Long-Term Epilation with Long-Pulsed Neodimium:YAG Laser

PIER LUCA BENCINI, MD,* ANTONIO LUCI, MD,† MICHEL GALIMBERTI, MD,* AND GIULIO FERRANTI†

Servizio di Dermatologia, Ospedale S. Raffaele, Milan, Italy, †Istituto Dermatologico dell'Immacolata, Roma, Italy

BACKGROUND. Unwanted body hair can represent a severe cosmetic disturbance. The traditional methods used to epilate often have limitations, side effects, and unsatisfactory results. In recent years, various light sources (lasers and others) have been developed for long-term epilation of unwanted hair.

OBJECTIVE. This study evaluates, on a large number of patients, the efficiency and safety of a long-pulsed low-potency Nd-Yag laser invented specifically for long-term hair removal.

METHODS. Some 208 subjects needing epilation were divided into three groups and treated during an 11-month period. Group A included 79 patients with a normal distribution of unwanted hair; Group B 67 patients with constitutional hypertrichosis; and Group C 62 patients with hirsutism. Treatment sessions were performed with a fluence of 23–56 J/cm² at 1-month intervals until obtaining desirable results. Follow-ups ranged from 1 to 6 months. In 3 patients 4-mm diameter punch biopsy specimens were obtained before the first session and again after 6 hours. A third biopsy was performed after 3 months.

RESULTS. Every session resulted in a 20–40% hair loss, depending on the color of hair. Complete epilation was obtained in 4 to 6 sessions. Only white hair was not receptive to laser light, and its growth was not modified. No patients, including dark-complexioned patients, had blistering, hypo-or hyperpigmentation. No pain was present during treatment except for the axillary area. In the specimen obtained after 6 hours, very extensive necrosis of the hair follicular and sebaceous gland epithelium was evident. Histologic findings of the biopsies taken after three months showed complete disappearance of hair and moderate fibrosis.

CONCLUSION. This study proves that the long-pulsed Nd:Yag laser treatment produces an excellent prolonged epilation with no relevant side effects. This laser light, having a 1064 nm wavelength, is minimally absorbed in superficial skin layers, and pronounced scattering up to 5 mm occurs targeting the deeper follicles.

UNWANTED FACIAL and body hair can represent a severe cosmetic disturbance, sometimes with social and even psychological implications. For this reason, many patients (both men and women) use epilation to decrease hair density. Until now, several methods have been used to remove superfluous hair: waxing, plucking, shaving, chemical depilation, and electrolysis, with various limitations and unsatisfactory results. Electrolysis is the only histologically proven permanent method of epilation, but this technique is time consuming, painful, prone to scarring, and impractical for treating large areas. Re-growth may occur again after the first series of treatments.[1,2] In recent years, various lasers and a broad-band light source have been developed for long-term epilation of unwanted hair.[3–9] In 1990, a high-potency Nd:Yag surgical laser was successfully employed on 3 patients to epilate hair-bearing urethral grafts.[10]

This article illustrates the first long-term study on a large number of patients, evaluating the efficiency and safety of a long-pulsed low-potency Nd:Yag laser (Smart-Epil, Deka-MeLa, Calenzano, Florence, Italy) invented specifically for permanent hair removal.

Address correspondence and reprint requests to: Pier Luca Bencini, MD, Corso Venezia, 37, 20121, Milan, Italy.

Materials and Methods

A total of 208 subjects were treated during an 11-month period. These subjects were divided into 3 groups: Group A—79 patients (71 women and 8 men). This group included subjects with normal size and distribution of hair in relationship to anatomical areas. Group B—67 patients (all women) with constitutional hypertrichosis, a condition that is commonly observed in Mediterranean countries and characterized by a general increase in body hair unrelated to underlying diseases and usually affecting women of the same family. Group C—62 patients (51 women, 11 transsexuals) with hirsutism (ie, increased androgen-modulated body hair). The women of this group had several hormonal abnormalities: polycistic ovary affected 36 patients, increased blood levels of DHEA-s in 10 patients, and increased blood levels of 17 OH progesterone in 5 patients.

The ages of these 3 groups of patients ranged from 18 to 56. The areas of treatment are shown in Table 1. Some 203 subjects were Caucasians with Fitzpatrick skin phototypes 2–4, and 5 patients were dark complexioned (1 from Ceylon and 4 from Brazil) (Fitzpatrick skin phototype 5). Moreover, 124 patients had dark hair, 2 patients had white hair semi-prevalent in the bikini area, and 78 patients had blond hair, but only 4 had red hair.

The number of sessions were determined in order to satisfy the aestethic and psychological expectations of the pa-

 • Published by Blackwell Science, Inc.
ISSN: 1076-0521/99/ • Dermatol Surg 1999;25:175–178

Table 1. Areas of Treatment*

• Face and neck	62/208	30%
• Groin	56/208	27%
• Lip	46/208	22%
• Abdomen	27/208	13%
• Legs	29/208	14%
• Chin	25/208	12%
• Arms	10/208	5%
• Axilla	6/208	3%

*Note that some patients had treatments on different areas

tients, not necessarily to obtain a complete epilation in all subjects. Therefore, the clinical protocol included only 1 treatment for the subjects who did not desire a complete epilation and follow-up visit every 4 weeks for 6 months. For the patients choosing complete epilation, treatment sessions were performed at 1-month intervals for at least 4 consecutive months or until obtaining desirable results. Follow-up procedures ranged from 1 to 11 months.

Treatment

The area to be treated was shaved before laser application and a transparent gel applied. The laser treatment was performed with a long-pulsed low-potence Nd:Yag laser (SmartEpil, Deka-MeLa, Calenzano-Florence, Italy). Laser energy was delivered in a 3 mm or a 4 mm spot with a fluence of 23–56 J/CM^2, depending on hair type (Table 2). The fluence was decreased according to the subjective distress of the patients. All the skin was covered by homogeneous, adjacent, non-overlapping light pulses. Topical anesthetic cream containing lidocain-prilocain (EMLA-ASTRA, Farmaceutici Spa, Milan, Italy) was applied 1 hour before treatment as needed. Post-treatment therapy consisted of only 1 application of steroid cream at the end of each session.

Patients were instructed not to expose the treated area to sun for 30 days. In three patients, who needed the procedure, 4-mm diameter punch biopsy specimens were obtained on a thigh before the first session and after 6 hours. A third biopsy was performed after 3 months from the end of the last treatment. Biopsy specimens were processed routinely.

Results

The first session resulted in a 20–40% hair loss of the treated area, lasting over 24 weeks. These results were considered satisfactory by 21 patients of Group A and by all 67 patients of Group B not requiring a complete epilation.

Group C patients and 58 patients of Group A needed a complete epilation and after 4 weeks had a second treatment with an increase of 20–40% hair loss. Complete depilation was obtained in 4 to 6 sessions (according to hair type and laser fluence used, see Table 3). Dark hair (124 patients) had a good response: 40% of hair loss, at middle (30–40 J/cm^2) and high (40–56 J/cm^2) fluences. However this caused an intense burning sensation in patients. To avoid this problem, we decreased the fluence for patients needing other sessions of treatment with a hair loss of 20–30% in every laser passage.

Blonde hair (78 patients) of any size had a good response (30–40% loss of hair at the first passage), at middle (30–40 J/cm^2), and high (40–56 J/cm^2) fluence without burning sensation.

Red hair (4 patients) is less sensitive to laser light than blonde hair similar in size and area (20–30% hair loss).

White hair (2 patients) was not sensitive to laser light and its growth was not modified. Biopsies from untreated skin showed normal hair shafts with follicular structures intact. In the specimen obtained 6 hours after treatments, extensive necrosis of the hair follicular and sebaceous gland epithelium was evident (Figure 1). Histologic findings in biopsies taken three months after the end of treatment showed complete disappearance of hair follicula with the occasional presence of arrector pili muscle and little focal fibrosis (Figure 2).

Side Effects

No patient had hypopigmentation or hyperpigmentation. In particular, we had also treated 5 dark complexioned patients with no resulting hypopigmentation. No persistent erythema was observed. Only a very mild,

Table 2. Fluence in Relation to Type of Hair

• Fine, lighter shades of hair	23–42 J/cm^2
• All types of dark hair	23–42 J/cm^2
• Light shades of leg and arm hair	30–56 J/cm^2
• Dark leg and arm hair	30–56 J/cm^2
• Light groin and axilla hair	40–56 J/cm^2
• Dark groin and axilla hair	30–42 J/cm^2
• Face hirsutism	23–42 J/cm^2

Table 3. Number of Treatments Required for Complete Epilation in Relationship to Hair Type

• Fine, lighter shades of hair	3–4
• All types of dark hair	3–4
• Light shades of leg and arm hair	4–6
• Dark leg and arm hair	4–6
• Light groin and axilla hair	3–4
• Dark groin and axilla hair	6–8
• Face hirsutism	6–8

Figure 1. Histologic findings (6 hours after laser session). Extensive necrosis of the hair follicular and sebaceous gland epithelium (H&E original magnification 250×).

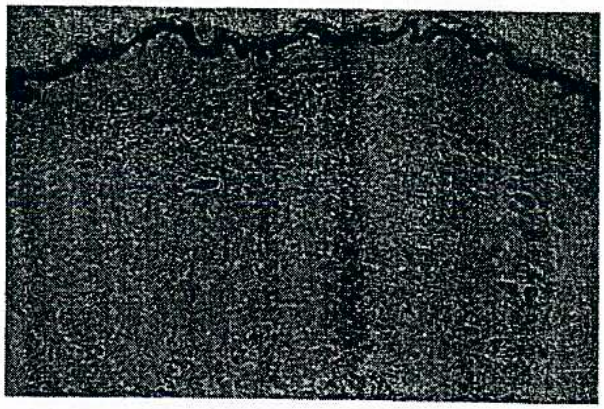

Figure 2. Histologic findings (3 months after the end of treatment). Disappearance of hair follicula (H&E original magnification 100×).

transient erythema was present in all patients after the treatment sessions. It regressed within 1 to 2 hours, with no further treatment except for our routine post-treatment medication.

No pain was present during the treatment (except for the axillary area). A burning sensation was the only discomfort experienced in 104 patients (13 were blonde and 91 brunette). However, only thick dark hair generated an intense burning sensation at fluences ranging from 40 to 56 J/cm^2. For this reason 91 dark-haired patients were treated with low fluences and had more treatments versus patients with lighter hair (Table 4). Use of lidocain-prilocain cream (EMLA-ASTRA) was necessary in the axilla of 6 subjects only.

No blistering was caused by the fluences used in this study.

Discussion

The hair follicle is a very resilient entity, able to rebuild itself and form new hair, even after severe injuries.[8] Its germinative structures are deeply located in the lower dermis and in the upper part of subcutis at the distance of 3–5 mm from the epidermal surface. Indeed, lethal follicular damage occurs only in the lower fourth of the follicle, thus causing permanent hair disruption.[8,11] The ideal technique of permanent epilation would be to destroy the deep follicular germinative structures without scarring. This would be a painless, quick, and cost-effective process, free of any unbecoming cosmetic side effects. Until now this optimal technique has never existed, and fine-needle electroepilation is considered the best standard treatment. All new methods must be compared in their efficiency to electroepilation.

The most recent progress in permanent epilation has been discovered through the use of lasers and laser light sources. However, these techniques are in their infancy and are just beginning to be explored through large-scale studies. Laser sessions are quicker and easier to perform than fine-needle electrolysis. Theoretically, these methods, based on the principle of selective photothermolysis,[12] would to be able to destroy only follicular structures, sparing surrounding tissue. Pilosebaceous units have many potential laser targets: follicular melanin, keratin and other proteins, hair dermal papilla vessels, and sebaceous gland structures. But there still remain to be defined the correct combinations of wave length, pulse width, and fluence able to penetrate deeply and to selectively destroy the lower third of the follicle, including follicular germinative cells and dermal papilla.[8] The methods of laser epilation most commonly used today are performed by three types of devices. The first method (such as long-pulsed ruby laser) is based on specific wavelengths, which are selectively absorbed by melanin.[5–7] The second is a Q-switched Nd:Yag laser associated to a topical carbon-based solution.[8] The third, known as the epilight hair-removal system, consists of a broad-band pulsed light ranging from 550 to 1200 nm.[9] All methods mentioned above have varying degrees of side effects. Several patients experienced pain, blistering,

Table 4. Burning Sensation in Relationship to Hair Color

Hair Color	Number of Patients	%
• White hair	0/2	0
• Red hair	0/4	0
• Blonde hair	13/78	16
• Dark hair	91/124	73

transient hypopigmentation, prolonged erythema, and hyperpigmentation after the ruby laser treatment.[6] A further limitation of the selective melanin-based photothermolysis is represented by the fact that the treatment is more effective for darker hair.

After the topical suspension-assisted Q-switched Nd: Yag laser hair removal treatment, erythema and a prolonged mild hyperpigmentation have been reported.[8] In the epilight hair-removal system, the most common side effects were severe erythema (70%), edema (8%), blistering (8%), and hyperpigmentation (3%).[9]

Because the depth of the germinative follicular structure changes according to the different stages within the hair cycle, many wave lengths produced by these lasers may not be able to efficiently target the deeply logged anagen follicles.[6]

This study proves that the long-pulsed Nd-Yag laser treatment produces an excellent, prolonged epilation in few sessions, with no relevant side effects. No cases of erythema, dyschromia, or particular pain have ever been reported, in spite of the large number of patients treated. Moreover, no epidermal melanin damage was present in dark complectioned patients.

The Nd-Yag laser produces light with a wavelength of 1064 nm. Because this kind of light is poorly absorbed by superficial tissues, pronounced scattering up to 5 mm occurs.[10] In this way, most follicles may be targeted. We had an excellent response with all hair colors with the exception of white. In particular, blonde and fine hair were better treated, due to an absence of burning sensations in spite of the higher fluences used. The reason why this wide spectrum of color is affected by this kind of laser light is unknown. Hypothetically speaking, a wavelength of 1064 nm might very well target follicular structures other than melanin alone.

Conclusions

This study shows the clinical effectiveness of the long-pulsed Nd:Yag laser for safe and prolonged epilation in spite of hair colors. The technique is painless, easy, and relatively quick, when compared to fine-needle electrolysis. However, further studies and long-term follow-ups are required to determine the duration of results.

References

1. Bergfeld WF, Redmond GP. Hirsutism in hair disorders. Dermatol Clin 1987;5:501–7.
2. Wagner RF. Physical methods for the management of hirsutism. Cutis. 1990;45:319–26.
3. Zaias N. Method of hair depilation. U.S. Patent 5,059,192, Oct. 1991.
4. Grossman MD, Yung R, Berlin AJ. Prospective evaluation of the argon laser in the treatment of trichiases. Opthalmol Surg 1992;23: 183–7.
5. Grossman MD, Brightwell JR, Huntington AC. Experimental comparison of laser and cryosurgical cilia destruction. Opthalmol Surg 1992;23:179–83.
6. Grossman MC, Dierickx C, Fannelle W, Flotte T, Anderson RR. Damage to hair follicles by normal mode ruby laser pulses. J Am Acad Dermatol 1996;35:889–94.
7. Lask G, Elman M, Slatkine M, Waldman A, Rozenberg Z. Laser assisted hair removal by selective photothermolysis. Dermatol Surg 1997;23:737–9.
8. Goldberg DJ, Littler CM, Wheeland RG. Topical suspension-assisted Q-switched Nd:Yag laser hair removal. Dermatol Surg 1997;23:741–5.
9. Gold MH, Bell MW, Foster TD, Street S. Long term epilation using the Epilight broad band, intense pulsed light hair removal system. Dermatol Surg 1997;23:909–13.
10. Finkelstein LH, Blastein LM. Epilation of hair-bearing urethral grafts utilizing the Neodimium:Yag surgical laser. Lasers, Surg Med 1990;10:189–93.
11. Reynolds AJ, Jahoda CAB. Inductive properties of hair follicles cells. Ann NY Acad Sci 1991;642:226–42.
12. Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery selective absorption of pulsed radiation. Science 1983; 220:524–7.