QSW Nd:YAG 1,064-nm & Pulsed Nd:YAG 1,064- nm Lasers for the Treatment of Nail Fungus

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ABSTRACT

Background There is supporting evidence (ex-vivo and in-vivo) of pigment-related photothermolysis of trichophyton rubrum (T. rubrum) Nd:YAG 1064-nm (near infra-red) spectrum that are well absorbed by red and brown pigments of the infected nail fungus.

Method & Material Twenty patients (15 males and 5 females) with mycological (fungul strains) and clinical diagnosis of onychomycosis on their hallux underwent 3 treatments every 4 weeks with 2 lasers: Initially, a Q-switched Nd:YAG 1,064-nm laser and a Nd:YAG 1064-nm laser (Alma Lasers Ltd, Caesarea, Israel). Post-treatment evaluation was done 3 months after the last treatment. The severity of infection was determined by the degree of fungal involvement of the nails and was graded on a scale of 0 to 4 (0 – none, 1 – Mild, 2 – Moderate, 3 – Significant and 4 – Severe). In both treatment groups, each laser hand piece (Q-Switched & Nd:YAG 1064-nm) were held over the nail perpendicular to the nail plate. The laser hand piece was continually moved in a controlled manner over the nail surface in a semi-circular movement over the entire nail plate. Pre-set energies expressed in Joules were invested at each nail. Nails were photographed with a high resolution digital camera (Nikon D-70, Japan) before treatment and at week 4 and 12 post last treatment. Time taken to treat both feet was approximately 20 minutes. Patients were treated without using anesthesia. Digital photographs of halluces of both feet were used to determine the efficacy of the laser treatments. The efficacy was graded in terms of visible improvement from 0 – 4 on the basis of cosmetic clearance of fungal involvement in the nails where 0 = (0 - 5%) improvement, 1 = (6 - 25%) improvement, 2 = (26 - 50%) improvement, 3 = (51 - 75%) improvement, 4 = (76 - 100%) improvement.

Results Two patients exhibited an improvement grade of 4 (76-100%); nine patients exhibited a grade of 3 improvement (51-75%); six patients exhibited an improvement grade of 2 (26-50%); three patients exhibited a grade of 1 (6-25%) 3 months after the last treatment. No adverse side effects were noted in any of the cases during or at 3 months post treatment.

Conclusion The Q-switched 1064-nm laser and the pulsed Nd:YAG 1064-nm modules are a safe and effective modality for the treatment of onychomicosis.

INTRODUCTION

Onychomycosis is a fungal infection of a nail. The fungus can invade the nail plate or nail bed, potentially causing the nail to separate from the nail bed, a thickening of the nail, discoloration, and nail deformation. The majority of infections are caused by moulds called dermatophytes and yeasts . Multiple therapies, including surgical, chemical, topical, and oral methods, have been described for the treatment of onychomycosis. In general, limitations of the current therapeutic options include: inadequate spectrum of activity, lack of efficacy, poor penetration to the nail plate/matrix, multiple drug interactions, inadequate pharmacokinetic profile, excessive costs, recurrence of the infection and duration of treatment . Thus, there is a great need for other modalities to eradicate dermatopathogens causing onychomycosis.

Recently, there has been a resurgence of interest in the potential of energy-delivery technologies such as lasers, for the local treatment of fungal nail infection . The rational for using a laser source for the treatment of nail fungus stems from their thermocidal and bactercidal effects via localized photo-thermal or photo-chemical skin-nail interaction in the affected fungus nail (1,2).

TECHNOLOGY

There are 2 laser type modules that can be used on the Harmony XL (Alma Lasers Ltd.) multi-application platform (Figure 1) for the treatment of nail fungus: 1) Nd:YAG 1064-nm laser module; and 2) Q-switched Nd:YAG 1064-nm laser module. The Nd:YAG 1064-nm handpiece delivers high average power energy of up to 6W. Fluence (up to 200mJ/p) and repetition rate (up to 30Hz) are adjustable.

Figure 1. Q-Switched Nd:YAG 1064-nm laser module (left) and pulsed Nd:YAG 1064-nm laser module (right).

The Q-switched Nd:YAG 1064-nm delivers intense nanosecond (ns) pulses with extremely high peak power. The Nd:YAG laser is a solid state laser containing a crystal of yttrium-aluminum-garnet (YAG) doped with neodymium (Nd) ions. A Nd:YAG rod is placed within the laser cavity where powerful xenon arc lamps excite the Nd ions to provide emission in the invisible near infrared spectrum at 1064-nm.

LASER-NAIL INTERACTION

The optical energy by the Nd:YAG lasers is aimed to 1) being absorbed in the region between the nail plate and the nail bed based on the principle of selective photo-thermolysis where the temperature is increased to thermally deactivate the unwanted organism without causing substantial unwanted injury or substantial permanent injury to surrounding tissue; 2) Non specific heat conduction is introduced by the laser beam where the unwanted organism is thermally deactivated as the target area absorbs the beam of radiation and transfers the thermal energy to the unwanted organism. There is supporting evidence of pigment-related photothermolysis of T. rubrum by the Q-Switched laser that are well absorbed by red and brown pigments rather than inhibition due to nonspecific thermal damage. Because of its xanthomegnin content the QSW Nd:YAG 1064-nm laser is well absorbed by the red pigment which is abundant in T. rubrum. Xanthomegnin is a diffusible pigment produced by T. rubrum which confers its prominent red pigment and melanin pigment both seen in T. rubrum culture. Although the wavelength of Nd:YAG 1,064 nm is beyond the absorption spectrum of xanthomegnin, inhibitory effects on the colonies treated with this wavelength might be due to melanin, as it is known that Trichophyton species contain melanin in their cell walls.

PROTOCOL

Apply in-motion technique where the tip is slightly touching the nail & moving on the entire nail infected area. For the Q-Switched Nd:YAG 1064-nm laser, a total of 5-10 passes over the nail should be employed during the treatment, with a 30 second waiting period between every 3-4 passes. Total accumulative energy should be monitored in accordance to the recommended treatment protocol for each module. For the pulsed Nd:YAG 1064-nm laser, an accumulative energy of about 600 Joules over the hallux nail and of about 150J over the digit nail should be employed during the treatment. The thicker the nail, the greater the number of passes. If the patient is experiencing an uncomfortable level of heat, the operator should stop lasing for about 10 seconds and then continue the treatment. Laser output parameters are selected using the control panel or touch screen of the Harmony XL platform. Gloves must be worn by the practitioner prior to the initiation of the treatment; Treatments should be done on clean, nail-lacquer-free nails. The nail should be placed on an elevated, solid, stationary surface where the nail plate is facing up towards the operator and the laser module.

The appropriate protective eyewear should be worn by both the operator and the patient when using these modules. Recommended number of treatments are 2-3 at 4 weeks interval each treatment.

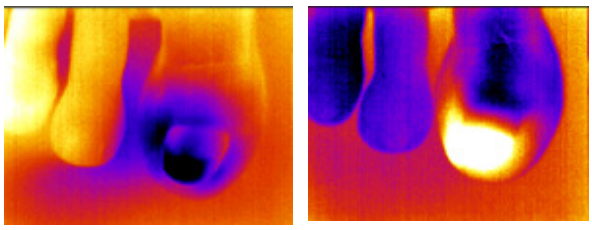

Figure 2. Thermal profile of nail fungus (hullux) before (blue/31.4ºC) and immediately after (white/45.5 ºC) treatment with pulsed Nd:YAG laser.

BEFORE & AFTER CASES

Figure 3. Before (left) and 4 weeks after (right) 3 treatment for male (upper) and female (lower) photos.

REFRENCES

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