Pseudofolliculitis barbae is a relatively common disorder that occurs in glabrous skin with coarse, curly hairs. It is a frequent disorder of any hair-bearing skin with thick, curly hairs that are removed repetitively by shaving, waxing, or plucking. Prevalence figures are only available for pseudofolliculitis barbae occurring in the beard area of African Americans who shave, and range from 45% to 83%. Shaving is a predisposing factor because it results in a sharp, pointed, short hair that may curl over and reenter the skin. Extrafollicular penetration of the hair shaft is one cause of pseudofolliculitis barbae. Transfollicular penetration of the hair shaft may occur as well. When the skin is held taut during shaving or when a double-edged razor is used, the sharply cut hair may retract under the skin and grow directly into the follicular wall. Incomplete wax epilation and electrolysis can also lead to transfollicular penetration of the growing hair shaft. In both cases, a foreign body inflammatory reaction ensues. The primary lesions of pseudofolliculitis are erythematous papules and pustules. When chronic inflammation is present, hypopigmentation, and fibrotic scarring may accompany the clinical picture. Biopsy results show foreign body giant cells in the dermis with microabscess formation. Cultures of the pustules are sterile, and bacteria are therefore not implicated in the pathogenesis of this disorder.

Treatment modalities used for pseudofolliculitis barbae have been largely disappointing, and include topical tretinoin cream, corticosteroids, topical and oral antibiotics, surgical depilation, electrolysis, and tedious shaving regimens. Pseudofolliculitis barbae will improve if the hairs are allowed to grow. When shaving is stopped, the ingrown hairs are released automatically by spring action within a 3- to 4-week period. The only definitive cure for pseudofolliculitis barbae is permanent removal...
**PATIENTS AND METHODS**

**PATIENTS**

Ten consecutive patients seeking laser hair removal for the treatment of pseudofolliculitis barbae were enrolled in this study. The age of the patients ranged from 18 to 45 years. All patients had skin phototypes II to IV, with coarse curly hair ranging in color from brown to black (Table). Each patient had a history of pseudofolliculitis barbae in the treatment area for a minimum duration of 1 year; patients 1 and 4 also had long-standing hyperpigmentation. Previous treatments included topical antibiotics, oral antibiotics, and intralosional corticosteroid injections.

**TREATMENT**

After informed consent was obtained, 35-mm photographs were taken of the treatment area. The area was shaved with a disposable razor, and a eutectic mixture of local anesthetics (lidocaine hydrochloride and prilocaine hydrochloride in an emulsion base) was applied with occlusion for 1 hour before treatment. An 810-nm diode laser (Lightsheer; Coherent, Palo Alto, Calif) was used with a 9-mm spot size and a pulse width of 20 milliseconds. Treatment fluences ranged from 30 to 38 J/cm². The affected areas were treated with contiguous laser pulses, and care was taken to stretch the skin during treatment to ensure close contact between the sapphire cooled handpiece and the patient’s skin. After treatment, a hydrogel dressing was placed, and patients were instructed to apply a combination of bacitracin zinc and polymixin B sulfate (Polysporin) or bacitracin ointment twice daily if crusting was present. The 2 patients with hyperpigmentation were treated with 4% hydroquinone cream (Lustra; Medicis, Phoenix, Ariz), which they began applying 1 week after each treatment. Follow-up visits and additional treatments were performed at 6- to 8-week intervals. Patients were instructed to shave the treatment area as needed between treatment sessions. During each visit, 35-mm photographs were obtained, and an additional treatment was performed as before. Each patient underwent 3 laser treatments. Grading was performed by 2 independent investigators comparing pretreatment and posttreatment photographs. Hair counts were determined from 35-mm photographs obtained before shaving the treatment area. A quartile grading system was used to rate papule and pustule formation, pigmentedary changes, and hair density reductions as follows: 1 indicated 0% to 25% improvement; 2, 26% to 50%; 3, 51% to 75%; and 4, greater than 75%. Patients were also questioned regarding their satisfaction with the treatment and their impressions were recorded.

of the hair follicles. Surgical depilation carries a high morbidity. Electrolysis is a laborious procedure, and incomplete follicular destruction has resulted in keratin granulomas and pseudofolliculitis barbae. Selective follicular damage or destruction has been demonstrated with a variety of laser systems, including ruby lasers,9,10 diode lasers,11 alexandrite lasers,12 Nd:YAG lasers,13,14 and a pulsed noncoherent light source.15 Although all of these systems have been shown to be effective in delaying hair regrowth, recent studies have demonstrated that some pulsed laser and light-source hair-removal systems are capable of producing a permanent reduction in hair density in the treated areas.

The successful treatment of pseudofolliculitis barbae in 10 women is reported herein.

**RESULTS**

All patients tolerated the laser treatments well and experienced minimal discomfort. Perifollicular edema and erythema developed immediately after laser treatment and lasted 2 to 3 days. Blister formation did not occur in any of the treatment areas. Two patients reported scattered crusts after the first treatment that resolved in 2 to 3 days. Complete hair-growth delays of 3 to 4 weeks’ duration were reported for facial hair, and 4 to 6 weeks for inguinal and axillary sites. In other body sites, patients reported complete growth delays of 4 to 6 weeks. At the last follow-up visit, a decrease in hair density of greater than 50% was observed in all patients. After 3 treatments, all patients reported greater than 75% improvement in the papules and pustule formation (Figure 1). Patients 1 and 4 had a history of firm hyperpigmented papules and nodules measuring up to 5 mm in diameter that were present for longer than 3 and 5 years, respectively (Figure 2). Both patients underwent electrolysis treatments in the past, which were discontinued after the development of pseudofolliculitis barbae in the affected areas. Patient 1 demonstrated an improvement rating of 4 and patient 4 showed an improvement rating of 3 in hyperpigmentation. The degree of hair reduction at the last follow-up visit was rated at least 3 in all patients (Figure 3). All patients were uniformly satisfied with their treatment and noted improvement after just 1 treatment session.

**COMMENT**

Pseudofolliculitis barbae is a common disorder of glabrous skin in individuals with course, curly hair that develops following hair removal, most commonly by shav-
Other hair removal methods, including wax epilation, plucking, and electrolysis, also can result in pseudofolliculitis barbae. Common locations include the beard and neck region in men and axillary and inguinal areas in women. Traditional therapies, including topical and oral antibiotics, tretinoin cream, corticosteroids, and laborious shaving methods, have yielded unsatisfying results. The most obvious treatment for this disorder is complete follicular destruction. Laser hair removal is therefore a logical therapeutic approach to this common and difficult problem.

Selective destruction of hair follicles was first described with the use of a long-pulsed ruby laser (694 nm, 270 microseconds), with hair-growth delays observed in all of the 13 subjects following a single treatment. Two years later, 4 of these subjects showed less than 50% terminal hair regrowth in the treatment areas, thereby demonstrating that permanent reduction in hair density could be achieved. Several other laser systems have been developed with the same goal in mind, and include the diode laser (800-810 nm), pulsed alexandrite laser (755 nm), Nd:YAG laser (1064 nm), and a pulsed noncoherent light source. Hair follicles are logical targets for laser therapy because they are structures located relatively superficially within skin, and because they contain high concentrations of a natural chromophore, melanin.

Selective laser destruction of hair follicles is achieved by using wavelengths of light that are well absorbed by melanin but poorly absorbed by other naturally occurring chromophores in the skin, such as hemoglobin and water. The laser pulse duration is chosen to be sufficiently small so that tissue heating is limited to the hair follicle and is not conducted to the surrounding tissues. This is accomplished by choosing a pulse duration smaller than the thermal relaxation time, or cooling time, of the hair follicle, and has been estimated to be 40 to 100 milliseconds for these 200- to 300-µm-diameter structures. The wavelength of the laser determines the depth of penetration of the laser beam in tissue as well as the degree of absorption by melanin. Melanin shows strong absorption from approximately 400 to 1000 nm, and longer wavelengths penetrate more deeply into tissue. At the lower end of the spectrum, melanin absorption is sufficiently high that the risk of epidermal damage becomes greater when treating darker skin types. Relative sparing of the epidermis can be achieved at the longer visible and near infrared wavelengths, but the ability to treat lighter hairs diminishes. The best laser wavelengths for...
hair removal are therefore somewhere in the range of 700 to 1000 nm.

One of the greatest challenges in laser hair removal is targeting follicular melanin while sparing epidermal melanin. Epidermal damage is limited by selecting pulse durations longer than the thermal relaxation time of skin, which has been estimated to be approximately 3 to 10 milliseconds. Longer heating times allow the basal layer to cool as it is slowly heated. Therefore, the theoretically ideal pulse duration for hair-removal lasers should lie between 10 and 100 milliseconds. Damage to the epidermis can also be limited by cooling the skin’s surface during laser treatment. A variety of novel skin-cooling methods are now being used for this purpose. The diode laser has a water-cooled sapphire tip that is applied directly to the skin during treatment and serves to lower the temperature of the epidermis by extracting heat away. Other methods of skin cooling include water-chilled quartz plates, cryogen spray cooling, and the application of cold gel to the skin surface during treatment. By selectively cooling the epidermis, high peak temperature can be generated within the hair follicle while minimizing accumulation of heat energy near the skin surface and resultant epidermal damage.

Permanent removal of hair requires irreversible damage to the follicular stem cells. The location of follicular germinative cells remains somewhat of a controversy; it is unclear whether the stem cells reside in the bulb or within a specialized area of the outer root sheath located at the point of insertion at the arrector pili muscle, which has been termed the bulge. The bulge is located at an approximate depth of 1.5 mm, whereas the bulb resides at an approximate depth of 2 to 3 mm. Damage to these potential stem cell sites may occur by means of direct heat conduction to these areas, and/or generation of photoacoustic shock waves from the shaft and matrix, which have a high concentration of melanin. Longer visible-light and near-infrared wavelengths provide the necessary combination of sufficient tissue penetration and adequate melanin absorption for this purpose. The 810-nm emission wavelength of the diode laser used in this study provides sufficient tissue penetration needed for follicular damage. At a pulse duration of 20 milliseconds, hair-follicle injury is achieved primarily by means of direct heat conduction from melanin-dense areas of the follicle.

This study has demonstrated that treatment with the diode laser improves the acute and chronic changes of pseudofolliculitis barbae. All patients exhibited a decrease in the numbers of papules and pustules. Two of the patients who demonstrated more chronic changes, including long-standing hyperpigmentation and fibrotic papules, showed global improvement. There was a reduction in the fibrotic papules, hyperpigmentation, and inflammatory lesions. This study shows that treatment with the diode laser improves pseudofolliculitis for 2 months. With the induction of long-term reductions in hair growth, we anticipate that disease remission will last even longer. Further studies with longer-term follow-up are needed to establish the duration of the therapeutic benefit. Remarkably, high fluence (30-38 J/cm²) did not produce epidermal damage or pigmentary alteration, even in the patient with phototype IV skin.

An added benefit of laser treatment was the induction of hair-growth delays in all body areas treated, including the beard, axillary, and inguinal regions. All subjects exhibited a decrease in hair density of greater than 50% at the last visit. Because of the short follow-up period after the last laser treatment (6 to 8 weeks), it was not possible to assess the degree of long-term hair reduction in these patients. However, based on other clinical studies using the same treatment variables, it is likely that these patients also will have achieved a permanent reduction in hair growth.

Pseudofolliculitis is a common problem typically affecting men in the beard area and women in the axillary and inguinal regions. Traditional treatment options are limited and yield unsatisfactory results. This report demonstrates that treatment of pseudofolliculitis barbae with a pulsed diode laser results in dramatic clinical improvement in as few as 3 treatment sessions, with the induction of significant hair-growth delays. This is a practical therapeutic approach, enabling treatment of large body-surface areas quickly with minimal morbidity to the patient.

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