
Incidence of side effects after laser hair removal

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Background: Despite the widespread use of lasers for hair removal there are few data published on the incidence of side effects from this treatment.

Objective: The aim of this study was to generate data on a large number of patients receiving laser hair removal to obtain an accurate assessment of the incidence and type of side effects resulting from treatment.

Methods: A multicenter prospective study of patients presenting for laser hair removal was conducted to determine incidence of side effects in relation to skin type and laser or lasers used.

Results: Laser hair removal is associated with a low incidence of side effects that are self-limiting in the majority of cases. The highest incidence of side effects was seen in patients with darker skin treated with the long-pulsed ruby laser.

Conclusions: Laser hair removal is inherently safe. For darker Fitzpatrick skin types the long-pulsed neodymium:yttrium-aluminum-garnet laser is preferred to the ruby laser. (J Am Acad Dermatol 2003;49:882-6.)

There has been an explosive increase in the use of lasers for hair removal since the first lasers were approved in 1996. Currently most devices target melanin in the hair follicle with millisecond-long pulse durations to produce, to some degree, selective photothermolysis of hair follicles. These lasers are the ruby, alexandrite, diode, and neodymium:yttrium-aluminum-garnet (Nd:YAG). The ruby laser with a wavelength of 694 nm has the shortest penetration depth and the most selective absorption by melanin. The Nd:YAG laser, emitting in the infrared at 1064 nm, has the deepest depth of penetration but the least selective absorption. The alexandrite (755-nm) and diode (810-nm) lasers sit between these extremes. Adverse reactions associated with laser-assisted hair removal are primarily related to unwanted epidermal damage after partial absorption of the laser energy. More absorption will occur in darker skin types and tanned skin. To reduce side effects, treatment can be performed with

concurrent epidermal cooling or selection of the appropriate wavelength, ie, longer wavelengths (eg, Nd:YAG laser) for darker skin types. Although laser hair removal is considered a safe procedure, previous studies have reported the incidence of side effects; but they have involved relatively few patients and treatment episodes.¹⁻³ The exception has been the study by Nanni and Alster⁴ who, in a retrospective chart review, analyzed the side effects from 900 laser hair removal treatments. Side effects observed were all of short duration and they concluded that laser-assisted hair removal is a safe procedure. Even in this large study the true incidence of uncommon complications such as scarring can not be determined with confidence. The aims of this investigation were to undertake a prospective multicenter study to assess a large number of patients receiving laser-assisted hair removal to determine the incidence of side effects and relate these to skin type and laser used.

MATERIAL AND METHODS

Lasercare clinics were established in the United Kingdom in 1990 and are one of the largest providers of skin laser treatment, both private and National Health Service, in the United Kingdom. In all, 11 clinics are in operation with laser hair removal provided by both doctors and trained nurses following protocols. Lasers used are the long-pulse ruby (Lambda, United Kingdom), long-pulse alexandrite (LPIR, Cynosure, Chelmsford, Mass) (1 clinic),

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Table I. Patient details

No. of patients	480
Mean age, y (range)	36.2 (8.82)
Skin type (%)	
I	41 (8.5)
II	204 (42.5)
III	123 (25.6)
IV	78 (16.2)
V	25 (5.2)
VI	6 (1.2)
Not stated	3 (0.6)

Table II. Treatment details

Total No. of treatments	3143
Median (range)	5 (1-29)
Body site treated	
Face	373
Bikini	28
Legs	23
Back	20
Chest	17
Abdomen	10
Upper limb	9
Scalp	1
Not stated	4
No. of patients treated by laser	
Ruby	322
Alexandrite	74
Nd:YAG	224

Nd:YAG, Neodymium:yttrium-aluminum-garnet.

Gentlelase (Candela, Wayland, Mass) (3 clinics), and Apogee (Cynosure) (1 clinic) using parameters as recommended by the manufacturers to produce mild perifollicular erythema, and Lyra (Laserscope, San Jose, Calif) long-pulsed Nd:YAG laser at 1064 nm, pulse width 50 milliseconds, and fluences up to 50 Jcm⁻². The alexandrite and Nd:YAG lasers are used in combination with a variety of epidermal cooling devices (gels, cold air, cryogen spray, or cold contact plates) as appropriate.

For a 3-month period commencing October 1, 2001, all patients attending the clinics for laser-assisted hair removal who had had at least 1 previous laser treatment were assessed for the presence of side effects. If the patient had experienced side effects, the nature, duration, and responsible laser was recorded. In all patients seen, age, skin type, body area treated, number of treatments, and laser or lasers used were recorded.

RESULTS

Details of the patients and their treatment are shown in Tables I to III. Some patients, over a period

Table III. Laser treatment by skin type

Skin type	No.	Laser	Percentage	No.
I	(41)	Ruby	30	54
		Alexandrite	10	18
		Nd:YAG	15	27
II	(204)	Ruby	161	58
		Alexandrite	40	14
		Nd:YAG	77	28
III	(123)	Ruby	109	71
		Alexandrite	10	6
		Nd:YAG	34	22
IV	(78)	Ruby	18	18
		Alexandrite	13	13
		Nd:YAG	66	68
V	(25)	Ruby	3	11
		Alexandrite	1	3
		Nd:YAG	24	86
VI	(6)	Nd:YAG	6	100

Nd:YAG, Neodymium:yttrium-aluminum-garnet.

of time, had treatment with different lasers and some patients had more than 1 body site treated. The incidence and details of side effects are shown in Tables IV and V.

A small atrophic scar developed on the face of a 27-year-old woman with Fitzpatrick skin type III after her third treatment with the ruby laser with a fluence of 23 Jcm⁻². The scar has almost completely cleared and she has had 12 further treatments without sequelae.

An area of superficial thrombophlebitis developed on the side of the chin submentally in a 29-year-old woman after 1 of 7 treatments with ruby and long-pulsed Nd:YAG lasers; the area persisted for 7 days. One other case of thrombophlebitis as a result of Nd:YAG laser hair removal has been seen and this may represent a previously unrecognized side effect of this laser.

It is possible to derive some indication of risk of side effects after laser hair removal but this is dependent on skin type and laser used. For skin types I to II, the ruby laser was used in 191 patients and produced blistering in 13 (6%). The alexandrite was used in 50 patients and produced blistering in 1 (2%). The Nd:YAG laser was used in 92 patients and produced blisters in 2 (2%). The incidence of hypopigmentation and hyperpigmentation in these skin types with ruby laser treatment was 1.6% and 1.0%, respectively.

For skin type III, the incidence of blistering with the ruby, alexandrite, and Nd:YAG lasers was 4.5%, 0%, and 8.8%, respectively. For hyperpigmentation the incidence with each laser was 2.8%, 0%, and 3%, respectively. Hypopigmentation developed in only 1 patient after Nd:YAG laser therapy.

Table IV. Incidence of side effects after laser-assisted hair removal in 480 patients

Side effect	No.	Percentage	95% confidence interval	Median duration, days (range)
Blistering	33	6.9	4.9-9.8	5 (2-10)
Hyperpigmentation	10	2.0	0.9-3.8	28 (7-180)
Scabbing	6	1.2	0.5-2.9	2 (1-7)
Hypopigmentation	6	1.2	0.6-3.2	120 (21->180)
Scar*	1	0.02	0.06-1.2	>180
Thrombophlebitis*	1	0.02	0.06-1.2	7

*See text for details.

Table V. Side effects by skin type and laser

Skin type (No.)	Side effect (No.)	Laser (No.)
I (41)	Blisters (2)	Ruby (1) Nd:YAG (1)
	Hypopigmentation (1)	Ruby (1)
II (204)	Blisters (14)	Ruby (12) Alex (1) Nd:YAG (1)
	Hyperpigmentation (2)	Ruby (2)
III (123)	Hypopigmentation (2)	Ruby (2)
	Blisters (8)	Ruby (5) Nd:YAG (3)
	Hyperpigmentation (4)	Ruby (3) Nd:YAG (1)
	Scar (1)	Ruby (1)
IV (78)	Thrombophlebitis (1)	Nd:YAG (1)
	Hypopigmentation (1)	Nd:YAG (1)
	Blisters (5)	Ruby (3) Nd:YAG (2)
V (25)	Hyperpigmentation (1)	Ruby (1)
	Hypopigmentation (1)	Ruby (1)
	Blisters (1)	Nd:YAG (1)
VI (6)	Hyperpigmentation (1)	Nd:YAG (1)
	Hyperpigmentation (2)	Nd:YAG (1) Ruby (1)
	Blisters (3)	Nd:YAG (3)
Not stated (3)	Hyperpigmentation (1)	Nd:YAG (1)

Alex, Alexandrite; Nd:YAG, neodymium:yttrium-aluminum-garnet.

Combining all patients with skin types IV to VI (109 patients) the incidence of blistering was 14.9% with the ruby laser and 5% with the Nd:YAG laser. For hyperpigmentation the incidence was 9.9% with the ruby and 2.1% with the Nd:YAG laser. The overall incidence of all side effects in skin types IV to VI treated with the Nd:YAG laser was 9.4%, and 29.9% in those treated with the ruby laser.

DISCUSSION

This is the largest study to date to investigate the frequency and nature of side effects of laser-assisted hair removal. Lasers effect hair removal by photothermolysis of hair follicles, which is selective to some degree.⁵ The wavelength of light is selected to target melanin in hair follicle epithelium. By using

millisecond-long (as opposed to nanosecond-long) pulses, hair follicles and the shaft are thermally injured in preference to epidermal melanosomes. This is because the longer pulse of the delivered light will allow cooling of smaller structures such as melanosomes without heat accumulation. However, there will be some absorption of the laser light by epidermal melanin and this will be more significant in darker skin types and suntanned skin. This light absorption will induce thermal changes that can result in adverse reactions including blistering, hypopigmentation, hyperpigmentation, and, if extensive, even scarring. Hyperpigmentation is usually reversible and results from a stimulation of melanin production from epidermal melanocytes similar to a UV-induced suntan. Hypopigmentation may be permanent and results from thermally induced destruction of melanocytes. The long-pulsed ruby laser, the first widely used laser for hair removal, is avidly absorbed by melanin and studies with this laser have been predominantly in lighter skin types.^{6,7} Where a range of skin types have been treated, adverse reactions have occurred more frequently in darker skin.^{1,3,8}

Other lasers have been developed for hair removal. With progressively longer wavelengths there is less avid absorption of the light by melanin both within the hair follicle and the epidermis. Higher fluences are required and, to minimize epidermal injury, a variety of surface cooling devices are used. In addition to the ruby the most widely used lasers are the long-pulsed alexandrite (755-nm), the long-pulsed diode (800-nm), and the long-pulsed Nd:YAG (1064-nm). The Nd:YAG laser will have the deepest depth of penetration and least selective absorption by melanin. A number of studies have demonstrated the efficacy of these longer wavelength lasers in hair removal,⁹⁻¹⁴ and that both diode and Nd:YAG lasers are efficacious in patients with dark skin.¹⁵⁻¹⁶

Effective laser-assisted hair removal will result in some perifollicular erythema and edema, which will

resolve in a few hours. These effects are a necessary part of laser photothermolysis and are not side effects. However, unwanted adverse effects of laser-assisted hair removal are recognized, the majority being a result of epidermal injury with blistering, fine epidermal crusting, or both reported in 10% to 15% of patients with both ruby and alexandrite lasers.¹⁷ These are significantly more common in darker skin types or tanned skin.

With the exception of Nanni and Alster,⁴ previous studies on the side effects of laser hair removal have been on the basis of relatively few patients, treatment episodes, or both. Campos et al³ reviewed the side effects after ruby laser hair removal. Transient pigmentary disturbance developed in 29% of patients. Pigmentary changes developed in 5 of 6 patients with skin type IV. No permanent side effects or scarring was seen.

Bjerring et al⁷ treated 133 patients from Scandinavia with a long-pulse ruby laser. Of their patients, 14.3% reported hyperpigmentation and 9.8% reported hypopigmentation. Wimmershoff et al,⁸ in treating 74 patients with a long-pulse ruby, reported hypopigmentation in 3%, hyperpigmentation in 5%, and atrophic scars in 3%. Scars were only seen in darker skin types. All patients with hypopigmentation had Fitzpatrick skin type III to IV.

The alexandrite laser has now been widely used for hair removal and is recognized as efficacious and generally safe.^{2,4,17} Nanni and Alster¹⁷ report that blistering, crusting, and pigmentary alteration may occur in darker skin types even when cooling devices are used. Using a 3-millisecond cryogen-cooled alexandrite laser in 89 patients, Eremia et al¹⁸ reported postinflammatory hyperpigmentation in 10%, burn with blister in 1%, and postinflammatory hypopigmentation in 2%.

In a study from Saudi Arabia on 150 patients of Fitzpatrick skin types IV to VI treated with an alexandrite laser, complications occurred in 2.7% of body locations.² Axillae and bikini line sites were at risk of complications. Two patients with skin type VI had adverse reactions; in one blistering was severe. The authors comment that for this skin type residual hypopigmentation or hyperpigmentation is the rule.

In the first clinical study of the long-pulsed Nd:YAG laser for hair removal¹³ the authors reported complete epilation in 4 to 6 sessions in 208 patients. There was no blistering, hypopigmentation, or hyperpigmentation. These results have not been matched in subsequent studies. However, this laser has been confirmed as being effective in darker skin types and most suitable for these patient groups.^{16,19}

In a study from Washington, DC,¹⁶ 20 patients with skin types IV to VI were successfully treated

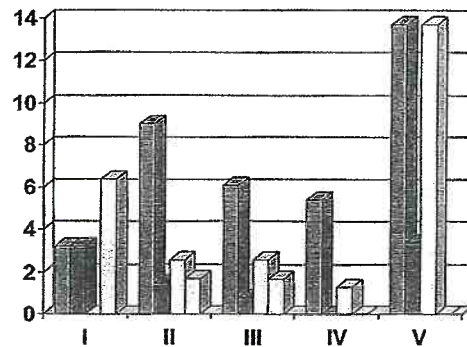


Fig 1. Side effects by skin types. Green, Blister, dark blue, hypopigmentation; light blue, hyperpigmentation; gray, scabbing.

with a 50-millisecond pulsed Nd:YAG laser. Side effects were mild and short-lived with hyperpigmentation in 5% lasting an average of 4 weeks.

It is clear from the published literature that laser-assisted hair removal can be associated with a number of side effects including crusting, blistering, hypopigmentation, hyperpigmentation, and scarring (atrophic). The incidence of side effects varies but is generally uncommon and short-lived in the majority of patients. With the exception of the long-pulsed Nd:YAG laser, side effects of laser-assisted hair removal in darker skin types appears to be more common and may be relatively more severe.

In the chart review of 900 laser treatments by Nanni and Alster⁴ and this current prospective study of 480 patients receiving 3143 treatments, a clear indication of side effects from treatment can be obtained. Because of the large number of patients and treatments studied it has also been possible to stratify risk both by skin type and laser used. The 2 studies confirm the low incidence of side effects in skin type I regardless of the laser used. The incidence of side effects increases with skin type but is still approximately 12% in skin type III. In this current study, 60% of side effects in this skin type were caused by the ruby laser.

In the study by Nanni and Alster⁴ the incidence of side effects with the ruby, alexandrite, and Nd:YAG lasers in skin type IV was 18.7%, 18.2%, and 10% respectively. For skin type V for the same lasers the rates were 37.8%, 37.7%, and 25%, respectively. In this current study, figures for type IV are 0%, 0%, and 2%, respectively. For skin types V and VI they are 3%, 0%, and 20%, respectively. The major difference in the lasers used was that Nanni and Alster⁴ used a Q-switched Nd:YAG in combination with a patented carbon solution (Soft Light, Thermolase Corp, La Jolla, Calif) compared with the long-pulsed Nd:YAG laser used in this study.

These data will be influenced, however, by the tendency to select lasers appropriate for the patients' skin type. In our study there was a tendency to treat patients with darker skin types with the Nd:YAG laser. As patient numbers become smaller, the true incidence of side effects becomes more difficult to predict. It is of value, however, to compare the overall incidence of side effects in skin types IV to VI (109 patients) treated with the ruby laser (29.9%) with the Nd:YAG laser (9.4%), which are 3 times higher.

This large prospective study has confirmed that laser-assisted hair removal is safe with a very low incidence of persisting side effects. The increased incidence of side effects in darker skin types has also been confirmed, particularly when treated with the ruby laser. It is recommended that the ruby laser should not be used for dark skin types when alternatives such as the Nd:YAG laser can be used considerably more safely.

This study has not addressed the association between clinical efficacy and incidence of side effects. It has not been possible in a study of this nature to link clinical outcomes with the data recorded. Clinical experience would indicate that higher fluences, in general, are associated with better epilation rates but may be more prone to generate temperature-dependent side effects. The treatments performed in this clinic follow protocols with fluences recommended by the laser manufacturers or those recommended in existing publications. Internal audit procedures have confirmed appropriate parameter laser selection and outcomes as expected.

It can be assumed, therefore, that side effects encountered in this study and their incidence accurately reflect current practice and clinicians can not only reassure their patients of the safety of this procedure but also appraise them of the likely risks of the treatment on the basis of the patient's skin type and laser used.

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