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Research Article

A Look at Light Sources for the Treatment of Onychomycosis

John Strawley[1], Tzipora Rosensaft[1], Ahmed M Sikder[1], Edward M Klepper[1*], Howard N Robinson[1]

[1]Robinson and Max Dermatology PA, Lutherville-Timonium, Maryland, USA

***Correspondence author:** Edward M. Klepper, MS, Robinson and Max Dermatology PA, Lutherville-Timonium, Maryland, USA; Email: edwardklepper@gmail.com

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Abstract

There are a multitude of light sources that have been promoted for the treatment of onychomycosis. While these may be viable alternatives for patients who are unable to take oral antifungals, their long-term efficacy has not been established. We have compiled in tabular form the majority of currently available light sources and their purported efficacy. The majority of results are not standardized against oral terbinafine. We attempted to compare the treatments against oral terbinafine as a gold standard comparison. Due to many studies lacking standardization with oral terbinafine and variation of treatment efficacy endpoints, these authors attempted to standardize efficacy against the known treatment benchmark, which is the use of oral terbinafine. What we found is tabulated below. We found approximately 6-7 light sources including Nd:YAG lasers and listed others that have been used for treatment of onychomycosis.

Keywords: Oral Terbinafine; Onychomycosis; Nd:YAG Lasers

Introduction

The treatment of onychomycosis has been quite an enigma. There has been no magic bullet treatment that has more than 90% efficacy. Currently, the highest efficacy for the treatment of onychomycosis has been oral terbinafine. There are several modalities for prescribing oral terbinafine, including continuous and pulsed dosing. However, the highest efficacy for complete mycological and clinical cure reported has been 38% at 48 weeks, with a relapse rate of 15% at the one year mark following completion of therapy [1]. The use of topical antifungals falls very short of the oral efficacy (although they are improving), ranging from an 8.5% cure rate with ciclopirox 8% lacquer, to a 17.8% cure rate with efinaconazole 10% solution [2,3]. As a result of incomplete clearance and high recurrence rates, there has been a need to explore alternative treatments for onychomycosis. Multiple light sources have been tried and their efficacies are varied. We attempt below to compile, in tabular form, a comprehensive look at the light sources as well as their treatment endpoints.

Methods

The literature search was performed using the National Institute of Health (NIH) Pubmed database. Articles were included from 2013 to May 2025. The search was limited to free, full text, peer reviewed articles. Articles included were clinical trials, randomized controlled trials, prospective or retrospective studies. Studies had to have an analysis of clinical efficacy along with mycological efficacy. Search terms included "onychomycosis" AND "treatment," "YAG," "light," "laser," or "photodynamic." The title and abstract of each article was screened for relevancy. Selected articles were then reviewed by the individual researcher that chose the article and relevant data was extracted and incorporated into this review. JADAD scoring was applied to each category of laser. However, to expand the diversity of light sources there were two exceptions. One for a retrospective study and one for a prospective study. Articles written before 2013 or in a language other than English were excluded. Systematic reviews and meta-analysis were also excluded. The review was conducted from 8 April 2025 through 21 May 2025. Five researchers participated in the search process. This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Fig. 1).

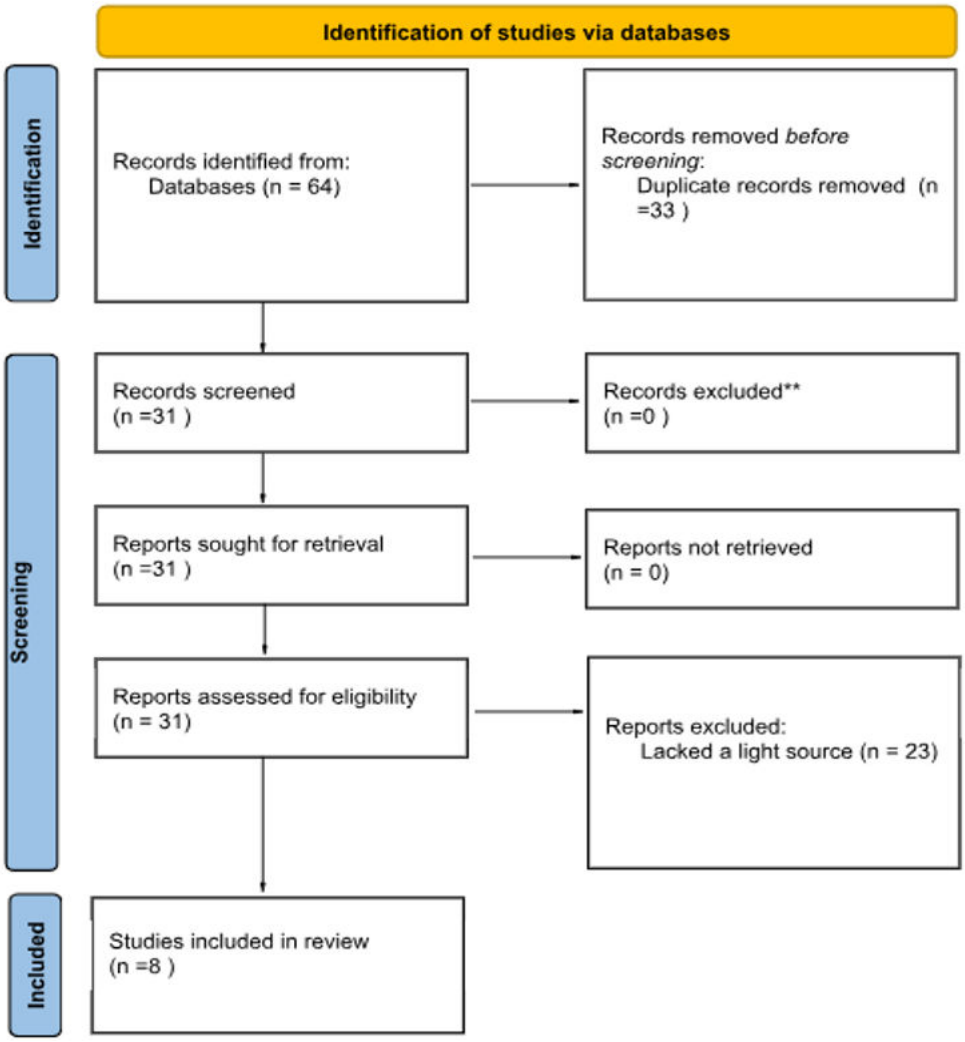

Figure 1: PRISMA 2020 flow diagram.

Results (Table 1)

Light Source	Study type	Treatment frequency	Evaluation endpoint	Percent of patients with 100% Clinical cure rate	Percent of patients with 100% Mycological cure rate	Comparison to oral terbinafine
Nd:YAG laser (1064 nm at 35-40 J/cm^2) [4]	Randomized controlled trial	1 session every week for 4 weeks (total of 4 sessions)	6 months post-treatment	100%*	80%	Superior
Nd:YAG laser (1064 nm at 200 mJ) [5]	Randomized controlled trial	1 session every 4 weeks for 12 weeks (total of 3 sessions; additional session at 12 week post-treatment follow-up as needed)	24 weeks post-treatment	15.2%***		Inferior
Class IV triple wavelength laser system (650 nm, 810 nm, 915 nm at 240 J) [6]	Prospective pilot study	~2 sessions every week for 28-44 days (total of 8 sessions)	1 month post-treatment	33%*	0%	Inferior

Intense pulsed light (500-600 nm at 10 J/cm^2) [7]	Randomized controlled trial	1 session every 1-2 weeks for 4 months (total of 8 sessions)	3 months post-treatment	80%***		Superior
Non-thermal dual-diode laser (635 nm red laser diode and 405 nm blue laser diode) [8]	Retrospective study of three clinical trials	1 session every week for 2 or 4 weeks (depending on trial)	2-13 months post-treatment (depending on trial)	67%* (sample of 50 patients from across the three trials)	Not reported	Inferior
Fractional CO_2 laser (10-15 mJ) [9]	Randomized controlled trial	1 session every 2 weeks for 6 months (total of 12 sessions)	6 months post-treatment	52.8%	Not reported	Inferior
Photodynamic therapy: 2% methylene blue irradiated with low-power red laser diode (670 nm at 200 mW) [7]	Randomized controlled trial	1 session every 1-2 weeks for 4 months (total of 8 sessions)	3 months post-treatment	70%***		Superior
Photodynamic therapy: 2% methylene blue irradiated with red LED (630 nm at 18 J/cm^2) [10]	Randomized controlled trial	1 session every 15 days for 6 months (total of 12 sessions)	12 months post-treatment	80%	Not report	Superior
Photodynamic therapy: methyl aminolevulinate irradiated with red LED (635 nm at 37 J/cm^2) [11]	Multicentre, Randomized controlled trial	1 session every week for 3 weeks (total of 3 sessions)	9 months post-treatment	18.18%	Not reported	Inferior

*Clinical cure rate was not specifically assessed for a complete, 100% clinical improvement in this study

***Cure rate was established by the authors as a combination of both 100% clinical clearance and negative fungal culture. Clinical cure rate and mycological cure rate were not provided as separate figures.

Table 1: Review of light sources [4-11].

Discussion

The exact light sources in the study were Nd:YAG lasers, class IV triple wavelength laser, intense pulsed light, non-thermal dual diode lasers, fractional CO_2 laser and photodynamic therapies. In the above table, the Nd:YAG lasers, intense pulsed light, fractional CO_2 laser and photodynamic therapies were all assessed in randomized clinical trials. The class IV triple wavelength laser was assessed in a prospective pilot study and the non-thermal dual diode laser was assessed in a retrospective study. The results in the table denote the percentage of complete cure achieved - meaning 1) the clinical efficacy, as determined by replacement of the mycotic nail bed and dystrophic nail plate with clear nail growth, in addition to 2) mycological efficacy as determined by KOH preparation, fungal culture or nail clipping/biopsy. Of the light sources assessed, PDT at 630 nm with methylene blue showed the highest efficacy, followed by intense pulsed light, followed by PDT at 670 nm with methylene blue.

Conclusion

After evaluation of a variety of light sources and their efficacy in treatment of nail onychomycosis compared with oral terbinafine which is the current gold standard, oral terbinafine remains the most clinically effective, cost-effective and efficient way to treat onychomycosis. While some of the light therapy treatments show promise of superior efficacy compared with oral terbinafine, the frequency of treatments over the duration of time required to attain these results make them unfeasible as a new standard of care for most patients. Additionally, onychomycosis has a high recurrence rate and none of the studies that were assessed follow patients for longer than 12 months to determine the longer term efficacy of treatment.

Conflicts of Interest
The authors declare no conflict of interest in this paper.

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Authors' Contributions
All authors contributed to conceptualization, treatment execution, manuscript writing and final approval.

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