Objective: To examine the safety and efficacy of a pulsed alexandrite laser for treatment of leg telangiectasia and reticular veins.

Design: Observational study.

Setting: Laser and Skin Surgery Center of New York, New York, NY.

Subjects: Twenty women with skin phototypes I to III and with 54 patches of leg veins measuring 0.3 to 2.0 mm in diameter.

Interventions: Each patch was treated once using 1 to 3 passes of a 755-mm, 3-millisecond alexandrite laser. An 8-mm spot and fluences of 60 to 80 J/cm² were used, with dynamic epidermal cooling.

Main Outcome Measures: Subjects underwent evaluation at 4 and 12 weeks for degree of clearance, based on a quartile grading system, and incidence of adverse effects.

Results: At the 4-week follow-up, 17 (35%) of 48 treatment sites showed greater than 75% clearance and an additional 16 (33%) showed greater than 50% clearance. By 12 weeks, 33 (65%) of 51 treatment sites showed greater than 75% clearance, and there was greater than 50% clearance in an additional 11 (22%). Hyperpigmentation was observed in 18 (35%) of 51 treatment sites.

Conclusion: A single treatment with a 755-nm, 3-millisecond alexandrite laser at high fluence in conjunction with cryogen skin cooling produced excellent clearance of telangiectasia and reticular veins of the leg with minimal adverse effects.

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D ISFIGURING telangiectatic and reticular leg veins are a common cosmetic concern, affecting a substantial portion of the population in the United States. Although sclerotherapy remains the gold standard of treatment, its drawbacks include the discomfort and phobia of injections, postsclerotherapy hyperpigmentation, telangiectatic matting, and allergy to the sclerosing agent. In addition, the success of the treatment depends on the technical skill and experience of the physician performing sclerotherapy. In recent years, a variety of lasers have been developed with the specific goal of treating leg telangiectasia. These include pulsed potassium titanyl phosphate lasers (532 nm), flashlamp-pumped tunable pulsed dye lasers (585-600 nm), and a noncoherent pulsed light source (515-1200 nm). These devices have been most successful in the treatment of small-caliber red telangiectasia measuring less than 1.0 mm in diameter. More recently, the use of longer wavelengths has been explored for the treatment of larger leg telangiectasia. The purpose of this study was to evaluate the safety and efficacy of a 755-nm, 3-millisecond pulsed alexandrite laser used in conjunction with cryogen spray cooling for the treatment of spider and reticular veins of the lower extremities.

RESULTS

Laser treatment was associated with an immediate burning sensation but was well tolerated in all subjects. Treatment of veins greater than 1 mm in diameter resulted in increased discomfort, presumably due to greater absorption of laser energy in areas containing a greater concentration of chromophore. Approximately half of the test sites were treated at 60 J/cm² with an 80-millisecond cryogen spray and 3-millisecond delay, and the other half at 80 J/cm² with a 100-millisecond cryogen spray and a 3-millisecond delay. If vessel blanching or intravascular thrombus was not apparent after a single pass, up to 2 additional passes were performed to achieve this end point. This end point was achieved in all cases with the exception of some vessels measuring less than 0.5 mm in diam-
PATIENTS AND METHODS

Twenty women with skin phototypes I to III and 54 patches of telangiectatic and reticular veins of the legs measuring up to 2 mm in diameter were enrolled in this study. Subjects with the following conditions were excluded from the study: a history of superficial thrombophlebitis, a history of deep venous thrombosis, large tortuous varicose veins, hypercoagulability, pregnancy, lactation, collagen vascular disease, photosensitivity, or a history of poor wound healing or keloid formation.

Before treatment, 5.0 x 5.0-cm test areas were mapped and recorded using a 35-mm cross-polarization Nikon system (Canfield Scientific, Fairfield, NJ). Treatment was delivered with a 755-nm, 3-millisecond pulsed alexandrite laser (GentleLASE; Candela Laser Corporation, Wayland, Mass). Test areas were treated with an 8-mm spot at fluences of 60 or 80 J/cm² based on results of dose-response testing before the study. The dynamic cooling device (DCD; Candela Laser Corporation) was used with cryogen-sprurt durations of 80 or 100 milliseconds and a 3-millisecond delay before laser pulse impact. A single pass of continuous laser pulses was delivered to all of the vessels in the treatment area. A second or third laser pass was performed to the patches of vessels immediately following completion of the first pass until the clinical end point of thrombus formation or vessel disappearance was noted. Following laser treatment, bacitracin ointment and a hydrogel patch were applied to the test areas, followed by a pressure dressing that was left on for approximately 24 hours. This is the standard regimen we use in our practice after laser treatment of leg veins. Subjects were instructed to avoid strenuous exercise for 2 to 3 days and to limit sun exposure for 4 weeks.

Follow-up visits were performed at 4 and 12 weeks by the treating physician (A.N.B.K. or W.W.L.) after a single treatment. Repeated photographs of the treatment area were taken using the same camera settings, film lot, lighting, and positioning.

Clearance was rated as follows: 1 indicated less than 25% improvement; 2, 26% to 50% improvement; 3, 51% to 75% improvement; and 4, greater than 75% improvement. The degree of clearance was assessed by 2 independent investigators unaware of treatment status by comparing pretreatment and posttreatment photographs. The clearance scores represent the percentage of veins within a patch that resolved completely. The presence of adverse effects such as hypopigmentation and hyperpigmentation was recorded using a scale of 0 to 3 as follows: 0 indicated absent; 1, mild; 2, moderate; and 3, severe pigmentary change. The presence of other adverse effects such as atrophic or hypertrophic scars was noted also. Treatment for adverse effects with bleaching agents or topical corticosteroids was not administered during the 12-week follow-up period.

The data were analyzed using commercially available software (Statistical Analysis Software; SAS Institute, Cary, NC). Correlation analyses provided pairwise Pearson correlation coefficients between clearance and hyperpigmentation at the 4- and 12-week follow-up visits. To further examine the effect of vessel size, fluence, and number of passes on clearance and adverse effects, polytomous logistic regression models were fitted with entry and exit probabilities of .1. Type I error for testing of hypotheses was P<.05.
Cimen was obtained in 1 patient 6 weeks after laser treatment. Results of biopsy demonstrated dermal melanophages, and iron stain findings were negative, showing no evidence of hemosiderin deposition.

**COMMENT**

Leg telangiectasia and reticular veins affect a large segment of the population and are of significant cosmetic concern to many women and men. The mainstay of treatment remains sclerotherapy, but enthusiasm for an efficacious noninvasive treatment remains high. Although adequate vessel clearance was achieved, most of these studies were limited to the treatment of pink to red telangiectasia measuring less than 1.2 mm in diameter, and approximate clearance rates ranged from 50% to 80% after multiple treatment sessions (6-10 sessions). More recently, near-infrared wavelengths that provide more deeply penetrating light have been explored for the treatment of leg veins.

The difficulties inherent in treating leg veins with lasers relate to their relatively complicated anatomy and physiological features compared with facial telangiectasia. Most facial telangiectasia are monomorphic, thin-walled, small-diameter vessels with low venous pressures. In contrast, leg veins constitute a heterogeneous group of vessels, often with multiple diameters and depths within tissue. Even the small, red telangiectasia of the legs have larger diameters and thicker walls and are situated more deeply in the dermis, compared with the average facial telangiectasia, and hydrostatic pressures are often elevated, even in the absence of obvious signs of venous insufficiency. When sclerotherapy is performed, the sclerosant solution is injected into all of the vessels within a given patch of telangiectasia, inducing an inflammatory response throughout the affected endothelium. Because of limitations in light penetration or fluence delivery, laser treatment of a patch of telangiectasia often produces segmental photocoagulation of the most superficial vessels in a network of telangiectasia, followed by subsequent vessel repair and recanalization. This may explain the sometimes unpredictable response of leg telangiectasia to laser therapy. For effective laser treatment of leg veins, sufficiently long wavelengths are necessary to provide sufficiently deep photon penetration and absorption by these larger, deeper vessels. Millisecond duration pulses best match the thermal relaxation time of such vessels. Infrared wavelengths provide the neces-
sary tissue penetration, but the absorption coefficient for hemoglobin drops, and higher fluences are required for effective photocoagulation. With greater risk to the epidermis posed by high-fluence treatment, techniques for selective epidermal cooling must be used.

Until recently, treatment of leg telangiectasia larger than 1.2 mm in diameter and reticular veins has been difficult with existing laser technologies. Some success with treating larger vessels has been reported with the use of the noncoherent light source (Photoderm VL; ESC, Needham, Mass)\textsuperscript{10}; however, standardization of therapy has been difficult and predictability of treatment outcomes has been variable. Dierickx et al\textsuperscript{11} studied an 800-nm diode laser with a water-cooled sapphire tip (Star Medical Tech Inc, Pleasanton, Calif) for the treatment of leg telangiectasia. Telangiectasia less than 0.4 mm in diameter were treated with a 20-millisecond duration pulse at a fluence of 40 J/cm\textsuperscript{2}. Approximately 25% of telangiectasia cleared after 1 treatment, 50% after 2 treatments, and 75% after 3 treatments, with vessels greater than 0.4 mm in diameter demonstrating better clearance than smaller ones. In a preliminary study, Weiss and Weiss\textsuperscript{12} found 75% improvement in vessels 0.5 to 3.0 mm in diameter with the use of a long-pulsed Nd:YAG laser (Vasculight; ESC) at fluences of 8 to 130 J/cm\textsuperscript{2} and single-, double-, or triple-synchronized pulses of 10- to 16-millisecond durations.

McDaniel and associates\textsuperscript{13} used a long-pulsed alexandrite laser (Photogenica; Cynosure Inc, Bedford, Mass) to treat leg telangiectasia. These treatments were performed with the 755-nm, 5-millisecond laser, used with a 10-mm spot size at a fluence of 20 J/cm\textsuperscript{2}, single pulsed, at 4-week intervals, and resulted in a 23% improvement in telangiectasia less than 0.4 mm in diameter. Veins of 0.4 to 1.0 mm in diameter improved by 48%, and veins greater than 1.0 mm in diameter responded by 32% after 3 treatments, using a fluence of 20 J/cm\textsuperscript{2}, double pulsed. In the present study, dramatically better clearance rates are reported with a 755-nm, 3-millisecond laser used at fluences of 60 to 80 J/cm\textsuperscript{2}. A clearance rating of 4 was achieved in 33 (65%) and a rating of 3 in 44 (86%) of 51 treatment sites 12 weeks after just 1 treatment session for vessels up to 2 mm in diameter. These results suggest that higher fluences are required for effective photocoagulation of leg telangiectasia and reticular veins.

We report excellent clearance for spider telangiectasia and reticular veins measuring 0.3 to 2.0 mm in diameter after just 1 treatment session. The 755-nm wavelength provides an excellent combination of sufficient tissue penetration and hemoglobin absorption to target superficial leg veins measuring up to 2 mm in diameter. The pulse duration of 3 milliseconds is less than the thermal relaxation time of the telangiectasia and reticular leg veins treated in this study, providing gentle heating of the targeted vessels and relative sparing of the epidermis. Efficient and selective cooling of the epidermis is achieved by the use of the dynamic cooling device. Cryogen spray cooling permitted the safe delivery of fluences of up to 80 J/cm\textsuperscript{2}, with up to 3 passes, without blister formation, epidermal necrosis, or scarring. The ability

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Figure 3. Leg telangiectasia before (A) and 12 weeks after (B) 1 treatment with the alexandrite laser at 60 J/cm\textsuperscript{2}. Photographs were taken using cross-polarization.

Figure 4. Reticular veins and telangiectasia of the dorsal foot before laser treatment (A). Excellent clearance and residual hyperpigmentation were seen at 12-week follow-up (B). Photographs were taken using cross-polarization.
to administer sufficiently high laser fluences likely contributed to successful coagulation of the wide range of vessel sizes and depths cleared in these patients.

The principal reason for poor clearance of leg veins after laser treatment appears to be inadequate heat generation within the larger vessels. Multiple treatments at lower fluences do not achieve the critical temperature necessary for irreversible vascular damage. Dynamic cooling used in this study allows the safe use of higher-incident light doses. With the application of cryogen to skin, a heat sink is created below the surface that removes heat before, during, and after each laser exposure. The epidermis is thereby protected from thermal injury produced by melanin light absorption and back-scattered radiation. Increased backscattering of light may occur with the treatment of deeper leg vessels, posing a greater risk for epidermal damage. Furthermore, previous studies have demonstrated that treatment discomfort is dramatically reduced with the addition of cryogen spray cooling.

This study has demonstrated excellent clearance of leg telangiectasia and reticular veins after just 1 treatment with a 3-millisecond, 755-nm alexandrite laser. Ideally, an investigation of a novel laser device for telangiectasia should evaluate the number of treatments required for complete clearance of leg veins. Nonetheless, the results from this preliminary study are compelling: complete clearance of greater than 75% of veins treated in 65% of test sites was achieved in 1 treatment. These data compare favorably with those of other studies of laser treatment for leg veins, where multiple treatment sessions were required to achieve the same degree of vessel clearance. Furthermore, we have observed complete clearance of patches of leg veins up to 2 mm in diameter after 2 to 4 treatment sessions (A.N.B.K., W.W.L., unpublished observation, March 2000).

Although laser treatment was well tolerated by most patients, treatment of larger leg veins (>1.0 mm) was associated with increased discomfort. Hyperpigmentation developed in 18 (35%) of 51 treatment areas, and results of histopathological analysis determined this pigment to be melanin, not hemosiderin, deposition. Faster resolution of hyperpigmentation was achieved in some study subjects after completion of the study with topical hydroquinone or Q-switched ruby laser (694-nm, 20-millisecond) treatment. The development of hyperpigmentation appeared to correlate with pass number and large vessel diameter. Statistical analysis of the data revealed that the use of multiple laser passes did not correlate with increased clearance at 12 weeks, but was associated with increased hyperpigmentation. The decision to perform multiple laser passes was based on the observation of immediate vessel blanching and the development of intravascular coagulation in segments of the treated vessels. Up to 2 additional laser passes were performed to achieve this clinical end point throughout the treatment area. Based on the data analysis, however, it would appear that a single laser pass is sufficient, and the demonstration of a clinical end point is unnecessary. It has been our observation that treatment of patients in our practice with 1 laser pass at 60 J/cm² minimizes the degree of hyperpigmentation without altering the efficacy.

Further studies with larger patient numbers should help elucidate this issue.

Results from other studies suggest that treatment of small-diameter telangiectasia (<0.5 mm) with infrared wavelengths yields inadequate results because the laser light bypasses these superficial vessels. Although there was a trend toward improved clearance with larger vessel diameters, the sample size in this study was too small to determine the efficacy for leg veins less than 0.5 mm in diameter. The data from this preliminary study suggest that the long-pulsed alexandrite laser used in conjunction with cryogen spray cooling can achieve excellent clearance of spider and reticular leg veins. Larger studies with multiple treatment sessions, with an end point of total lesion resolution, should help better define the role of this novel device in the treatment of telangiectasia and reticular veins of the legs.

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REFERENCES


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