
Alexandrite Laser Hair Removal is Safe for Fitzpatrick Skin Types IV-VI

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BACKGROUND. Various lasers have been developed for epilation of unwanted hair. Most studies, however, have been done in white patients with minimal reference to dark-skinned individuals.

OBJECTIVE. To determine the safety profile of a long-pulsed alexandrite laser for hair removal in patients with Fitzpatrick skin types IV-VI exclusively.

METHODS. Prospective clinical evaluation conducted from June 1998 to April 1999 at a referral private clinic. Prelaser skin testing was performed starting at 16 J/cm² and energy fluence

selected according to response. Complications were recorded at each visit.

RESULTS. One hundred and fifty patients are reported (18 men and 132 women) ranging in age from 15 to 50 years, for a total of 550 treatment sites. Complications occurred in only 2% of cases.

CONCLUSION. The long-pulsed alexandrite laser is safe for hair removal in darker skin tones. Prelaser skin testing was not helpful in this study, as there was no relationship between skin reaction and the incidence of complications.

CURRENT LASER SYSTEMS for hair removal are relatively new, and although there is a lack of long-term results, success is conventionally reported in terms of permanent elimination of hair or marked delay in its growth.¹⁻³ Most studies, however, have been performed on individuals with light skin tones (Fitzpatrick types I-III) with only limited experience regarding darker skin types.

Fitzpatrick skin types IV-VI are particularly challenging because of a potential increase in the occurrence of complications such as hypo/hyperpigmentation, blistering, crusting, and subsequent scarring, at least when using lasers that target melanin as their chromophore. As skin color should not constitute a limiting factor for medical or cosmetic therapy, modifications in treatment protocols or laser systems aiming at enhancing results and minimizing adverse effects in dark skin should become a welcome addition for physicians and patients alike. Herein we report the incidence of complications after long-pulsed alexandrite laser in 150 patients with Fitzpatrick skin types IV-VI exclusively.

Materials and Methods

This is a prospective clinical study conducted from June 1998 to April 1999 at a referral private clinic. Hair removal laser treatment was provided to healthy adult men and

women with excess hair in facial and nonfacial sites that could be identified photographically. We excluded pregnant women, patients with a history of keloid scars, light sensitivity, collagen tissue disorders, and uncontrolled systemic disease (diabetes, heart/kidney/liver disease). All patients had Fitzpatrick skin types IV-VI.

Patients were instructed to avoid sun tanning and waxing of hair for 3 weeks prior to treatment. Hydroquinone 2%/glycolic acid at night and an SPF 15 sunblock three times a day was applied to sun-exposed areas starting 10 days before laser treatment.

The day of treatment the skin was prepped with soap and water and the hairs were shaved. A test was performed on all patients in order to define initial laser energy. We arbitrarily selected a fluence of 16 J/cm² as the initial fluence. The goal was to provoke mild perifollicular erythema. The fluence was modified according to the response. If the skin showed marked or diffuse erythema the energy fluence was reduced by 0.5 J/cm² and the test repeated. If a reaction was not evident the fluence was increased by 0.5 J/cm² each time until a response was elicited. The test was performed in each area to be treated (face, trunk, or extremities).

A 755 nm long-pulsed alexandrite laser was used in all cases. Patients had the option of using EMLA cream 2 hours before therapy, but most underwent laser treatment without anesthesia. Treatments were performed using a 12.5 mm handpiece (occasionally a 10 mm handpiece was selected), 40-msec pulse duration, and 1 Hz repetition rate. A thin coat (approximately 1 mm) of refrigerated cold gel was applied to the area immediately before laser treatment for epidermal cooling. After treatment, all areas were covered with a fusidic acid 20 mg/betamethasone valerate 1 mg cream. Careful sun avoidance and regular use of sunblock was recommended for 2 weeks after treatment. Clinical photographs were obtained before and after treatment. Patients were seen 1 week after laser treatment

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and at 3–6 weeks for repeated treatment when hair grew back. The incidence of complications was assessed and recorded at each visit, including hypo/hyperpigmentation, blistering, excoriation, crusting, ingrown hairs, and folliculitis. Response to treatment was classified further by hair counts and photographic evaluation. Improvement was further defined as follows: (1) delay in hair growth as per individual history; (2) change in the quality of existing hair (lighter or thinner); (3) decrease in hair counts in a 2 cm × 2 cm control area (Figure 1).

Results

One hundred and fifty patients are reported with an average of three treatment sessions and 6-month follow-up. There were 18 men and 132 women ranging in age from 15 to 50 years old. A total of 550 sites were treated, including 457 facial and 93 nonfacial locations (Table 1). Fitzpatrick skin types were IV ($n = 80$), V ($n = 68$), and VI ($n = 2$).

Although a significant delay in hair growth was evident from the first treatment, efficacy correlated directly with energy fluence. An approximate 40% reduction in hair count was evident after at least three treatment sessions using a minimum of 18 J/cm² for most facial and nonfacial sites. In the study, energy fluence ranged from 13 to 24 J with an average of 18 J.

Pretreatment testing resulted in heterogeneous skin responses. Most patients showed either perifollicular or diffuse erythema, but urticarial and purpuric reactions were also noted. Sometimes the reaction was the same in spite of reducing energy fluence according to protocol. If diffuse erythema, urticarial, or purpuric papules were still elicited when using a minimal fluence of 15 J/cm², then we proceeded with treatment. Of interest, there was no correlation between the type of response and the incidence of adverse events. Complications occurred in 15 treatment sites or 2.7% of body locations: blistering

Table 1. Treatment Sites

Anatomic location	Number of treatments
Upper lip	161
Chin	97
Full beard	84
Cheeks	52
Sideburns	31
Legs	23
Neck	17
Axillae	17
Arms	13
Nose	11
Chest	9
Ears	6
Areola	6
Forehead	5
Back	4
Abdomen	3
Bikini line	3
Fingers	2
Thighs	2
Buttocks	1

($n = 9$), folliculitis ($n = 2$), transient hyperpigmentation ($n = 3$), transient hypopigmentation ($n = 2$), and excoriations ($n = 1$). Scarring was not observed.

Discussion

Limitations when selecting melanin as the target for laser hair removal include that melanin is also found in the epidermis and that hair pigmentation varies widely. Even with optimal technique there may be inadvertent damage to the epidermis and there may be absorptive interference by epidermal melanin. In spite of that, reports on complications after laser hair removal are surprisingly scarce, have focused on lighter skin tones (Fitzpatrick type I–III), and lack photographic documentation of side effects. Ruby lasers have been the most extensively studied to date.^{4,5} Grossman et al.⁶ treated 13 Caucasian patients using a pulse duration of 0.270 msec and a spot size of 6 mm. Complications were temporary and included hyperpigmentation in 23% and hypopigmentation in 15% of patients treated.

Bjering et al.⁷ used a prototype 694 nm ruby laser with a pulse duration of 0.600 msec in 133 Caucasian patients. Temporary crusting of the skin, hyperpigmentation, and hypopigmentation were seen.

Williams et al.⁸ treated 25 fair-skinned Caucasians with a pulse duration of 3 msec and a spot size of 7–10 mm. A sapphire lens was incorporated into the hand-piece to minimize side effects by cooling the epidermis to 4°C. Complications were transient and included edema and erythema in 100% of patients, hyperpigmentation

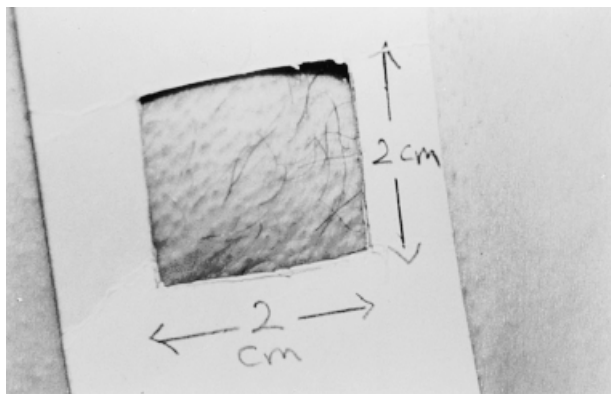


Figure 1. Hair counts and photographic evaluation of control areas must be done at each visit.

in 20%, and hypopigmentation in 48% of patients. Solomon⁹ used a similar laser to treat 72 patients. Complications included transient hypopigmentation in 1.4% and hyperpigmentation in 2.9%.

The overall incidence of side effects has been lower with the diode than with the ruby laser, owing to the longer wavelength and longer pulse duration, but studies have been limited. The most common side effect has been transient hypopigmentation in 10% of cases, clearing in approximately 1–6 months.¹⁰ Dierickx et al.¹¹ used the pulsed diode laser with a wavelength of 800 nm, a pulse width of 5–30 msec, and a spot size of 9 mm × 9 mm, with a cooling device incorporated into the handpiece. Fifty patients were treated and there were no adverse long-term sequelae. The only complications were transient pigmentary changes.

Complications after Q-switched Nd:YAG laser (1064 nm) in conjunction with an exogenous carbon suspension include edema, erythema, and petechiae. Apparently all skin types can be treated, but efficacy is somewhat lower than with other lasers.^{12,13} Nanni and Alster¹⁴ reported no pigmentary changes or other long-term complications in 12 patients. Goldberg et al.¹³ treated 35 patients and the most common complication seen was posttreatment erythema. One patient developed temporary hyperpigmentation.

The 755 nm wavelength of the alexandrite laser may theoretically be less absorbed by epidermal melanin than the ruby laser at 694 nm, but side effects of both lasers are reported as similar.¹⁵ Connolly and Paolini¹⁶ used the long-pulsed infrared alexandrite laser with a pulse width of 20 msec and 10 mm spot size to treat 20 patients. Twenty percent of patients had crusting of the skin after treatment with 14–25.6 J/cm². No pigmentary changes were noted.

The Epilight laser (intense pulsed light source) produces an incoherent multiwavelength pulsed light at 550–1200 nm. Gold et al.¹⁷ treated 37 sites in 31 patients. Complications reported after treatment with various fluences included erythema (70%), edema (8%), blistering (8%), and hyperpigmentation (3%).

Our results compare very favorably with those reported in the literature and they are significant because we only treated patients with dark skin types (Fitzpatrick type IV–VI). Complications were documented in only 2.7% of our patients (15 of 550 treated areas). This low incidence of adverse events may be due to the following:

1. The pulse length of the alexandrite laser lies between the thermal relaxation time of the epidermis (3–10 msec) and that of the hair follicles (40–100 msec), and therefore is theoretically ideal. This laser system is based on the principle of thermoki-

netic selectivity, which dictates that target structures of large volume (e.g., hair) are not as capable of radiating the absorbed heat through their relatively small surface area and transmitting it into the surroundings as small volume structures of the same chromophore are capable of doing. In other words, the thermal energy is accumulated in hair structures with minimal damage to the epidermis when using the appropriate pulse duration.

2. As with other cosmetic laser and resurfacing procedures in dark-skinned individuals, skin preparation with hydroquinone/glycolic acid and meticulous sun protection is essential for preventing hyperpigmentation in sun-exposed areas.
3. Careful selection of energy fluence, epidermal cooling, and avoidance of overlapping pulses can reduce the amount of direct thermal damage inflicted to the surrounding tissues.
4. Postlaser topical corticosteroids are probably of paramount importance in dark skin tones. These compounds decrease inflammation whether produced by chemical, biological, or physical injury, ultraviolet light, or immunologic events. They interfere with prostaglandin synthesis, suppress lymphocyte activity, and block the access of lymphokines to target cells. Vasodilation, leakage from capillaries, migration of white cells, and chemotaxis are inhibited.¹⁸

In our experience, the occurrence of complications was hard to predict. Prelaser skin testing was not useful in this study, for there was no correlation between type of reaction and incidence of adverse events. Variability was the rule among different patients and at various body locations in the same individual. Prelaser skin testing was only useful to determine the initial energy fluence. The changes on the skin indicate that a clinical threshold has been reached, and the visual end point helps guide the treatment.

Skin reactions included mild perifollicular erythema, diffuse erythema with edema, and urticarial and purpuric lesions. It seemed logical to associate the most severe reactions with a larger amount of thermal damage, but there was no relationship between energy fluence and type of skin reaction. In other words, a patient with minimal erythema could have marked erythema, urticaria, or purpura in the contralateral site, even when using lower fluences (Figure 2). Body location was irrelevant, except for purpura, which was observed only in lower extremities, probably reflecting the influence of gravity and higher hydrostatic pressure.

Blistering and excoriation were rare but occurred unpredictably. Some patients with mild initial reactions went on to develop blisters, while the majority of patients with diffuse erythema, urticaria, or purpura had uneventful recovery. Several factors, however,

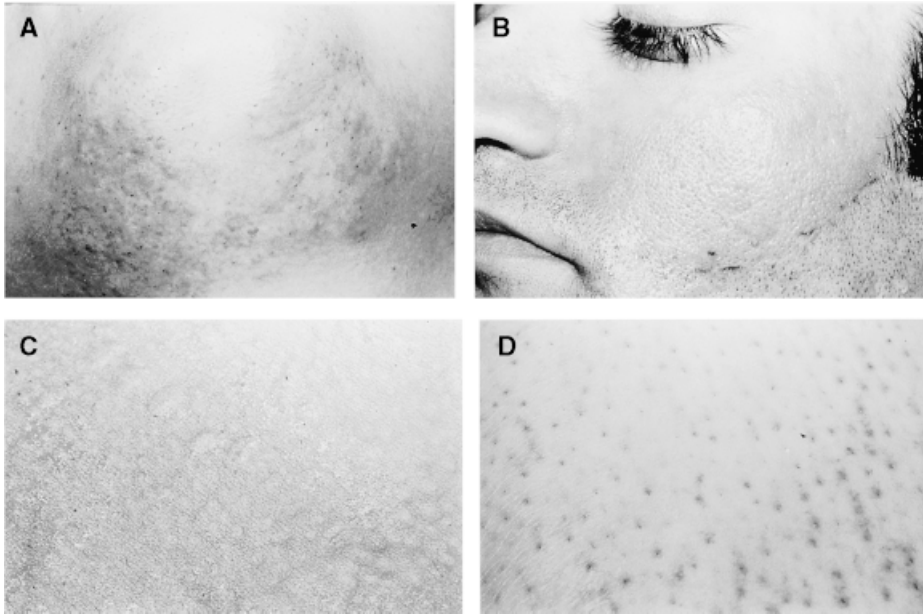


Figure 2. Laser skin testing resulted in heterogeneous reactions. There is no relationship between energy fluence and type of reaction. A) Mild erythema after laser treatment. This reaction persists for several minutes and can be controlled with cool compresses. B) Diffuse erythema disappears in hours. Occasionally it persists for several days. C) In a minority of patients the initial skin reaction is urticarial, lasting only a few hours. D) Purpuric reactions tend to occur in the lower extremities. The reaction lasts for several days.

must be acknowledged. Instead, we believe that blistering was associated with poor technique, certain body locations, and skin type VI.

Poor technique is operator related, for placing the tip of the handpiece in direct contact with the skin removes the protective gel. More importantly, burned debris tends to accumulate on the tip, resulting in excessive thermal damage to the epidermal surface. The blistering pattern is characteristic (Figure 3). Overlapping of pulses is another obvious cause of thermal buildup (Figure 4).

Even with meticulous technique, the axillae and bikini line were at risk for complications (Figure 5). The



Figure 3. Characteristic blistering pattern due to inappropriate technique and accumulation of debris. The blisters are of the exact shape and size as the tip of the handpiece. To avoid this complication, the tip must be cleaned frequently during the treatment session.



Figure 4. Overlapping of pulses can result in blisters and excoriations, even in patients with mild initial skin reactions.

response seemed to be idiosyncratic, but other factors such as occlusion and racially determined hyperpigmentation could be relevant. Caution must be exerted in these locations along with lower energy fluences.

Only two patients with skin type VI were treated and both of them had adverse events. In one case the blistering was severe (Figure 6). Hyperpigmentation ($n = 3$) and hypopigmentation ($n = 2$) was a direct consequence of blistering and excoriation, and should be considered postinflammatory in nature.

In conclusion, long-term results for permanent laser hair removal are lacking, and the scarcity of comparative data makes it difficult to decide on the most effective laser system. Options include intense pulsed light sources with filters (variable wavelength), and ruby (694 nm), diode (800 nm), Nd:YAG (1064 nm), and

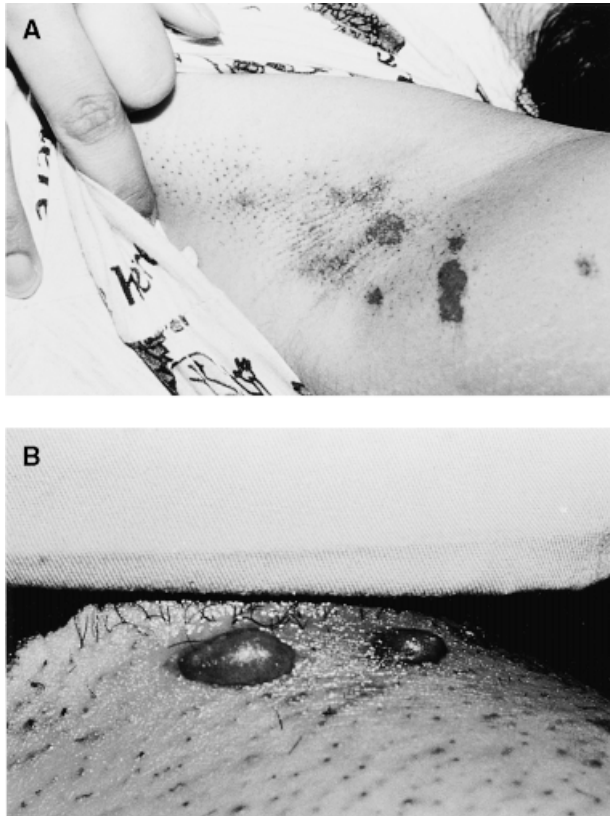


Figure 5. The axillae and bikini line are more sensitive than other body parts and must be approached with caution. A) Increased melanin content in axillae may be an important factor for developing blisters and excoriations. Lesions resolve with transient postinflammatory hyperpigmentation. B) Large bullae after laser treatment of the bikini line. Therapy included iced-saline compresses and topical corticosteroids. There was transient postinflammatory hyperpigmentation but no residual scarring.

alexandrite (755 nm) lasers. Comparative trials and standardization of treatment parameters are sorely needed to put the relative efficacy and safety of all these systems in perspective.

Our study is an initial effort to scrutinize laser hair removal in dark-skinned individuals. Based on our findings, we can reasonably conclude that patients with Fitzpatrick skin types IV and V can be safely treated with the long-pulsed alexandrite laser. Fitzpatrick skin type VI constitutes a relative contraindication for treatment with this laser system, as complications are likely.

Future studies should define the importance of prelaser skin testing; the clinical difference between 20-msec and 40-msec pulse duration; histologic documentation of laser-tissue interactions at different fluences; the use of postlaser topical corticosteroids versus placebo; and the relative efficacy and safety of the long-pulsed alexandrite laser as compared to other systems for hair removal in dark skin tones.

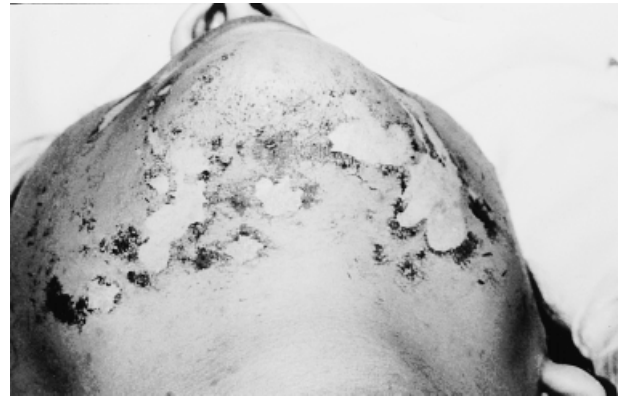


Figure 6. Fitzpatrick skin type VI is a risk factor for complications during alexandrite laser hair removal. Residual hypopigmentation or hyperpigmentation of variable duration is the rule.

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