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Mini Review

Laser and Light-Based Devices used for Hair Removal

Reschke Ulrike*

Department of Dermatology, University Medical Center Mainz, Mainz, Germany

ABSTRACT

Laser treatment is the standard for hair removal. It provides a longer lasting hair-free period than other methods. Long treatment times, from minutes on the face to hours on the back, limited its practicality. Shortly thereafter, the quality switch Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG) laser in combination with a carbon-based topical suspension was approved by the Food and Drug Administration (FDA) as the first laser hair removal treatment. Hair regrowth was delayed by up to 4 months but not permanently. Laser devices provide longer-lasting results due to targeting the germinative cells and destructing them in the hair follicles.

Keywords: Laser treatment; Nd:YAG; Hair follicles; Melanin; Alexandrite laser

INTRODUCTION

The discussion will include the long-pulse alexandrite, long pulse diode, long pulse Nd:YAG, IPL system, and newer home use devices. Before doing the laser treatment for hair removal the patient selection criteria and various treatment considerations. Unwanted hair is a common problem. Hirsutism is a condition that occurs in women i.e. excessive hair growth like male pattern hair growth on a woman's face, chest and back. Although shaving, waxing, plucking, chemical hair removal and electrolysis hair removal can improve the quality of life, many of these techniques provide a temporary solution for unwanted hair. Electrolysis can permanently remove hair, but it is a slow, operator-dependent process with varying degrees of effectiveness. The same wavelength is absorbed by the epidermal melanin.

For people with dark skin, the higher the melanin content in the epidermis, the more it competes with the hair follicles for light absorption, increasing the risk of hot blisters and hyperpigmentation. In addition, reducing the total amount of energy that melanin can reach deep into the hair shaft reduces the overall effect per pulse. For these reasons, the ideal candidates for laser hair removal are fair-skinned, untanned skin and black hair [1]. The mechanism of action of laser hair removal is reflected in the immediate histological changes in the skin and its effect on the hair growth cycle. Microscopically, the treated follicle shows immediate changes in keratinocyte swelling, scattered apoptosis and necrotic keratinocytes, and full-thickness necrosis of the follicle, depending on the amount of energy absorbed. Permanent hair loss with complete loss of hair follicles is achieved only in 15% to 30% of the treated hair with each treatment with optimal parameters. More generally, transient hair loss is caused by the hair follicles being "rested" and inducing a state such as a telogen where hair growth does not occur.

LITERATURE REVIEW

Alexandrite laser

The long-term effects of long-pulse alexandrite lasers range from 65% to 80.6%. Uses a long pulse 755 nm alexandrite laser for effective hair removal in the face, arms and legs. The pulse duration of up to 6, 10, and 20 ms can be achieved for up to 6 months with an equivalent hair alexandrite laser. Lou et al. found that there was no significant difference in the effectiveness of alexandrite and diode lasers when treating patients with skin types I to V [2]. Treatment of patients with skin type I-IV sequential diodes followed by alexandrite laser did not result in greater average hair loss than the equivalent number of alexandrite laser treatments alone, but the former had more follicular inflammation, erythema, blisters, etc. Use of alexandrite laser in skin types I-III because there is no competing epidermal melanin and the risk of laser-induced pigmentation abnormalities or burns is low [3]. Long-pulse and short-pulse alexandrite lasers show no statistically significant difference in efficacy compared to IPL in type II to type IV skin. Temporary side effects such as erythema, edema, and paradoxical hair growth are greatest with long-pulse alexandrite and the IPL

Correspondence to: Reschke Ulrike, Department of Dermatology, University Medical Center Mainz, Mainz, Germany, E-mail: ulrike.reschke@charite.de

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system. In summary, alexandrite lasers are effective for hair removal, with results comparable to those of diode lasers and IPL devices. Alexandrite lasers are recommended for type I-III skin as there is no competing epidermal melanin and the risk of laser pigmentation and burns is a low diode [4].

The reduction in hair count reported with 810 nm long pulse diode lasers ranges from 22% to 59%. In skin treated with diode lasers, histological analysis showed a statistically significant reduction in hair density and thickness. Long-wavelength lasers such as diodes and 1064 nm Nd:YAG lasers have fewer side effects such as pain and post-inflammatory pigmentation than short-wavelength lasers and are suitable for treating dark skin types. Longer wavelengths induce less epidermal melanin absorption. The effects of hair removal between the diode and the Nd:YAG laser are inconsistent in the study. When treating Asian skin, diode lasers were less painful than Nd:YAG. Studies using diode lasers have recently proposed to move away from standard high fluence devices and adopt a low fluence (5-15 J/cm^2) approach [5]. Pigmentary changes and transient erythema are common side effects. In contrast to photo destruction of stem cells using the conventional technique, low fluence lasers may also trigger photo modulation of germinative cells, leading to altered hair growth. No long-term adverse effects were noted. The mechanism of hair removal using low fluence devices may be through induction of hair miniaturization of coarse terminal hairs. In contrast to photo destruction of stem cells using the conventional technique, low fluence lasers may also trigger photo modulation of germinative cells, leading to altered hair growth. Skin phototypes III to V can be effectively and safely treated with low flounce (5-15 J/cm^2) diode lasers.

NeodymiumDoped Yttrium Aluminum Garnet

The 1,064 nm Nd:YAG laser is considered the best laser for hair removal in patients with darker skin. The longer wavelength of the Nd:YAG allows for less epidermal melanin absorption. Adverse effects of pain and inflammation, greater hair reduction and a higher level of patient satisfaction occur in the Nd:YAG laser-produced than in the IPL system. Nd:YAG is recommended for people with skin types IV to VI because of the low risk of epidermal melanin absorption.

Intense pulsed light

Intense pulsed light (IPL) is a device that emits high-intensity, polychromatic, non-coherent and uncollimated light, whose beams have wavelengths starting from 400 nm to 1400 nm, and pulse duration of 2 ms to 400 ms. Current IPL devices consist of a chamber containing Xe gas, that is crossed by an electrical current that releases pulses of energy within the variety of radiant energy via a sapphire or quartz tip. Wavelengths above 950nm shouldn't be used for they need additional affinity with water, entailing they contribute to heat the epidermis. This wave is fragmented into multiple emission pulses, permitting the energy to be efficiently delivered to the target chromophore, avoiding injury to adjacent structures. The mechanism of action of IPL depends on the capture of energy by target tissue-the chromophores-through the principle of selective photothermolysis. The 3 main human skin chromophores are hemoglobin (Hb), melanin, and water; every of that includes a specific light absorption peak. Thus, the flexibility of IPL permits the mixture of parameters, aiming at treating the vascular and melanocytic skin lesions, further as perform epilation and photorejuvenation treatments, with a high skin coverage rate due to the large size of the spot.

Monochromatic (creating a single wavelength or a narrow band of wavelengths), unlike laser light with high output density and minimal coherence, IPL devices are multicolor xenon broadband flash with optics. Filters of non-coherent light rays in the visible to infrared spectrum (500-1200nm) are generated using a lamp. Based on the type of blocking filter used, the IPL device emits a defined range of wavelengths to reach the desired depth of the target structure [6,7]. Like lasers, IPL technology is based on the principle of selective photothermal decomposition. Due to its ability to emit a spectrum of wavelengths, a single exposure to light can simultaneously stimulate multiple chromophores of the skin (hemoglobin, water, and melanin). Therefore, inexperienced doctors and non-healthcare professionals are more prone to complications from non-specific thermal injuries. In addition, the immediate inducible perifollicular edema and erythema seen with lasers rarely occur with IPL, making it difficult to place the next pulse exactly next to the previous pulse and accidentally treating the skin patch. Finally, IPL devices have been shown to emit inconsistent fluence and wavelength on a pulse-by-pulse basis, with unpredictable clinical outcomes. The mechanism and wavelength range of light generation emitted by an IPL are essentially different from that of a laser, creating a particular set that stems from its strengths and weaknesses. IPL devices in the light range starting in the lower wavelength range are not recommended for darker skin, as the low wavelengths emitted in the optical spectrum of the IPL device can adversely target epidermal melanin. Cooling mechanisms (forced cooling, contact cooling, or delayed cooling) use cold or liquid nitrogen to lower the surface temperature of the skin, protect epidermal melanin, and prevent unwanted pigmentation and burns [8]. The forced cooling device continuously draws 6 to 10 inches of cold air from the skin to the direction of movement of the laser handpiece. It has an analgesic effect and reduces patient discomfort85. Cooled air partially protects the epidermal melanin, resulting in a shorter duration, weaker erythema, and fewer side effects such as less crusting and edema. Higher laser fluence is also acceptable. Another type of cooling device is contact cooling commonly used in IPL devices. Patients with dark skin types have a higher risk of side effects such as pigmentation and scarring due to the high melanin content of the epidermis. By using longer wavelengths, longer pulse durations, discreet fluence, and a more efficient cooling system, these complications can be minimized in individuals with darker skin. Epidermal melanin has low absorption efficiency and low harmfulness in long-wavelength lasers such as Nd:YAG. The best laser system for pigmented skin is Nd:YAG. Epidermal melanin is a small structure that cools faster than large structures such as hair follicles. The longer pulse duration allows the hair follicles to be effectively heated while the epidermal melanin is cooled and thermally protected.

CONCLUSION

Laser hair removal devices effectively provide a permanent and efficient way to remove unwanted hair. A detailed understanding of the characteristics of each laser is essential for the clinician to tailor the individual treatment to the individual patient. Laser technology for hair removal has been continuously developed since its inception in the mid-1990s. Current research aims to optimize the safety, efficacy and comfort of patients of all skin types. In the future, these improvements may lead to longer-lasting treatment results while minimizing unwanted side effects.

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