail varnish 2 times a week for 6 months.

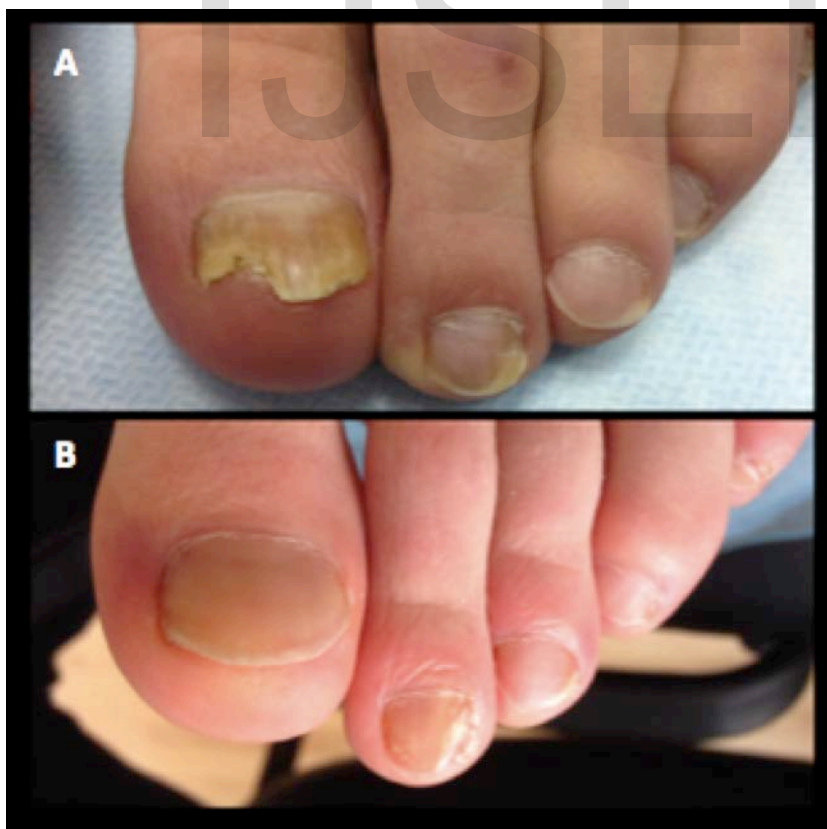
RESULTS

70% (28) of patients in the experimental group showed considerable improvement in the form of normal toenail growth from the proximal side. After 4 months of treatment 75% (30) of patients examined the healthy nail growth without subungual hyperkeratosis (Fig. 1). In 6 months after laser therapy in 90% (36) of patients we noticed a growth of the healthy whole nail plate for more than 60% of its size with normal colour and thickness. This condition is evaluated as a complete cure. 2 (5%) patients showed significant improvement, 2 (5%) patients – improvement. These patients were recommended to continue laser therapy.

All the patients showed high tolerance to the treatment. Some patients (25%; 10 patients) experienced mild stabbing pain which however didn't require an immediate treatment cessation. In 6 months after the laser treatment all patients had negative fungal culture.

As a result of systemic therapy in 34 (85%) patients of the control group we observed a complete response, in 2 (5%) – clinical improvement, in 4 (10%) – improvement. 7.5% (3) of patients experienced such adverse effects as epigastrium and right upper quadrant discomfort, diarrhea, nausea, reversible loss of taste sensation.

Figure 1. A – Pretreatment; B – Posttreatment (after 8 laser sessions)



DISCUSSION

The new diagnostic and treatment methods for onychomycosis are well known among the specialists however there are certain difficulties in managing fungal infections of the nail. Systemic medications and topical antifungals (ointment, cream, nail lacquer, and their combination) are usually used in a standard treatment. [9] Apparatus methods have been successfully applied for removing the affected nail plates. Onychomycosis favors older persons with associated severe diseases, immunocompromised, and having contraindications to systemic antifungals, all that leads to certain difficulties in reaching a complete cure. [10]

Every patient needs an individual treatment based on the causative organism, localization, nail growth rate, aging, associated diseases, antifungals actions and their sensitivity, otherwise the treatment will not be successful. Topical therapy proved to have no serious side and toxic effects, which were reported in systemic therapy. Topical medications don't enter the bloodstream that's why such a treatment is safe. At the same time topical therapy has some disadvantages, for example, after applying on the nail surface topical medication not always reaches the pathogen – fungus – localized in the nail bed or in the nail matrix. Topical therapy is obviously ineffective if the nail matrix is affected, besides it requires more efforts and time. [11, 12]

Topical therapy is effective for fungal infections involving small area, but when the degree of involvement is severe systemic therapy is used despite side effects and contraindications. [13, 14]

Thus, laser therapy for onychomycoses is an effective and safe method which can be comparable to systemic antifungals. This treatment may significantly improve the life quality and expand the choice of onychomycosis treatment.

The above-described onychomycosis treatment results in a clinical response regardless of the mycoses species. There are no contraindications, adverse effects (e.g. stabbing) are rarely observed and don't require an immediate treatment cessation.

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