Importance of Thermal Relaxation Time (TRT) in Onychomycosis and Pigmentation treatments

Background

Technological utilization of light's therapeutic properties in medical and aesthetic devices has become a main tool in today's scientific world.

Different types of light and levels of energy can be used for different diagnostic procedures or treatments. The most complicated challenge is to understand in detail how different biochemical compositions in the body respond to different light stimulus, and then making accurate models, often based on mathematical algorithms, to determine whether a test indicates normal or diseased physiology. The quantity of energy applied to the target must be sufficient to achieve the desired effect, but not enough to cause collateral damage on adjacent tissues.

Suiting of the correct wavelength to the clinical condition in order to achieve the desired therapeutic effect has been widely researched during the last decade. Today we know which wavelength is proper in order to perform hair or scars removal procedures, or acne treatments, but photobiology of human tissue is very complicated, and another key parameter we must consider is how long will it take to achieve the desired temperature minimizing or even avoiding collateral damage. This key factor is called "Thermal Relaxation Time" (TRT).

Thermal relaxation time is a commonly-used parameter for estimating the time required for heat to conduct away from a directly-heated tissue region. It represents the time taken for heated tissue to lose 50% of its heat through diffusion. This is significant in light-based treatments since if the application of light energy persists longer than the thermal relaxation time of the target, heat is conduced to the surrounding tissue leading to unwanted thermal injury. This is prevented by using exposure times within the thermal relaxation time of the target tissue (Katsambas & Lotti, 2003).

TRT in pigmented and vascular lesions

The data and histologic assessment of the vessel injury strongly suggest that pulse durations for ideal light treatment are in the 1-10-millisecond region and depend on vessel diameter (C.

Formatk Systems LTD, 3 Ha Yozma St', Tirat Carmel. 39032.
tel: 972-4-8571848, fax: 972-4-8570810, Mail: ilan@formatk.co.il, www.forma-tk.com

Diedrickx, 1995). Pulse duration in the same range as the thermal relaxation time, cause coagulation of targeted chromophore (melanin/ hemoglobin). When pulse duration is much longer than thermal relaxation time there is a significant heat transfer at a distance, which could result in nonselective damage.

Correct wavelength combine with correct TRT will achieve quick hemoglobin coagulation and posterior peeling. When thermal relaxation time is exceeded, same clinical consistence is not achieved, more treatment sessions are usually necessary to achieve same lesional clearance and there is also a theoretically higher incidence of scarring.

According to X. Muller (Lasers for Ischemic Heart Disease, 2000) pulse duration choice is as important as that of the wavelength.

TRT in Onychomycosis treatments

Thick, discolored, disfigured, and/or split nails can be common symptoms of disease of a fingernail or toenail. This disease can be caused by bacteria, mold, a fungus, viruses, parasites, or other organisms or microorganisms, and if left untreated, the disease can result in partial or complete destruction of a patient's nail plate.

In general, the most common type of nail disease is onychomycosis, which can be caused by a fungus, such as, a dermatophyte that invades the nail plate and nail bed. Creams, ointments and oral medications can be used to treat onychomycosis or other nail diseases. These treatments, however, usually do not eliminate the source of the disease, do not work for many patients, and can cause numerous side effects.

An innovative method of treating diseased nails is based on delivering a beam of radiation to a target area, to thermally deactivate an unwanted organism without causing substantial unwanted injury. This method includes irradiating the target area, such that radiation absorbed is converted to thermal energy that is trapped by the nail plate of the diseased nail to thermally deactivate the unwanted organism (fungus) present in at least one of the nail bed and the nail plate. The organism

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can be a dermatophyte, such as, for example, epidermophyoton floccosum, trichophyton rubrum, or trichophyton mentagrophyte. Wavelength chosen should be within the absorption range of the colony. For example, three of the most common fungi (e.g., dermatophytes) that cause nail disease are epidermophyton floccosum, trichophyton rubrum, and trichophyton metagrophytes. Each of these dermatophytes are orange to brown in color. For example, when grown in a Petri dish, epidermophyton floccosum colonies are a brownish-orange on the bottom of the colony and a brownish-yellow on the top of the colony; trichophyton rubrum is blood red at the bottom of the colony and a whitish-cream on the top of the colony; and trichophyton mentagrophytes is a pale pinkish brown on the bottom of the colony and cream on the top of the colony. As a result of the orange/red/brown color of the dermatophytes responsible for the nail disease, a blue to green wavelength (e.g., about 400 nm to about 550 nm) should be selected. This treatment eliminates or substantially eliminates the source of disease in the nail . Tissue surrounding the organism itself can absorb radiation and transfer thermal energy to the organism, and/or the organism can absorb directly the radiation. Deactivation of the organism can render it unable to grow, reproduce and/or replicate, or destroy the organism. Deactivation can result from thermal destruction, from denaturing or partially denaturing one or more molecules forming the organism or from initiating a photobiological or photochemical reaction that attacks the organism. The temperature in the region where the unwanted organism resides must be raised sufficiently to deactivate the organism, but not high enough to result in unwanted injury to the surrounding tissue. By delivering energy to the nail plate and/or the junction region, we can maximize the injury to the disease causing factor while minimizing injury to the surrounding tissue. This can be achieved by irradiating the nail in a period no longer than the tissue thermal relaxation time.

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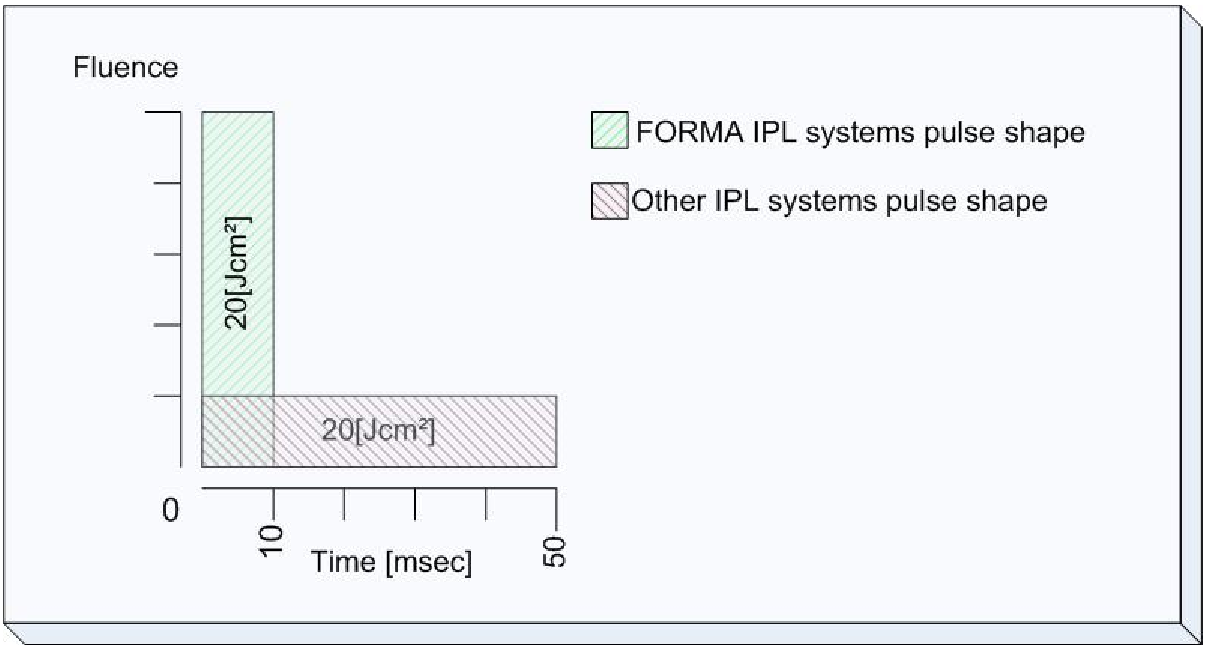
Forma-tk has developed an innovative, non invasive method for treating onychomycosis and pigmentation lesions based on IPL technologies, considering all these parameters, using the correct wavelengths and combining them with the adequate thermal relaxation times, achieving the most effective, safe technique for treating diseased nails and performing skin rejuvenation treatments, currently available in the market.



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