

## The new 940-nanometer diode laser: An effective treatment for leg venulectasia

Thierry Passeron, MD,<sup>a</sup> Valérie Olivier, MD,<sup>a</sup> Luc Duteil, MD,<sup>b</sup> François Desruelles, MD,<sup>a</sup>  
Eric Fontas, MD,<sup>c</sup> and Jean-Paul Ortonne, MD<sup>a</sup>  
Nice, France

**Background:** The 940-nm diode laser has been shown to be an effective treatment for leg veins.

**Objective:** We sought to evaluate the effectiveness of the 940-nm diode laser on leg veins, depending on the size and morphologic aspect of the treated vessels.

**Methods:** A total of 60 patients (mean age: 44.4 years, Fitzpatrick skin types I-IV) underwent up to 3 treatment sessions at 4-week intervals using the 940-nm diode laser. Treatment parameters were: vessels < 0.4 mm in diameter, 0.5-mm spot, pulse duration of 10 milliseconds, fluence 306 J/cm<sup>2</sup>; 0.4 to 0.8 mm in diameter, 1-mm spot, pulse duration of 30 milliseconds, fluence 306 J/cm<sup>2</sup>; and 0.8 to 1.4 mm in diameter, 1.5-mm spot, pulse duration of 70 milliseconds, fluence 317 J/cm<sup>2</sup>. Repetition rate was 2.5 Hz. Success rate was evaluated through double-blind observation.

**Results:** Only 13.33% of patients with telangiectases less than 0.4 mm in diameter had a percentage of vessel clearance superior to 75%. However, 88.24% of patients with vessels between 0.8 and 1.44 mm in diameter obtained more than 75% vessel clearance.

**Conclusion:** The treatment of leg veins by the 940-nm diode laser strongly depends on the size of the target vessel. Better results were obtained with 0.8- to 1.4-mm leg venulectases. (J Am Acad Dermatol 2003;48:768-74.)

Leg telangiectases are represented by an expanded venule, capillary, or arteriole. The clinical aspects and physiopathology are quite different within each variety of telangiectases. Color, depth, diameter, and placement define the various categories of telangiectases.<sup>1-3</sup> Superficial telangiectasia, venulectasia, and reticular veins measuring, respectively, 0.1 to 0.3 mm, 0.4 to 2 mm, and 2 to 4 mm in diameter represent 3 distinct target vessels. Treatment strategy must be modified to achieve greater success. Sclerotherapy combined with a variety of agents is considered the gold standard treatment for leg telangiectasias.<sup>4,5</sup> However, pain, pigment changes, ulceration, scarring, and telangiectatic matting may result.

Since the development of laser technology in dermatology, vascular indications such as port wine stains or spider angioma have been treated successfully. As an alternative method, leg telangiectases were also treated, but results were less convincing. Laser beams in the wavelength range of 500 to 600 nm such as KTP, frequency-doubled neodymium:yttrium-aluminum-garnet, and long pulsed dye lasers have been used for the high absorption of hemoglobin in these wavelengths.<sup>6-11</sup> Clinical response rates reported were inconsistent, and adverse effects were comparable and sometimes significantly greater than those achieved by sclerotherapy. However, better results were obtained when treating superficial telangiectases with a diameter less than 0.5 mm. The relatively large diameter and the depth of some telangiectases prevented the complete coagulation of the vessels. Lasers emitting longer wavelengths, such as long-pulsed alexandrite,<sup>12,13</sup> neodymium:yttrium-aluminum-garnet,<sup>14,15</sup> and 800- and 810-nm diode<sup>16-18</sup> lasers, had previously produced some favorable responses to this treatment. The 940-nm diode laser has interesting possibilities for the treatment of leg telangiectases. However, only 46% of

From the Department of Dermatology,<sup>a</sup> Centre de Pharmacologie Clinique Appliquée à la Dermatologie,<sup>b</sup> and Centre d'Information et de Soins de l'Immunodéficience Humaine,<sup>c</sup> Archet-2 Hospital. Funding sources: None.

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Reprint requests: Jean-Paul Ortonne, MD, Department of Dermatology, Archet-2 Hospital, BP 3079, 06202 Nice, CEDEX 3, France. E-mail: jean-paul.ortonne@unice.fr.

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patients in a recent study achieved 75% clearing.<sup>19</sup> The objective of this study was to evaluate the effects of the 940-nm diode laser on a large group of patients, depending on size and morphologic aspect of the treated vessels. Long-term results and occurrence of side effects were also studied.

## MATERIALS AND METHODS

A total of 60 patients seeking treatment for leg telangiectases were enrolled in the prospective study after obtaining written consent. Patients ranged in ages from 25 to 75 years with the mean age being 44.4 years and the minimum age being 18 years. Of the patients, 58 were women. Fitzpatrick skin type among patients was I (4), II (18), III (35), and IV (3). Patients having Fitzpatrick skin type V and VI were excluded. All categories of telangiectases were included (linear, arborized, and spider). Spider telangiectases were differentiated from arborized telangiectases by virtue of a perforating venule in the center. Treatment sites were varied to study different locations on the lower extremities. Calculating distances in millimeters, and the exact treatment sites for clinical, photographic, and Doppler flow evaluations were noted for each patient from different anatomic marks. They were then precisely located on tracing paper where the telangiectases, naevi, lentigo, and other selected natural marks were reproduced to allow precise identification of the treatment site during the course of the study. Personal history of sclerotherapy was noted. Pregnancy, lactation, poor healing, previous sclerotherapy, or other laser therapy for leg veins within the last 2 months, and a history of deep or superficial vein thrombosis were all criteria of exclusion. Patients were instructed to shave their legs before each laser session and to avoid sun exposure until 6 weeks after the last treatment.

Patients were treated by a 940-nm diode laser (Dornier Medilas D, SkinPulse). Both fluence and pulse duration were selectable within a range of 200 to 1000 J/cm<sup>2</sup> and 10 to 100 milliseconds, respectively. Three hand pieces allowed the delivery of laser energy with 0.5-, 1-, and 1.5-mm diameter spot sizes. Telangiectases less than 0.4 mm in diameter were treated by a 0.5-mm spot with a pulse duration of 10 milliseconds. For telangiectases between 0.4 and 0.8 mm in diameter, a 1-mm spot with a pulse duration of 30 milliseconds was used, and a 1.5-mm spot with a pulse duration of 70 milliseconds was used for telangiectases between 0.8 to 1.4 mm in diameter. Repetition rate was 2.5 Hz. Each procedure involved a fluence of 306 J/cm<sup>2</sup> when the 0.5- or 1-mm spot was used and 317 J/cm<sup>2</sup> with 1.5-mm spot. Fluences were adapted to have complete ves-

sel disappearance without blanching of the epidermis. The study involved treatment of entire length of the vessels until they were no longer visible. No cooling device was used. Postlaser care consisted only of taping emollient cream. Patients returned for follow up treatment every 4 weeks, for a total of 3 treatments. A final visit was scheduled 4 weeks after the final treatment. Patients were re-evaluated 1 year later to determine the long-term effectiveness of the treatment.

Patients were instructed to rate the pain perceived during treatment on a visual scale of 1 to 10, with 1 representing minimal discomfort and 10 representing severe pain. Complications including hyperpigmentation, erythema, telangiectatic matting, purpura, crusting, and scarring were recorded before each new laser séance and at the final visit.

Photographs were taken before treatment, after each session, and at the final visit. A Polaroid Macro 5 SLR magnifying X1 and X3 was used with identical parameters on each occasion. Evaluation was done by 2 physicians who reviewed in a blinded manner the photographs of each patient. For each patient, the percentage of vessel clearance was estimated and an average of these 2 evaluations was made. A laser Doppler perfusion imager (PIM 1.0, Lisca Development AB, Linköping, Sweden) was used to scan the selected area (2.5 × 2.5 cm) before each laser séance and at the final visit to study the evolution of the spatial distribution of the skin perfusion. Finally, each patient who had previously undergone sclerotherapy was asked to compare the 2 methods as to their effectiveness and level of pain.

## RESULTS

Of the 60 patients, 52 returned for all posttreatment evaluations. A total of 6 patients were unable to tolerate the pain and 2 patients decided to stop after 1 séance because of no improvement. These patients were all considered to have had ineffective treatment (clearance rates 0%-25%). The degree of concordance between the 2 observers was evaluated by linear weighted  $\kappa$ . The  $\kappa$  was very good (0.91). Only 13.33% of patients with telangiectases less than 0.4 mm in diameter had a vessel clearance of more than 75%. However, 88.24% of patients with vessels between 0.8 and 1.4 mm in diameter obtained more than 75% vessel clearance. Complete vessel clearance (>95%) was obtained only in the group with vessels between 0.8 to 1.4 mm in diameter. In this group, 35.3% (6 of 17) patients obtained complete vessel clearance. The results of the 940-nm diode laser in 60 patients are summarized in Figs 1 to 3. Examples of pretreatment and posttreatment photographs are shown in Figs 4 and 5.

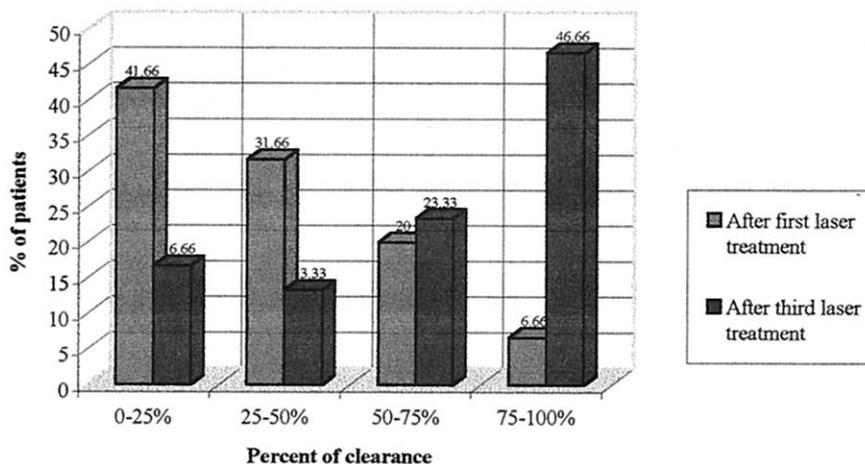


Fig 1. Vein clearance rates by number of treatment.

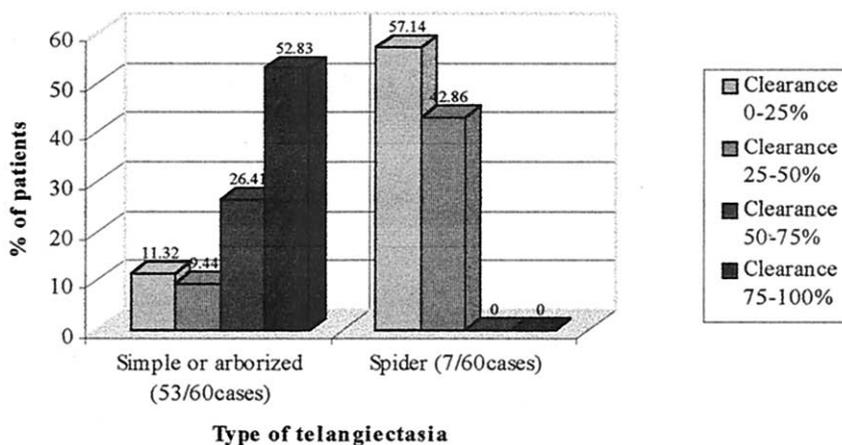
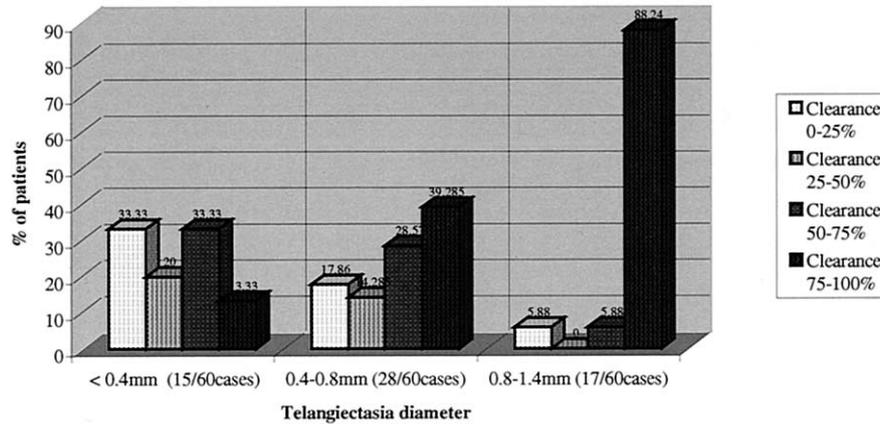


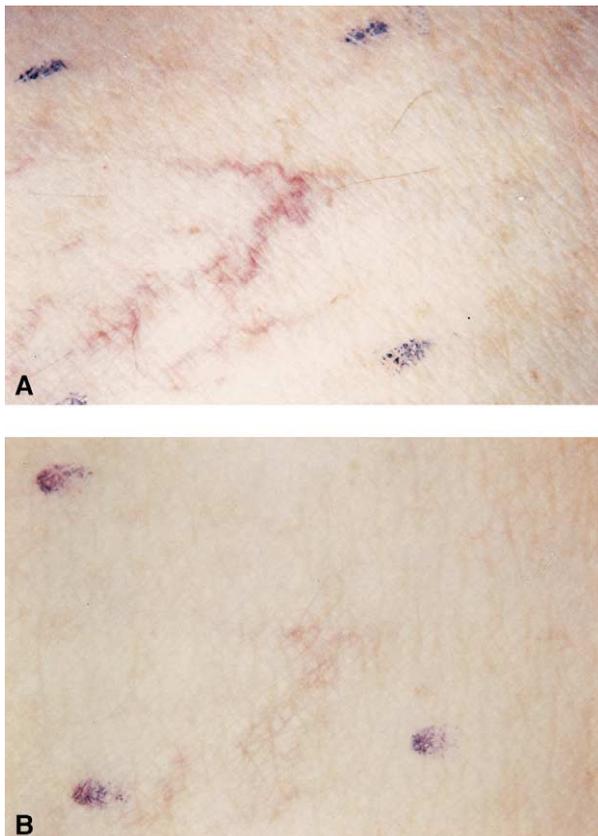
Fig 2. Effectiveness of treatment by type of telangiectasias.

For each perfusion image, 4 skin blood flow (SBF) parameters were calculated: mean value (Mean); minimum; maximum (Max); and SD. Table I summarizes the SBF parameters (mean  $\pm$  SD) obtained at each visit and grouped by diameter-vessel class. An analysis of variance was performed to assess the effects of time (visit) and vessel diameter on these parameters. The results of this analysis showed that a significant diameter effect was detected ( $P = .017$ ). Indeed, whatever the visit, the minimum and Mean SBF were found higher in the small-vessel class ( $<0.4$  mm) compared with the 2 other classes. Concerning the time effect, no significant effect was found except for parameter Max SBF where the value measured at the last visit was higher ( $P = .006$ ) than for the former visits, whatever the diameter class. This last point was mainly true in the small-vessel class where Max SBF at the last visit was twice the baseline value. The descriptive analysis of Table

I indicates that SBF parameters were quite comparable for the medium- and large-vessel classes. A variability of responses was observed in this study on the SBF parameters. At the final visit, an increase of Mean SBF was observed mainly in the small-vessel class (72%) whereas a decrease of Mean SBF was observed on the medium- (56%) and the large- (60%) vessel classes. Fig 6 illustrates the decrease of Mean SBF after laser diode treatment observed on the perfusion images for 2 patients belonging to medium- and large-vessel classes. The analysis of the relationship between SBF parameters and the percentage of clearance showed poor correlation ( $r < 0.2$ ). This was probably a result of the high variability of SBF parameters observed in this study. Nevertheless, the lower clearance rates observed for the small-vessel class compared with the 2 others were probably related to the highest Mean and Max SBF values observed in this class.



**Fig 3.** Effectiveness of treatment by diameter of treated vessel.



**Fig 4.** Leg telangiectases before treatment (A) and 1 month after the third session of laser diode treatment (B).

Pain during laser treatment was important (mean: 6.09/10; range: 1-10). Adverse effects were minor. Mild erythema in the distribution of the treated veins was quite common immediately after laser treatment. Transitional crusting was observed in 21 patients for 1 to 4 weeks without permanent sequela. Minimal telangiectatic matting was noted in 3 pa-

tients. Hypopigmentation was observed in 4 patients, all of whom had Fitzpatrick skin type III, lasting 4 to 8 weeks before cleaning. No adverse effect was noted in the 3 patients having Fitzpatrick skin type IV. No scarring occurred in any patient.

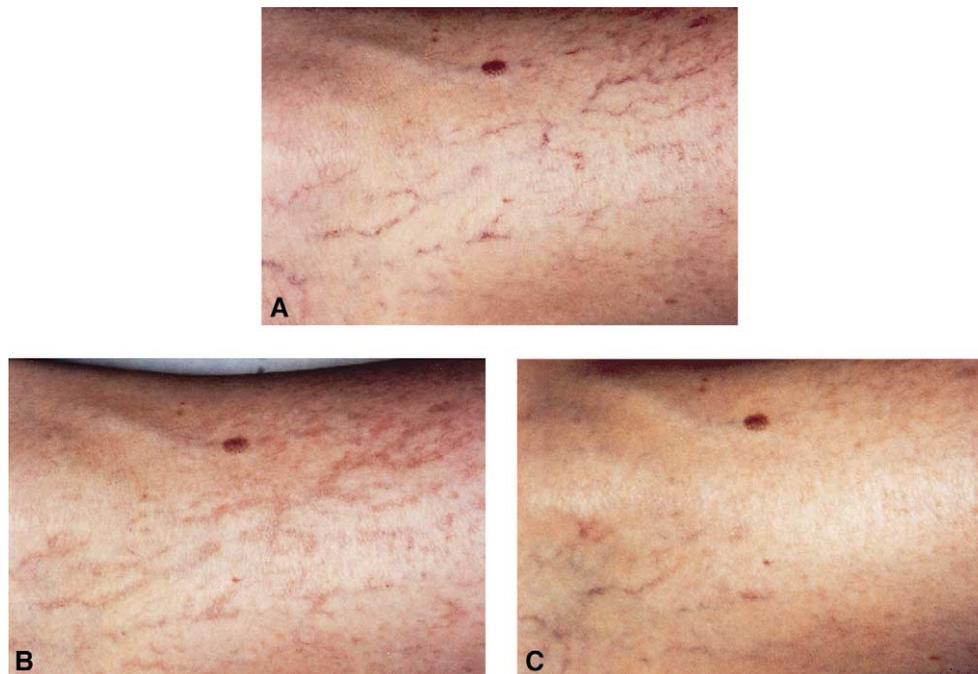
A total of 46 patients had a history of sclerotherapy treatment for leg veins. Of these, 20 patients found laser treatment more efficient, but 21 patients found sclerotherapy had given better results. The remaining 5 patients considered the treatment equal. Laser therapy was more painful than sclerotherapy for 31 of the 46 patients.

In all, 28 patients were evaluated 1 year beyond the treatment, of which only one had partial vessel recurrence.

## DISCUSSION

Lasers with long wavelengths of light, within the visible spectrum, penetrate more deeply into the skin, making them more suitable for deeper vessels.<sup>20</sup> The 940-nm diode laser (Dornier Medilas D, SkinPulse) was expected to allow better penetration of the dermis as a result of its longer wavelength. In addition, this wavelength corresponds with the second absorption peak of hemoglobin, decreases interference of melanin, and covers the entire vascular volume.

The large number of patients allowed for analysis of the results according to vessel type and diameter. About 80% of the patients had more than 50% vessel clearance and more than half had more than 75% vessel clearance when linear or arborized telangiectases were treated. However, none of the 6 patients with spider telangiectases obtained more than 50% vessel clearance. When effectiveness is evaluated according to vessel diameter, the results are more conclusive. Only 13.33% of patients with telangiectases less than 0.4 mm in diameter had a percent of vessel clearance more than 75%. However, 88.24%



**Fig 5.** Leg telangiectases before (A) and just after first laser treatment (B). C, Clinical aspect after 1 year.

**Table I.** Skin blood flow parameters (mean  $\pm$  SD)

Vessel class	<0.4 mm		0.4-0.8 mm		0.8-1.4 mm		Global	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Diameter	0.35	0.07	0.52	0.06	0.95	0.09	0.60	0.24
Clearance	41	26	60	25	76	10	60	25
Mean SBF V0	0.45	0.29	0.37	0.19	0.34	0.25	0.38	0.23
Mean SBF V1	0.40	0.18	0.32	0.24	0.30	0.18	0.34	0.21
Mean SBF V2	0.53	0.25	0.37	0.28	0.28	0.22	0.38	0.27
Min V0	0.12	0.15	0.05	0.06	0.06	0.09	0.07	0.10
Min V1	0.07	0.06	0.06	0.11	0.06	0.07	0.06	0.09
Min V2	0.13	0.11	0.08	0.11	0.05	0.10	0.09	0.11
MaxV0	1.78	1.26	1.97	1.88	2.09	1.63	1.96	1.65
MaxV1	2.00	1.66	1.71	1.26	2.08	1.31	1.89	1.36
MaxV2	4.05	2.07	2.20	1.77	2.46	2.52	2.73	2.15
SD V0	0.19	0.11	0.22	0.14	0.23	0.18	0.21	0.14
SD V1	0.22	0.12	0.19	0.13	0.20	0.11	0.20	0.12
SD V2	0.34	0.17	0.22	0.13	0.22	0.16	0.25	0.15

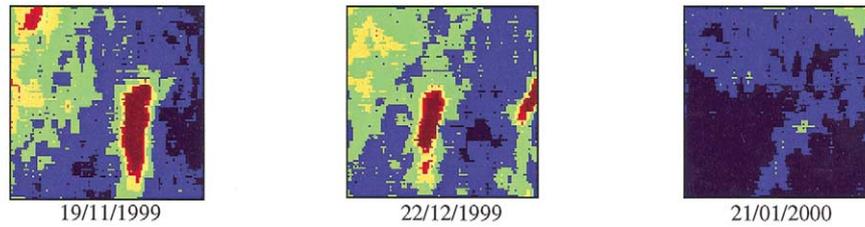
Max, Maximum; Min, minimum; SBF, skin blood flow; V0, baseline visit; V1, visit 1; V2, visit 2.

The mean values of Min, Max, and Mean SBF, and SD of SBF were calculated for each vessel class at each visit and also for grouped vessel sizes (global).

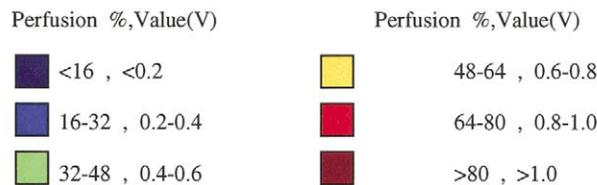
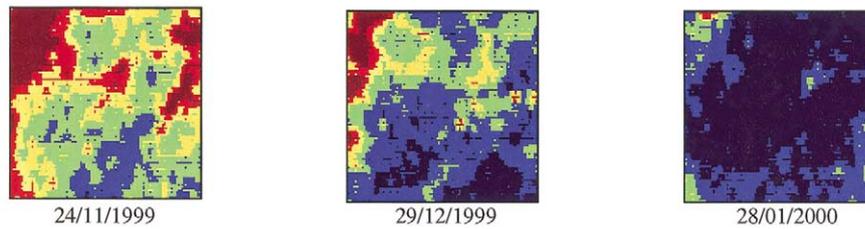
of patients with vessels between 0.8 and 1.4 mm in diameter obtained more than 75% vessel clearance. Only 1 patient obtained less than 50% vessel clearance but was among patients who had stopped the study because of severe pain and, therefore, was considered as a treatment failure. Our study clearly

demonstrated that results obtained with the diode laser strongly depend on type ( $P = .011$ , Fisher chi-square) and diameter ( $P < .001$ , chi-square) of treated telangiectases. As type and diameter were not linked in our study, there was no confusion bias. The poor response of spider telangiectases is easily

**Patient 1**



**Patient 2**



**Fig 6.** Images of skin blood flow perfusion (telangiectases) observed at baseline and during subsequent visits for 2 patients. *Top row*, Patient 1; *bottom row*, patient 2.

understandable as the laser, with the parameters used in this study, was not able to treat the central perforating venule. These types of telangiectases should be first treated by sclerotherapy. Moreover, this study corroborates and statistically proves the accepted results that deeper and larger vessels are best targeted by longer wavelengths, whereas these longer wavelengths are not suitable for superficial and thin telangiectases. Laser Doppler measurements indicated that small-vessel class showed higher Mean and Max SBF values compared with the 2 other classes. This was probably a result of the fact that the vessel networks under investigation were different in size and depth. This difference of vessel classes was well identified by the SBF imaging measurements in the sense that, in the measured SBF, a vessel class stood out compared with 2 others. Analysis of the hemoglobin oxygenation in the different treated vessels could not be done. However, blue coloring was significantly associated with the larger vessels (0.8-1.4 mm), whereas red coloring was associated with the smaller vessels. Flow rate was also proportional to vessel size. These 2 important parameters might play a role in treatment response. However, the statistical analysis could not indicate

differences of results within the 3 sized groups for each of these parameters. Three sessions were necessary to obtain effective results. Compared with the results obtained by Kaudewitz et al<sup>19</sup> with the same diode laser, our overall results were identical. This study demonstrated the interest in and necessity for analyzing results according to vessel type and diameter.

For the 45 patients who had prior treatment by sclerotherapy, the laser method was equally effective but more painful. However, 18 of the 23 patients who had telangiectases larger than 0.4 mm in diameter and who were previously treated by sclerotherapy found the laser treatment more effective than sclerotherapy.

Side effects were rare and disappeared within 8 weeks. Patients having Fitzpatrick skin type IV did not present additional side effects compared with the patients with other Fitzpatrick skin types. Crusting of 21% is a high degree of epidermal effect for a laser that penetrates deeply into tissues and interacts less with superficial cutaneous layers. As it was observed when superficial red telangiectases were treated, it is believed that this was a result of feedback diffusion to the epidermis of the thermal en-

ergy delivered to the superficial vessels. The recommendation is to wait 5 or 6 weeks between 2 treatments because transitional crusting was observed up to 4 weeks after the laser séance. Pain sometimes curbed the treatment, but lengthening of the laser repetition rate allowed decrease in the pain with little loss of time. An open study was performed on two thirds of the patients where they were treated with prior application of EMLA cream. As this topical anesthetic could cause vasoconstriction of vessels and, therefore, interact with the results obtained, studies were made on the effects of the laser when using this cream on the other lower limb, similar to the one used for the central study. Indications were that the use of EMLA cream an hour before the séance decreased the pain significantly, without apparent loss of effectiveness. Nevertheless, it should be noted that the measurements of vessel diameter were done just before each laser séance so it was impossible to determine if the EMLA cream had led to a vasoconstriction capable of decreasing the effectiveness of the laser. Cooling technology is the standard of care in laser treatment of leg vessels. A cooling devise was not used in the study, but it is likely that the use of cooling technology will appreciably decrease pain and crusting.

Development of laser technology allows for many wavelengths with variation of pulse duration, fluence, and spot size. All these parameters should be adapted to the type of telangiectases of each patient. The 940-nm diode laser is a useful treatment for leg veins with clinical response lasting 1 year in the segment of patients we could monitor for this period. The method is safe and can be afforded to patients having Fitzpatrick skin type III or IV. However, a treatment plan should be clearly outlined according to the type of leg veins to afford the best treatment for the patient. For this, the 940-nm diode laser should be used for simple and arborized leg veins with 0.8- to 1.4-mm diameter. Smaller telangiectases should be treated by a laser using shorter wavelengths.

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