Hair removal with a second generation broad spectrum intense pulsed light source – a long-term follow-up

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Introduction

Many people either desire more hair or want to get rid of unwanted hair. Traditional methods of hair removal such as shaving, plucking, waxing and electrolysis are associated with clinical limitations and side effects. Hair removal using optical methods was discovered as early as 1979 and since 1995 the public and manufacturers have shown a great interest in the new hair removal lasers and intense pulsed light (IPL) sources that have been developed. Unfortunately, clinical studies regarding the long-term efficacy and clinical safety of these procedures have lagged behind the actual widespread use of this modality all over the world.

Long-term or permanent hair reduction is based on...
thermal damage to the hair follicle obtained by absorption of optical energy in the hair followed by heat conduction to the surrounding hair follicle cells. This damage may be restricted to the hair follicles by the principle of selective photothermolysis, which predicts that thermal injury will be restricted to a hair follicle if the pulse duration is shorter than the cooling time or thermal relaxation time of the follicle. Melanin in the hair shaft, the bulb and parts of the outer root sheath is the main chromophore and broadly absorbs light across the optical spectrum.

Treatment with different lasers, for example ruby, alexandrite, Q-switched Nd:YAG and diode lasers, as well as broadband light, have proved to delay hair growth significantly. However, it has been difficult to compare the devices in terms of the long-term or permanent hair removal result because the follow-up periods in some studies have been too short, which means that the full growth cycle as well as the recovery time for the hair follicles have not been covered. Also confusing is that many studies have included different anatomical locations with different growth cycles in the same study. Evaluation of the abilities of the different devices for hair reduction may be inaccurate unless exact hair follicle counting is provided. A computer imaging system (CIS) was used for this purpose in the present study. Furthermore, the different devices all have different pulse durations, wavelengths, beam profiles and fluences.

In order to evaluate the long-term hair reduction potential of this new IPL device, a follow-up time of at least two full hair cycles was chosen. This was obtained in 8 months for hairs in the bikini line area (Richards-Meharg table).

Materials and methods

Volunteers

A total of 11 healthy females, without any hormonal disturbances and with a mean age of 31 (SD ± 9.2) years (range 21–56) were treated on both sides of their bikini areas.

All volunteers had dark blond hair to dark hair with Fitzpatrick skin types II–IV, with the majority being type III. The tan of the treated areas varied between none to heavy; the majority were evaluated to have a medium pigmentation.

The IPL system

The Ellipse Relax Light 1000 (Danish Dermatologic Development, Hoersholm, Denmark) is a second generation IPL system device designed for long-term epilation and vascular treatments, and the mode of action is based on the theory of selective photothermolysis.

In this present study, a handpiece for hair removal with a special ‘dual mode filtering’ was used. It consists of a high-energy flashlamp and a fixed and sealed 600-nm filter together with a water-filled filter reducing wavelengths above 950 nm. In this way the water-filled filter absorbs all wavelengths that would otherwise lead to skin burns due to non-specific heating of the water content of the epidermis. This integrated water filtering enlarges the therapeutic window and there is therefore no need for changing filters according to skin type and pigmentation. The large spot size of 48 × 10 mm increases the effective optical depth in the skin tissue. The direct contact between the light guiding crystal and the skin is accomplished by a thin layer of optical index-matching gel, and the design of the light guide allows re-use of reflected and scattered photons by reflecting them back into the skin (photon recycling) (Figure 1).

Treatment procedure

Prior to the treatment, the groin area was photographed and shaved. A transparent optical index-matching gel was applied to the skin. The test areas were treated in one pass with an overlapping of 10%. No cooling or any other post-treatment regime was utilized.

Four treatments were performed on each volunteer on both sides of the bikini areas with intervals of 4–5 weeks.

During the treatment the handpiece was held with a moderate pressure on the skin in order to empty the cutaneous blood vessels. This also results in indentations in the gel layer where the treatments have been performed. No alignment sheets were needed.

The thermal relaxation time of the relatively thick hairs of the bikini area is in the range of 30–50 ms. The IPL can be adjusted to a pulse duration up to 50 ms. For all volunteers, a pulse duration of 44.5 ms was chosen. The pulses were composed of an undulating train of four individual pulses of 10 ms spaced by 1.5-ms intervals. The fluences used were a mean of 18.3 (SD ± 3.3) J/cm².

The follow-up visits included digital photography 4 and 8 months after the last treatment (Figure 2). Two of the 11 patients were controlled 10 months after the treatments and their treatment results improved in comparison with their hair reduction at the 4-month control. Photographs were stored and analysed on a computer system (Mirror Image Software System; Canfield Clinical Systems, Fairfield, NJ, USA). A standardized photography set-up was used with the photographs centred in the groin area and with the volunteers’ legs abducted 60° in order to get the identical skin tension in the groin area at each visit. When comparing the photographs, compensations for different focal distances during exposures were performed. Each photograph was calibrated to a standard size in the computer using a ruler, and test areas of 25 × 25 mm were marked for hair counting. When comparing pictures on the same volunteer, the target area was mapped on the pretreatment picture and all subsequent
Figure 1
The use of the IPL system handpiece is demonstrated on the skin.

Figure 2
Bikini line before (left panel) and 8 months after (right panel) four IPL treatments, demonstrating how the follicles were counted with the help of the computer imaging system.
photographs on the same volunteer were measured in the same area of each photograph. Computerized photographs like these can be enlarged and brightened, which facilitates the counting of separate strands of hair in the test areas.

**Results**

Before treatment, the average number of hairs in the target areas of $25 \times 25$ mm was 33.9 (SD ± 9.4). At the first follow-up, 4 months after the last treatment, 20 analysed treatment sites demonstrated a reduction of the average number of hairs by 74.7% (SD ± 18.3%).

At 8 months following the last treatment an average hair reduction of 80.2% (SD ± 20.3%) was registered (Table 1). The individual results for each volunteer are demonstrated in Table 2. The distribution of the results after grouping the results in poor (0–24%), moderate (25–49%), good (50–74%) and excellent (75–100%) are shown in Table 3.

Some 70% of the volunteers experienced excellent (75–100%) hair reduction. There was no statistically significant difference between the result obtained at the 4-month and the 8-month follow-up, which may indicate that the hair reduction obtained may be permanent. Two of the volunteers also suffered from folliculitis caused by ingrowing hair due to shaving; however, after the first treatment both of them experienced complete improvement. After the treatments all volunteers experienced a smoother texture of the skin and the quality of the remaining hairs had changed from a darker course type to a lighter thinner type of hair. Volunteers with thicker hair had a slower response than those with thinner hair.

**Side effects**

No major immediate or late complications were seen after the treatments. Most volunteers experienced a light redness as well as slight tenderness of the treated area, which disappeared within 2 days.

After the second treatment two volunteers developed a few small blisters as a result of shaved burned hair debris attaching to the front surface of the light guide crystal. Both volunteers healed within a week without any scarring. No patients experienced any pigment changes after the treatments.

Patients were asked to grade the discomfort or pain associated with the treatment on a visual analogue scale of 1–10, where 0 was defined as no pain or discomfort and 10 was maximally imaginable pain. The average pain score was 5 on the medial areas and 3 on the lateral areas.

**Statistics**

The Wilcoxon’s test for paired differences was used; $p<0.05$ was considered as the level of significance.

**Discussion**

To our knowledge this is the first study published using a second generation IPL. The present study demonstrates a very high percentage of hair reduction after more than two full hair follicle cycles in the bikini area without any
significant side effects. These results may be due to the very long light pulses, which match the thermal relaxation times of the relatively coarse hairs in the bikini area. Despite the follow-up of more than two full hair cycles, it is not known whether these results are permanent. Hillock and Ackerman\(^{16}\) stated that the destruction of the hair papilla is essential for permanent epilation, although Oliver\(^{17}\) and Costarelis et al\(^{18}\) have claimed that hair follicles can regenerate in the absence of the hair bulb. Histology has shown miniaturization and granulomatous degeneration of the hair follicles after normal-mode ruby laser treatment with less effect on blond hair and a fluence-dependent hair reduction.\(^7\) On the other hand, McCoy et al\(^{19}\) found that there was no evidence of permanent follicle death after one 3-ms pulsed ruby laser treatment. Also, the papillae always remained viable. New anagen follicles were still evident after three treatments, but there were no hairs extending to or through the epidermis. They concluded that it is possible that laser-induced damage to the isthmus and upper stem may interfere with the interaction between dermal and epidermal germinative cells, thus inhibiting or altering the normal hair cycle.

Whether the hairs are in anagen or telogen phase at the time of the treatment may be important for optical depilation because only anagen hairs are particularly sensitive to chemical, cytostatic, physical, hormonal, infectious or inflammatory insults.\(^20\) It is not known if this also applies to the damage caused by lasers and IPL sources. Due to unsynchronized cyclic growth, not all hair follicles will be in anagen phase\(^{21-24}\) at the time of the treatment. More treatments will therefore always be required in the same area to ensure treatment of all follicles while in anagen phase. Maybe the best treatment interval should be when a certain amount of the hair is in anagen phase,\(^{21-24}\) at the time of the treatment. More treatments will therefore always be required in the same area to ensure treatment of all follicles while in anagen phase. The authors would like to thank Lena Olsson, RN, for help with administration and treatments.

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**References**