

Therapeutic Efficacy of Q: Switched Nd: Yag LASER in Onychomycosis**Parul Goyal¹, Gurveer Singh Rana², Lamya Grewal³, Fanish Godara⁴, Vasav Rathore⁵, Anurag Sood⁶**^{1,3,4,5}**Junior Resident, Department of Dermatology, Venereology and Leprosy, Maharishi Markandeshwar Medical College and Hospital, Kumarhati, Solan**²**Junior Resident, Department of Dermatology, Venereology and Leprosy, Government Medical College, Patiala**⁶**Assistant Professor, Department of Dermatology, Venereology and Leprosy, Maharishi Markandeshwar Medical College and Hospital, Kumarhati, Solan****Received: 25-08-2024 / Revised: 23-09-2024 / Accepted: 26-10-2024****Corresponding Author: Dr. Anurag Sood****Conflict of interest: Nil****Abstract:****Background:** Onychomycosis (OM) is a slow-growing nail fungal infection that if left untreated, may result in the total loss of the nail plate. Oral and topical antifungal therapy are usually prescribed to patients for treating onychomycosis. Non-pharmacological therapeutic techniques such as photodynamic therapy, diode lasers, long pulse and Q switched-Nd-YAG LASER, and fractional CO₂ lasers have recently become popular for treating the OM.**Objective:** This study was conducted with the aim to study the safety and efficacy of Q switched Nd: Yag LASER in OM.**Methodology:** Total 130 nails from 11 PAS positive onychomycosis patients were selected based upon the inclusion and exclusion criteria. Each nail received 4 sessions for fingernails and 6 sessions for toe nails of Q-switched Nd-Yag LASER (nanosecond pulse) therapy at 2 weekly intervals. In each session three passes were given at a gap of 30 seconds. Evaluation by OSI was carried out before starting therapy and then every 2 weeks for 3 months and then monthly till end point of therapy.**Results:** The mean age of the patients was 45.09 ± 12.06 years with a predominance of females (63.63%). The mean size of the infected area was 4.63 ± 1.02 mm. The morphology of the nail indicates DLSO in 44 (33.85%) nails, endonyx in 19 (14.62%) nails, PSOM in 37 (28.46%) nails, and WSO in 30 (23.08%) nails. The mean OSI exhibited a significant linear declining trend over the increasing number of therapy sessions.**Conclusion:** In patients with onychomycosis, we think the Q Switched Nd: YAG (1064 nm) laser is a safe therapy option. It may be especially advised for people who are contraindicated or who would prefer not to use oral antifungals. Nonetheless, we believe that in order to be effective, lengthier follow-up times and sessions may be required.**Keywords:** Onychomycosis, DLSO, Endonyx, PSOM, WSO, Q Switched Nd: YAG.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Onychomycosis (OM) is a slow-growing nail fungal infection that if left untreated, may result in the total loss of the nail plate. Onychomycosis is an infection of the nail which is dermatophytic in the 99 percent of cases or can be nondermatophytic in only one percent of cases [1,2]. *Trichophyton rubrum* and *Trichophyton mentagrophytes* are the most common pathogens, accounting for up to 90% of cases.

There are various clinical type of OM including distal and proximal subungual, endonyx, white superficial, and total dystrophic [3,4]. Onychomycosis affects 0.5–12% of individuals in India and around 5% of people globally [5]. Onychomycosis (fungal nail infection) is caused by

three groups of fungal pathogens namely dermatophyte molds (DM), non-DM (NDM) and yeasts. While NDM often affects toe nails, dermatophytes can affect both finger and toe nails. NDM are plant pathogens that are saprophytic [6,7].

There are several forms of onychomycosis, including complete dystrophic, proximal subungual, endonyx, white superficial, and distal subungual. The most prevalent kind, called distal subungual onychomycosis (DSO), affects the nail bed and then the nail plate. On the surface of the nail plate, white superficial onychomycosis (WSO) often appears as superficial white spots with clear borders [8]. There are several investigations which

can confirm the diagnose of OM. According to Begari et al. the sensitivity of KOH is found to be 81.82 percent whereas sensitivity of PAS found to be 84.56 percent, and of culture found to be 57 percent. Culture was less sensitive than PAS or KOH.

Furthermore, PAS was more sensitive than KOH. KOH specificity was 92.86 percent, culture specificity was 92.86 percent, and PAS specificity was 57.14 percent [9]. For the diagnosis of onychomycosis, direct microscopy and fungal culture are considered the gold standards. On the other hand, fungal culture might take many weeks and has a poor sensitivity (35–60%). Onychoscopy, also known as dermoscopy of the nail unit, is a rapid, low-cost, and accurate diagnostic technique for cutaneous malignancies, inflammatory conditions, and skin infections [10].

Because oral antifungal medication requires fewer courses of treatment and has a greater cure rate than topical antifungal therapy, it is regarded as the gold standard for treating onychomycosis in both adults and children. For the treatment of onychomycosis, oral antifungal medications consist of fluconazole (Diflucan, Celozole), itraconazole (Sporanox, Sporaz, Orungal), and terbinafine (Lamisil) [11]. As a result, non-pharmacological therapeutic techniques such photodynamic therapy, diode lasers, long pulse and Q switched-Nd-YAG LASER, and fractional CO₂ lasers have become popular [12,13]. The most popular laser for the treatment of OM is the long-pulse Nd: YAG laser. When compared to other lasers, the Q-switched Nd: YAG laser provides more energy in brief pulses, rapidly raising the target area's temperature and inducing photomechanical disruption combined with immunological activation [14].

Using 1,064- and 532-nm Nd: YAG lasers, some research evaluated the in vitro growth suppression of *Trichophyton rubrum*. In addition to heat degradation, the results were likely caused by the presence of melanin, which is a chromophore in the cell walls of *Trichophyton* species, and xanthomegnin, a red pigment produced by *T. rubrum* that works as a chromophore at the wavelength of 1,064 nm [15-17]. Hence this study was conducted with the aim to study the safety and efficacy of Q switched Nd: Yag LASER in OM.

Material and Methods

Study design: Total 130 nails from 11 PAS positive onychomycosis patients were selected based upon the inclusion and exclusion criteria. Patients of onychomycosis over 18 years of age and of any gender and patients found PAS positive on

nail clipping examination were enrolled in the study. Patients had received systemic antifungal medication for 1 month prior to study, patients utilized vasodilators, which may make the heat from a laser more painful and likely to burn the nail bed and patients with nail discoloration brought on by causes other than fungal infections were excluded from the study.

Data collection:

The demographic data, detailed history and clinical examination of all patients was recorded in a structured proforma. All patients clinically diagnosed as OM was classified depending upon the clinical type of OM (distal lateral and proximal subungual, endonyx, white superficial, complete dystrophic) the clinical diagnosis was confirmed by PAS staining of nail clipping.

Onychomycosis Severity Index (OSI): The Onychomycosis Severity Index (OSI), a categorization system created by Carney et al. that rates the severity of distal subungual onychomycosis, was utilized to conduct the clinical assessment of nails diagnosed with onychomycosis [18]. Onychomycosis scores range from 1 to 5, with mild cases falling between 6 and 15, and severe cases between 16 and 35.

Treatment protocol:

Each nail received 4 sessions for fingernails and 6 sessions for toe nails of Q-switched Nd-Yag LASER (nanosecond pulse) therapy at 2 weekly intervals. In each session three passes were given at a gap of 30 seconds. First two passes were performed by 1064 nm Nd -Yag LASER, with energy of 750 mj and a spot size of 1mm. third pass was performed by 532 nm Nd - Yag LASER, with energy of 750 mj and a spot size of 1mm. Evaluation by OSI was carried out before starting therapy and then every 2 weeks for 3 months and then monthly till end point of therapy.

Results

The mean age of the patients was 45.09 ± 12.06 years. Among all 11 cases, 2 (18.18%) cases belong to age group of 18-30 years, 6 (54.54%) patients belong to age group of 30-50 years and 3 (27.27%) patients belong to age group of >50 years. Among total 11 patients, there were 4 (36.36%) male and 7 (63.63%) females. The occupation of 5 (45.45%) patients was farming, 3 (27.27%) patients were housewife, 2 (18.18%) patients were students and 1 (9.09%) patient was office worker. Total 5 (45.45) patients were coming from the urban background and 6 (54.55%) patients were from rural areas (Table 1).

Table 1: Sociodemographic determinants of the enrolled patients

Variable	Domain	Number	Percentage
Age distribution	Mean age	45.09 ± 12.06 years	
	18-30 years	2	18.18
	30-50 years	6	54.54
	>50 years	3	27.27
Gender	Male	4	36.36
	Female	7	63.63
Occupation	Farmer	5	45.45
	Housewife	3	27.27
	Student	2	18.18
	Office worker	1	9.09
Residence	Urban	5	45.45
	Rural	6	54.55

The chief complaints among 6 (54.55%) patients were thickening of nail plate whereas yellowish discoloration of nail was observed in 5 (45.45%) patients. The mean duration of illness was 6.45 ± 3.53 years among all patients. Duration of illness was 1-5 years in 5 (45.45%) patients, 6-10 years in 5 (45.45%) patients and >10 years in 1 (9.10%) patient. Among 3 (27.27%) patients, there was involvement of B/L feet; in 6 (54.54%) patients, there was involvement of B/L hands; and in 2 (18.18%) patients, there was involvement of both

B/L hands and feet (Table 2). The mean size of the infected area was 4.63 ± 1.02 mm in all 130 nails. The shape was proximal to nail in 63 (48.46%) nails whereas distal to nail in 67 (51.54%) nails. The color of the nail was white in 31 (23.85%) nails whereas yellow in 99 (76.15%) nails. The morphology of the nail indicates DLSO in 44 (33.85%) nails, endonyx in 19 (14.62%) nails, PSOM in 37 (28.46%) nails, and WSO in 30 (23.08%) nails (Table 3).

Table 2: Clinical examination of the enrolled patients

Variable	Domain	Number	Percentage
Chief complaint	Thickening of nail plate	6	54.55
	Yellowish discoloration	5	45.45
Duration of illness	Mean duration	6.45 ± 3.53 years	
	1-5 years	5	45.45
	6-10 years	5	45.45
	>10 years	1	9.10
Limb involved	B/L Feet	3	27.27
	B/L Hands	6	54.54
	B/L Feet & Hands	2	18.18

Table 3: Nail examination

Variable	Domain	Number	Percentage
Size of the infected area		4.63 ± 1.02 mm	
Shape	Proximal	63	48.46
	Distal	67	51.54
Color	White	31	23.85
	Yellow	99	76.15
Morphology	DLSO	44	33.85
	Endonyx	19	14.62
	PSOM	37	28.46
	WSO	30	23.08

The mean OSI exhibited a significant linear declining trend over the increasing number of therapy sessions. Mean OSI in session 1 was 43.29 ± 22.68, session 2 was 34.52 ± 15.31, session 3 was 26.52 ± 8.217, session 4 was 21.45 ± 2.467, session 5 was 19.38 ± 4.556, session 6 was 15.85 ± 5.728, session 7 was 12.31 ± 4.385, and session 8 was 3.84

5.06 (Figure 1). The mean OSI exhibited a significant linear declining trend over the increasing number of therapy sessions in both B/L hands and B/L feet. There was no significant difference was observed in the mean OSI of B/L hands and B/L feet during any of the therapy session among total 8 sessions (Figure 2).

The mean OSI exhibited a significant linear declining trend over the increasing number of therapy sessions in both white- and yellow-colored nails. There was no significant difference was observed in the mean OSI of white- and yellow-colored nails during any of the therapy session except in session 7 where the mean OSI of yellow color nails was significantly lower than the white color nails (Figure 3).

The mean OSI exhibited a significant linear declining trend over the increasing number of therapy sessions in all morphological patterns of nails. There was no significant difference was observed in the mean OSI of various morphological patterns of during any of the therapy session except in session 5 where the mean OSI was significantly lower in PSOM than the other patterns (Figure 4).

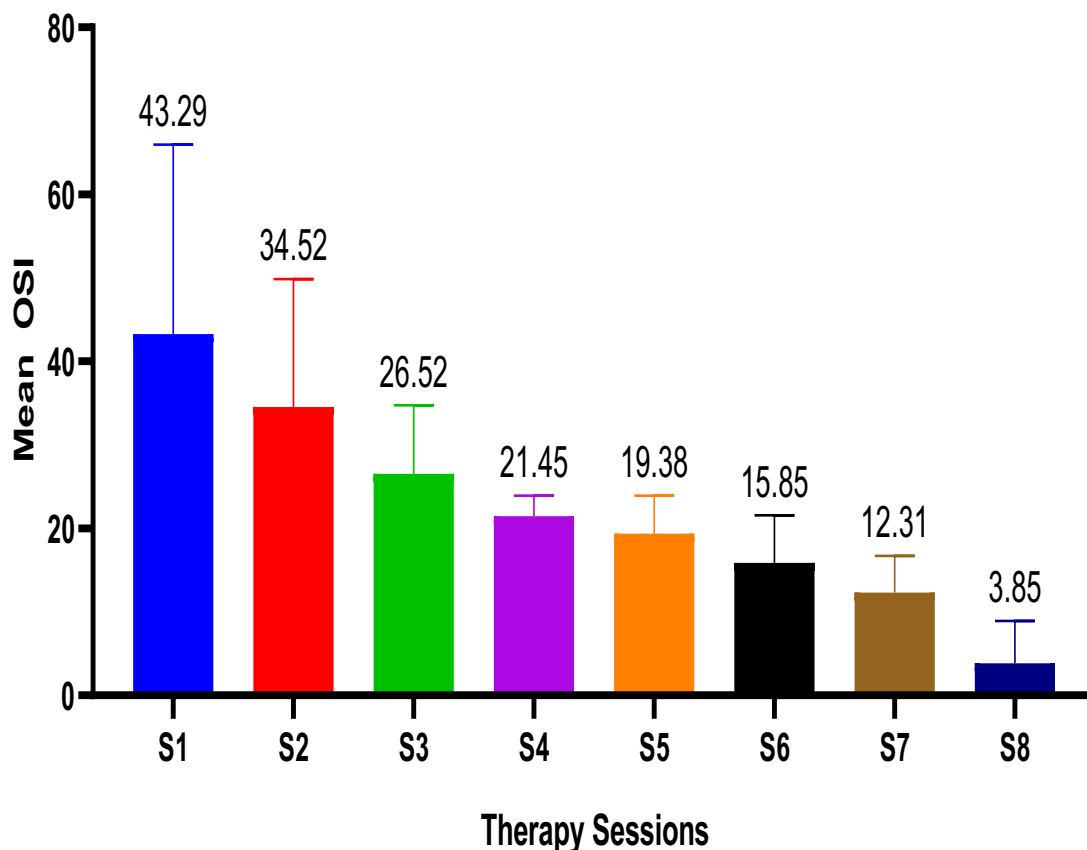


Figure 1: Mean OSI in various sessions of treatment

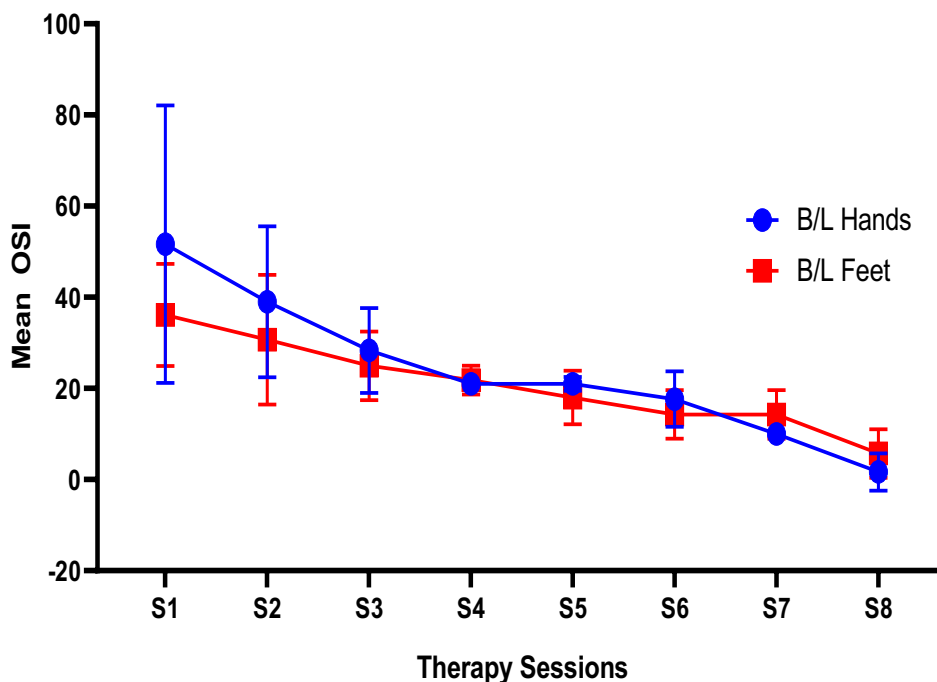


Figure 2: Mean OSI according to limb involvement

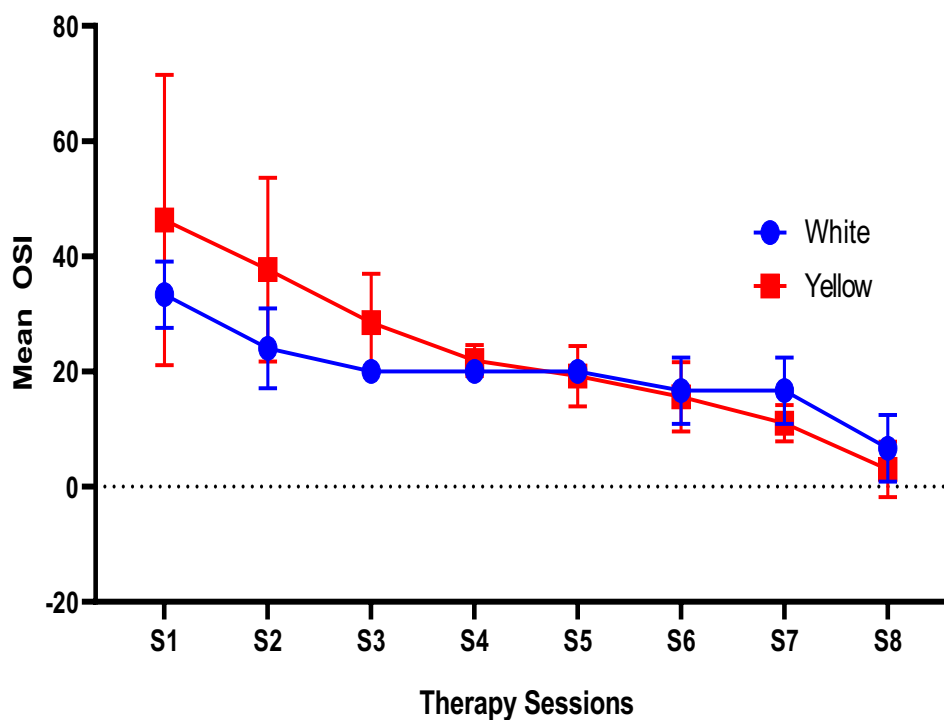


Figure 3: Mean OSI according to color of nail

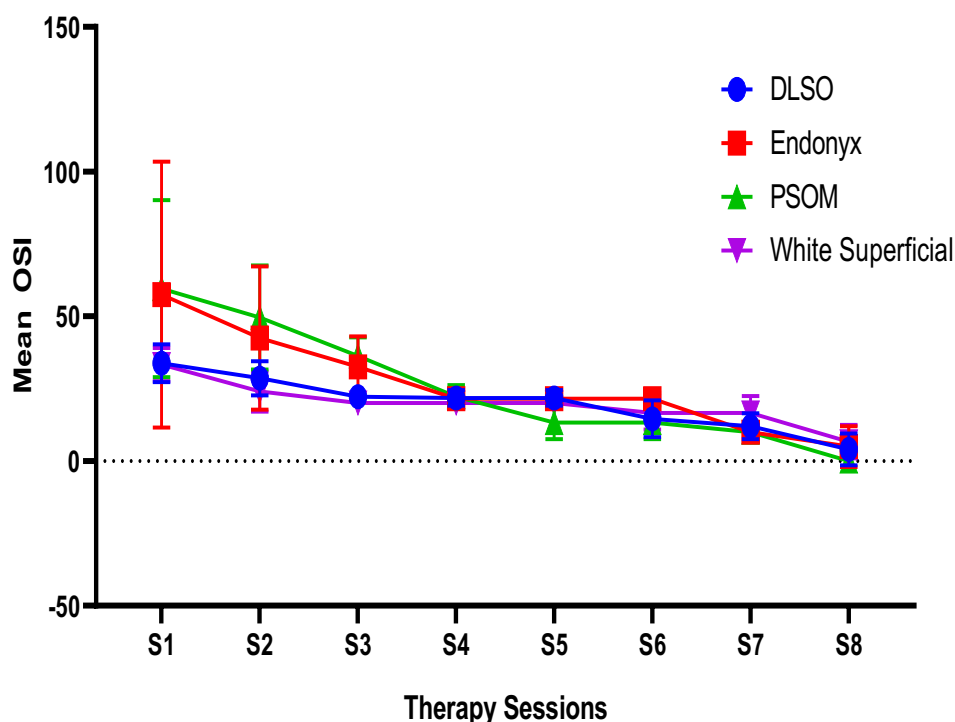


Figure 4: Mean OSI according to morphology

Discussion

The most popular laser used for managing OM is the long-pulse Nd: YAG laser. Compared to other laser devices, the Q-switched Nd:YAG laser delivers more energy in short bursts, which quickly raises the target area temperature, disrupts the photomechanical system, and stimulates the immune system [19]. The incidence of onychomycosis increases with age and is most common in the age range of 40-60 years [20]. In present study, mean age of the patients was 45.09 ± 12.06 years which is similar to the previous study by Altunisik et al. in which the mean age of the patients was 50.6 ± 12 years [21]. In present study most of the participants were females (63.63%). Similar results have been reported in the study by the Altunisik et al. in which 61.5% of the patients were female [21]. Women were the 71.8% of patient sample in the study by Kalokasidis et al. [5]. Male preponderance could occur possibly because of greater outdoor occupation and prolonged wearing of closed footwear.

The occupation of majority of male patients in present study was farming (45.45%) while most of females were housewife (18.18%). According to the study Rezk, onychomycosis was more common in housewives [22]. Similar results have been reported in the study by Singal et al. [23]. Women, particularly housewives, are more likely to engage in domestic tasks like laundry and cleaning. Their hands and feet are consequently more likely to be exposed to chemicals, detergents, and water, which

increases their risk of nail injuries. In comparison to men, they are also more preoccupied with their cosmetic appearance. Males on the other hand may have high exposure to fungal agents while working in farmlands.

In our study, most of the patients (54.54%) encountered with the involvement of B/L hands followed by B/L feet (27.27%) and B/L hands and feet (18.18%). Three patients in the Altunisik et al. research had involvement in their hands, one patient involved both hands and feet, and the other patients all included their feet [21].

In present study, the most common morphological pattern was DLSO reported in 33.85% nails followed by PSOM (28.46%), WSO (23.08%) and endonyx (14.62%). In the study by Kandpal et al. DLSO was the most common reported pattern of OM which corroborated with findings of our study [14]. In the another study by Kalokasidis et al. DLSO was the most common OM pattern [14].

In present study, we have conducted eight sessions of Nd: YAG laser treatment for the treatment of onychomycosis. In the study by Kandpal et al. patients of OM were administered 12 weekly sessions of the laser [14]. In the research conducted by Kalokasidis et al., 9 bimonthly sessions of the laser were administered [5]. In the study by Espírito Santo, five sessions of laser therapy were performed, 1-2 weeks apart [24].

Two sessions at 4-week intervals were administrated in the study by Rizk et al. [22]. In

present study, we have use 1064 nm Nd: YAG laser treatment for the treatment of onychomycosis. In the study by Kandpal et al. Nd: YAG laser of same wavelength was used (1064 nm). In the research conducted by Kalokasidis et al., Nd: YAG 1064nm/532nm laser was used [5]. In the study by Espirito Santo, 1,064-nm Nd: YAG laser was applied [24]. In the study by Rizk et al. 1064-nm Nd: YAG laser was employed [22].

Elmorsy et al. discovered that in 10 patients with onychomycosis who had five sessions of laser therapy once a month using a 1064 nm Q-switched Nd: YAG laser, the rate of mycological clearance was 30% right after the final laser session and 50% at the 6-month follow-up [25]. Kim et al. observed that after 12 and 24 weeks, clinical improvement was 47.6% and 57.1%, respectively, for patients with onychomycosis treated with Nd: YAG laser therapy [26]. In a research comparing the number of 1064 nm Nd-YAG laser applications to patients with onychomycosis, it was discovered that the group with more applications and patients with less severe illness had greater effectiveness [27].

The small number of patients evaluated likely made it more difficult to draw firm conclusions regarding this course of treatment. The small number of patients may be due to the fact that Q-switched Nd: YAG laser is new treatment modality and people may have fear regarding the possible side effect of the treatment. Also, the therapy session needs multiple hospital visits which is difficult for the patients who were coming from the remote area. One of our study's main weaknesses is the brief follow-up time.

Nail growth rate was not assessed, but the study was based on clinical results, such as obvious nail growth and posttreatment KOH mount or fungal culture. As a result, no quantitative information about the rate of nail growth was identified. Because false-negative culture findings can occur often, a negative culture, or mycological cure, does not always imply a clinical cure. We also note that our study strong baseline culture positivity may not always translate into actual positives in later cultures.

Conclusion

In present study, a higher incidence of OM was reported in the mean age of 45.09 years with a predominance of females. The occupation of majority of male patients in present study was farming while most of females were housewife. Most of the patients comes from the rural background and most of the patients reported with the involvement of B/L hands.

The most common morphological pattern was DLSO followed by PSOM, WSO and endonyx. The mean OSI exhibited a significant linear

declining trend over the increasing number of therapy sessions. In patients with onychomycosis, we think the Q Switched Nd: YAG (1064 nm) laser is a safe therapy option. It may be especially advised for people who are contraindicated or who would prefer not to use oral antifungals. Nonetheless, we believe that in order to be effective, lengthier follow-up times and sessions may be required.

References

1. Ormerod A, Campalani E, Goodfield M. British Association of Dermatologists guidelines on the efficacy and use of acitretin in dermatology. *British Journal of Dermatology*. 2010;162(5):952-63.
2. Scher RK, Tavakkol A, Sigurgeirsson B, Hay RJ, Joseph WS, Tosti A, et al. Onychomycosis: diagnosis and definition of cure. *Journal of the American Academy of Dermatology*. 2007; 56(6):939-44.
3. Uemura EVG, Barbosa MdS, Simionatto S, Al-Harrasi A, Al-Hatmi AM, Rossato L. Onychomycosis caused by *Fusarium* species. *Journal of Fungi*. 2022;8(4):360.
4. Thomas J, Jacobson G, Narkowicz C, Peterson G, Burnet H, Sharpe C. Toenail onychomycosis: an important global disease burden. *J Clin Pharm Ther*. 2010;35(5):497-519.
5. Kalokasidis K, Onder M, Trakatelli M-G, Richert B, Fritz K. The effect of Q-switched Nd: YAG 1064 nm/532 nm laser in the treatment of onychomycosis in vivo. *Dermatology research and practice*. 2013; 2013.
6. Grover C, Khurana A. Onychomycosis: newer insights in pathogenesis and diagnosis. *Indian J Dermatol Venereol Leprol*. 2012;78:263.
7. Gupta AK, Cooper EA, Wang T, Lincoln SA, Bakotic WL. Single-point nail sampling to diagnose onychomycosis caused by non-dermatophyte molds: utility of polymerase chain reaction (PCR) and histopathology. *Journal of Fungi*. 2023;9(6):671.
8. Gupta A. Types of onychomycosis. *Cutis*. 2001;68(2 Suppl):4-7.
9. Begari V, Pathakumari P, Takalkar AA. Comparative evaluation of KOH mount, fungal culture and PAS staining in onychomycosis. *Int J Res Dermatol*. 2019;5(3):554-8.
10. Litaïem N, Mnif E, Zegloui F. Dermoscopy of onychomycosis: A systematic review. *Dermatology Practical & Conceptual*. 2023;13(1).
11. Leung AKC, Lam JM, Leong KF, Hon KL, Barankin B, Leung AAM, et al. Onychomycosis: An Updated Review. *Recent Pat Inflamm Allergy Drug Discov*. 2020;14(1):32-45.

12. Beyzaee AM, Patil A, Goldust M, Moslemi M, Kazeminejad A, Rokni GR. Comparative Efficacy of Fractional CO₂ Laser and Q-Switched Nd: YAG Laser in Combination Therapy with Tranexamic Acid in Refractory Melasma: Results of a Prospective Clinical Trial. *Cosmetics*. 2021;8(2):37.
13. Boixeda P, Calvo M, Bagazgoitia L. Recent advances in laser therapy and other technologies. *Actas Dermo-Sifiliográficas (English Edition)*. 2008;99(4):262-8.
14. Kandpal R, Arora S, Arora D. A study of Q-switched Nd: YAG laser versus itraconazole in management of onychomycosis. *J Cutan Aesthet Surg*. 2021;14(1):93.
15. Vural E, Winfield HL, Shingleton AW, Horn TD, Shafirstein G. The effects of laser irradiation on *Trichophyton rubrum* growth. *Lasers Med Sci*. 2008;23:349-53.
16. Xu Z-L, Xu J, Zhuo F-l, Wang L, Xu W, Xu Y, et al. Effects of laser irradiation on *Trichophyton rubrum* growth and ultrastructure. *Chin Med J*. 2012;125(20):3697-700.
17. Hashimoto T, Wu-Yuan C, Blumenthal HJ. Isolation and characterization of the rodlet layer of *Trichophyton mentagrophytes* micro conidial wall. *J Bacteriol*. 1976; 127(3):1543-9.
18. Carney C, Tosti A, Daniel R, Scher R, Rich P, DeCoster J, et al. A new classification system for grading the severity of onychomycosis: Onychomycosis Severity Index. *Arch Dermatol*. 2011;147(11):1277-82.
19. Bhatta AK, Keyal U, Wang X, Gellén E. A review of the mechanism of action of lasers and photodynamic therapy for onychomycosis. *Lasers Med Sci*. 2017;32:469-74.
20. Ständer H, Ständer M, Nolting S. Incidence of fungal involvement in nail psoriasis. *Der Hautarzt; Zeitschrift für Dermatologie, Venerologie, und Verwandte Gebiete*. 2001;52(5):418-22.
21. Altunışık N, Türkmen D, Durmaz İ, Özcan KN, Şener S. Q-switched 1064 nm Nd: YAG Laser Therapy in Onychomycosis. *Journal of the Turkish Academy of Dermatology*. 2023;17(2).
22. Rezk SM, ElRefaai AM, Elghabaty AA, Abdel Hamid HS, Salem RM. Long pulsed Nd: YAG 1064-nm laser in treatment of onychomycosis. *Benha medical journal*. 2022;39(3):933-40.
23. Singal A, Khanna D. Onychomycosis: Diagnosis and management. *Indian J Dermatol Venereol Leprol*. 2011;77:659.
24. Espírito Santo RBd, Deps PD. Case study of onychomycosis patients treated with 1,064-nm Nd: YAG laser. *Case Rep Dermatol*. 2018;10(2):216-25.
25. Elmorsy EH, Abou Khadr NA, Taha AA, Abdel Aziz DM. Long-pulsed Nd: YAG (1,064 nm) laser versus Q-switched Nd: YAG (1,064 nm) laser for treatment of onychomycosis. *Lasers Surg Med*. 2020;52(7):621-6.
26. Kim MS, Jung JY, Cho EB, Park EJ, Kim KH, Kim KJ. The effectiveness of 1,064-nm long-pulsed Nd: YAG laser in the treatment of severe onychomycosis. *J Cosmet Laser Ther*. 2016;18(6):317-22.
27. Zhang R-n, Zhuo F-l, Wang D-k, Ma L-z, Zhao J-y, Li L-f. Different numbers of long-pulse 1064-nm Nd-YAG laser treatments for onychomycosis: a pilot study. *BioMed Research International*. 2020;2020.