

Topical

Suspension-assisted

Q-switched Nd:YAG Laser

Hair Removal

BACKGROUND. Many individuals seek to decrease facial and scores revealed that the majority of patients had over 25% fewer body hair density. Although a variety of epilating methods are hairs. The 12-week mean percentage of hair reduction, based on available, improved techniques would be of interest to patients anatomic sites, ranged up to 66% and 44% as judged by phyand physicians alike. sicians and subjects, respectively. Adverse events were minimal **OBJECTIVE.** To determine the safety and clinical efficacy of a new and temporary.

laser-based method of hair removal.

METHODS. A Q-switched Nd:YAG laser was used to scan skin with increased hair after applying a topical carbon-based solution. Thirty-five healthy, adult volunteers were treated with a single treatment to selected facial, neck, and axillary sites.

RESULTS. Twelve weeks after a single treatment, integrated site

CONCLUSION. Topical suspension-assisted Q-switched Nd:YAG laser therapy reduces hair density after a single treatment. Advantages include its speed, technical ease, and minimal adverse effects. © 1997 by the American Society for Dermatologic Surgery, Inc. *Dermatol Surg* 1997;23:741-745.

Human hair is largely of cosmetic significance, both socially and sexually. Its appearance is often considered critical and is therefore the subject of much manipulation. Alterations in hair may take many forms including changes in color, shape, length, and density. The first three changes may be achieved easily in contrast to the latter. Innovations superior to current density reduction techniques would certainly be welcome, especially to those who are anxious and distressed due to increased hair in cosmetically objectionable sites.¹

Excess human hair has many causes. It is often divided into hirsutism (increased hair in females in androgen-dependent sites) and hypertrichosis (increased hair on any body site, male or female). Hirsutism is caused by increased androgens or exogenous androgenic compounds. Many recent articles review its evaluation and treatment.³⁻⁵ Studies have found significant hirsutism in young females to vary from 9% to 15%.⁶⁻⁷ Hypertrichosis may be congenital, acquired, hereditary, or caused by medications. The increased hair may be

localized or generalized. In addition, it may be associated with a variety of syndromes or disorders.⁸

Many patients with hirsutism and hypertrichosis solicit hair removal. However, a number of individuals who do not suffer from either of these disorders seek epilation, even though their hair would be considered normal in distribution and density. Frequent sites of concern include the female face, neck, axillae, and legs. In addition, requests for hair removal are not exclusively from women. Many males seek removal of dense back or shoulder hair and male transgender patients want hair eliminated from wide body areas.

Numerous methods of hair removal are available today, but each has limitations.⁹ The gold standard to which all other methods must be compared is electroepilation, as it is the only histologically demonstrated "permanent" method of hair removal.¹⁰ Yet, even this technique has drawbacks. After years of electroepilation, individuals may see only a minimal decrease in their hair density. In addition, this technique can be painful, potentially scarring, and impractical for treating large areas. An optimal hair removal technique would be quick, reasonably painless, cost effective, and free of major side effects.

The last 10-15 years have witnessed a dramatic increase in the selectivity of lasers. The theory of selective photothermolysis proposed in 1983 by Anderson and Parrish¹¹ has contributed to the production of lasers that can precisely damage cutaneous targets without

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Table 1. Enrollment by Age

Age (yrs)	Male	Female
Under 30	3	0
31-40	3	0
41-50	5	0
51-60	1	0
Over 60	3	0

injuring the surrounding structures, thus reducing the scarring potential. Melanin, tattoo pigment, and hemoglobin have been some of the targets pinpointed up to this time. Many other targets in the skin remain untapped, including the hair follicle. In order to cause selective hair damage, an innate and unique property of the follicle must be attacked. Theoretically, follicular melanin, keratins, or other proteins could be used, but the right combination of wavelength, pulsewidth, and fluence has yet to be determined. Alternatively, an agent capable of laser absorption may be placed in proximity to the hair. If an appropriate topical chromophore is applied, penetrates around the hair, and is then activated by laser light, heating of this chromophore would in turn heat and damage the surrounding follicle. This study examines just such a technique utilizing a Q-switched Nd:YAG laser in conjunction with a topical carbon-based suspension in an attempt to target, damage, and decrease unwanted hair.

Materials and Methods

The treatment was conducted on 35 healthy, adult volunteers, ranging in age from 20 to 74 years (Table 1). Individuals were in good general health and had excess hair in the treatment sites that could be identified photographically.

Treatment sites included the upper lip, chin, cheeks, neck, and axilla. The skin was prepared with alcohol and the hair was trimmed to a length of 1-2 mm. A topical carbon/mineral oil suspension was then massaged into the treatment sites and allowed to absorb for 5-10 minutes. The excess suspension was then wiped away and the laser treatment with a Q-switched Nd:YAG laser (Thermolase, San Diego, CA) was undertaken. Patients were assessed at 4 and 12 weeks. Laser energy was delivered in a 7-mm diameter spot with a fluence of 2-3 J/cm² and a 10-nsec pulse. The output beam was de-

Table 3. Mean Percentage Hair Reduction at 12 Weeks by Anatomic Sites Treated

Physicians' Evaluations	Subjects' Evaluations No.
of Subjects Reduction No. of Subjects Reduction	
Cheek 4 66% 2 39%	Chin 8 33% 5 11%
Neck 8 35% 7 25%	Axilla 5 31%
Upper lip 11 63%	10 44%

livered to the skin through a seven-mirror articulated arm and beam delivery handpiece at a repetition rate of 10 Hz.

Both physician and subject evaluated the effectiveness of treatment at follow-up visits. The primary parameter evaluated was degree of hair reduction, judged by the physician at 4 and 12 weeks and by the subject at week 12. A vertical line was placed on a horizontal bar indicating from 0% to 100% reduction after comparing the clinical appearance with baseline photographs. The final 12-week assessment was made by comparing the baseline with the 12-week photograph. The physician alone recorded the degree of posttreatment erythema, pigmentary changes, or scars.

Results

The primary effectiveness parameter evaluated was the percentage of hair reduction. The results are summarized overall and by anatomic site in Tables 2 and 3. The only common reaction was erythema, seen immediately following treatment. Erythema resolved in all patients within 48 hours. One patient had mild hyperpigmentation, which had completely resolved at week 12. No patients showed any scars or texture changes (Figures 1 and 2).

Discussion

Topical solution-assisted laser hair removal may damage hair follicles in the following manner. Nd:YAG laser light has been shown to be strongly absorbed by carbon (in contrast to other cutaneous chromophores such as melanin). As the topical carbon interacts with 1064-nm laser light, it undergoes a rapid temperature rise. The resulting shock waves propel carbon particles

Table 2. Overall Percentage Hair Reduction

Physicians' Scores												Subjects' Scores														
Week 4						Week 12																				
Reduction	No. of Sites	Percent of Total				No. of Sites	Percent of Total				No. of scores	Percent of Total														
0-25%	7	10%	15	27%	21	49%	26	50%	30	44%	23	42%	16	37%	51	75%	16	24%	9	12%	3	7%	76	100%	15	22%
	8	18%				3	7%																			
Total sites	68	100%				55	100%				43	100%														



Figure 1. A) Hair before treatment with topical suspensionassisted Q-switched Nd:YAG laser. B) Four weeks after treatment. C) Twelve weeks after treatment.

Figure 2. A) Hair before treatment with topical suspensionassisted Q-switched Nd:YAG laser. B) Four weeks after treatment. C) Twelve weeks after treatment.

in multiple directions, presumably down the follicle as well. Carbon particles traveling at high speed may cause follicular damage that subsequently delays hair regrowth.

The laser technique described herein was shown to

safely reduce hair density after a single treatment over the course of this study. Physician evaluation revealed hair reduction to be greater than 25% in 90% of subjects at week 4 and 73% at week 12. Subject evaluations were 51% at week 12. When evaluated by anatomic site the

mean week 12 physician scores ranged from 31% to 66%. The subjects mean scores ranged from 11% to 44%. Incomplete elimination and eventual hair regrowth may be due to below threshold damage to the follicle. Multiple treatments or other modifications may generate irreversible injury resulting in permanent effects.

Although melanin-specific lasers are currently available, for epilation purposes there may be some drawbacks in choosing a wavelength that primarily targets this chromophore. Such lasers can only be useful for dark-haired individuals, excluding the patient population who request removal of lighter colored or white hair. In addition, melanin-absorbing wavelengths are in the visible light range. These wavelengths are relatively short and hence less penetrating. If it is true that deep follicular structures need to be destroyed in order to eradicate a hair, then deeply penetrating, longer wavelengths should be chosen (eg, near infrared light). Finally, absorption by melanin in the epidermis decreases energy delivered to the deep follicle and may increase side effects such as dyspigmentation. Patients with Fitzpatrick skin types IV-VI may not be able to undergo treatment without developing significant pigmentary changes.

Laser-based methods for hair removal are just beginning to be explored." These methods rely either on a unique property of the follicle or an exogenous agent to absorb laser energy, subsequently damaging the follicular structure. The procedure utilized in this study primarily exploits the energy produced in a carbon-containing topical suspension as a result of exposure to 1064-nm Q-switched Nd:YAG laser light. It is postulated that the absorbed energy subsequently damages the follicle in contact with the suspension producing selective injury to unwanted hair. This laser-tissue interaction is similar to that which occurs between laser light and tattoo pigment. However, the fluence used in this procedure is only a fraction of that used for effective tattoo removal.^{15,16}

Treatment at a low energy density has a multifold significance. Less energy translates into less heat and therefore less pain. Even though topical suspension-assisted laser hair removal is not devoid of discomfort, it is easily tolerated by most patients. No patient in this study required a topical or local anesthetic. In addition, a lower fluence decreases the risk of adverse events. Although Q-switched Nd:YAG lasers, used at higher fluences in the treatment of tattoos, rarely cause scarring, dyspigmentation may still be seen.^{15,16} Permanent pigmentary changes were not seen in this study.

The hair follicle is an incredibly resilient structure, regrowing after seemingly lethal injury. Effective laser hair removal requires that the site of critical follicular structures be identified. Several animal studies suggest that damage must occur to more than the lower third of

the follicle in order to destroy it. The structures in this area include the dermal papilla and follicular germinative cells. If either remain, they can apparently induce their counterpart to reform." Human studies are consistent with these data. Histologic examination of biopsies taken from seven individuals after successful thermolysis revealed early thermal damage with a subsequent surrounding inflammatory response that eventually destroyed the lower follicle.¹⁰

Several advantages of topical suspension 1064-nm laser hair removal should be noted. The 7-mm spot size and 10-Hz repetition rate allow large areas to be treated in a relatively short period of time. Although this is possible with other hair removal procedures, such as depilatories and waxing, techniques providing any longevity, such as electroepilation, are quite slow in comparison. In addition, laser hair removal is relatively easy to perform. It is much simpler to scan a laser light over the skin surface than it is to insert a fine needle to a precise location in an irregularly shaped hair follicle. The results are therefore much less operator dependent. The noninvasive nature of the procedure and the absence of needles make the risk of disease transmission negligible. Finally, recovery is quick (less than 48 hours), pain of treatment is reduced, and there are few associated side effects because of the low fluences required for treatment.

Conclusion

The technique of laser hair removal is in its infancy. We have shown that topical suspension-assisted Q-switched Nd:YAG laser treatment can safely and effectively reduce unwanted hair. Further studies are required to determine appropriate laser parameters for long-term hair removal.

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