TREATMENT OF PSEUDOFOLLICULITIS BARBAE IN VERY DARK SKIN WITH A LONG PULSE ND:YAG LASER

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Background: Pseudofolliculitis barbae affects some individuals with coarse curly hair. Currently available treatment modalities are often ineffective. In some studies, lasers have been shown to be potentially helpful in mitigating disease severity by reducing the number and/or thickness of hair shafts.

Methods: This was a side-by-side interventional study conducted at a military tertiary medical facility. The study group included 26 patients (skin types IV, V, and VI) referred from primary care physicians with a diagnosis of pseudofolliculitis barbae refractory to medical therapy. A neodymium YAG laser was used to treat one half of the neck. One month later, shaving bumps were counted and compared to their preoperative levels on both sides.

Results: Mean postoperative papule counts were 11.6 ± 6 (SD) and 30.1 ± 19 (SD) on the treated side and untreated sides, respectively.

Conclusion: Neodymium YAG laser treatment represents a safe and effective option for reducing papule formation in patients with pseudofolliculitis barbae. (*J Natl Med Assoc.* 2002; 94:888–893.)

Key words: laser ♦ hair ♦ pseudofolliculitis ♦ skin

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BACKGROUND

Pseudofolliculitis barbae (PFB) is an inflammatory condition of the beard area that affects primarily men, but also women, with coarse hair. Typically, the follicle is at an acute angle to the skin surface, and the sharpened end of the shaved shaft re-enters the skin at or next to the follicular opening. The subsequent formation of inflammatory papules and pustules can result in patient discomfort, secondary infection, and occasionally hypertrophic or keloidal scars.[1-8] Growing a beard can decrease the number of inflammatory lesions. However, in the military, with the exception of certain medical conditions (i.e., uncontrollable PFB or se-

vere facial scarring), a clean-shaven face is mandatory.[9,10] Also, in the civilian sector, beards are frequently discouraged in the workplace.

Topical steroids, antibiotics, and /or exfoliating agents have all been used for treatment of PFB. Although sometimes helpful, they rarely clear the papules and pustules completely. Chemical depilatories may be effective, however, skin irritation precludes their regular use in some patients. Some affected individuals will tediously extract impaled hairs with tweezers, sometimes spending as long as 30 minutes each day in the process. Although effective, this is a time-consuming process.[2]

Previous investigators have used lasers in the treatment of PFB. Nanni et al.[11] treated patients with a long pulsed alexandrite laser and found temporary hair reduction and mild improvement of PFB. Rogers and Glaser[12] reported a reduction in the number of inflammatory papules and pustules after treatment with a Q switched Nd:YAG laser. The treatment was performed after application of a topical carbon suspension. Chui et al.[13] used a normal mode ruby laser on a Caucasian patient with PFB and observed improvement even 10 months after the last of three monthly treatments. More recently, Kauvar,[14] Greppi,[15] and Adrian,[16] in separate studies, have shown a reduction in the severity and number of shaving bumps with an 800 nm diode laser using pulse durations ranging from 20-100 msec. However, when very dark type VI skin was treated, blistering was sometimes observed.

In two recent studies, hair reduction was observed in very dark skin, but shaving bumps were not specifically addressed nor treated. In the first study, Battle et al.[17] reported the use of a long pulse 800 nm laser (20–200 ms) in darker skin types (up to type VI). The investigators achieved safe and effective hair reduction by combining lower fluences with longer pulses. Most recently, Alster et al.[18] reported the use of a long-pulsed Nd YAG laser in V and VI skin types and showed greater than 50% hair reduction on the face six months after treatment.

It has been shown that longer wavelengths of light penetrate deeper than shorter wavelengths. It follows that longer wavelengths allow for a greater ratio of dermal to epidermal heating, which in turn leads to epidermal sparing.[19,20] Accordingly, we investigated the Lyra 1064nm Nd:YAG laser (Laserscope, San Jose, CA) for the treatment of PFB in patients with skin types IV (typical Caucasian with olive complexion), V (typical light skinned African American) and VI (typical dark skinned African American). In a preliminary study,[21] we treated small 2x2 cm patches of active PFB in the inframandibular area. Based on the decrease in papule counts observed after treatment, we treated entire inframandibular regions in this present expanded study.

METHODS AND MATERIALS

Twenty-six patients were enrolled. The protocol was approved by the Institutional Review Board of our hospital. Twenty-two patients completed the study; the remaining four were unable to return for follow-up due to operational commitments at sea. Of the participants, 20 patients were skin type VI, one was type V, and one was type IV. The Fitzpatrick skin typing system was used.[22] This system classifies skin "color" based on its tolerance for ultraviolet light exposure. (It should be noted that more comprehensive skin color typing systems have been proposed, but none has been as universally accepted as the Fitzpatrick system.).[22,23] All patients showed some evidence of pseudofolliculitis barbae. Most patients showed only moderate numbers of papules and pustules, but many were clipping their hair (to ~ 1/8 inch length) rather than shaving, to decrease the disease severity.

Patients were instructed to shave on the morning of therapy. At the initial exam, shaving bumps were counted by one of the investigators for each side of the neck. The region included a zone extending from the base of the mandible down to the level of the hyoid bone. A shaving papule (or pustule—we included pustules in the counting process as "papules" to

simplify the data analysis) was counted if its diameter exceeded ½ mm. After the counts, three photographs (left, right, and frontal neck views) were taken with a 35 mm SLR camera equipped with a 50 mm macrolens (Minolta 7000i with 1200 model ringflash, Minolta, Ramsey, NJ) and Ektacrhome100 slide film (Kodak, Rochester, NY). In our pilot study,[21] we found the level of pain intolerable in previously performed test areas. Therefore, a topical anesthetic (EMLA cream, AstraZeneca, Wilmington, DE) was applied 75 minutes prior to irradiation on the treatment side (without occlusion). The light dose for each patient was chosen from safe settings established from the aforementioned pilot study. Fluences (light doses) for Type IV, V, and VI skin were 70, 60, and 50 J/cm^2, respectively. The pulse duration was held constant at 50 msec. Laser pulses were delivered with a scanner at 4 Hz. Each spot within the scan was 5 mm. The scan size was 25 x 25 mm and was operator controllable. The total number of spots per scan was 20. Scans were laid down adjacent to each other with less than 10% overlap. There was no overlap *between* spots within the scan. The beam was fired through a cooling sapphire window approximately 3.5 cm in diameter. For each scan, the window was left in contact with the skin surface for 1 second prior to irradiation. The window was chilled by circulating water which continuously cooled the surrounding brass fastener at ~ 5°C. Ice packs were applied immediately after irradiation. Ten minutes later, 0.05% clobetasol cream was applied to the surface to reduce inflammation.

After treatment, patients resumed shaving and/or clipping (whatever their normal hair removal method was) beginning one week after treatment. The study sites were re-examined 30 days after treatment, at which time papule counts were performed by a blinded investigator. Patients completed a questionnaire at the end of the study period. Specifically, patients were asked to check off the approximate percent shaving bump reduction.

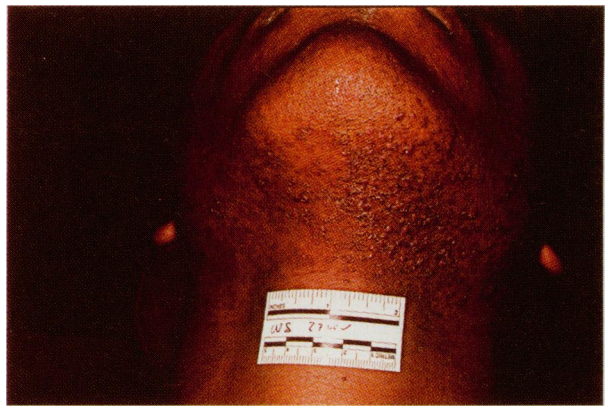

Figure 1. Representative Patient 30 Days After Single Treatment on Patient's Right Side. Left Side was Untreated

RESULTS

Acutely, hair "stubs" at the surface were observed to partly vaporize during irradiation. Some thicker hairs were forcibly expelled, such that the entire shaft and bulb were "melted" to the undersurface of the scanner window. When hairs were attached to the window, it was cleaned with an alcohol pad prior to the next scan. The procedure was well tolerated during, with most patients reporting pain at 4-5 out of 10 on a 1-10 scale. Pain tended to crescendo during each six-second scan. Within three to five minutes after treatment, there was prominent perifollicular edema that resolved within 20 additional minutes.

Two patients reported one 5-mm blister and subsequent crusts that began about one day after treatment. By the 30-day follow-up visit, these areas were visible as mild hypopigmentation. Two other patients returned two days after treatment with multiple monomorphic appearing pustules. The areas were cultured and found to grow Staphylococcus aureus sensitive to methicillin. Accordingly, the patients were placed on a 14-day course of dicloxacillin (250 mg qid) with resolution of the lesions by five days.

A representative patient is shown in Figure 1. Examination of the skin 30 days after treatment showed papules only in focal areas where there was still hair. These focal areas appeared to be in "skipped" zones between scans, where the

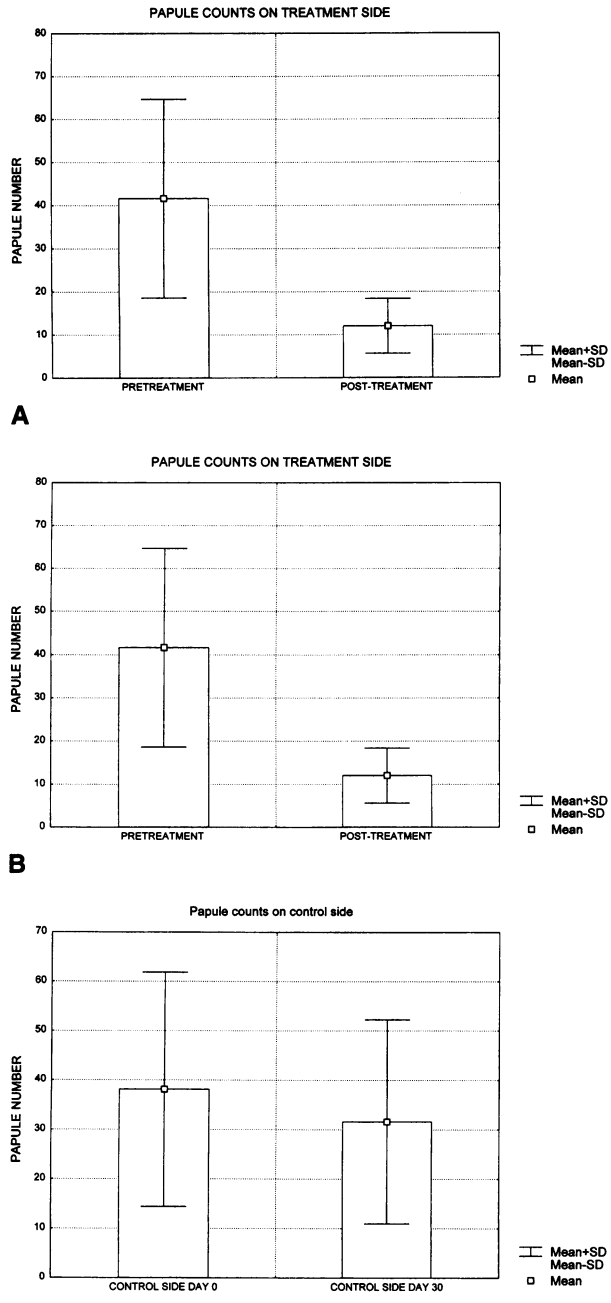

Figure 2. Graph Showing Significant Change in Papule Counts Before and After Treatment

hexagonal pattern was not perfectly contiguous with the adjacent scan. The pretreatment and post-treatment papule counts, as well as controls are shown in Figure 2. Using a paired t-test, the mean papule/pustule count was significantly reduced ($p < 0.05$) in the treatment sites as compared to the control sites. The questionnaire showed a subjective assessment of 80% to 90% average reduction in bump counts, as compared to baseline, after one treatment.

DISCUSSION

The data show that very dark skinned patients can safely be treated with a long pulsed Nd:YAG laser. Also, the destruction and/or miniaturization of hair shafts correlated with a decrease in the number of papules characteristic of PFB.

Melanin is the selective target for lasers in hair reduction. Because of the localization of melanin in the skin (epidermis and hair), extreme laser-induced heating will be confined to melanized areas, so long as the laser pulse is short.[24] In individuals with type VI skin, the deeply pigmented epidermis is almost always lighter than the hair color, so that for equal local fluences, the hair follicle would be expected to achieve higher peak temperatures. On the other hand, because fluence decreases as a function of depth, the superficial position of the epidermis favors its destruction. Nonetheless, we were able to exploit the differences in melanin concentration between the hair bulb and epidermis, as follows: Laser-induced temperature elevation in (1) the hair bulb and (2) the basal layer of the epidermis, is proportional to both the laser fluence (light dose) and the relative photon absorption for a specific wavelength. Also, the faster the energy is delivered, the greater will be the peak target temperature.[24] From Jacques et al.[25], one can estimate the relative absorption for 1064 nm radiation for black coarse hair to be about 1.5X that of a very dark epidermis. Thus, a light dose or fluence "window" exists for black thick hair and brown skin (typical patient with PFB). Within this fluence window, one can achieve sufficient hair heating without epidermal damage, particularly if surface cooling is used.

The distance between the hair bulb/bulge and the epidermis enhances the choice of 1064

nm for hair reduction in very dark skin. In general, scattering losses as a function of depth are decreased for longer wavelengths, so that there is greater penetration into the dermis. This enhanced penetration was shown by Zhao and Fairchild[26] who found that in black skin, the penetration of 1064 nm light was 3x higher than 700 nm light when measured 3.3mm deep in the dermis (typical depth of a hair bulb). It follows that the *ratio* of T_b to T_e (temperature of the hair bulb to the temperature of the epidermis) increases with increasing wavelength.[20]

Questions remain regarding this strategy for treating PFB. Long-term observations show that for the great majority of patients following a single treatment, some hairs regrow (about 30% regrowth three months after treatment compared to the hair reduction observed one month after treatment). However, these hairs are thinner than pre-treatment and do not appear to be associated with PFB. Following patients for six to 12 months, these hairs have shown a tendency to return to their pretreatment thickness. However, with four to six treatments one-month apart, we have observed over 80% long-term (six months after the final treatment) hair and shaving bump reduction. Also, in one type V patient with very dark thick facial hair and only one treatment, hair has either not regrown at all or has remained thin and wispy for eight months. We suspect that the persistence in hair removal was due to the higher fluence used (80 J/cm^2) versus in those patients with type VI skin (50 J/cm^2).

Treatments were well tolerated but only if the EMLA cream was applied thickly and for at least one hour prior to treatment. Pain was sometimes reduced by longer applications of the cooling window. Pain during the procedure was presumably associated with 1) heating of the hairs, as we noted patients wincing precisely when particularly thick hairs were irradiated, 2) heating of the epidermis, 3) heating of tissue hemoglobin, and, to a smaller degree, 4) heating of tissue water.

The mechanisms for hair follicle injury with 1064 nm irradiation are most likely similar to other wavelengths for millisecond time domains. Based on histology in our previous study,[21] the hair bulb appears to be the most severely damaged target. This finding is not unexpected, as the hair bulb contains the greatest concentration of melanin. Interestingly, where we observed vessels near the bulb, they appeared undamaged on routine hematoxylin and eosin stains. However, Adrian et al.[27] reported peribulbar vascular injury after both 800 and 1064 nm irradiation, suggesting that vascular injury might contribute to subsequent follicular injury.

Regardless of the pathophysiology of laser-induced follicular injury, the most important aspect of this treatment is its effectiveness, which has social and economic impact, as follows. The reduction in shaving papules allows for compliance with many workplace grooming codes. The subsequent clean-shaven face in these typically minority workers permits their full participation in organizations where facial hair is discouraged or prohibited, or where there are real or perceived biases against facial hair. By demonstrating solidarity with the organization, a potential obstacle to promotion is removed, and employees gain an equal footing with their counterparts unaffected by the disease.

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