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Case Report

Q-switched Nd:Yag 1064 nm laser therapy for onychomycosis: Two case reports

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Abstract Onychomycosis is the most common nail disease. Current treatment strategies include the use of oral and topical antifungals. Laser is one of the therapeutic options that can be used. We report 2 cases of onychomycosis with distolateral subungual and proximal subungual types, in which nail discoloration and subungual hyperkeratosis were found. Onychoscopy examination revealed longitudinal lines and jagged spikes. Potassium hydroxide examination was positive in both cases, with spores found in the first case and long hyphae in the second case. Culture examination from nail scrapings showed identification of Candida tropicalis, and PCR sequencing examination in the second patient showed identification of Aspergillus persii. Based on the history, physical examination, and investigations, the diagnosis of non-dermatophyte onychomycosis was established. Treatment with Q-switched Nd:Yag 1064 laser, with spot sizes of 3mm, 4Hz, and 1000 mJ/P, and a 2-week treatment interval were given to the patient with 3 dan 4 sessions, respectively**.** Q-switched Nd:Yag laser are by photothermolysis, targeting xanthomagnin and melanin so that it has a fungicidal effect Clinical response was observed to improve after 3 and 4 times of therapy with Q-switched Nd:Yag 1064 laser, with spot sizes of 3mm, 4Hz, and 1000 mJ/P, and a 2-week treatment interval. Laser therapy modalities still have a low cure rate as a single therapy for onychomycosis. Combination oral therapy and laser therapy should be suggested to accelerate healing and provide maximum results.

Key words
Candida; Laser treatment; Non dermatophyte; Onychomycosis; Qswitch Nd:Yag.

Introduction

Fungal infections of the nails can be caused by dermatophytes or non-dermatophytes, either yeast or mold. In general, clinical symptoms include discoloration of the nails, onycholysis, and thickening of the nail plate. Other parts of the nail, such as the nail matrix and nail bed, may also be involved.[1–3] Onychomycosis is a fungal infection of the nails caused by non-dermatophyte organisms and yeast. The most common non-dermatophyte organisms associated with onychomycosis are *Scopulariopsis brevicaulis, Acremonium spp., Aspergillus spp., Fusarium spp. and Neoscytalidium* and cause 10% of onychomycosis of the toenails.[4] Onychomycosis caused by yeast is most likely caused by Candida spp. and is more likely to be the cause of 30% of onychomycosis in fingernails.[4,5] Clinically, onychomycosis is divided into 3 types, distolateral subungual onychomycosis, proximal subungual onychomycosis, and superficial white onychomycosis.[4,6]

Onychomycosis therapy aims to remove the fungal organism and return the nail to its normal

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Figure 1 Digiti I, III, IV, V right hand and digiti I left hand had yellowish white spots on the proximal part of the nail, followed by onycholytics in that area.

state as it grows. The main therapy is systemic antifungals, but we need to pay attention to the patient's condition, especially in patients with liver and kidney disorders. Topical therapy in for nails takes a long time, up to several months. Laser is one of the therapeutic options that can be used. The main principle of laser is selective photothermolysis.[7]

Two cases of onychomycosis were reported with distolateral subungual and proximal subungual types caused by non-dermatophyte fungi, namely *Candida tropicalis* and *Aspergillus persii*, which experienced clinical improvement with q-switched Nd:Yag 1064nm laser therapy.

Case Presentation

Case 1 A 70-year-old male patient came with complaints of 2 months of dull and brittle fingernails. The patient began to feel the lower part of his right middle finger looking bumpy and brittle. Over time, both thumbs experienced the same thing, followed by the fourth and fifth fingers of the right hand. The patient also feels that the color of the fingernails has become duller. The patient is a pensioner. Since the emergence of the COVID-19 pandemic, patients often wash their hands every time they carry out activities for fear of being exposed to COVID-19. There was no history of trauma to the nails. There is no medical history; the patient has never treated his complaint. History of diabetes mellitus and hypertension was denied. History of food allergy and drug allergy was denied.

On dermatological examination, the nails of digiti I, III, IV, V right hand and digiti I left hand appeared with dull white spots on the proximal part of the nails followed by longitudinal lines on the nails, and fragility **(Figure 1)**. Onychoscopy obtained a longitudinal line parallel to the nail and appeared fragility in the proximal part of the nail **(Figure 2)** Investigations were carried out by scraping the nails by scraping the proximal part of the nails and followed by microscopic examination with 20% KOH for nails. On microscopic examination, the appearance of spores was obtained.

Culture of nail scrapings on SDA on the 10th day of culture showed a macroscopic appearance of yellowish-white colonies, with a smooth and slightly wrinkled structure, with an appearance

Figure 2 Onychoscopic examination of the patient, longitudinal lines parallel to the nails and brittle.

Figure 3 Comparison before therapy to after the 3rd therapy in the 6th week.

similar to Candida spp. Then, microscopic examination was performed using Lactophenol Cotton Blue (LCB) staining and found pseudohyphae and budding yeast cells. To identify the causative fungal species, a follow-up MALDI-TOF examination was carried out with the Vitek-MS tool; the identification results were found to be *Candida tropicalis*.

From the history, physical examination, and supporting examinations, the patient was diagnosed with subungual proximal onychomycosis, with *Candida tropicalis* as the causative agent. Patients were given Q-switch Nd:Yag 1064 nm therapy with a spot size of 3mm, a fluence of 1000mJ/P and a PRR of 4 Hz, with an interval of 1 treatment per 2 weeks.

After the third laser therapy (6th week of control), the fragility of the nails appeared to decrease. There was an improvement of all the nails. Comparison of nails before treatment to the 6th week of control **(Figure 3)**.

Case 2 A 40-year-old male patient came with a complaint of 3 years thickening of the tips of both toenails. The patient felt that the tip of the 3rd fingernail on the right foot thickened. Gradually the tip of the second toe of the right foot also experienced the same thing. Brittle of the nail when the patient cut his nail was observed. The patient was an office worker who often wore closed shoes, had a history of frequent hiking and use of mountain sandals. History of treatment with the topical drug Emtrix for approximately 6 months, but no

Figure 4 Subungual hyperkeratosis was seen followed by a yellowish and brittle discoloration of digits II and III pedis dextra.

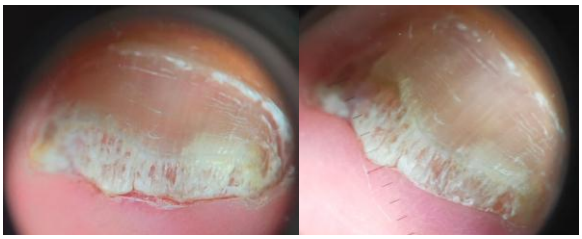

Figure 5 Onychoscopic examination of the patient, obtained an irregular thorn with a longitudinal line

improvement was felt so the patient stopped the treatment. History of diabetes mellitus and hypertension was denied. History of food allergy and drug allergy was denied.

Dermatological examination noted that the digiti II and III pedis dextra nails showed subungual hyperkeratosis, discoloration, and fragility **(Figure 4)**.

Onychoscopy was done with noted irregular spines with longitudinal lines were found **(Figure 5)**. On potasium hydroxide examination, long hyphae were found to be insulated and branched. PCR sequencing examination of the patient's nail preparations was carried out, and

the result of the identification of *Aspergillus persii* was obtained.

The patient was diagnosed with dorsolateral subungual type of onychomycosis, with *Aspergillus persii* as the causative agent. Patients were given Q-switch Nd:Yag 1064 nm therapy at 2-week intervals, with a spot size of 3mm, a fluence of 1000mJ/P and a PRR of 4 Hz. Treatment was given 4 times. There appears to be good nail growth in the proximal part, but in the distal part there is still subungual hyperkeratosis. Comparison of nails before treatment to the 8th week of control **(Figure 6)**.

Discussion

In 2012, the FDA determined that several therapeutic lasers could be used for adjuvant therapy in onychomycosis, such as short-pulsed and Q-switched Nd:Yag, CO2 lasers, and diode lasers.[8] When the laser light penetrates the skin, the melanin present in the cell wall of the fungus is selectively absorbed, thereby providing an antifungal effect. After being absorbed selectively by the target color base, the laser energy can be converted into rotational and vibrational energy composed of biological molecules, which stimulates the thermal motion of the biological molecules, thereby increasing the temperature in the irradiated local tissue. Temperature causes cellular proteins to experience oxidative stress, causes cell apoptosis, and kills up to 90% of microorganisms. Maximum effectiveness is obtained with a firing duration shorter than the target chromophore's thermal relaxation time. Penetration of the nail plate and targeting of the fungus occurs at a wavelength of 750 to 1300 nm. Q-switched Neodymium (Nd) yttrium-aluminum-garnet (YAG) is a therapeutic option for treating fungal nail infections with mixed results.[7]

The Q-switched Nd:Yag 1064nm laser is a non-ablative laser widely known to be used for rejuvenation, removing tattoos especially black and blue, for vascular disorders, and also for hair removal. Apart from the uses above, the Q-Switched Nd:Yag laser can also be used to help treat onychomycosis. The workings of this q-switched Nd:Yag laser are by photothermolysis and targeting xanthomagnin and melanin so that it has a fungicidal effect.[9,10]

In this case, the patient was given Q-switched Nd:Yag laser therapy with 3 mm spot size, 4 Hz, 150 J, and 1000 mJ/P fluence with an interval of 2 weeks.[11] A case report by Espirito reported that 3 treatments with an interval of 2 weeks with 1.5mm spot size, 1 Hz, and 500mJ/P gave satisfactory clinical and mycological results, and did not show relapse after 3 months.[12,13] Research shows that the goal of onychomycosis therapy is to eliminate the infecting fungal organisms and return the nail to its normal state as it grows. Using the principle of selective photothermolysis, the laser has a photothermal effect on the fungus, with chitin adding to the heating effect. Because a temperature of 50^0C is

Figure 6 Comparison before therapy and after 4th treatment.

required to achieve this fungicidal effect, the use of pulse duration minimizes pain and reduces complications, including necrosis. Temperatures above 50°C have been shown to have an immediate thermal killing effect on fungal mycelia. The chitin surrounding the fungal mycelium is slow to dissipate heat, resulting in heat build up and an increase in temperature, producing a fungicidal effect. Energy absorption by the fungus chromophores xanthomegnin, chitin, and melanin has a further fungicidal effect. Maximum efficacy is obtained with a shorter pulse duration than the target chromophore thermal relaxation time. Penetration of the nail plate and targeting of the fungus occurs at a wavelength of 750 to 1300 nm.[2,8] In these two cases, after laser treatment for 3 and 4 times of therapy, clinically minimal improvement was obtained, but mycological, there was still colony growth on SDA culture.

Conclusion

Laser therapy modalities still have a low cure rate as a single therapy for onychomycosis. Combination oral therapy and laser therapy should be suggested to accelerate healing and provide maximum results.

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