Lasers in Medical Science (2004) 19: 48–51
DOI 10.1007/s10103-004-0298-6

ORIGINAL ARTICLE

Ahmed F. El. Bedewi

Hair removal with intense pulsed light

Received: 20 January 2004 / Accepted: 29 April 2004 / Published online: 1 July 2004

Abstract The use of light and laser for hair removal has evolved during the past few years. Laser systems such as the ruby laser (694 nm), alexandrite laser (755 nm), diode laser (810 nm) and neodymium:yttrium-aluminium-garnet (Nd:YAG) laser (1,064 nm) are commonly used in hair removal. However, permanent hair removal has been difficult to achieve using lasers owing to the long growth/rest cycle of normal human hair follicles. There is still an increasing demand for safer and more efficient hair removal techniques. The latest and most effective choice in the treatment of hair removal is non-coherent intense pulsed light (IPL), which is both efficient and safe for hair removal. A group of 210 patients with skin type III–V were treated for superfluous hair in different areas of the body (face, extremities, axillae, bikini line and back) for three to five sessions at 6-week intervals using IPL. There was a significant hair reduction of about 80% with no side effects and minimal complications. Follow-up was done 6 months after the last session. In conclusion, IPL is very effective and safe for hair removal.

Keywords Faun-tail nevi · Female · Hair removal · Intense pulsed light (IPL) · Leucotrichia · Paradoxical

Introduction

Laser hair removal is now the treatment of choice for the reduction of unwanted hair. It is widely used in clinical practice and is a safe and effective alternative to traditional methods including shaving, waxing, tweezing, depilation and electrolysis [1]. Many reports have been published on the clinical efficacy of various laser systems, such as the ruby laser (694 nm), alexandrite laser (755 nm), diode laser (810 nm) and neodymium:yttrium-aluminium-garnet (Nd:YAG laser (1,064 nm) as well as intense pulsed light (IPL) using filters to limit its use to a specific portion of the spectrum (580 and 615 nm). They all work on the principle of selective absorption of energy by components of the hair follicle. The target chromophore is melanin in the hair bulb and outer root sheath zones of the hair follicle, while the competing chromophores are any other melanin-containing components of the skin and other light-absorbing components such as haemoglobin in blood vessels. Therefore, patients with darker skin types present a greater treatment risk; the goal for these patients is to deliver the highest fluence to the hair follicles without causing injury to the epidermis. Many factors influence the efficacy of treatment such as spot size, divergence/convergence of the beam and wavelength that determines the depth of penetration, pulse duration, fluence and the adjacent cooling system [2]. The amount of energy absorbed by the target and surrounding tissue is measured by fluence (J/cm^2) and can be delivered in pulses. A more important concept is to measure the ''effective fluence'', a term representing the fluence delivered to the target depth. Moreover, the measured skin surface fluence does not reflect the true fluence delivered to the hair follicles located below the skin surface. Thus, measurements of the fluence in hair removal on the skin surface can be misleading.

Material and methods

This study was carried out during 2002–2003 on 210 patients from Egypt, 207 women and 3 men, with ages ranging from 20 to 57 years and with Fitzpatrick skin types ranging between III and V. These patients had no history of oral retinoid intake within the previous year, and no history of dermatological disorders such as photosensitivity or inflammatory, pre-malignant or malignant skin diseases. They had not shaved during the week before treatment with a fluorescent IPL source (Medical Bio Care, Sweden).

A. F. El. Bedewi
National Centre of Radiation Research and Technology,
Cairo, Egypt
E-mail: aelbedewi@hotmail.com

Treatment protocol

Intense pulsed light was used with filtered light to selectively target the melanin by selective photo-thermolysis. A sapphire crystal wave-guide conducted the filtered light to the target chromophores in the tissues. It operated through the creation of a direct incoherent light beam of spectrally balanced bandwidth. All patients underwent three to five IPL treatments at 6-week intervals. Follow-up was done 6 months after the last session. The energy density was delivered in the range of 25–40 J/cm^2 with a pulse duration of 50–80 ms, delivered by a cut-off filter of 615 nm with doubled pulse illumination. According to the skin type, a single pulse was used as a test. If there was no erythema or burning sensation within 1 h, a suitable treatment protocol was selected; usually the lighter the skin colour, the higher the energy needed to produce effective results. For example, skin type III needed a fluence of 40 J/cm^2 with a pulse duration of 80 ms delivered by a cut-off filter of 615 nm. However, for skin type V, fluence was adjusted to 25 J/cm^2 with a pulse duration of 50 ms with a 615-nm cut-off filter. Each treatment was given by applying a thin layer of cold optical contact transparent gel (Sonogel, Germany) over the area to be treated. Energy was delivered through a 10×20-mm light guide that was pre-cooled with ice water. Pre-anaesthetic preparation (Emla 5%; AstraZeneca AB, Södertälje, Sweden) was administered to a few patients, especially on the upper lip. Each patient was evaluated after each treatment session; if skin erythema or early oedema appearance suggested a mild burn, the patient was given topical steroid cream and 600 mg ibuprofen daily for several days. Hair assessment was carried out before each session and 6 months after the last session; in a field of 10×10 cm, a hair count was performed using a digital camera connected to a computerised image analyser. The data were obtained using a Leica Qwin 500 image analyser computer system (Leica Imaging Systems, Cambridge, UK), which was first calibrated automatically to convert the measurement units (pixels) produced by the image analyser program into actual micrometre units using the colour detect menu.

Results

All patients undergoing three to five treatments achieved significant hair reduction in different body sites with a mean of 80% as shown in Table 1. A mean reduction of facial hair of 80, 70 and 70%, respectively, was achieved in patients with skin type III, IV and V 6 months after the last session. This failure rate, in the range of 20–30%, was due to the presence of villous hair, which has a poor response to IPL. However, the extremities, axillae and bikini line had a better response in the range of 80–85% due to the terminal hair per se. Patients tolerated the treatment but a few hirsute patients suffered mild pain in the upper lip, which was eliminated by ice packs and local anaesthetic cream. Transient erythema and mild perifolicular oedema appeared in most patients immediately after the procedure. No post-inflammatory hyper- or hypo-pigmentation and no scarring or burn was detected. One female patient with skin type IV had faun-tail nevus in the lumbo-sacral region. She was treated with a fluence of 35 J/cm^2, as shown in Table 1. Two female patients with polycystic ovary (PCO) syndrome and skin type III and IV were treated with a fluence of 32–35 J/cm^2; one of them had paradoxical hair growth. One female patient with skin type IV had leucotrichia and facial scarring due to previous repeated electrolysis therapy. One transsexual male patient with skin type III underwent treatment on the face and chest in the same session. Pseudofolliculitis barbae on the face and the bikini line was also treated successfully in three patients with skin type IV and V.

Discussion

From the above data we conclude that hair removal with IPL is effective. IPL treatment of 132 hirsute patients of

Table 1 Summary of IPL treatment according to skin type and site

Site	Skin type	Number of patients	Fluence/patient (J/cm^2)	Hair count		Percentage of improvement
				Before treatment	After treatment	
Face	III	87	32	25 ± 6	5 ± 1.2	80
	IV	38	32	26 ± 7	7.8 ± 2.1	70
	V	7	23	22 ± 5	6.6 ± 1.5	70
Extremities	III	22	40	23 ± 2	3.4 ± 0.3	85
	IV	23	35	20 ± 5	4 ± 0.7	80
	V	9	35	18 ± 4	3.6 ± 0.8	80
Axillae	III	18	40	11 ± 3	1.6 ± 0.6	85
	IV	11	37	10 ± 4	2 ± 0.8	80
	V	5	35	8 ± 2	1.6 ± 0.4	80
Bikini line	III	10	32	15 ± 7	2.2 ± 0.1	85
	IV	12	30	16 ± 5	3.2 ± 1	80
Back	IV	2	35	7 ± 3	1 ± 0.4	85
Chest	III	2	35	6 ± 4	1.2 ± 0.8	80

skin type III–V involved in this study resulted in a hair reduction of about 70–80%. Hirsutism affects 5–10% of unselected women, depending on ethnicity. In 1999, Gold et al. [3] found that 1 year after a single IPL treatment session, hair in hirsute patients was diminished by 75%. Flash-lamp technology now offers the potential for rapid, safe and effective treatment of unwanted hair. This technique is also effective for hair removal in patients of very dark skin types [4]. In the present study, an average response rate of 76.6% was noted for 21 patients of skin type V who were followed up for 6 months after IPL treatment of the face, extremities and axillae. Moreover, pseudofolliculitis was eliminated completely in the beard in two men and in the bikini line in one female patient. Lor et al. [5] evaluated patient satisfaction in 207 patients 5 years after IPL treatment of unwanted facial and body hair. Overall, 45 (22%) of the patients were very satisfied, 93 (45%) were satisfied and 69 (33%) remained unsatisfied with the outcome of light-assisted hair removal. Hair-free periods ranging from weeks to years were observed [5]. On the other hand, when single vs. multiple IPL treatments, and effects of anatomic site and skin type on the efficacy of photo-epilation, were evaluated in 34 hirsute patients (8 men, 26 women), the mean hair removal efficiency achieved was 76% after a mean of 3.7 treatments. Maximal photo-epilation was achieved after the initial one to three treatments; only a small added benefit was seen after more treatments [6]. In the double treatment protocol, hair clearance of 64% was achieved immediately after the second treatment. After 6 months, hair counts were reduced by 33%. IPL is safe with minimal side effects of epidermal injury or pigmentation change [7]. All patients in this study ($n = 210$) received double pulse illumination as routine in each session.

In the current study, leucotrichia was found in one patient,, who had facial scarring due to previous electrolysis. Moreover, Radmanesh et al. [8] reported that following treatment with IPL, 29 of 821 patients developed leucotrichia. Thirteen of these patients had no white or grey hairs before IPL therapy, while the remaining 16 patients, who had few white hairs before treatment, reported accelerated development of new white hairs starting after the first or second IPL therapy. Restoration of hair colour occurred in nine patients and the remaining 20 patients had no improvement or experienced worsening of the condition within the next 2–6 months. Temporary or permanent leucotrichia may develop after IPL and laser hair removal therapy. This finding may be explained by the difference in the thermal relaxation time, which is the time needed for an object to cool by 63%; it varies according to the surface volume ratio multiplied by the square of the object's diameter [8]. In general, the light absorbed and the heat produced by melanin may be sufficient to destroy or impair the function of melanocytes but insufficient to damage the hair follicle cells. Terminal hair has longer thermal relaxation than villous hair, which explains the poor response of villous hair to IPL. It should also be added that the occurrence of hypo-pigmentation after laser irradiation is related to the suppression of melanogenesis in the epidermis (which is reversible), rather than the destruction of melanocytes. Moreover, it is generally believed that hair follicles are more responsive to treatment while they are in the growing (anagen) phase, with no consensus on the most favourable treatment sites [2].

In the present study, one female patient had a fauntail nevus in the lumbo-sacral region, which responded very well (about 85% hair reduction) after three sessions of IPL. In 1989, Basak et al. [9] reported a case of tail nevus. A long tuft of hair over the back in the lumbar region hid a bony defect of the fifth lumbar spine. No neurological symptoms were encountered [9].

In general, there are similar success rates for treatment with ruby, alexandrite or diode lasers and for IPL, although these are somewhat lower for the Nd:YAG laser. It was also found that IPL was 3.94 times more effective than ruby laser and there was no need to treat the chin and neck with more than three sessions. However, it seems that there is no obvious advantage of one laser system over another in terms of treatment outcome (except for the Nd:YAG laser, which is found to be less efficacious, but more suited to patients with darker skin); laser parameters may be important when choosing the ideal laser for a patient [10]. Overall, laser hair removal should not be considered permanent. Repeated therapies are necessary, although complete alopoecia is rarely achieved, and it is unclear at what point the maximum benefit is reached during multiple therapies [11]. In the current study, a 28-year-old male transsexual patient was treated for excess hair in the beard, eyebrows and chest. No difference in hair removal was found between transsexual patients, who were undergoing hormonal treatment, and those who were not. Follow-up lasted an average of 44 months [12].

In the current study, two female patients who presented with PCO syndrome exhibited normal levels of FSH, LH, TSH, T3, T4, prolactin and progesterone. Although testosterone levels were high and the dehydroepiandrosterone sulphate (DHEAS) level was 16–20 ng ($n = 0.8$–10.5), ultrasonography revealed multiple cysts within both ovaries in both patients. These patients had a paradoxical hair growth after four IPL sessions. It should also be pointed out that Moreno-Arias et al. [13] studied 49 female patients with facial hirsutism; hyperandrogenism of tumoural origin was excluded in all subjects. Serum levels of FSH, LH, prolactin, testosterone, androstenedione, DHEAS, 17-OH-progesterone and sex hormone-binding globulin were determined prior to IPL treatment. A total of five patients with ''paradoxical effect'' were identified. The patients ranged in age from 13 to 44 years and all of them had skin type III. All these subjects were diagnosed with PCO syndrome and presented ovarian hyper-androgenism. Patients underwent six to nine IPL sessions, and a paradoxical effect was observed at different times during the protocol, between the third treatment session and 6 months after the treatment. These authors confirmed

the present study results that IPL may induce activation of dormant hair follicles in untreated areas close to hirsute-treated areas [13]. Most side effects secondary to IPL photo-depilation are mild and transient. Permanent side effects such as scars are unlikely but they may occur [14].

The IPL technique offers a more reliable and practical solution for hair removal, especially for patients with skin irritation, dark skin and ingrowning hair. In conclusion, hair removal with IPL is an effective and safe method with long-term epilation of unwanted hair.

References

1. Eremia S, Li CY, Umar SH, Newman N (2001) Laser hair removal: long-term results with a 755-nm Alexandrite Laser. Dermatol Surg 27:920–924
2. Liew SH (2002) Laser hair removal: guidelines for management. Am J Clin Dermatol 3:107–115
3. Gold MH, Bell MW, Foster TD, Street S (1999) One-year follow-up using an intense pulsed light source for long-term hair removal. J Cutan Laser Ther 1:167–171
4. Johnson F, Dovale M (1999) Intense pulsed light treatment of hirsutism: case reports of skin phototypes V and VI. J Cutan Laser Ther 1:233–237
5. Lor P, Lennartz B, Ruedlinger R (2002) Patient satisfaction study of unwanted facial and body hair: 5 years experience with intense pulsed light. J Cosmet Laser Ther 4:73–79
6. Sadick NS, Weiss RA, Shea CR, Nagel H, Nicholson J, Prieto VG (2000) Long-term photoepilation using a broad-spectrum intense pulsed light source. Arch Dermatol 136:1336–1340
7. Weiss RA, Weiss MA, Marwaha S, Harrington AC (1999) Hair removal with a non-coherent filtered flash lamp intense pulsed light source. Lasers Surg Med 24:128–132
8. Radmanesh M, Mostaghimi M, Yousefi I, Mousavi ZB, Rasai S, Esmaili HR, Khadivi HA (2002) Leukotrichia developed following application of intense pulsed light for hair removal. Dermatol Surg 28:572–574; discussion 574
9. Basak P, Kanwar AJ, Kaur S, Dhar S (1989) Faun-tail nevus–a case report. Indian J Dermatol 34(3):66–68
10. Bjerring P, Cramers M, Egekvist H, Christiansen K, Troilius A (2000) Hair reduction using a new intense pulsed light irradiator and a normal mode ruby laser. J Cutan Laser Ther 2:63–71
11. Sanchez LA, Perez M, Azziz R (2002) Laser hair reduction in the hirsute patient: a critical assessment. Hum Reprod Update 8:169–181
12. Schroeter CA, Groenewegen JS, Reineke T, Neumann HA (2003) Ninety percent permanent hair reduction in transsexual patients. Ann Plast Surg 51:243–248
13. Moreno-Arias GA, Castelo-Branco C, Ferrando J (2002) Paradoxical effect after IPL photoepilation. Dermatol Surg 28:1013–1016; discussion 1016
14. Moreno-Arias GA, Castelo-Branco C, Ferrando J (2002) Side effects after IPL photo depilation. Dermatol Surg 28:1131–1134