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Newer Technologies in Laser Hair Reduction Using Simultaneous Emission of Multiple Wavelengths: A Mini Review

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Mini Review

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Abstract

Laser hair reduction has become one of the most sought-after procedures for unwanted hair removal. This has given rise for a necessity to improve efficacy, safety and tolerance of the procedure and make it suitable for individuals of all skin types. Newer technologies in laser hair reduction have emerged consisting of combined simultaneous emission of wavelengths to capitalize upon the advantages of each individual wavelength when fired simultaneously. This review sheds light on the mechanism of hair reduction, novel laser systems available and their respective efficacies and safety profile.

Keywords: Laser hair reduction; Wavelength; Nd: YAG; Diode; Alexandrite

Introduction

Undesirable hair is a widespread aesthetic concern for both women as well as men [1]. Laser-based hair reduction technologies, based on high-intensity, coherent, monochromatic, narrow-waveband lasers, have emerged as the standard for hair depilation, as it provides a longer-lasting hair-free period than other methods. These lasers have seen significant technological advancements improving the efficacy and comfort, resulting in laser hair reduction (LHR) as one of the most requested treatments and popular choice for the permanent hair reduction [1-3].

Mechanism of Hair Reduction

Laser hair reduction works by causing a significant reduction in the number of terminal hairs, thus giving a clinical appearance of hair reduction without altering the actual number of hair follicles [4].

According to the theory of selective photo-thermolysis, laser energy of a specific wavelength is selectively absorbed by a pigmented target (chromophore) and transformed into heat [5]. Within the hair follicle, there is slight physical separation of the chromophore, that is the melanin inside the hair shaft, and the actual targets, which are the stem cells located in the bulge region. On exposure to light, the hair shaft melanin absorbs light and converts it to heat, which then diffuses towards bulge cells resulting in its collateral damage during the anagen growth phase as according to the extended theory of photo-thermolysis [1,6]. Microscopic changes observed based on the amount of light energy irradiated on the follicle include immediate keratinocyte swelling, scattered apoptotic and necrotic keratinocytes, and full-thickness necrosis of the follicle [1,7].

Wavelengths and Color of Skin and Hair

Wavelengths used for hair reduction are competitively absorbed by epidermal melanin and fail to reach the melanin located deep within the hair shaft. This poses a higher risk of thermal blisters, hyperpigmentation and even scarring in darker skinned individuals as well as reduces efficacy per pulse. Thus, the most suitable candidate for hair reduction would be a fair skinned, untanned individual with dark, coarse terminal hair [1].

The lasers that are available for LHR operate in the red or near-infrared wavelengths and include ruby (694-nm), alexandrite (755-nm), diode (800 to 810-nm) and neodymium:yttrium-aluminum garnet (Nd:YAG)(1064-nm) lasers [8].

Ruby lasers have high melanin absorption at 694-nm and are appropriate for persons with light skin types (Fitzpatrick I to III) and dark hair. These lasers have become obsolete for safety concerns as well as its high-power utilization [3]. Alexandrite (755-nm) lasers are solid state lasers which do not penetrate deeply and are more suitable for skin types I to III. [1] Diode semiconductor lasers (810-nm) are less absorbed by melanin in contrast to alexandrite lasers offering better safety for treatment of those with darker skin types [9]. The Nd: YAG (1064-nm) laser has least melanin absorption and greatest depth penetrating capacity as compared to ruby and alexandrite lasers, therefore lowering the risk of epidermal interference [3,9]. This makes it the ideal laser for skin types IV to VI due to less occurrence of side effects. On the other hand, more pain is perceived by patients owing to its deep optical penetration and increased fluence necessary to damage the hair bulb, as this wavelength is not easily absorbed by melanin [3,9].

To overcome these drawbacks posed by various individual wavelengths, methods such as utilizing longer wavelengths, longer pulse durations and skin cooling, have been employed for better comfort and safety. Parameters such as wavelength, pulse duration, and fluence must be customized for each patient for considerable hair reduction [10].

Available Devices

To overcome the limitations and capitalize on advantages of established LHR wavelengths, numerous new laser devices utilizing a simultaneous emission of more multiple wavelengths have become available in the market. In addition to sporting traditional wavelengths (755, 810, and 1064-nm) and their respective source media (alexandrite, diode, Nd: YAG), laser systems with novel LHR wavelengths (760, 805, 808, 940 and 1060-nm) have emerged from diode lasers. Several of such combinations available to the best of our knowledge are presented in Table 1 as dual, triple and even quadruple wavelength lasers.

Number of wavelengths	Amplifying medium	Wavelengths (nm)
Dual wavelength lasers	Alexandrite/Nd: YAG	755, 1064
	Diode	755, 810
		760, 808
		805, 1060
		808, 1064
		810, 1064
Triple wavelength lasers	Alexandrite/Diode/Nd: YAG	755, 810, 1064
	Diode	755, 808, 1064
Quadruple wavelength lasers	Alexandrite/Diode/Nd: YAG	755, 810, 940, 1060
	Diode	755, 810, 940, 1060

Table 1: Combinations of available multiple wavelength emitting systems

Dual Wavelength Lasers

With advent of newer laser technologies, dual wavelength lasers most commonly sporting hand pieces emitting Alexandrite/ Nd: YAG 755/1064-nm wavelengths and diodes emitting novel wavelengths apart from 810-nm have been introduced.

Gold, et al. [11] conducted a study wherein 50 patients were treated with a combination of 755/810-nm wavelength and another 50 with 810/1064-nm wavelength diode handpiece at various body sites for 3 sessions, 6 weeks apart, and evaluated hair counts at 6 months after the final treatment. Hair reduction was found to be 84% and 81% respectively in each group showing similar efficacy in reduction and with no significant adverse effects proving this device's safety and efficacy for all skin types.

A study by Bernstein, et al. [12] comparing the efficacy, safety and side effect profile of a laser system having single wavelength firing mode i.e., Alexandrite 755-nm alone versus a multiplex mode with 755/1064 and 1064/755 wavelength laser pulses over the axilla and evaluated at 6 months follow up after four sessions at 4 to 6 week intervals found all three firing modes were found to be equally efficacious and tolerable by all patients [12].

Zerbinati, et al. [9] explored the efficacy of simultaneous emission of Alexandrite 755-nm and Nd: YAG 1064-nm on skin types I-IV and found hair reduction to vary between 79.6-83% at different anatomical areas with no permanent adverse effects. Among the different skin types, no significant variability of pain tolerance and was noted and overall treatment process was comfortable probably owing to lesser fluences required in simultaneous emission mode [9]. The comparative efficiency of Alexandrite 755-nm, Nd: YAG 1064-nm and a blended mode of Alexandrite/ Nd: YAG 755/1064-nm was tested over the axilla and lower extremities in 36 patients of skin types I-IV by Ross and Domankevitz [13]. Fluence tolerance decreased with increase in skin type for the individual Alexandrite 755-nm and Nd: YAG 1064-nm exposures but higher fluences of the Nd: YAG 1064-nm in the blended mode were tolerable. Over the lower limbs, 50% hair reduction at follow up was seen in 60% of patients after exposure to the blended mode, which was significantly more than other two lasers individually. Similar hair reduction efficacies were seen in the axilla with all three combinations [13].

Triple Wavelength Lasers

Triple wavelength lasers possessing the properties of all three standard wavelengths have also been introduced. A study was conducted by Lehavit, et al. [14] using a simultaneous triple wavelength device (Alexandrite/diode/ Nd: YAG, 755/810/1064-nm) on 11 male participants of skin types III-V, using fluence of 7-9 J/cm^2, spot size of 2-4 cm^2 and frequency of 9-10 Hz, with 6 treatments at 4-6 weeks apart and followed up for 6 months. Efficacy was assessed using physician global aesthetic improvement scale (GAIS), score of which was found to be 3.4/4 and no adverse events reported.

Another study conducted by Raj Kirit, et al. [15] used the combined triple wavelength laser system (Alexandrite/ diode/Nd: YAG, 755/810/1064-nm) on 25 patients of skin types IV and V, using fluence 4-8 J/cm^2, 2 cm^2 spot size and pulse repetition of 10 Hz. Ninety anatomical sites were treated and physician GAIS score at the end of 6 sessions at 6 weeks follow up was found to be 3.9/4 with no adverse effects.

Discussion

The ever-growing demand for LHR treatment of unwanted hair has necessitated the increased requirement for better efficacy and safety of the procedure for all skin types. This has led to the emergence of innovative technologies in the field of LHR, such as introduction of inbuilt cooling mechanisms within the handpiece, different modalities of delivery of the laser beam, variable pulses, skin flattening techniques, robotic assistance, introduction of novel wavelengths as well as integration multiple simultaneous wavelengths in a single beam [16-20].

The concept behind combining multiple wavelengths as an integrated simultaneous pulse from a single handpiece is to provide the theoretical benefit of delivering the wavelengths within 50 ms, which would allow each wavelength to act within the thermal relaxation time (TRT) of the hair follicle [21]. A mixed modality also helps to overcome the disadvantage of the properties of each individual wavelength. For example, by combining the high efficacy of the Alexandrite 755-nm laser with the deep penetration and safety of Nd: YAG 1064-nm laser, this lends deeper penetration for lighter skin types and better efficacy for darker skin types while maintaining safety [9]. It is also hypothesized that using two different laser emissions simultaneously improves the prospect of damaging both deep and superficial targets, i.e., follicles at various depths [21,22]. Furthermore, several devices have the option of adjusting the fluence of each individual limb of the combined laser to customize the parameters according to the patient's hair color, skin type and tolerance to obtain maximum results [9,10].

Several earlier studies have been performed to evaluate the efficacy of sequential instead of simultaneous exposures of different LHR wavelengths to a given site in the same treatment area and session as compared to a single wavelength. It was found that sequential exposures were either equally or less efficacious than Alexandrite 755-nm and diode 810-nm individually, but more effective than Nd: YAG 1064-nm alone, and that sequential treatment could possibly lead to more complications [21-24]. The relative decrease in sequential exposure efficacy could be due to the time gap of several minutes between subsequent irradiation resulting in time extending beyond the TRT of the hair follicle. If the pulse duration is longer than the TRT, heat disseminates from the chromophore before permanent heat destruction occurs leading to shorter hair free periods [1,21]. Multiplex lasers with simultaneous emission results in beams firing within the TRT. Thus, these lasers have proven to be overall efficacious and safe with minimal to no adverse effects for all skin types as they bring together the advantages of each individual laser [9,11-15].

Comparability of the studies is limited with respect to skin types, anatomical sites, parameters applied, treatment regimens and evaluation techniques. All these are important factors in the determining the effectiveness of these lasers

[22]. Also, further studies comparing multiple wavelength lasers to single wavelength lasers are required to prove relative efficacy.

Conclusion

Usage of multiple and simultaneous emission of wavelengths for hair reduction was found to be an effective mode of treatment that is well tolerated with minimal discomfort to patients of all skin types.

References

1. Gan SD, Graber EM (2013) Laser hair removal: a review. Dermatol Surg 39(6): 823-838.
2. Bonan P, Troiano M, Verdelli A (2020) Safety and efficacy of single pass vs multipass emission with 755 alexandrite laser for all-skin-type hair removal: A pilot study. Dermatol Ther 33(6): e14001.
3. Thomas MM, Houreld NN (2019) The “in’s and outs” of laser hair removal: a mini review. J Cosmet Laser Ther 21(6): 316-322.
4. Casey AS, Goldberg D (2008) Guidelines for laser hair removal. J Cosmet Laser Ther 10(1): 24-33.
5. Anderson RR, Parrish JA (1983) Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. Science 220(4596): 524-527.
6. Altshuler GB, Anderson RR, Manstein D, Zenzie HH, Smirnov MZ (2001) Extended theory of selective photothermolysis. Lasers Surg Med 29(5): 416-432.
7. Dierickx C (2000) Laser-assisted hair removal: state of the art. Dermatol Ther 13: 80-89.
8. Atta-Motte M, Załęska I (2020) Diode Laser 805 Hair Removal Side Effects in Groups of Various Ethnicities - Cohort Study Results. J Lasers Med Sci 11(2): 132-137.
9. Zerbinati N, Protasoni M, Dalla Gasperina D (2021) Combined laser assisted treatment for permanent hair removal for skin types I-V with Alexandrite 755 nm and ND:YAG 1064 nm lasers. Dermatologic Therapy 34: e14599.
10. Ross EV, Ibrahimi OA, Kilmer S (2018) Long-term clinical evaluation of hair clearance in darkly pigmented individuals using a novel diode1060 nm wavelength with multiple treatment handpieces: A prospective analysis with modeling and histological findings. Lasers Surg Med 50(9): 893-901.
11. Gold MH, Hellman J, Dahan S, Mulholland SR (2019) Clinical evaluation of a novel blended mode diode laser for hair removal. Journal of Cosmetics, Dermatological Sciences and Applications 09: 19-29.
12. Bernstein EF, Basilavecchio L, Plugis J (2012) Bilateral axilla hair removal comparing a single wavelength alexandrite laser with combined multiplexed alexandrite and Nd:YAG laser treatment from a single laser platform. J Drugs Dermatol 11(2): 185-190.
13. Ross EV, Domankevitz Y (2021) Hair Removal With Blended 755/1064 nm Laser Energy. Lasers Surg Med.
14. Lehavit A, Eran G, Moshe L, Assi L (2020) A Combined Triple-Wavelength (755nm, 810nm, and 1064nm) Laser Device for Hair Removal: Efficacy and Safety Study. J Drugs Dermatol 19(5): 515-518.
15. Raj Kirit EP, Sivuni A, Ponugupati S, Gold MH (2021) Efficacy and safety of triple wavelength laser hair reduction in skin types IV to V. J Cosmet Dermatol 20(4): 1117-1123.
16. Das A, Sarda A, De A (2016) Cooling Devices in Laser therapy. J Cutan Aesthet Surg 9(4): 215-219.
17. Royo J, Moreno-Moraga J, Trelles MA (2017) Clinical assessment of a new 755 nm diode laser for hair removal: Efficacy, safety and practicality in 56 patients. Lasers Surg Med 49(4): 355-360.
18. Fiskerstrand EJ, Svaasand LO, Nelson JS (2003) Hair removal with long pulsed diode lasers: a comparison between two systems with different pulse structures. Lasers Surg Med 32(5): 399-404.
19. Kono T, Kikuchi Y, Groff WF, Sakurai H, Yamaki T (2010) Split-face comparison study of cryogen spray cooling versus pneumatic skin flattening in skin tightening treatments using a long-pulsed Nd:YAG laser. J Cosmet Laser Ther 12(2): 87-91.
20. Lim HW, Park S, Noh S, Lee DH, Yoon C, et al. (2014) A study on the development of a robot-assisted automatic laser hair removal system. Photomed Laser Surg 32(11): 633-641.
21. Khoury JG, Saluja R, Goldman MP (2008) Comparative evaluation of long-pulse alexandrite and long-pulse Nd:YAG laser systems used individually and in combination for axillary hair removal. Dermatol Surg 34(5): 665-670.
22. Bouzari N, Tabatabai H, Abbasi Z, Firooz A, Dowlati Y (2004) Laser hair removal: comparison of long-pulsed Nd:YAG, long-pulsed alexandrite, and long-pulsed diode

lasers. Dermatol Surg 30(4 Pt 1): 498-502.

23. Rao J, Goldman MP (2005) Prospective, comparative evaluation of three laser systems used individually and in combination for axillary hair removal. Dermatol Surg 31(12): 1671-1676.

24. Davoudi SM, Behnia F, Gorouhi F, Keshavarz S, Nassiri Kashani M, et al. (2008) Comparison of long-pulsed alexandrite and Nd:YAG lasers, individually and in combination, for leg hair reduction: an assessor-blinded, randomized trial with 18 months of follow-up. Arch Dermatol 144(10): 1323-1327.