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Original Article

Assessment of clinical efficacy of Q-switched Nd:YAG laser 1064-nm in onychomycosis

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Abstract

Objective Onychomycosis (OM) is a chronic fungal infection of the finger and toenails. Emerging treatments include lasers, like CO2 laser and Nd:YAG Laser 1064-nm which combine both efficacy and safety. The objective of the study is to determine the clinical efficacy of Q-switched Nd:YAG Laser 1064-nm in OM.

Methods This study undertaken in Dermatology Department, Mayo Hospital, Lahore was conducted on 118 adult patients with clinical OM and positive KOH smear for fungal hyphae.

Results There was mild female predominance (54% females versus 46% males) in the subjects. More than one third (35.6%) of the subjects had an excellent clinical response and only 5.1% had a poor response. Disease duration longer than 6 months was significantly associated with poorer outcome. No side effects were observed except mild discomfort during the treatment session.

Conclusion Q-Switched Nd:YAG Laser 1064-nm is an effective noninvasive treatment option for OM in our population. It should be considered in all patients with recent disease onset, especially where long term systemic agents are contraindicated or poorly tolerated.

Key words
Onychomycosis; 1064-nm Nd:YAG wavelength laser; Systemic antifungal agents.

Introduction

Onychomycosis (OM) is a common fungal infection that affects the finger and toe nails. The worldwide prevalence of OM is about 2–8% and this increases with age.[1] Dermatophyte fungi, yeasts and non-dermatophytes are the main pathogenic organisms involved in OM.[2] The clinical features range from mild discoloration of the superficial nail, nail thickening and retarded nail growth to onycholysis or whole nail dystrophy.[3] In addition, to the clinical burden of an infective disease, OM also has a negative impact on the psycho-social life of the affected individuals.[4]

The mainstays of treatment in OM are oral antifungal agents such as itraconazole, terbinafine and occasionally fluconazole. Due to the slow rate of nail growth, these agents often need to be prescribed for several months leading to enhanced risk of side effects like hepatotoxicity and drug interactions. Occasionally, topical agents such as ketoconazole, amorolfine or ciclopirox may be used in cases with limited disease.[5] Despite the availability of all these options, many individuals experience treatment failure or

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recurrence of OM.[6] There is, therefore, an ongoing need for a relatively non-invasive and effective treatment modality with minimal toxicity and potential for drug interactions.

In the recent years, many different minimally invasive devices have been utilized by researchers for the treatment of OM. These include photodynamic therapy, neodymium-doped yttrium aluminum garnet (Nd:YAG) lasers, fractional CO2 lasers, near-infrared diode laser and nonthermal low-level laser devices.[7] Among these the CO2 lasers and Nd:YAG lasers (long-pulsed and Q-switched) have shown satisfactory efficacy in various studies.[8] Q-switched Nd:YAG laser produces a high energy pulse of a short duration (nanoseconds) that damages the fungal organisms by producing localized high temperatures over a brief time span, thereby preventing damage to the adjacent healthy human tissues. Many studies have observed a good clinical response of OM to Q-switched Nd:YAG laser.[9] Additionally, some recent case reports have observed a beneficial effect of this laser in recalcitrant OM.[10] However, similar to the studies conducted in other forms of laser there is a wide variation in the treatment protocols followed and the observed results. The observed efficacy rates of Q-switched Nd:YAG laser in OM vary from 30% to 100% among different researches.[11,12]

The various laser studies performed for OM have indicated a high safety profile of these devices although the efficacy rates have fluctuated. Laser treatment of OM is, therefore, still an attractive option especially in subjects where systemic toxicity of oral antifungal agents prohibits their prolonged use. Although a recent study from Pakistan discussed infrared light use in OM, there is no local research on the use of laser devices in OM.[13] The purpose of the current study was to assess the role of Q-switched Nd:YAG laser 1064-nm in the treatment of OM in the Pakistani population.

Methods

118 male and female patients aged between 18-60 years having clinical features of OM (nail discoloration, dystrophy or debris below the nail plate) and positive KOH smear for fungal hyphae were enrolled through non-probability consecutive sampling. The expected percentage of excellent response was as 18.4% (95% confidence level with 7% margin of error). The individuals with a chronic medical condition and those who had taken some oral antifungal in the past 3 months were excluded.

The Onychomycosis Severity Index (OSI) was calculated according to the following formula as described by Carney *et al*.[14]

OSI = Area of Involvement X Proximity of Disease to Matrix + (Subungual Hyperkeratosis >2 mm).

Table 1 shows the values allotted to each of these features with resultant OSI value ranging from 0 (complete clearance/ normal) to 35 (complete involvement).

Table 1 Onychomycosis Severity Index (OSI).

Area of Involvement		*Proximity of Disease to Matrix*	
Percentage of affected Nail	*Points*	*Amount of Involvement from distal Edge*	*Points*
1-10	1	Less than 1/4	1
11-25	2	1/4 to 1/2	2
26-50	3	1/2-3/4	3
51-75	4	More than 3/4	4
76-100	5	Matrix involvement	5

*Subungual hyperkeratosis greater than 2 mm is given 10 points, while no points are given if it is absent or is less than 2 mm.

Five weekly sessions of Q-switched Nd:YAG laser 1064-nm device using pulse duration of 10 ns, frequency 1Hz, spot size 3mm at low energy (max energy 800mJ and 500mJ) were performed in a grid pattern (repeated once) from a distance of 4-5cm. OSI of target nail was calculated pre-treatment and post treatment.

Clinical response was calculated at 12 weeks according to percentage reduction in OSI as:

- Excellent: Greater than 75% reduction
- Very Good: 51%-75% reduction
- Good: 26%-50% reduction
- Moderate: 6%-25% reduction
- Low: less than 6% reduction

All the data was processed using SPSS version 25.0. The age was described as Mean±SD. While, gender and clinical response scale were expressed in frequencies and percentages. Data was stratified for age, gender and duration of disease and Chi-square test was applied to observe their significance (p-value ≤0.05 was considered significant).

Results

The 118 enrolled cases (one nail in each case) ranged from 19 years to 59 years in age and 3 months to 14 months in duration of OM. **Table 2** displays the demographic characteristics of the study cases. The nail condition was longer than 6 months in 74 (62.7%) individuals while it was equal to or less than 6 months in the remaining 44 (37.3%) subjects.

Table 2 Demographic features of the study population (n=118).

Feature	*Mean±SD*
Age (years)	39.31 ± 11.94
Duration of disease (months)	7.29 ± 3.03
Gender	
Male	54 (45.8%)
Female	64 (54.2%)
Age groups	
18-40 years	70 (59.3%)
41-60 years	48 (40.7%)

Table 3 Clinical efficacy of Q-switched Nd:YAG laser in onychomycosis (n=118).

Clinical Response	Frequency	Percentage
Excellent	42	35.6%
Very Good	19	16.1%
Good	16	13.6%
Moderate	35	29.7%
Low	6	5.1%

Table 3 demonstrates the clinical efficacy of the laser therapy undertaken for OM. Stratification of clinical response was performed with age groups, gender and disease duration group. P-values were found to be 0.661, 0.960 and 0.035, respectively, indicating that only a prolonged duration of nail disorder was significantly associated with a poor response to Q-switched Nd:YAG laser.

There were no major side effects observed except mild discomfort during the laser session, and none of the enrolled subjects dropped out due to side effects.

Discussion

Recently, the focus of OM research has shifted towards innovative therapies like lasers due to the relatively shorter duration of treatment needed (usually few weeks) and their safety profile in diverse population groups including children, pregnant and lactating women, elderly subjects and those on multiple drugs for various other systemic disorders.

The present intervention using Q-switched Nd:YAG laser for OM displayed a good to excellent clinical efficacy in about two-thirds (65.3%) of cases. The remaining patients had less than 26% reduction in OSI score. However, several researchers have observed even better results with Q-switched Nd:YAG laser in OM. Chaitanya *et al*. from India observed that more than three-quarters (78%) of their subjects had

complete clinical clearance of OM (100% reduction in OSI).[15] However, they had given upto 12 weekly sessions of Q-switched Nd:YAG laser which probably accounts for such a high response. Some European researchers documented a 95.4% mycological cure with only two sessions of this laser at 3 months followup.[9] Their energy setting was higher (14 J/cm^2) which might explain the better outcome. Similarly, in a recent Egyptian study Nasif *et al*. observed that almost all of their subjects (19 out of 20) had an excellent response (more than 75% reduction in OSI).[16] Their study had also utilized a higher power of 12.6 J/cm^2 during the laser therapy. Garcia from Mexico elicited a 100% clinical cure in OM using only a single session of Q-switched Nd:YAG laser.[12] The main difference in his research was the use of three laser passes in a single session instead of the usual two undertaken in most other studies, including the present one.

In contrast, some other researchers from Egypt observed only a 30% mycological cure with Q-switched Nd:YAG laser, although the clinical improvements were statistically significant.[11] Their study sample was very small (10 patients treated with Q-switched Nd:YAG laser) which might explain this negatively biased result.

The wide range of clinical and mycological response seen in the various studies is probably due to the differing characteristics and size of the selected study sample, variations in the underlying causative pathogens and non-uniformity in the treatment protocols undertaken. Furthermore, there is a marked variation in the targeted end-results as well as the duration of follow-up among the various studies.

Limitations

The main limitation of the study was a relatively short follow-up period (three months) and the lack of fungal cultures to prove mycological cure of infection due to limitations in resources. In the future, more prolonged studies need to be carried out to assess the efficacy of Q-switched Nd:YAG laser at 6 months or even one year, especially for toenail OM. In addition, different laser settings at different intervals and in combination with other treatment options could be compared for establishing the optimum protocol for OM in this population.

Conclusion

Q-switched Nd:YAG laser showed good clinical efficacy in OM, especially in cases with shorter duration. This noninvasive treatment modality should be considered as an initial therapy either alone or in combination with other antimycotic agents in cases where a prolonged course of systemic antifungals is not tolerated or is contraindicated.

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