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Q-switched 1064 nm Nd:YAG Laser Therapy in Onychomycosis

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ABSTRACT

Background: Recently, laser therapy in onychomycosis has become an alternative treatment because it is a minimally invasive procedure and positive results can be obtained in a few sessions. Our aim in our study was to evaluate the results of Q-switched neodymium-doped yttrium aluminum garnet (Nd:YAG) laser in the treatment of patients followed up with the diagnosis of onychomycosis.

Materials and Methods: Twenty-six patients with a diagnosis of onychomycosis were included in the study. Q-switched Nd:YAG laser treatment was applied for a total of three sessions every two weeks. The patients were re-evaluated one month after the last session.

Results: The most common type of onychomycosis was the distal lateral (73.1%) type. The average of the onychomycosis score index values, which were measured to evaluate the clinical response, decreased significantly after the treatment (p=0.001).

Conclusion: Q-Switched Nd:YAG (1064 nm) laser is a safe method in onychomycosis patients. It can be recommended especially in patients who do not want to use oral antifungals or have contraindications. Longer sessions may be required for effectiveness.

Keywords: Q-switched Nd:YAG laser, Onychomycosis, Nail

Introduction

Onychomycosis is a fungal infection of the nail caused by dermatophytes, non-dermatophytic molds or candida species. Although it is seen in 10% of the population in general, it is observed in more than 50% of those over the age of 70 [1]. Clinical findings, microscopic examination and mycological culture are used in diagnosis. When onychomycosis is not treated, a non-cosmetic appearance, pain and secondary bacterial infections of the nails may occur. In treatment, chemical debridement, topical antifungals and systemic antifungals are used alone or in combination [2]. In recent years, laser therapy has become an alternative treatment for onychomycosis. Most laser systems use heat effects or work with the breakdown of fungal structures and the production of toxic reactive oxygen species, thereby disrupting the mitochondrial membrane potential [3].

In the literature, there are onychomycosis treatment results with various laser types [4,5,6]. Carbon dioxide (CO_2) laser, kills fungi by directly disrupting the tissues [7]. On the other hand, the CO_2 laser is no longer used due to its pain and trauma side effects. In a study, it was shown that a long-pulse neodymium-doped yttrium aluminum garnet (Nd:YAG) laser with a wavelength of 1064 nm could cure 52% of 154 infected nails in 33 onychomycosis patients [8]. Another approach is the idea that fungal hyphae can be destroyed with extremely short pulses of a Q-switched laser [9].

However, studies with more case series are needed to select the standard treatment plan and the best dose regimen. Our aim in

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our study is to evaluate the results of Q-switched Nd:YAG laser in the treatment of onychomycosis and compare them with the data in the literature.

Materials and Method

Twenty-six patients diagnosed with onychomycosis after clinical and microscopic examination were included in the study. Demographic characteristics, nail fungus type, treatment history and onychomycosis score index (OSI) values of the cases were recorded. Informed consent form consent was obtained from the patients. Pregnant women, cases with subungual hematoma or nevoid formation in the nail, and participants with diseases affecting the nail plate (such as lichen planus or atopic dermatitis) were not included in the study. Clinical and mycological evaluations were performed before the treatment and one month after the last session of the laser treatment (Figure 1).

Determining Onychomycosis Severity

The nail area held (1-10=1, 11-25%=2%, 26-50=3, 51-75%=4%, 76-100=5), the proximity of the disease to the matrix (matrix involvement=5), whether it is >2 mm dermatophytoma or subungual hyperkeratosis (absent=0, present=10) are evaluated and the obtained scores are collected [10].

Laser Therapy

Q-switched 1064 nm Nd:YAG Laser (Lutronic, Spectra) was applied to the patients for three sessions with an interval of two weeks. The parameters used were determined as, 8 J/cm^2, spot size 4 mm and frequency 5-Hz. Laser scanning was performed on the nail plate, proximal and lateral nail folds and hyponychium. No anesthetic was applied before the laser. The endpoint during laser application was that the patient felt pain. No side effects were observed during or after laser application in the patients. Patients who completed three sessions of treatment were re-evaluated one month after the last session. Patients were instructed not to use any other antifungal therapy during this treatment. No side effects were detected in the patients who were called for control one month after the treatment.

Figure 1. Pre-treatment and post-treatment images

Before starting the study, approval was obtained from the Malatya Clinical Research Ethics Committee (decision no: 2019/13, date: 06.02.2019).

Statistical Analysis

All data were expressed as mean ± standard deviation and statistically analyzed with SPSS 19.0 (SPSS Inc. USA). The clinical profile of the patients was analyzed with the chi-square test for qualitative variables. Student's t-test was used to compare quantitative variables. A probability level of 5% was considered statistically significant ($p<0.05$).

Results

Demographic and clinical data are shown in Table 1. A total of 26 patients were included in the study. The mean age of the patients was 50.6±12 years. Sixteen (61.5%) of the patients were female and 10 (38.5%) were male. Three patients had hand involvement, one patient had both hands and feet, and all the remaining patients had foot involvement. The most common type of onychomycosis was distal lateral (73.1%), and the second most common type was total dystrophic (26.9%).

After treatment, culture growth was detected in all patients except three patients. The most abundant fungal type in culture was dermatophytes. All of the dermatophytes were trichophyton species. Candida grew in pretreatment culture in only one patient.

All of the patients were in the moderate and severe groups according to the OSI scoring. While 24 patients were evaluated as moderate according to the OSI scoring, two patients were in the severe group. After treatment, the OSI values of two patients decreased from severe to moderate. After treatment, nine patients continued to be in the severe group according to the OSI assessment, but their scores decreased. A statistically significant decrease was found in the mean of OSI values measured before and after treatment (p=0.001) (Table 2).

Table 1. Demographic and clinical data

		Number (n)	%
	Female	16	61.5
	Male	10	38.5
Onychomycosis type	Distal lateral	19	73.1
	Total dystrophic	7	26.9

Table 2. Onychomycosis severity index scores

	Mean ± SD	Median (min-max)	p-value
Before treatment	25.7±7.0	26 (9-35)	0.001
After treatment	22.2±6.9	22 (9-35)	

min-max: Minimum-maximum, SD: Standard deviation

Discussion

Onychomycosis is a difficult disease to treat. Because the infection is embedded in the nail. Topical antifungal agents hardly penetrate the nail plate and do not provide local therapeutic effect. Systemic oral antifungal agents are not suitable for some patients with abnormal liver function [2,11,12]. Laser therapy appears to be a promising new treatment regimen with its low side-effect profile and easy applicability.

The incidence of onychomycosis increases with age and is most common in the age range of 40-60 years [13]. The age of the patients included in our study was 50.6±12 years, consistent with the literature. The majority of the patients were women (61.5%). In our study, dermatophytes were detected most frequently in fungal culture. Elmorsy et al. [14], in their study comparing the efficacy of Q-switched Nd:YAG laser and long pulse Nd:YAG laser in the treatment of onychomycosis, found candida as the most common agent.

Although a significant decrease was detected in OSI scores after laser treatment in our study, culture positivity was detected in all patients, except three, as a result of the culture performed one month after the treatment. It was thought that this may be related to the early detection of the culture and the low specificity of the fungus culture [15]. The low negative rates in fungal culture in the early period may be due to the fact that laser energy does not kill all fungal colonies in the infected nail and limits their ability to proliferate and survive [16]. In their study, Elmorsy et al. [14] reported that in 10 onychomycosis patients who applied five sessions of laser treatment with 1064 nm Q-switched Nd:YAG laser once a month, they found the rate of mycological clearance as 30% immediately after the last laser session and 50% at the 6-month follow-up [n]. Kim et al. [17] found clinical improvement with Nd:YAG laser treatment in onychomycosis patients as 47.6% and 57.1% at 12 and 24 weeks, respectively. In a study comparing the number of 1064 nm Nd-YAG laser applications to onychomycosis patients, the efficacy was found to be higher in the group with more applications and in patients with milder disease severity [18].

In the literature, it has been reported that the mycological and clinical efficacy of combining topical drugs with laser therapy is significantly higher than laser therapy alone [19]. In a clinical study in which the efficacy of Q-Switched Nd:YAG (1064 nm) laser in the treatment of onychomycosis was compared with oral itraconazole, one group of patients received weekly laser treatment and the other group received itracanazole treatment for 3 months. It was found that Q-switched Nd:YAG laser (1064 nm) application in onychomycosis patients was more effective than itraconazole in 3-month treatment, and both methods were effective in one-year follow-up [20].

The exact mechanism of laser therapy in onychomycosis is still under investigation. Various laser and light sources used in the treatment of onychomycosis have the potential to destroy dermatophytes by various methods, including photothermal and photochemical effects. Q-switched Nd-YAG lasers exert both selective photothermal and photomechanical effects on the fungus. It is thought that denaturing one or more molecules in the pathogen in this way can inactivate the fungi [21]. Another possible mechanism is to stimulate the immune system response to attack the organism. All of these hypotheses describe how the host cells surrounding the infected tissue are protected from this attack with little or no damage [22].

In our study, the patients did not have any complaints other than mild pain during the procedure, and no side effects were observed during and after the procedure. Similar side effects have been reported in the literature, most commonly mild, tolerable pain. In a study comparing the effectiveness of long-pulsed Nd:YAG (1064 nm) laser and Q-Switched Nd:YAG (1064 nm) laser in onychomycosis, it was found that Q-Switched Nd:YAG laser has fewer side effects than long pulse Nd:YAG laser in terms of pain intensity during the procedure [14].

Study Limitations

The low number of participants and the short follow-up period are the limitations of our study.

Conclusion

We believe that Q Switched Nd:YAG (1064 nm) laser is a safe treatment method in patients with onychomycosis. It can be recommended especially in patients who do not want to use oral antifungals or who have contraindications. However, we think that longer sessions and longer follow-up periods may be needed for effectiveness.

Ethics

Ethics Committee Approval: Before starting the study, approval was obtained from the Malatya Clinical Research Ethics Committee (decision no: 2019/13, date: 06.02.2019).

Informed Consent: Informed consent form consent was obtained from the patients.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: N.A., İ.D., K.N.Ö., S.Ş., Concept: N.A., D.T., İ.D., Design: N.A., S.Ş., Data Collection or Processing: N.A., İ.D., Analysis or Interpretation: D.T., Literature Search: N.A., D.T., İ.D., K.N.Ö., Writing: N.A., İ.D.

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