Removal of Bikini Hair by Rapid 810-nm Diode Laser

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The efficacy, safety, and treatment time of a new, high-speed, very long-pulsed (90–200 ms) 810-nm diode laser have been evaluated for the rapid removal of bikini hair. Study participants (n=20) received 5 treatments at 6-week intervals. Hairs were counted from pretreatment and posttreatment photographs. Among the 16 people who completed the study, the median hair count at 6 months after the fifth treatment was significantly lower than the median pretreatment hair count ($P<.0001$). The median hair count reduction fractions increased after the second treatment and continued to increase at 3- and at 6-month follow-up visits, indicating continual improvement. Hair count reduction fractions achieved a median of 87.6% (mean=84.4%) at 6 months after the final treatment. Adverse effects were not observed, and treatment time was short. The 810-nm diode laser has been observed to safely and efficiently remove unwanted hair from the bikini area.

Unwanted hair has traditionally been removed by wax, tweezers, shaving, chemical depilatories, or electrolysis. These techniques are time consuming, monotonous, painful, and have limited efficacies.[1] Electrolysis, once a popular procedure for permanent hair removal,[1,2] is invasive, tedious, and only partially effective and can result in scarring or postinflammatory hyperpigmentation.[2]

Laser and light-based devices offer alternatives to traditional physical methods and have gained considerable popularity. In 2006, removal of hair by a laser device was the third most frequently performed nonsurgical cosmetic procedure in the United States.[3] Laser and light-based modalities destroy hair follicles by selective photothermolysis (SP),[4] in which melanin in the hair shaft and surrounding follicular epithelium is the target chromophore. When red and near-infrared wavelengths penetrate deeply into the dermis and are selectively absorbed by melanin, thermal damage is restricted to the hair follicles as a result of SP.[5]

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The application of SP for laser hair removal was first described in 1996 by Grossman et al.[6] Since then, use of the ruby, alexandrite, Nd:YAG, and diode laser devices for hair removal have been evaluated and reviewed in detail.[7,8]

The purpose of the study described in this article was to evaluate the efficacy and safety of a new, high-speed, very long-pulsed 810-nm diode laser for the rapid removal of hair from the bikini area.

MATERIALS AND METHODS

In this prospective study, 20 women aged 19 to 59 years (median age 44.0 years) with Fitzpatrick skin types I to III were treated in the bikini area for 5 times at 6-week intervals with a continuous-wave 810-nm diode laser device that protects the epidermis during treatment by both contact (sapphire) and air (Zimmer) cooling. The Zimmer cooling device, set to level 4, was attached to the head of the 810-nm diode laser and did not require a second operator. To encourage study participants to return for their 6-month follow-up visit, an additional treatment was given at this final visit after photographs and hair count data were obtained. The 6-week interval between treatments was chosen to permit regrowth of hair in the treated areas.[9,10] Participants had either black

Fluences and Pulse Durations Available on the 810-nm Diode Laser

	Pulse Duration, ms	
Fluence, J/cm^2	Program I	Program II
36	81	120
40	90	133
44	100	146
48	110	160
52	118	173
56	127	186
60	136	200

or brown hair. They provided signed informed consent to participate, and the study was conducted according to the principles outlined in the Declaration of Helsinki.

The participants had received no laser or electrolysis treatments prior to the study, did not tan or use self tanners during the study, did not shave for 3 weeks before the first treatment and before 3-month and 6-month follow-up visits, and did not wax in the treated areas. Shaving was permitted during the study but not electrolysis and waxing. Anatomic reference points were marked on areas of skin measuring 9 cm^2, which were then photographed and used for hair counts. The treated areas were immediately photographed with a 35-mm digital camera, and the photographs were used to obtain a count of the hair strands immediately before the first and third treatments and 3 and 6 months after the final (fifth) treatment.

Combinations of fluence and pulse duration were available in 2 programs (Table). Participants with Fitzpatrick skin types I and II were treated with program I, starting at a fluence of 40 J/cm^2 and increasing by 4 J/cm^2 at each subsequent visit unless adverse effects or excessive redness developed. Pulse duration was varied automatically from 90 to 136 ms, with increasing fluence. Participants with Fitzpatrick skin type III were treated with program II, starting at a fluence of 36 J/cm^2 and increasing by 4 J/cm^2 with each subsequent treatment unless adverse effects or excessive redness developed. The pulse duration was varied from 120 to 200 ms. Some participants with Fitzpatrick skin type III were changed from program II to program I for the duration of the study after the second or third treatment, thereby shortening the pulse duration. The maximum fluence for participants was 60 J/cm^2. In all treatments, the spot (ie, beam) was rectangular and measured 12×10 mm. The treatment head was moved over each area without overlapping, using a small amount of aqueous ultrasound gel. Unlike circular beams, rectangular beams do not require overlapping to cover the entire treatment area. The repetition rate with both programs was 3 Hz. Lidocaine 4% was applied to the treated areas 30 to 60 minutes before each treatment by the participant. Treatment time for each site ranged from 5 to 7 minutes. Posttreatment care was not necessary.

Hairs were counted from the marked areas on the photographs just before the first and third treatments, 3 months after the final treatment, and 6 months after the final treatment. Six months was chosen for the final follow-up to approximate the length of the growth cycle of a single hair.[11] In this way, we measured long-term hair reduction rather than short-term posttreatment hair loss due to temporary injury to the follicles.

Differences in 6-month hair counts from pretreatment values were evaluated with the Wilcoxon signed rank test, a nonparametric alternative to the paired samples *t* test. Hair reduction fractions were calculated by subtracting the hair count at a given treatment from the pretreatment hair count, and dividing that number by the pretreatment hair count.

RESULTS

Of the 20 participants, 16 completed the study. Four withdrew for personal reasons unrelated to efficacy or the adverse effects of treatment. Because hair count values were not all normally distributed, data were analyzed and expressed nonparametrically as medians and interquartile ranges (IQRs). The IQR is the difference between the 75th and 25th percentiles and is a measure of dispersion. The median and IQR hair count values were 70.5 and 46.8, respectively, before the first treatment; 35.0 and 22.2, respectively, just before the third treatment; 19.0 and 7.8, respectively, at 3 months; and 11.0 and 8.2, respectively, at 6 months.

The median hair reduction fractions increased after the second treatment and continued to increase at 3- and at 6-month follow-up visits (Figure 1). The median hair count at 6 months was significantly lower than the median pretreatment hair count ($P<.0001$). Median hair count reduction fractions increased to 87.6% (mean=84.4%) at 6 months after the final treatment. Clinical examples are shown in Figures 2 and 3.

Although pain during treatment was not specifically assessed, no participant asked to stop the procedure or withdraw from the study because of discomfort. Pigmentation changes, blistering, and paradoxical hair growth were not observed in any participant.

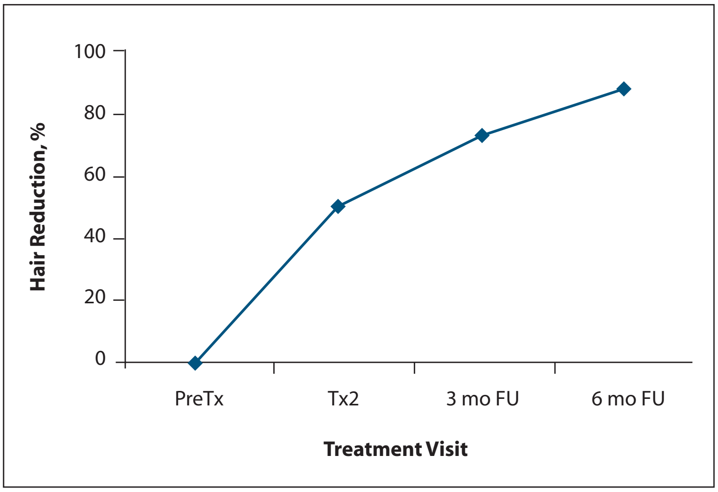

Figure 1. Median hair reduction percentages before treatment, after 2 treatments, 3 months after the final treatment, and 6 months after the final treatment. PreTx indicates pretreatment; Tx2, 2 treatments; FU, follow-up.

COMMENT

The efficacy and safety of diode lasers for the long-term removal of hair has been shown.[12-18] Repetitive treatments have been found to provide greater hair reduction than a single treatment[13] at 20-month follow-up, and treatment outcomes are comparable with those obtained with the alexandrite laser[19] and Nd:YAG laser.[20]

The bikini area has been treated with the alexandrite laser,[10,21] normal-mode ruby laser,[22] long-pulsed ruby laser,[23] Nd:YAG laser,[24,25] and diode laser.[14,15] Clinical results were supported by histologic data in 2 studies.[15,24]

It is difficult to compare the results of the present study with those of other studies because of the different methods of assessing hair removal, the differences in the number of treatments, the lack of specific data on hair removal from the bikini area, and the different follow-up times. However, as shown in Figure 1, the present study found that 5 treatments with the new 810-nm diode laser removed approximately 87% of hair in the bikini area after 6 months. This clearance rate is higher than the 78% clearance rate achieved after 5 treatments with the alexandrite laser after 1 year.[10]

The 810-nm diode laser is designed to optimize hair removal by careful configuration of wavelength, spot size, pulse duration, and fluence. The 810-nm wavelength and large spot size allowed for deep penetration, good melanin absorption, and avoidance of excessive competition from other chromophores.[17] In addition, the large spot size and high repetition rate led to very short treatment times of 5 to 7 minutes per participant. The short treatment times allowed for many participants to be treated in a single day, which added to participant satisfaction because the short duration of the procedure made it easier to tolerate comfortably.

For a laser or light-based device, treatment time is determined by the coverage rate, which is the product of the area of the spot and the repetition rate.[26,27] In our study, the 810-nm diode laser spot was rectangular, measuring 12×10 mm, so the area of the spot was 120 mm². Since the repetition rate was 3Hz, the coverage rate is 360 mm²/s. The coverage rate of a comparable 800-nm diode laser device used for hair removal may be similarly calculated. In the study of Lou et al,[13] the spot of the 800-nm laser device was square shaped, measuring 9×9 mm. Since the maximum repetition rate of this device is 2 Hz,[5] the coverage rate is 162 mm²/s, less than half of the coverage rate of the 810-nm diode laser used in the present study. A square spot measuring 12×12 mm,

Figure 2. The bikini area of a 44-year-old female before treatment (A) and at 6-month follow-up (B) who achieved an 84.8% reduction in hair counts after 5 treatments with the 810-nm diode laser.

Figure 3. The bikini area of a 42-year-old female before treatment (A) and at 6-month follow-up (B) who achieved an 87.9% reduction in hair counts after 5 treatments with the 810-nm diode laser.

or 144 mm^2, has also been used in published studies of the 800-nm diode laser.[5] With this larger spot, the coverage rate increases to 288 mm^2/s, which is still lower than the 360 mm^2/s of the 810-nm device. The shorter treatment time is an even greater advantage when the 810-nm diode laser is used to treat body areas larger than the bikini area, such as the back and legs.

The rectangular shape of the spot of the 810-nm diode laser device permits a shorter treatment time than a traditional circular spot. With a circular beam, a minimum of 17% beam overlap is required to cover the entire treatment area.[26] Therefore, the calculated coverage rate for a circular beam must be multiplied by 0.83 to correct for the overlap. Circular beams are used in the alexandrite lasers,[21,28,29] Q-switched Nd:YAG lasers,[30] ruby lasers,[12,29] and Nd:YAG lasers.[16,29]

The pulse durations of previous studies with the diode laser are 5 to 20 ms,[14] 5 to 30 ms,[13,18] and 80 to 100 ms.[15] Since the thermal relaxation time (TRT) of hair follicles 200 to 300 μm in diameter is estimated at 40 to 100 ms and the TRT for the epidermis is 3 to 10 ms,[6] a pulse duration of 20 ms would appear to optimize the selective destruction of the hair follicle because 20 ms lies between the TRTs of the epidermis and hair follicles.[10,21]

The pulse durations of our study (90–136 ms and 133–200 ms) are longer than those used in previous studies. However, pulse durations between 50 and 100 ms may result in heat diffusion during the laser pulse and significant damage to the epidermis and superficial dermis. To overcome this potential limitation and reduce pain during treatment, Ross et al[11] suggested the use of active conductive epidermal cooling, such as cold water in a sapphire window. Cooling also permits the use of higher fluences to damage the hair follicle.[15]

In our study, the epidermis was protected during treatment by both contact (sapphire) and air (Zimmer) cooling. The sapphire device also compressed the dermis and its blood vessels, which decreased the distance between the laser and the follicle[11] and decreased interference from hemoglobin.

Long-pulse durations have been the topic of additional investigations. Eremia and Newman[31] suggested that although pulse widths of 30 to 100 ms may exceed the TRT of coarser hairs, longer 100- to 1000-ms pulses may actually increase efficiency by providing another pathway to injuring different areas of the follicles. In most treatments of the present study, pulse durations fell within the suggested 100- to 1000-ms range.

Rogachefsky et al[32] used a super long-pulsed 810-nm diode laser to remove hair from the legs and neck. These investigators introduced the concept of thermal damage time, which is the time needed for delivered laser energy to diffuse from the treated hair to the follicular-associated hair stem cells. Thermal damage time ranged from 170 to 1000 ms, with fluences ranging from 23 to 115 J/cm^2. Optimal hair reduction 6 months after 1 or 2 treatments was observed at 400 ms.

The limitations of our study are that the results were not compared to results from other studies with untreated controls, hair counts were not obtained by a blinded evaluator, and treated areas were marked, but not tattooed, as suggested by Baugh et al.[15]

CONCLUSION

The 810-nm diode laser was observed to safely and efficiently remove unwanted hair from the bikini area. However, further studies with more participants are needed to confirm these results.

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