The Role of Lasers and Light Sources in the Treatment of Leg Veins

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Telangiectasia of the legs occurs in 29% to 41% of women in the United States. The variation in size, flow, depth, and type preclude the possibility of a single effective treatment modality. When a systematic approach is used where feeder vessels are first surgically removed and sclerotherapy proceeds from largest to smallest vessels, 80–90% of vessels respond to a single sclerotherapy treatment. Because of the relatively modest results demonstrated with lasers and light sources and the high rate of success and the relatively low cost of ambulatory phlebectomy, compression sclerotherapy and superficial sclerotherapy, we generally recommend using lasers and light sources only for vessels that remain after this treatment approach. Lasers and light sources should be considered prior to sclerotherapy in patients who are fearful of needles, who do not tolerate sclerotherapy, who fail to respond to sclerotherapy, or who are prone to telangiectatic matting. Carefully monitored, controlled studies are essential to better define the role of the available laser and light sources in the treatment of leg veins.

Unsightly or symptomatic venulectasis and/or telangiectasia on the legs occur in 20–41% of women and 6–15% of men in the United States.[1] These smaller vessels are most often directly or indirectly connected to larger reticular or varicose "feeding" veins. Even though up to 53% of patients with leg telangiectasia have associated symptoms, the most common reason patients seek consultation is cosmetic.[2] The ideal treatment for unwanted leg veins would be painless and would clear 100% of vessels in one treatment with no associated side effects.

The variations in vessel size, flow, depth, and type preclude the possibility of a single effective treatment modality. Vessel types include varicosities, reticular or feeder veins, and superficial spider veins. Despite the fact that sclerotherapy has a long list of potential side effects, including pain, swelling, urticaria, systemic allergic reaction, hyperpigmentation, telangiectatic matting, skin necrosis, and phlebitis, it remains the treatment of choice for most leg veins less than 4 mm in diameter.[3–7]

A variety of lasers and light sources have been used in an effort to enhance clinical efficacy and minimize the adverse sequelae of sclerotherapy. In this paper we review available information in an effort to determine the role of laser and light sources in the treatment of leg veins.

Leg Vessel Anatomy and Physiology

The lower extremity vasculature is composed of both superficial and deep venous components, which are interconnected by epifacial connecting perforating veins. The superficial venous system is composed of two major axial conduits, the greater and lesser saphenous veins (usually >6 mm in diameter), which interconnect from sites of proximal reflux. These larger varicosities in turn interconnect with smaller vessels, such as reticular, and terminate in accessory veins (2–4 mm in diameter), which then connect with post-capillary venulectasia (0.4–2 mm in diameter) and telangiectasia.[8] A complete discussion on the anatomy and pathophysiology of varicose and telangiectatic leg veins will be found elsewhere.[9]

The diameter of post-capillary venules ranges from 12–35 μm,[10] while collecting venules range in size from 40 to 60 microns in the upper and mid-dermis and enlarge to 100–400 microns in diameter in the deeper tissues. Most superficial leg telangiectasia measure 0.03 to 0.3 mm in diameter.[11]

Leg telangiectasia differ from the ectatic vessels of port-wine stains (PWS), which are arranged in a loose fashion throughout the superficial and deep dermis. Vessels in PWS are more superficial and much smaller than leg telangiectasia, usually measuring 10–100 μm in diameter.[12]

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Algorithmic Approach to the Treatment of Leg Telangiectasia

Treatment of varicose veins follows an algorithmic approach,[13] (Figure 1). When leg veins are managed in this systemic approach, feeder vessels are first surgically removed, and sclerotherapy proceeds from largest to smallest vessels, 80–90% of vessels respond to a single treatment.[13] Given the high success rate of sclerotherapy, the relative low cost of ambulatory phlebectomy, compression sclerotherapy and superficial sclerotherapy, and the relatively limited improvement demonstrated with lasers and light sources, thus far, we recommend using laser and light therapy for vessels that remain after this treatment approach and that cannot be cannulated with a 30 gauge needle and treated with a sclerosing agent. Only those vessels that either do not respond to sclerotherapy, which are too small to be injected, or vessels that remain after feeding vessels are treated, should be considered for laser and light treatment. By adhering to these principles, patients will receive cost-effective, efficient, and logical care.

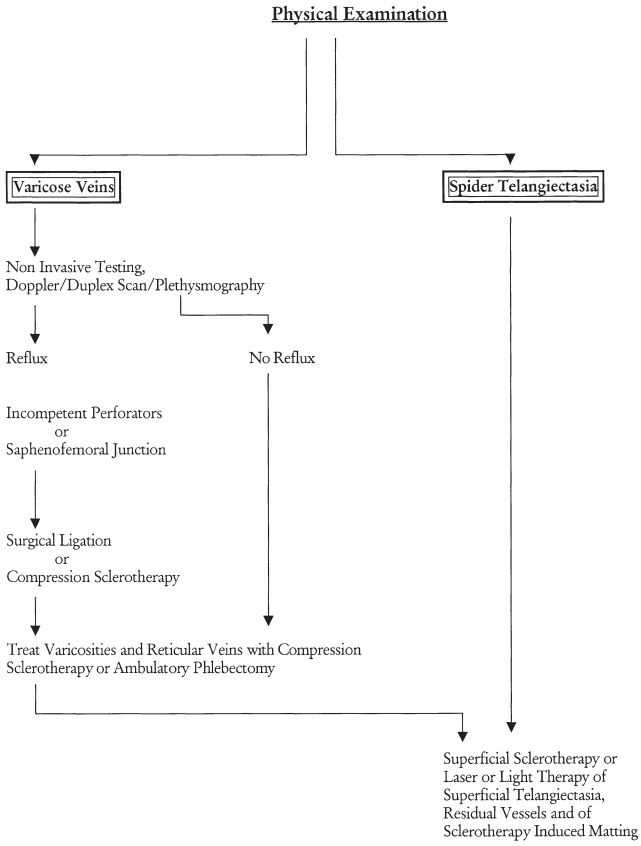

Figure 1. Algorithmic approach to the treatment of leg veins.

Laser Treatment of Leg Telangiectasia

Lasers have been used to treat leg telangiectasia since the early 1970s. While it was not until the development of the pulsed-dye lasers in the late 1980s that the first reasonable results were achieved, recent development of longer-wavelength, longer-pulse-duration, pulsed lasers and light sources has improved outcomes significantly. Basic requirements for a laser or light source to treat leg veins are (1) a wavelength that is proportionately better absorbed by the target (hemoglobin) than surrounding chromophores, (2) ability to penetrate to the full depth of the target blood vessel, (3) sufficient energy to damage the vessel without damaging the overlying skin, and (4) an exposure duration long enough to slowly coagulate the vessel and its lining without damaging the surrounding tissue.

Ideal parameters, therefore, depend on wavelength, pulse duration, and beam diameter. In general, longer-wavelength visible light penetrates deeper into skin and should be chosen to target deeper vessels. The larger the vessel diameter, the longer the required pulse duration in order to slowly heat the entire vessel. Larger spot sizes penetrate deeper into tissue, and optimize fluence delivery to the target (Table 1).

Continuous Wave Lasers

Carbon Dioxide Laser. Carbon dioxide (CO_2) lasers were used early on in an effort to obliterate telangiectatic vessels by means of precise vaporization without significant damage to adjacent tissue.[14–17] However, because CO_2 laser light is so well absorbed by water in the overlying epidermis and dermis overlying the blood vessel, nonspecific thermal injury is guaranteed, regardless of whether pulsed or continuous wave sources are used.[16] All reported studies demonstrate unsatisfactory cosmetic results.[14–17] Treated areas show multiple hypopigmented punctate scars with either minimal resolution of the treated vessel or neovascularization adjacent to the treatment site. Because of its nonselective action, the CO_2 laser is of no advantage over the electrodessication needle in treating leg telangiectasia.

Argon and Continuous Wave Dye Lasers. Argon (488 and 514 nm) and continuous wave dye lasers (515 to 590

Table 1. Ideal laser/light parameters for treatment of leg veins

	Vessel diameter (mm)				
	0.1	*0.3*	*0.6–1*	*Vessel depth (mm)*	
Wavelength (nm)	580	590	≥600	<1	>1
Pulse duration (ms)	1	10	20–100	<500nm	>600nm
Beam diameter				smaller	bigger

nm) are well absorbed by hemoglobin and penetrate to the depth of mid-dermal vessels, over 1 mm into skin. Because of unwanted, nonspecific thermal damage that occurs because of the continuous nature of the beam, results in treatment of leg veins have been discouraging (Dover JS and Arndt KA, unpublished observations, Nov 1987). In a report of 38 patients treated by Apfelberg et al.,[17] 49% had either poor or no results from treatment, and only 16% had what were considered acceptable results. In addition, almost half of the patients had hemosiderin bruising. In another series, Dixon et al.[18] noted significant improvement in just under half of their patients. They speculated that after initial improvement, incomplete thrombosis, recannalization, or new vein formation produced reappearance of the vessels after 6–12 months.

In an effort to enhance therapeutic success with leg vein sclerotherapy, the argon laser has been used to interrupt the telangiectasia every 2–3 cm prior to injection of a sclerosing agent.[19] In the 11 of 16 patients who completed treatment, 2 developed punctate depigmented scars, and 3 patients developed hyperpigmentation. However, 93.7% of patients were reported to have "satisfactory" results. Cooling the skin simultaneously with argon or argon dye (577 nm, 585 nm) laser treatment has been demonstrated to produce improvement in 67% of leg telangiectasia 1 mm in diameter or less.[20] This may, however, have been due to temperature-related vasomotor changes in blood flow.[21]

Continuous Wave Neodymium: Yttrium Aluminum Garnet (Nd:YAG) Laser. The Nd:YAG laser at 1064 nm has also been used to treat leg telangiectasia.[14] Because absorption in blood is relatively poor at this wavelength, because the penetration depth is so great (up to 3.7 mm), and because so much nonspecific damage is produced, there is no role for the CW Nd:YAG laser in the treatment of leg vessels.

Pulsed Lasers and Light Sources

KTP Lasers. Early unsuccessful attempts were made to treat leg vessels with the CW potassium titanyl phosphate (KTP) crystal laser. A group of pulsed KTP lasers have recently been introduced for treatment of vascular lesions (Table 3). For a variety of reasons, 532 nm KTP light was chosen, including the fact that 532 nm light is absorbed by hemoglobin as well as 585 nm light, and the penetration depth is almost the same. KTP crystals are highly reliable, convenient to work with, and easily available to laser manufacturers. While the mechanism of these devices varies, each produces millisecond domain pulses at 532 nm.

The *Versapulse* (Coherent, Palo Alto, CA) produces a true millisecond domain pulse while other lasers in this category group nanosecond domain Q-switched pulses into millisecond laser pulses, resulting in slightly lower energy output (*Aura* and *Orion*, Laserscope, San Jose, CA; Iriderm, Mountainview, CA)

Table 2. Lasers and light sources for leg veins

Laser/Light Source	*Wavelength (nm)*	*Pulse Duration (msec)*
Pulsed KTP	532	1–100
Coherent *Versapulse*		
Laserscope *Aura* and *Orion*		
Iriderm *Diolite*		
Long pulsed dye	585, 590, 595, 600	1.5
Cynosure *LV, VLS*		
Candela *Sclerolase*		
Long pulsed alexandrite	755	3–20
Cynosure *LPIR*		
Candela *GentleLase*		
ESC/Sharplan *EpiTouch Alex*		
Long pulsed Nd:YAG	1064	1–50
Laserscope *Orion*		50
HGM *Veinlase*		2–16
ESC *Vasculight*		
Diodes	800, 810, 930	1–250
Palomar/Coherent *Light Sheer Featherlite*		
Pulsed light source	515–1200	2–20
ESC *Photoderm LV*		

Results of treatment of facial vessels have been excellent.[22] Early results in the treatment of leg veins using small spots and pulse durations of 10 msec or less have been disappointing.[23] Recent results have been more promising, using larger spot sizes (3–5 mm) and pulse duration of 10–50 msecs in duration at fluences of 14–20 J/cm^2. Cooling appears to be of significant benefit in protecting the epidermis, thus allowing use of higher, more effective fluences.[24]

Flashlamp Pumped-Pulsed Dye Laser. The traditional pulsed dye laser (PDL) (585 nm, 450 μsec pulse duration) is highly effective in treating a variety of cutaneous vascular lesions, including PWS and facial telangiectasia (Table 4). It is less effective, however, in the treatment of leg veins. The original PDL was developed for the treatment of port wine stains in children, where the average vessel is superficial and has a diameter of 100 μm and an average depth of 0.46 mm. While 585 nm light can penetrate 1.2 mm to reach the typical depth of leg telangiectasia,[25] the pulse duration is inadequate to effectively damage all but superficial fine vessels, approximately 0.1 mm or smaller in diameter. In general, telangiectasia of the lower extremities treated with the PDL are less responsive and are

Table 3. 532 nm frequency doubled Nd:YAG lasers

Name	Aura *(*Starpulse*) and/or* Orion	Versapulse	Diolite 532
Laser type	Grouped Q-switched pulses, Nd:YAG frequency doubled	Nd:YAG frequency doubled	Nd:YAG frequency doubled
Manufacturer	Laserscope (San Jose, CA)	Coherent (Palo Alto, CA)	Iriderm (Mountainview, CA)
Wavelength	532 nm	532 nm	532 nm
Pulse duration	1–50 ms	2–50 ms	1–100 ms
Pulse rate	1–10 Hz	Single to 10 Hz	
Spot sizes	0.5, 1, 2, 4 mm	1–10 mm	200–1400 um
Maximum fluence	1–20 J/cm^2	0.26–38 J/cm^2	0.1–20 J/cm^2
Other features	Smartscan	Chill tip	

Advantages: No post-operative purpura, larger pulse duration. More compatible with thermal relaxation time of larger vessels.
Disadvantages: Wavelength is well absorbed by melanin. Risk of pigmentary change in darker skin types slightly higher.

more prone to post-therapy hyperpigmentation than when treated with sclerotherapy.

Polla et al.,[26] treated 35 superficial leg telangiectasia with the traditional PDL. The only parameters revealed in the report were that vessels were treated an average of 2.1 times with a maximum of 4 separate treatments. Red-purple raised, and blue flat vessels were treated without regard for the existence of reticular or feeder vessels. Fifteen percent of treated vessels had greater than 75% clearing, but 73% of treated vessels showed little or no response to treatment. The only lesions that responded at all were red-pink tiny telangiectasia. Almost 50% of the treated patients developed persistent hypo- or hyperpigmentation.

In preliminary animal studies in the rabbit ear vein, approximately 50% of vessels treated with an effective concentration of sclerosant demonstrated extravasated red blood cells (RBCs); while after PDL treatment extravasated RBCs were apparent in only 30% of vessels treated.[27] Rabbit ear vein treatment with the PDL resulted in a relative decrease in perivascular inflammation, compared to vessels treated with sclerotherapy alone.

Table 4. 585 nm pulsed dye lasers

Name	*Candela SPTL-1b* Sclerolaser/Scleroplus	*Cynosure* PhotoGenica V/LV
Laser type	Flashlamp-excited pulsed dye laser	Flashlamp-excited pulsed dye laser
Manufacturer	Candela Corp. (Wayland, MA)	Cynosure Inc. (Chelmsford, MA)
Wavelength	585, 590, 595, 600 nm	585, 590, 595, 600 nm
Pulse duration	450 μs/1.5 ms	300–500 μs (V) 1.5 ms (LV)
Pulse rate	Single or 1 Hz	Single or 1 Hz
Spot sizes	2 × 7, 3, 5, 7, 10 mm	3, 5, 7, 10 mm
Maximum fluence	10 J/cm^2/20 J/cm^2	10 J/cm^2 (V) 20 J/cm^2 (LV)

Advantages: Clearance of vessels <1.0 mm in diameter, but most effective for vessels <0.5 mm in diameter. VLS combines characteristics of both V and LV.
Disadvantages: Post-operative erythema, purpura, and post-operative pigmentation changes.

Goldman and Fitzpatrick systematically examined the clinical effects of various fluences of the PDL in specific leg telangiectasia.[28] They chose red superficial telangiectasia less than 0.2 mm in diameter and telangiectatic matts induced by prior sclerotherapy. Thirty female patients with telangiectatic leg veins were treated. Telangiectasia were superficial, red, and measured less than 0.2 mm in diameter. Thirteen of 101 telangiectatic areas were noted to have an associated reticular "feeding" veins 2–3 mm in diameter, which was not treated. Thirty-nine telangiectatic areas, chosen randomly, and 7 patients with 25 areas of telangiectatic matting after previous sclerotherapy were treated with the traditional PDL (Candela Corp, Wayland, MA), using a 5 mm spot with fluences of 6.5 to 8.0 J/cm^2 without concomitant cooling. At the conclusion of treatment, compression stockings were continuously worn over a foam dressing for approximately 72 hours. Sixty-seven percent of linear telangiectatic areas cleared completely within 4 months of a single treatment. The best results were seen in vessels in which there was no identifiable feeder vessel. Hyperpigmentation, which developed in <10%, resolved completely within 6 months. There were no episodes of cutaneous ulceration, thrombophlebitis, or post-telangiectatic matting, perhaps because the PDL produces less inflammation than sclerotherapy. Hypopigmentation developed in all patients who were tanned at the time.

Long-Pulse Dye Lasers

Based on the theory of selective photothermolysis, the predicted pulse duration ideally suited for thermal destruction of vessels the size of leg telangiectasia (0.1 to several mm in diameter) is in the 1–50 msec domain.[29] Two "long-pulse" dye lasers with 1.5 ms pulse durations are now available (Cynosure, Chelmsford, MA,

and Candela, Natick, MA) (Table 5). Both devices use a rhodamine dye to produce wavelengths of 585 nm, 590, 595, or 600 nm. While 1.5 msec is shorter than ideal, the longer pulse duration and wavelength should theoretically improve our ability to treat deeper, larger-caliber vessels.

Six studies have assessed the effectiveness of these long-pulsed dye lasers in the treatment of leg veins. Results have been variable. In 18 patients with vessels ranging in diameter 0.6–1 mm, a single treatment was performed, in which feeding vessels were previously successfully treated with sclerotherapy, with a 2 × 7 mm elliptical handpiece through a transparent hydrogel dressing. At a fluence 15 J/cm^2, 50% of vessels cleared, while at 18 J/cm^2 67% of vessels cleared.[30] Side effects included crusting, hyperpigmentation, and hypopigmentation. In a similar study, which demonstrated that 595 nm was the more effective wavelength, results and side effects were similar.[31]

In a single treatment of vessels less than 0.4 mm in diameter using the 595 nm, 1.5 msec pulsed dye laser (Cynosure) and an experimental 595 nm, 4 msec pulsed dye laser, clearing rates were not clinically significant with either device, and the rates of both hypopigmentation and hyperpigmentation were significant.[32]

In a multiple treatment study, 3 treatments were performed 6 weeks apart using the 595 nm, 1.5 msec PDL (Candela) through a transparent hydrogel dressing with a 2 × 7 mm elliptical spot at 20 J/cm^2. One hundred percent of patients had at least 50% clearing, but 50% of treated areas became hyperpigmented and 20% hypopigmented.[33]

Lee and Lask treated 25 women with leg telangiectasia <1 mm in diameter with the long pulsed PDL (Candela).[34] Each patient had 4 areas treated; 4 at a wavelength of 595 nm with energies of 15 or 20 J/cm^2, with 2 additional areas treated with a 600 nm wavelength at 15 or 20 J/cm^2 respectively. A maximum of 3 treatments were performed at 6-week intervals. All patients noted improvement. The best results were achieved at 595 nm and 20 J/cm^2. Treatment response was variable and unpredictable, with some patients having complete resolution and some having only slight improvement. Three patients had superficial scabbing, which resolved without apparent scarring. Hyperpigmentation occurred in over half of the treated sites but resolved completely within several months.

Reichert treated 250 sites of leg telangiectasia ranging in size from 0.1 to 1.0 mm in diameter in 80 patients with the 1.5 msec pulsed dye laser (Candela) at wavelengths of 585 to 600 nm.[35] Patients were selected in whom refluxing reticular veins either were not present or had been previously treated. Ice packs were used to cool the skin prior to treatment. Total clearing was achieved after 1 or 2 treatments 6 weeks apart in all vessels with diameters up to 0.5 mm, while vessels 0.5–1.0 mm in diameter faded in approximately 80% of the cases after up to 4 separate treatments. Scarring, thrombophlebitis, and telangiectatic matting never occurred, but there was transient hyperpigmentation in 50% of cases and hypopigmentation in 50% of cases.

Other Pulsed Lasers

Based on deep penetration of long-wavelength visible and near infrared light, and a small peak of hemoglobin absorption in the 700–900 nm range, long pulsed alexandrite, and Nd:YAG lasers have been developed to treat moderately deep, larger-caliber spider and feeding reticular veins. Characteristics of the available alexandrite lasers are wavelengths of 755 nm and pulse durations of 3–20 msec; of the Nd:YAG lasers, wavelength 1064 nm, pulse duration up to 100 msec; and of the diode lasers, wavelength 800, 810, 930 nm and pulse duration of 10–250 msec (Tables 5, 6). Early results indicate that small vessels, less than 0.5 mm in diameter, are not very responsive to such long pulse durations, but larger caliber vessels respond relatively well (Dierickx C, personal communication, April 1998) (Weiss RA, personal communication, Aug 1998).

Table 5. Long Pulse Alexandrite Lasers

Name	PhotoGenica LPIR	GentleLase	EpiTouch Alex
Laser type	Solid state, alexandrite	Solid state, alexandrite	Solid state, alexandrite
Manufacturer	Cynosure, Inc. (Chelmsford, MA)	Candela Corp. (Wayland, MA)	ESC/Sharplan
Wavelength	755 nm	755 nm	755 nm
Pulse duration	5, 10, or 20 ms	3 ms	2 ms
Pulse rate	Single and 1 Hz	1 Hz	5–10 Hz
Spot sizes	7, 10 mm 6 × 10 mm (optional)	8, 10, 12 mm	5, 7, and 10 mm
Maximum fluence	7 mm-40 J/cm^2, 10 mm-25 J/cm^2, 6 × 10 mm-J/cm^2	8 mm-100 J/cm^2, 10 mm-60 J/cm^2, 12-45 J/cm^2	1–50 J/cm^2
Other features	Cooling tip	Cryogen spray cooling	Rapid repetition rate

Advantages: Deeper penetration, less melanin absorption, effective for reticular veins, no post-operative purpura.
Disadvantages: Less effective for vessels <0.5 mm.

Table 6. Long pulse Nd:YAG (1064 nm) lasers

Name	Orion	VeinLase	Vasculight Nd:YAG
Laser type	Nd:YAG	Nd:YAG	Nd:YAG
Manufacturer	Laserscope (San Jose, CA)	HGM (Salt Lake, UT)	ESC Medical Systems (Needham, MA)
Wavelength	1064 nm	1064 nm	1064 nm
Pulse duration	1–50 ms	50 ms	
Pulse rate	1–20 pps		
Spot sizes	1–4 mm	2 mm	6 mm
Maximum fluence	1–50 J/cm^2	60 W	150 J/cm^2
Other features	Also functions in a Q-Switched mode and at 532 nm		Synchronized double or triple pulses

Advantages: Poor absorption in skin permits penetration to target relatively deep vessels. Long pulse durations ideally suited for large caliber vessels.
Disadvantages: Insufficient data to make conclusions on effectiveness.

Diode Lasers

A group of 800 nm diode lasers (5–250 msec pulse duration) have been used in the treatment of superficial and deep small-to-medium-size leg telangiectasia with encouraging results (Table 7). The concept behind using near infrared wavelengths lies not only in the deeper penetration of this wavelength and in decreased melanin absorption, but most importantly in the tertiary hemoglobin absorption peak at 915 nm. By choosing these longer wavelengths, even moderately deep vessels, such as feeder, reticular veins can be treated, and by varying the pulse width from a few msec to several hundred msec, a variety of different size vessels can also be targeted.

High Intensity Pulsed Light Source

In an effort to maximize efficacy in treating leg veins, a high-intensity pulsed light source was developed in 1993 (*PhotoDerm VL*®, ESC Medical Inc, Needham, MA), which emits single, double, or triple pulses of broadband light from 515 to 1200 nm in pulses 2–20 msec in duration (Table 8).

The principles behind development of this pulsed, broad-band light source are several. Both oxygenated and deoxygenated hemoglobin absorbs at these wavelengths; deeper wavelengths penetrate deeper into skin, increasing the likelihood of damage to deep vessels; and longer pulse durations heat larger-caliber vessels slowly and gently, producing uniform heating without vessel rupture.

Based on studies of rabbit ear veins which demonstrated the ability to selectively target vessels 0.4 to 0.8 mm in diameter, clinical trials using various parameters with the *Photoderm VL*, including multiple pulses of variable duration, were undertaken. A multicenter demonstrated efficacy ranging from clearing of 90% of vessels <0.2 mm in diameter, to clearing 80% of vessels 0.2 to 1 mm in diameter.[36] Adverse sequelae included occasional epidermal crusting, hyperpigmentation, and hypopigmentation in 19%, which usually resolved within 4–6 months. Blistering and superficial erosions were frequent in tanned or darkly pigmented skin. Treatment parameters that were found to be most successful for vessels <0.2 mm ranged from a single pulse of 22 J/cm^2 or a double-pulse of 40 J/cm^2, given in 2.4 and 4.0 msec pulses separated by a 10

Table 7. Diode lasers

	Featherlite	Lightsheer
Laser type	Gallium arsenide	AlGaAs semiconductor diode
Manufacturer	Laserlite (Boston, MA)	Star Medical Tech, Inc. (Pleasanton, CA)
Wavelength	805 ± 25 nm	800 nm
Pulse duration	50–250 ms	5–30 ms
Pulse rate	5 Hz	0.5 Hz
Spot sizes	2, 5, 2 × 4 mm	Spot 9 × 9 mm
Maximum fluence	60 W	10–40 J/cm^2
Other features		Chill tip

Advantages: Deeper penetration, less melanin absorption effective for reticular veins, no post-operative purpura.
Disadvantages: Less effective for vessels <0.5 mm.

Table 8. Non-coherent pulsed light source

Name	Photoderm VL
Light source	Intense pulsed light source
Manufacturer	ESC Medical Systems (Needham, MA)
Wavelength	515–1200 nm
Pulse duration	VL: 2–25 ms
Pulse rate	Single, double, or triple pulses: delay between pulses
Spot sizes	8 × 35 mm and 8 × 15 mm
Energy range	VL: 3–90 J/cm^2

Advantages: Treat vessels up to 2 mm in diameter. Parameters can be individualized for skin type and vessel size. No post-operative purpura.
Disadvantages: Long, slow learning curve potential for pigmentary change if used with lower wavelength filters in darker skin. Slow repetition rate (8 sec between pulses).

msec delay. Vessels that were 0.2–0.5 mm responded best, with the same double pulse parameters or with a 2.4–2.4 ms pulse at 35 J/cm^2 with a 20 msec delay time. Vessels 0.5 mm to 1.0 mm were treated with triple pulses of 3.5–3.1–2.6 ms with pulse delays of 20 ms at a fluence of 50 J/cm^2 or with triple pulse of 3–4–6 ms with a pulse delay of 30 ms at a fluence of 55–60 J/cm^2. The choice of a cut-off filter was based on skin color—light skinned patients were treated using a 550 nm filter, and darker skinned patients using a 570 or 590 nm filter.

Contradictory results have recently been reported by Green, who found that leg vein clearance rates were low, and the side effect rate unacceptably high.[37] Several recent studies have, however, reported encouraging results. By increasing the pulse durations up to 10 ms in 2 consecutive pulses, separated by a 20 ms delay with a 570 nm cut-off filter and fluences as high as 70 J/cm^2, response rates of 74% in 2 treatments with an 8% incidence of temporary hypo- or hyperpigmentation (Weiss R, personal communication, August 1998).

In a study of 120 patients with a variety of vascular lesions, including leg telangiectasia, Schroeter and Neumann demonstrated the versatility of the intense pulsed light source.[38] Plethysmography and Doppler ultrasound were performed in all patients with leg veins. Varicose veins were first treated with surgery and sclerotherapy as needed. 84% of leg telangiectasia up to 1 mm in diameter cleared 1 month after a single treatment.

While results of the treatment of leg veins with the intense pulsed light source (*Photoderm VL*) are encouraging, they are far from being easily reproduced, and the technique requires significant experience to achieve good results. Unlike pulsed lasers, where only the spot size, and fluence can be varied, the intense pulsed light source offers a wide array of choices, including wavelength, fluence, number of pulses, and pulse delay time, and as a result, ideal treatment parameters have been slow to be established. As experience grows, optimal parameters for the treatment of leg veins are becoming established.

The Role of Cooling

The concept of cooling the skin in an effort to protect the epidermis during laser treatment of dermal targets was first studied by Gilchrest[39] with the use of ice prior to argon laser treatment of port-wine stains. There has been a recent resurgence of interest in skin cooling during skin laser therapy in an effort to not only cool and protect the epidermis, and to prevent other collateral dermal damage, but also to reduce the discomfort associated with treatment. Because high fluences are required to adequately damage leg veins, cooling appears to be especially important in their treatment, in an effort to limit unwanted collateral injury. Several approaches have been taken, including water-cooled chambers applied directly to the skin through which the laser beam is directed (e.g., *Chess Chamber*, *Versapulse* chill tip, Coherent; *Photoderm* chiller, ESC Medical Inc, Needham, MA) cooling coupling gels, and refrigerated spray cooling devices (e.g., *Dynamic* cooling device, Candela Corp). Preliminary results suggest that cooling helps to spare epidermal damage, allowing use of higher fluences, thus yielding more damage of the targeted vessels, with a greater degree of clearing per treatment.[40,41]

Conclusions

The role of lasers and light sources in treating lower-extremity blood vessels has not been as successful as in treatment of facial telangiectasia to date. There are several reasons for this disparity. Increased hydrostatic pressure on the lower extremities may lead to less effective photothermal destructive coagulation. Anatomic considerations are also important, in that lower extremity blood vessels are in a deeper location, have thick surrounding adventitial tissue, and increased basal lamina as compared to facial telangiectasia.

Since sclerotherapy treatment is highly effective and inexpensive, do lasers and light sources have a role in the treatment of leg telangiectasia? A rational approach to the treatment of leg vein follows. Varicosities, incompetent perforators, and reticular veins must first be treated, using appropriate surgical means or sclerotherapy where indicated. This should be followed by superficial vessel sclerotherapy until only vessels smaller than the diameter of a 30 gauge needle and vessels resistant to sclerotherapy remain. It is these vessels that will respond best to pulsed lasers and light sources, along with telangiectatic matting caused by sclerotherapy. There are instances where laser and light source treatments should be considered prior to superficial sclerotherapy; patients who are fearful of needles or who do not tolerate sclerotherapy, patients whose vessels fail to respond to sclerotherapy, or who are prone to telangiectatic matting. Further carefully monitored and controlled studies are essential to better define the role of each of the available lasers and light sources in the treatment of leg telangiectasia.

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Commentary

A review that tries to recommend the best therapeutic approach to a certain medical problem, especially when dealing with a field that has so many conflicting claims, is always difficult to present. However, these authors have made a clear, logical case to support their recommendation of basically using sclerotherapy for leg veins in all cases except in special circumstances. These minority of cases include patients fearful of needles, sclerotherapy failures, and those with very fine telangiectatic vessels (such as matting).

Various claims have been made on behalf of both sclerotherapy and lasers. As with all medical procedures, the level of clinical expertise, in approaching a patient, will greatly dictate the outcome. When performed well, sclerotherapy may have desirable results in many of our patients. However, there are still

those cases that not only fail, but have disturbing, adverse effects, such as permanent hyperpigmentation. The same is applicable to lasers, and other light sources, in treating leg veins. We all have patients who have responded very well to diverse light sources and are genuinely satisfied with their outcome. However, there are many who may remain unresponsive to laser light, or other light source therapy, even with repeat procedures, or even worse, may have such negative changes as dyspigmentation and even frank scarring. Again, the amount of clinical experience plays a pivotal role. However, even in the best of hands, unresponders and side effects happen with these lasers.

The continued proliferation of different, available lasers only indicates the current lack of a clear choice for laser treatment of leg veins. However—as seen from this review—progress continues to be made. The clinician who treats leg veins should be encouraged that there are several lasers, or other light sources, which can, at times, be beneficial. Although sclerotherapy still remains the gold standard, it would be a true advance for our patients if we could just shine a light on their leg veins and have them consistently disappear, with minimal adverse effects. Perhaps we will soon have a dependable, specific laser, or lasers, that will be the treatment of choice for leg veins of various sizes and depths, either in conjunction with, or supplanting, sclerotherapy.

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