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ORIGINAL ARTICLE

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A comparison study of the efficacy and side effects of different light sources in hair removal

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Abstract Unwanted hairs are a common problem in which different light sources were developed as the treatment of choice. Alexandrite laser, diode laser, and intense pulsed light (IPL) were clinically used for this purpose with long-term scarce comparative results. The objective of the study was to compare the clinical efficacy, complications, and long-term hair reduction of alexandrite laser, diode laser, and IPL. Clinical trials on 232 persons using diode, alexandrite, laser and IPL were conducted. The number of sessions to reach optimal result varied between 3 and 7. Then the side effects were evaluated. Six months after the last session, optimal hair reduction was observed with no significant differences between the light sources, but a hair reduction was found to be higher using the diode laser. Side effects were observed with all light sources but more frequently with diode. Our findings indicate that all three light sources tested have similar effects on hair removal and in Iranian patients, using lower wavelengths minimizes the side effects.

Keywords Alexandrite laser · Diode laser · Laser hair removal · Intense pulsed light

Introduction

Unwanted hair is a common problem in women most often encountered in the primary care setting. The condition may be caused by androgen overproduction, increased sensitivity to circulating androgens, or other metabolic and endocrine disorders, and should be properly evaluated. Options for hair removal vary in efficacy, degree of discomfort, and cost. Clinical studies on the efficacy of many therapies are lacking. Short of surgical removal of the hair follicle, the only permanent treatment is electrolysis. However, the practice of electrolysis lacks standardization and regulation of the procedure varies from state to state. Shaving, epilation, and depilation are the most commonly attempted initial options for facial hair removal. Although these methods are less expensive, they are only temporary. Laser hair removal, although better studied than most methods and more strictly regulated, has yet to be proved permanent in all patients. By the time most patients consult a physician, they have tried several methods of hair removal. The use of lasers in hair removal allows selective targeting of the hair bulb and can diminish regrowth for at least 3 months [1–4].

The basis for laser hair removal is the specific targeting of melanin in the hair bulb. Melanin absorbs the light emitted by the laser at a specific wavelength. The energy of the laser converts into heat, causing the selective destruction of the hair bulb. However, melanin in the surrounding epidermis can also be targeted, which may limit the success of the procedure. With too much melanin in the adjacent skin, the laser energy is absorbed into the surrounding epidermis, causing epidermal damage or absorptive interference with less effective hair destruction. Patients with dark hair and light skin have a relatively higher concentration of melanin in the hair compared with the epidermis, allowing for more selective absorption of light within the hair bulb, reducing damage to or interference by the melanin in the epidermis. Conversely, gray or white hair is a poor target for laser energy. The most common side effects of laser hair removal are folliculitis, hypo-pigmentation, and hyper-pigmentation relating to skin color, blisters, and crusts. The process itself can be slightly painful because of the short burst of heat energy created [1–4].

Materials and methods

This study was performed as a clinical trial on 232 persons using diode (Palomar; 810 nm wavelength, 12.5-ms pulse

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width, and fluence of 40 to 64 J/cm^2 through a 9 mm^2 sapphire chill tip), alexandrite laser (Cynosure; 755 nm wavelength, 2-ms pulse length, 10 mm spot size, and fluence of 16 to 20 J/cm^2), and intense pulsed light (IPL) (Medical Bio Care, Sweden; cut-off filter of 650 nm wavelength with double pulse illumination, fluence of 22 to 34 J/cm^2, 20 ms pulse duration, and 10 to 40 ms between consecutive pulses) from March 2002 to June 2004. Patients were explained about the three different lasers in this study and after a voluntary consent, the choice of their laser treatment was randomized based on the last digit of their file number. Patients were matched according to skin types and treatment areas. Patients presenting with hirsutism were Fitzpatrick skin-typed. Women with Fitzpatrick types II–IV and dark hair were included in the study (Table 1).

The exclusion criterion included any previous laser treatment to the study areas, regional electrolysis within 6 months of study entry, waxing, depilatory or bleach use within 1 month of study entry, shaving or clipping of hair within 1 week of laser treatment, hormonal dysfunction, use of medications or hormones with androgenic effects, history of keloid scarring, active bacterial, viral, or fungal cutaneous infection within the treatment area, isotretinoin use within 6 months of entry in the study, photosensitivity or seizure disorder triggered by infrared light, and chronic sun exposure or tanning. After recording patients' information (including age, sex, any current use of drugs, and history of hormonal or any underlying diseases), hairs were counted in the treatment area. In cases where hairs were abundant in the treatment areas, a 1-cm square area was selected in a suitable distance from anatomical landmarks and the hairs existing in that area were counted. The related area was shaved before the treatment.

The treatment areas were exclusively on the face and neck. Thirty patients were treated on the jaw, 97 patients on the chin, 13 patients on the forehead, 52 patients on the lip, and 32 patients on the neck (Table 2). The number of treatment sessions to reach an optimal result, which was the patient's satisfaction of the results, varied between 3 and 7 sessions (alexandrite=4.52±0.84, diode=4.29±0.76, and IPL=4.58±0.82 with F=2.693 and P=0.07) with an interval of 4–6 weeks. The number of treatments was determined by the aesthetic expectations of the patients, not complete epilation. Local anesthesia was not required in any patient. Patients were advised to perform ice pack cooling of the skin and to keep the treated areas from the sun for 3 months.

The treatment variables, including fluence and the interval between two consecutive pulses, were adjusted according to the skin type (Table 3). The patients were evaluated 4–6 weeks after each treatment and hair reduction was determined as a fraction of the number of lost hairs after each treatment to the primary total number of hairs before starting the treatment and was expressed as a percentage. During each visit, side effects in the treated areas including changes in skin pigmentation, blisters, crusts, and folliculitis were evaluated. All patients were monitored for 6 months after the last treatment session and related information was recorded. SPSS (version 11.5) software was used for data analysis. ANOVA mode and the least significant digit post hoc method were used for the comparison of the treatments.

Table 1 Patient's skin type based on different lasers

Laser skin type	Alexandrite	Diode	IPL	Total
II	16	14	11	41
III	49	44	42	135
IV	19	18	19	56

Table 2 The treated areas based on the light sources

Area light source	Jaw	Chin	Forehead	Lip	Neck
Alex	15	30	4	22	13
	17.9%	53.7%	4.8%	26.2%	15.5%
Diode	14	32	6	17	8
	18.4%	42.1%	6.6%	22.4%	10.5%
IPL	10	35	3	13	11
	13.9%	48.6%	4.2%	18.1%	15.3%

Results

The comparison of the treatment results after 6 months did not show any significant statistical difference between alexandrite (68.75±16.92%), IPL (66.96±14.74%), and diode (71.71±18.12%) (P=0.194, F=1.653), although hair reduction was observed to be higher with the last. Comparing the results based on the number of sessions showed that the efficacy of the alexandrite laser is different according to the number of sessions (P=0.0001, F=7.411). The diode (Pierson Factor=0.485, P=0.001) and IPL's (Pierson Factor=0.306, P=0.009) efficacy was significantly related to the number of treatment sessions so that an increase improved the results. Pierson factor, which works by finding combinations of the predictors (variables) to use to predict the responses linearly, demonstrated that an increase in the number of sessions was related to an increase in hair removal. The alexandrite (P=0.539, F=0.622) and diode's (P=0.678, F=0.39) efficacy was not dependent to the skin type.

Table 3 Fluence range and pulse interval based on different skin types and lasers

Laser skin type	Alexandrite (J/cm^2)	Diode (J/cm^2)	IPL
II	20	64	34 J/cm^2 & 10 ms pulse interval
III	18	50	28 J/cm^2 & 25 ms pulse interval
IV	16	40	22 J/cm^2 & 40 ms pulse interval

The statistical comparison of the incidence of side effects based on the light sources showed a significant statistical difference (P=0.0001) with the diode laser being higher than the others (Table 4).

In all the light sources, the statistical comparison demonstrated a specific correlation between the skin type and incidence of side effects, no relation between treated areas and side effects, and no relation between the number of sessions needed for optimal results and incidence of side effects.

Discussion

A total of 232 patients were recruited into the study and were randomly assigned to one of the three lasers (alexandrite, diode, and IPL). Patients were matched according to their skin type and treatment areas to increase accuracy. Our results determined that almost all the three light sources, which are currently used for hair removal, have acceptable and at the same time almost similar effects on hair removal. The comparison of the follow-up results between the three light sources did not show any significant statistical difference. For a better result, symmetrical areas on the same patient need to be selected, which was not possible in our study. Besides the higher efficacy of diode laser than other common light sources, this difference was not practically significant. Our results on hair removal based on different skin types determined that the treatment area and also skin type have no influence on the treatment results.

Handrick and Alster [5] used long-pulsed diode (800 nm, 12.5 or 25 ms, 9 mm spot) and long-pulsed alexandrite (755 nm, 2-ms pulse, 10 mm spot) lasers for hair removal. Optimal clinical response was achieved 1 month after the second laser treatment regardless of the laser system or fluence used. Six months after the third and final treatment, prolonged clinical hair reduction was observed with no significant differences between the laser systems and fluences used. Side effects including treatment pain and vesiculation were rare after treatment with either laser system but were observed more frequently with skin type IV and long-pulsed diode system at the higher fluence of 40 J/cm^2. The probable reason behind higher hair reduction in their study compared to ours was the higher number of treatment sessions used in Handrick's study [5].

Garcia et al. [6] proposed alexandrite laser hair removal as safe for Fitzpatrick skin types IV–VI. One hundred and fifty patients were studied for a total of 550 treatment sites and a complication rate of 2%. They observed that long-pulsed alexandrite laser was safe for hair removal in darker skin tones and that prelaser skin testing was not helpful because there was no relationship between skin reaction and the incidence of complications [6].

Hussain et al. [7] studied laser-assisted hair removal in Asian skin, it's efficacy, complications, and the effect of single vs multiple treatments. The study was done on 144 Asian subjects with Fitzpatrick skin types III to V using a cooled 40-ms alexandrite laser with fluences of 16 to 24 J/cm^2. No subjects had scarring or long-term pigmentary changes and there appeared to be no correlation between test patch acute complications and those seen after actual treatments. They concluded that although Asian skin can be effectively treated with a cooled, long-pulsed alexandrite laser, complications do occur. Laser hair removal efficacy was increased with multiple treatments. There does not appear to be an exact correlation in Asian skin between complications occurring after test patch treatment and those seen with subsequent treatments [7].

Galadari [8] compared different hair removal lasers in skin types IV, V, and VI. One hundred female patients were compared using different laser systems: 35 patients underwent epilation using an Nd-Yag laser, 33 patients using an alexandrite laser, and 32 patients using a diode laser. Follow-up 12 months after the multiple treatments (three to six sessions) showed an insignificant difference between these three groups (35–40%). Their findings indicated that all three laser systems tested could be used for dark skin; however, one should select a system that minimizes side effects, primarily hypo/hyper-pigmentation, especially when used for skin types IV, V, and VI [8].

Eremia et al. [9] evaluated the long-term efficacy and safety of a 3-ms 755-nm alexandrite laser equipped with a cryogen cooling device for patients with Fitzpatrick skin types I–V. Eighty-nine untanned patients with skin types I–V underwent a total of 492 treatments of laser hair removal over a 15-month period. The patients had a mean of 74% hair reduction. Rare side effects included transient postinflammatory hyper-pigmentation (n=9; 10%), burn with blisters (n=1; 1%), and postinflammatory hypo-pigmentation (n=2; 2%). They concluded that the 3-ms cryogen cooling-equipped alexandrite laser could safely and effectively achieve long-term hair removal in patients with skin types I–V [9].

Our results determined higher side effects using a diode laser than other light sources with the lowest belonging to alexandrite. In all cases, side effects were temporary; even in cases with pigmentary changes, all the side effects returned to normal after 6 months. By increasing the skin type, higher frequency of side effects associated with diode laser was observed. It seems that in Iranian patients, using lower wavelengths is associated with lower side effects. Patients with a darker skin have higher melanin in epidermis, which can act as a competing chromophore to

Table 4 The type of side effects based on light sources

Side effect light source	Folliculitis	Pigmentary change	Blister	Crust	Total
Alex	5 (6%)	3 (3.6%)	–	–	8 (9.5%)
Diode	3 (3.9%)	12 (15.8%)	7 (9.2%)	–	22 (28.9%)
IPL	7 (9.7%)	–	2 (2.8%)	2 (2.8%)	11 (15.3%)

absorb more energy in the skin. The lower wavelength and fluence of alexandrite laser may theoretically be responsible for a lower absorption of energy by the epidermal melanin, contributing to a lower incidence of side effects.

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