Aspects of Diode Laser (805 nm) Hair Removal Safety in a Mixed-Race Group of Patients

Izabela Załęska¹, Magdalena Atta-Motte²*

¹The Section of Professional Cosmetology, The Faculty of Motor Rehabilitation, the University of Physical Education in Krakow, Poland
²5th Avenue Medical Clinic, London, UK

*Correspondence to Magdalena Atta-Motte, 5th Avenue Medical Clinic, London, UK. Tel: +4407932857109 Email: magda.atta.motte@consultant.com

Published online xx xx 2019

Abstract

Introduction: Laser hair removal (LHR) has become one of the most popular treatments in aesthetics. Side effects are an inevitable part of laser therapy, therefore managing them is crucial for every laser practitioner to ensure patients' safety along with achieving the best results. The available references describe the effectiveness of the diode LHR for all skin types according to the Fitzpatrick scale, but the question of patient safety and minimization of side effects and postoperative complications in mixed-race patients remains unanswered. This study aims to illustrate aspects of specific side effects in patients of mixed ethnicity and the impact of those effects on the results of the treatment.

Methods: The study was conducted in Poland and the United Kingdom on 216 patients of various ethnic backgrounds. This study analyses the frequency of side effects in a mixed-race group of 32 participants, taking into account their skin type according to the Fitzpatrick scale. The patients received a course of 6 treatments using diode laser 805 nm. An objective and a subjective method were used to analyse treatment results and side effects, with adverse effects documented, if observed. Treatment settings were adjusted to skin reaction during the patch test.

Results: Objective analysis was different from the subjective analysis of the treatment's effectiveness. No adverse effects were observed. Side effects such as hyperpigmentation, skin irritation, skin burns, and skin hypersensitivity were found.

Conclusion: 805 nm diode laser is effective and efficient at hair removal in mixed-race patients. It is a safe treatment in terms of skin reaction as only short-term side effects were observed in the treated area and no adverse effects were noted. To achieve the best results and to avoid adverse effects it is necessary to adjust treatment settings according to the individual patient's skin reaction.

Keywords: Side effects; Epilation; Diode laser; Ethnicity; Hair removal.

Introduction

Patients who decide to undergo a permanent hair removal course of treatments put the effectiveness of the method and a fast and long-lasting result as their priority.¹ For the practitioner, patient safety should be as important as the results of the treatment. During the initial consultation, it is necessary to inform the patients about the possible occurrence of side effects as part of the therapy and educate them on all skin care routines that might cause or minimize those side effects.²,³

Patients may expect redness, skin irritation, erythema, postoperative hypersensitivity and possible burns manifested by blisters and scabs. It is also possible to experience pigmentary changes such as hyperpigmentation. Less frequently described cases are scarring, purpura, folliculitis, cyanobacteria, pruritus or urticaria.³⁶

The available literature describes the effectiveness of the diode laser as a method for all skin types according to the Fitzpatrick scale hair removal, but the question of patient safety and minimization of side effects and postoperative complications in mixed-race patients remains unanswered.¹,³⁷⁻¹⁴

In diode laser, the hair removal principle of selective photothermolysis applies where the chromophore is melanin in the hair shaft itself and the bulge. However, the same chromophore can be found as skin pigment. Some parts of the body, such as underarms or the pubic area, are more pigmented.

It is difficult to achieve the best results in laser hair removal (LHR) in the pubic area – one of the most popular treatments – and the procedure itself is quite embarrassing for the patient. On top of that, darker-skinned patients are much more sensitive in this area, which makes the treatment even more challenging. That is why the authors focused on this part of the body for further analysis.

The literature reports on such adverse effects and
complications resulting from the use of an Alexandrite laser as: paradoxical hyperkeratosis and discoloration and post-inflammatory discoloration, de-novo growth of hair outside the area treated by laser, potentiation of co-existing vellus hair in the treatment area, induction or aggravation of acne, rosacea-like rash, premature greyness of hair, tunnelling of hair under the skin, prolonged diffuse redness and enema of the face, focal hypopigmentation of the lip, angular cheilitis, purpura and inflammatory and pigmented changes of pre-existing nevi. Research on cooling sapphire handpiece Alexandrite reports no severe side effects. The literature also provides information about side effects using Ng-Yage Q switched and ruby lasers. It is said the majority of diode laser patients experience no long-term side effects.

The researchers’ experience shows that the ethnic background of patients is rarely analysed by the therapist which might result in unexpected, severe side effects. Unfortunately, practitioners performing these treatments focus only on using the basic minimum information – like the Fitzpatrick skin phototype, colour and hair structure. Those are not the only factors which affect the safety of the treatment or treatment parameter settings. When treating mixed-race patients, it is essential to consider their ethnicity and a detailed ethnic history.

The scientific literature presents numerous reports on the effectiveness of LHR but is limited to different parts of the body and no reports on mixed-race participants have been found.

Objective
The authors of this study have noticed that mixed-race patients’ skin reacts differently than similar skin types according to the Fitzpatrick scale of non-mixed-race patients and so far no related research was found. The objective of the study was to investigate the occurrence and types of side and adverse effects after performing diode laser 805 nm hair removal in a group of mixed-race participants with phototypes III-V and to assess its impact on the results of the treatment measured as a percentage of hair reduction in the treated area.

Methods
The research was carried out in Poland and the United Kingdom from April 2015 to April 2017. 235 people took part in the study, of which 216 – after the initial consultation – were qualified for the course of 6 treatments (n = 216 / f = 174 (1 transgender), m = 42). Exclusion criteria included:
• any previous laser or IPL treatments in the study area,
• cancer,
• use of hormonal drugs,
• photosensitizing drugs,
• antibiotic therapy,
• use of cosmetics containing retinol, vitamins A, E, C, fruit acids,
• intake of herbs which can be photosensitizing,
• suntan,
• chemical or mechanic depilatory, or hair bleaching during prior 6 weeks,
• irritated skin,
• dermatosis of various etiology,
• reticularis,
• photodermatitis,
• epilepsy,
• pregnancy and breastfeeding,
• isotretinoin use within the past year,
• history of photosensitivity,
• history of hypertrophic scars and keloids,
• age below 20 or above 40 years old.

A course of 6 treatments was completed by 206 participants (f = 168, m = 39). One person was excluded from the analysis due to a 100% success of the therapy after three treatments. Nine participants discontinued the therapy due to the occurrence of side effects.

During initial consultations, according to the study protocol and to ensure patients’ safety, investigators assessed skin types using the Fitzpatrick Scale Quiz. The Fitzpatrick scale is defined as a classification for human skin colour as a way to estimate the response of different types of skin to light exposure. The Fitzpatrick scale is a recognized tool for dermatological research into human skin pigmentation. Type I always burns, never tans (pale white; blond or red hair; blue eyes; freckles). Type II usually burns, tans minimally (white; fair; blond or red hair; blue, green, or hazel eyes). Type III sometimes burns mildly, tans uniformly (cream white; fair with any hair or eye colour.) Type IV burns minimally, always tans well (moderate brown). Type V very rarely burns, tans very easily (dark brown). Type VI never burns, never tans (intensely pigmented dark brown to darkest brown).

To define ethnicity, in addition to the medical questionnaire ethnic background questions were asked following the Census 2001 scheme acknowledged in the United Kingdom.

Several ethnic background types were distinguished in the examined group:
• White: participants with white skin,
• Black: participants with black skin,
• Asian: participants who come from Asia,
• Mixed-race
  ♦ White and Black African: participants whose ancestors were white and black who originally came from Africa.
  ♦ White and Black: participants whose ancestors had white and black skin which came from non-African countries.
  ♦ White and Asian: participants whose ancestors had white skin and Asian skin, who came from
Asian countries.

This study was focused on a sub-group of mixed-race participants \( n = 32 \) (\( f = 24, m = 8 \)) (Figure 1) of various nationalities (Figure 2) and skin types (Figure 3) chosen from the main group, who indicated their ethnicity as mixed-race.

Diode laser with the wavelength of 805 nm, minimum peak power 2100 W and a pulse duration between 15 and 400 ms, ET sapphire cooling assisted handle 9 × 9 mm large, and pulse energy density between 10 and 100 J/cm\(^2\) used for all treatments.

This research protocol adhered to patch tests treatment settings such as fluence (J/cm\(^2\)) and pulse duration (ms) as per manufactures guidelines for different Skin Type, Hair Colour, Hair Texture (Table 1) and modified according to individual skin reactions.

Patch test settings were starting points for treatments. To achieve the best results and to ensure patients safety (and taking into account their ethical history) during each treatment, fluence and pulse width were adjusted to the individual participants' skin reaction.

Initial settings and final settings of pulse duration (ms) and fluence (J/cm\(^2\)) were documented for this study.

During the initial consultation, practitioners had explained a realistic expected outcome of the course of 6 treatments. Participants were familiarized with the definition of permanent hair reduction issued by the FDA and the possible result of the treatment as a long-term, stable reduction in the number of hairs regrowing after the course of treatments. Participants were aware that hair reduction would last for four to twelve months and permanent hair reduction doesn't mean the elimination of all hairs in the treatment area. The reference point for an excellent result was defined to be an 80% hair loss. Participants were aware of side effects and adverse effects possibilities. Before carrying out the treatment, the patient's skin was shaved and cleaned, and during the course of 6 treatments the patients were not using any other methods of hair removal, as per the therapist's pre and post instructions.

All respondents had 6 treatments planned with intervals

![Figure 1. Group of Mix Race Participants.](image1)

![Figure 2. Nationality of Mix Race Participants.](image2)

![Figure 3. Fitzpatrick's Skin Types in Group of Mix Race Participants.](image3)

### Table 1. Initial Patch Tests Settings for Different Skin Types, Hair Color and Hair Structure According to the Manufacturer's Guidelines

| Skin Type | Hair Colour | Hair Texture | Fluence (J/cm\(^2\)) | Pulse Duration (ms) |
|-----------|-------------|--------------|----------------------|---------------------|
| Blond/red | Not observed | N/A | N/A |
| Light brown | Medium | Coarse | 28 | 30 |
| Light brown | Medium | Fine | 30 | 15 |
| Dark brown | Medium | Coarse | 28 | 30 |
| Black | Medium | Fine | 26 | 15 |
| Black | Medium | Coarse | 24 | 30 |
| Blond/red | Not observed | N/A | N/A |
| Light brown | Not observed | N/A | N/A |
| Dark brown | Medium | Coarse | 26 | 30 |
| Dark brown | Medium | Fine | 5-6 | 30 |
| Black | Medium | Fine | 8-9 | 100 |
| Black | Medium | Coarse | 8 | 100 |

During the initial consultation, practitioners had explained a realistic expected outcome of the course of 6 treatments. Participants were familiarized with the definition of permanent hair reduction issued by the FDA and the possible result of the treatment as a long-term, stable reduction in the number of hairs regrowing after the course of treatments. Participants were aware that hair reduction would last for four to twelve months and permanent hair reduction doesn't mean the elimination of all hairs in the treatment area. The reference point for an excellent result was defined to be an 80% hair loss. Participants were aware of side effects and adverse effects possibilities. Before carrying out the treatment, the patient's skin was shaved and cleaned, and during the course of 6 treatments the patients were not using any other methods of hair removal, as per the therapist’s pre and post instructions.

All respondents had 6 treatments planned with intervals
of 6 weeks, in accordance with the pubic area hair growth cycle. The duration of the telogen phase in this public area is three months, 30% of hairs are in the anagen phase of growth; therefore, authors adjusted the study protocol to the manufacturer’s guidance.

Subjective and objective percentage assessment of hair reduction was indicated.

In the objective method, reliable evaluation of hair reduction was introduced by taking photographs with zoom ×20 of a 1 cm² area, 4 cm lower from the middle distance between iliac spines. The number of hairs was counted and the assessment of percentage reduction was introduced before the first treatment and 6 weeks after the last one was carried out.

Simultaneously, 6 weeks after completing the treatment cycle the patients were asked to share their opinion on hair loss percentage and to estimate the percentage of hair loss in the treated area.

Before and after each treatment, in cooperation with participants the side effects were defined as:
- skin hyperpigmentation,
- skin redness,
- skin irritation,
- skin hypersensitivity,
- skin burns
and adverse effects defined as:
- discomfort,
- damage to the natural skin texture,
- scarring,
- excessive swelling,
- blisters,
- bruising
all of which were documented when observed.

Treatment settings such as fluence and pulse duration were documented.

The STATISTICA 12 PL tool, licensed by the Jagiellonian University of Krakow, Poland, was used for statistics. The Wilcoxon signed-rank test used for comparison of exposure parameters of first and sixth treatment and the hair loss percentage in the subjective and objective assessment according to the study methodology in the area of 1 cm². Spearman’s rank correlation coefficient was used for the results of exposure and selected parameters of laser radiation analysis. Multivariate modelling by multiple regression was also applied. In the obtained study model, the dependent variable was the hair loss percentage according to the study methodology in the area of 1 cm², and the independent variables were the parameters of the first and sixth treatments and changes in the observed area of 1 cm² between first and sixth treatment. The results were statistically significant when the significance level was less than or equal to 0.05. Lack of statistical significance was marked with the abbreviation NS (statistically nonsignificant).

Results

It was noted that side effects such as hyperpigmentation (n = 2), skin irritation (n = 3), skin burns (n = 5), skin hypersensitivity (n = 16) were observed in 81.25% of mixed-race participants (Figure 4).

None of the adverse effects such as discomfort, damage to the natural skin texture, scarring, excessive swelling, blisters, bruising were observed.

It was observed that occurrence of side effects correlates to the skin type (P<0.01) according to the Fitzpatrick scale (Figure 5).

The treatment effectiveness was statistically different (P<0.001) in the objective and subjective assessment (Figure 6).

In this study pulse duration (ms) and fluence (J/cm²) were adjusted to the participants’ skin reaction during a patch test to ensure best results and to minimize the risk of side effects; therefore, initial settings of pulse duration were increased (Figure 7).

During multivariate analysis, multivariate regression was used in which the hair loss percentage determined
Diode Laser (805 nm) Hair Removal Safety in a Mixed-Race Group of Patients

In this study pulse duration (ms) and fluence (J/cm²) had no impact on the effectiveness of the treatment. Pulse duration increase (ms) has no impact on the effectiveness of the treatment.

Conclusion

Diode laser 805 nm hair removal is safe and effective for mixed-race participants. However, to minimize the occurrence of side effects, it is necessary to adjust

Table 2. Correlation Between Treatment Settings and the Effectiveness of the Treatment in the Group of Mixed-Race Participants

| Ethnicity       | Effectiveness | Pulse Duration (ms) 1st Treatment | Fluence (J/cm²) 1st Treatment | Fluence (J/cm²) 6th Treatment | Delta J/cm² |
|-----------------|---------------|-----------------------------------|-------------------------------|-------------------------------|-------------|
| Objective       | r=0.285       | N=32                              | P=0.0117                      | N=32                          | p=0.2848    |
| Subjective      | r=0.1446      | N=32                              | P=0.082                       | N=32                          | p=0.167     |

r, correlation ratio; N, number of participants; P, statistical significance.

Table 3. Regression Summary for Dependent Variable: Hair Loss Percentage After 6 Treatments According to Methodology in the Area of 1 cm²

| N=32 | b* | Standard Error of b* | b | Standard Error of b | t (29) | P Value |
|------|----|----------------------|---|---------------------|-------|--------|
| Intercept | 112.466 | 11.537 | 9.748 | 0.0000 |
| Fluence (J/cm²) 1st treatment | -1.042 | 0.395 | -1.115 | 0.422 | 2.640 | 0.0132 |
| Pulse duration (ms) 1st treatment | -0.670 | 0.394 | -0.0298 | 0.018 | -1.698 | 0.1001 |

R²=0.50801394, R²=0.25807816, Adjusted R²=0.20691114, F (2,29) =5.0438, P<0.01319, Standard Error of estimate: 4.9812.

Include condition: Ethnicity=Mixed Raced.

In the dependent variable regression b* includes standardised regression ratios. The value of b* ratios lets us compare the relative input of each independent variable to a dependent variable prediction.
Ethical Considerations
All procedures in this study and involving human participants were performed following the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study has been registered in the ISRCTN registry (identifier: ISRCTN10288390).

Conflict of Interests
The authors declare no conflict of interest.

References
1. Cameron H, Ibbotson SH, Dawe RS, Ferguson J, Moseley H. Within-patient right-left blinded comparison of diode (810 nm) laser therapy and intense pulsed light therapy for hair removal. Lasers Med Sci. 2008;23(4):393-397. doi:10.1007/s10103-007-0510-6
2. Payne RA, Perper M, Eber AE, Aldahan AS, Nouri K. Laser and Light Treatments for Hair Reduction in Fitzpatrick Skin Types IV-VI: A Comprehensive Review of the Literature. Am J Clin Dermatol. 2018;19(2):237-252. doi:10.1007/s40257-017-0316-7
3. Royo J, Urdiales F, Moreno J, Al-Zarouni M, Cornejo P, Trelles MA. Six-month follow-up multicenter prospective study of 368 patients, phototypes III to V, on epilation efficacy using an 810-nm diode laser at low fluence. Lasers Med Sci. 2011;26(2):247-255. doi:10.1007/s10103-010-0846-1
4. Agarwal M, Velaskar S, Gold MH. Efficacy of a Low Fluence, High Repetition Rate 810nm Diode Laser for Permanent Hair Reduction in Indian Patients with Skin Types IV-VI. J Clin Aesthet Dermatol. 2016;9(11):29-33.
5. Wanner M. Laser hair removal. Dermatol Ther. 2005;18(3):209-216. doi:10.1111/j.1529-8019.2005.00500.x
6. Gan SD, Graber EM. Laser hair removal: a review. Dermatol Surg. 2013;39(6):823-838. doi:10.1111/dsu.12116
7. Nanni CA, Alster TS. Laser-assisted hair removal: side effects of Q-switched Nd:YAG, long-pulsed ruby, and alexandrite lasers. J Am Acad Dermatol. 1999;41(2 Pt 1):165-171.
8. Lanigan SW. Incidence of side effects after laser hair removal. J Am Acad Dermatol. 2003;49(5):882-886. doi:10.1067/s0190
9. Ibrahim OA, Avram MM, Hanke CW, Kilmer SL, Anderson RR. Laser hair removal. Dermatol Ther. 2011;24(1):94-107. doi:10.1111/j.1529-8019.2010.01382.x
10. Sadigha A, Mohaghegh Zahed G. Meta-analysis of hair removal laser trials. Lasers Med Sci. 2009;24(1):21-25. doi:10.1007/s10103-007-0515-1
11. Pavlovic MD, Adamic M, Nenadic D. Fixed, low radiant exposure vs. incremental radiant exposure approach for diode laser hair reduction: a randomized, split axilla, comparative single-blinded trial. J Eur Acad Dermatol Venereol. 2015;29(12):2377-2381. doi:10.1111/jdv.12339
12. Tremaine AM, Avram MM. FDA MAUDE data on complications with lasers, light sources, and energy-based devices. Lasers Surg Med. 2015;47(2):133-140. doi:10.1002/lsm.22328
13. Ormiga P, Ishida CE, Boechat A, Ramos ESM. Comparison of the effect of diode laser versus intense pulsed light in axillary hair removal. Dermatol Surg. 2014;40(10):1061-1069. doi:10.1097/DSS.0000000000000138
14. Koo B, Ball K, Tremaine AM, Zachary CB. A comparison of two 810 diode lasers for hair removal: low fluence, multiple pass versus a high fluence, single pass technique. Lasers Surg Med. 2014;46(4):270-274. doi:10.1002/lsm.22226
15. Al-Hamamy HR, Saleh AZ, Rashed ZA. Evaluation of Effectiveness of Diode Laser System (808 nm) versus Intense Pulse Light (IPL) in the Management of Unwanted Hair: A Split Face Comparative Study. Int J Med Phys Clin Eng Radiat Oncol. 2015;4(1):41-48. doi:10.4236/ijmpco.2015.41006
16. Krauss MC. Removal of bikini hair using a rapid 810-nm diode laser. Cosmet Dermatol. 2008;21(7):392-396.
17. Jo SJ, Kim JY, Ban J, Lee Y, Kwon O, Koh W. Efficacy and Safety of Hair Removal with a Long-Pulsed Diode Laser Depending on the Spot Size: A Randomized, Evaluators-Blinded, Left-Right Study. Ann Dermatol. 2015;27(5):517-522. doi:10.5021/ad.2015.27.5.517
18. Alajlan A, Shapiro J, Rivers JK, MacDonald N, Wiggins J, Lui H. Paradoxical hypertrichosis after laser epilation. J Am Acad Dermatol. 2005;53(1):85-88. doi:10.1016/j.jaad.2004.06.054
19. Rasheed AI. Uncommonly reported side effects of hair removal by long pulsed-alexandrite laser. J Cosmet Laser Ther. 2009;8(4):267-274. doi:10.1111/j.1473-2165.2009.00465.x
20. Honeybrook A, Crossin T, Bernstein E, Bloom J, Woodward J. Long-term outcome of a patient with paradoxical hypertrichosis after laser epilation. J Cosmet Laser Ther. 2018;20(3):179-183. doi:10.1080/14764172.2017.1383614
21. Al-Hargan A, Ghobara YA, Al-Issa A. Purpura induced by laser hair removal: a case report. J Med Case Rep. 2018;12(1):60. doi:10.1186/s13256-018-1604-4
22. Nistico SP, Del Duca E, Farnetani F, et al. Removal of unwanted hair: efficacy, tolerability, and safety of long-pulsed 755-nm alexandrite laser equipped with a sapphire handpiece. Lasers Med Sci. 2018;33(7):1479-1483. doi:10.1007/s10103-018-2503-z
23. Battle EF Jr, Hobbs LM. Laser-assisted hair removal for darker skin types. Dermatol Ther. 2004;17(2):177-183. doi:10.1111/j.1396-0296.2004.00418.x
24. Galadari I. Comparative evaluation of different hair

treatment settings – such as pulse duration and fluence – according to the individual skin reaction taking into account the patient’s ethical history.

Besides excellent results (above 80%) of hair reduction observed in the treated area in subjective and objective assessments, a high percentage of side effects were observed but no adverse effects were noted. Side effects occurring in the group of mixed-race patients correlated to their skin type.

It is worth to note that the study was conducted among participants of various ethnicities who live in Poland or United Kingdom, which can be a factor minimising the risk of heat or sun exposure related side effects.
25. Haedersdal M, Wulf HC. Evidence-based review of hair removal using lasers and light sources. *J Eur Acad Dermatol Venereol*. 2006;20(1):9-20. doi:10.1111/j.1468-3083.2005.01327.x

26. Amin SP, Goldberg DJ. Clinical comparison of four hair removal lasers and light sources. *J Cosmet Laser Ther*. 2006;8(2):65-68. doi:10.1080/14764170600717902

27. Lancer HA. Lancer Ethnicity Scale (LES). *Lasers Surg Med*. 1998;22(1):9. doi:10.1002/(SICI)1096-9101(1998)22:1<9::AID-LSM4>3.0.CO;2-T

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