

Fractional carbon-dioxide (CO₂) laser-assisted topical therapy for the treatment of onychomycosis

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Background: Inability of topical medications to penetrate via nail plate brings a great challenge to clinicians in treating onychomycosis. Furthermore, oral medications are not appropriate for all patients because of drug interactions, adverse effects, and contraindications.

Objective: We sought to evaluate the clinical efficacy of fractional carbon-dioxide laser-assisted topical therapy for onychomycosis.

Methods: In total, 75 patients with 356 onychomycotic nails confirmed by mycologic examination were included in this study. All the affected nails received 3 sessions of laser therapy at 4-week intervals and once-daily application of terbinafine cream for 3 months.

Results: In all, 94.66% and 92% of the treated patients were potassium hydroxide and culture negative, respectively, after 3 months of treatment. However, only 84% and 80% were potassium hydroxide and culture negative, respectively, at 6 months of follow-up. Using Scoring Clinical Index for Onychomycosis electronic calculator, 73.33% of the patients scored higher than 6 and 26.66% of the patients scored 6 or less. Those who scored more than 6 were evaluated clinically and 98.18% of them showed response to treatment at 3 months and 78.18% of them at 6 months of follow-up.

Limitation: Lack of control group and short duration of follow-up are limitations.

Conclusions: Fractional carbon-dioxide laser therapy combined with topical antifungal was found to be effective in the treatment of onychomycosis. However, randomized clinical studies are needed before it can be widely used in clinics. (J Am Acad Dermatol <http://dx.doi.org/10.1016/j.jaad.2015.12.002>.)

Key words: dermatophytes; fractional laser; onychomycosis; topical therapy.

Onychomycosis, a fungal infection of the nail, is considered one of the most prevalent disorders of the nail. It occurs after primary infection of the nail bed, which may lead to subungual hyperkeratosis.¹ Other than a cosmetic concern, onychomycosis is also frequently associated with tinea pedis, which can result in serious secondary infections such as osteomyelitis and cellulitis, particularly in diabetic patients.

Abbreviations used:

CO ₂ :	carbon dioxide
DLSO:	distal lateral subungual onychomycosis
KOH:	potassium hydroxide
Nd:YAG:	neodymium:yttrium-aluminium-garnet
PSO:	proximal subungual onychomycosis
SCIO:	Scoring Clinical Index for Onychomycosis
SWO:	superficial white onychomycosis
TDO:	total dystrophic onychomycosis

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Conflicts of interest: None declared.

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Etiologically, dermatophytes such as *Trichophyton rubrum* and *T mentagrophytes* account for 80% to 90% of all cases.² Other causative organisms are nondermatophyte molds and yeasts. *Candida albicans* accounts for approximately 70% of onychomycosis caused by yeasts. The predisposing factors include advanced age, diabetes, peripheral vascular disease, low immune status, HIV, obesity, and smoking.

The available treatment options for onychomycosis are topical drugs such as ciclopirox, amorolfine, efinaconazole, or tavaborole in mild cases and systemic drugs such as terbinafine, fluconazole, itraconazole, or griseofulvin in severe cases.³ Topical antifungals are often ineffective because of their inability to penetrate via nail plate. Systemic treatments, although effective, have limited application because of adverse effects such as hepatotoxicity and potential drug interactions, especially in patients with comorbidities. Moreover, successful therapy of onychomycosis has at least a 20% to 25% rate of relapse or recurrence.⁴ Therefore, many in vitro and in vivo therapeutic trials are being conducted in a search of a safe and effective alternative therapy.

Recently, photodynamic therapy and laser-based treatments have been explored as a possible alternative treatment for onychomycosis. Long-pulse 1064-nm neodymium:yttrium-aluminum-garnet (Nd:YAG) laser, diode laser, Q-switched Nd:YAG laser, titanium:sapphire laser, and short-pulse Nd:YAG 1064-nm laser have all been studied and found to be safe and effective for treating onychomycosis. In our study we used fractional carbon-dioxide (CO₂) laser and topical terbinafine to treat onychomycosis. The fractional CO₂ laser systems were developed to maximize the effect of ablative laser therapies and minimize side effects.⁵

METHODS

Patient selection

In total, 75 patients with 356 onychomycotic nails were enrolled in the study. Both fingernails and toenails with all 4 types of onychomycosis (distal lateral subungual onychomycosis [DLSO], proximal subungual onychomycosis [PSO], superficial

white onychomycosis [SWO], and total dystrophic onychomycosis [TDO]) were considered for treatment. Only those affected nails that were positive for both potassium hydroxide (KOH) and culture were included in the study. Shanghai Tongji Hospital Ethics Committee approved the research (trial no. 244) and the research was registered (no. ChiCTR-OOC-14005547) in China Clinical Trials Registry, a World Health Organization-recognized organization.

Scoring Clinical Index for Onychomycosis

The Scoring Clinical Index for Onychomycosis (SCIO) (range 1-30) was calculated using the clinical index component and the growth

component in the following equation⁶:

$$\left[\left(\frac{d}{3} \right)^{3-f} (f + h(3-f)) \right]^{1 - \frac{(2-f)(3-f)}{2}}$$

Where d = depth of involvement, f = clinical form, and h = degree of hyperkeratosis.

We used an electronic calculator for SCIO and found that only 20 of 75 patients scored 1 to 6 and would receive topical treatment, whereas 55 patients scored 6 to 30 indicating they would require systemic therapy, combination therapy, or nail avulsion.

KOH preparation and fungal culture

Fungal examination was done at the beginning of treatment, at 3 months, and at 6 months. KOH preparation showing septate hyphae or pseudohyphae was considered positive. Sabouraud dextrose agar medium was used for culture.

Photography

Photographs were taken using the same camera settings, lighting, nail position, and background on a digital single-lens camera (Power Shot, G12 lens, ×5 zoom, 10 megapixel [Canon, Tokyo, Japan]). Photographs were taken at the beginning of treatment, and at first, second, third, and sixth months.

Topical anesthesia

Before laser therapy, 5% lidocaine cream (Beijing Ziguang Zhiyao Youxian Co) was applied under occlusion on the infected nail and periungual area for 30 minutes.

CAPSULE SUMMARY

- Treatment options for onychomycosis are limited.
- Fractional carbon-dioxide laser-assisted topical therapy provides an alternative to effectively treat onychomycosis.
- This technique provides new treatment options for this condition.

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