Treatment of benign venous malformations with an intense pulsed light source (PhotoDerm® VL)

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Abstract

Deep-seated, hemangiomatous lesions may be treated by surgical excision, sclerosing therapy, laser treatment and possibly by radiotherapy. An intense, non-coherent pulsed light source, the PhotoDerm® VL, offers an innovative therapeutic concept. We report on two of our patients, who suffered from benign, but extensive, vascular venous malformations, which had not been amenable to other treatments available. With wavelengths of > 590 nm, fluences between 40 and 70 J/cm², and relatively long pulses, lesions at depths of up to 1.2 cm could be targeted effectively. The more superficial vessels were treated by shorter, but multiple pulses and lower fluences. There was a very good response, as post-therapeutic sonography showed a complete obliteration of the respective vessels. The PhotoDerm® VL device turned out to be extremely effective in the treatment of these otherwise resistant, vascular deformities and led to very good functional and aesthetic results. (Key words: hemangioma, laser therapy, PhotoDerm® VL, vascular malformation, venous malformation.)

Introduction

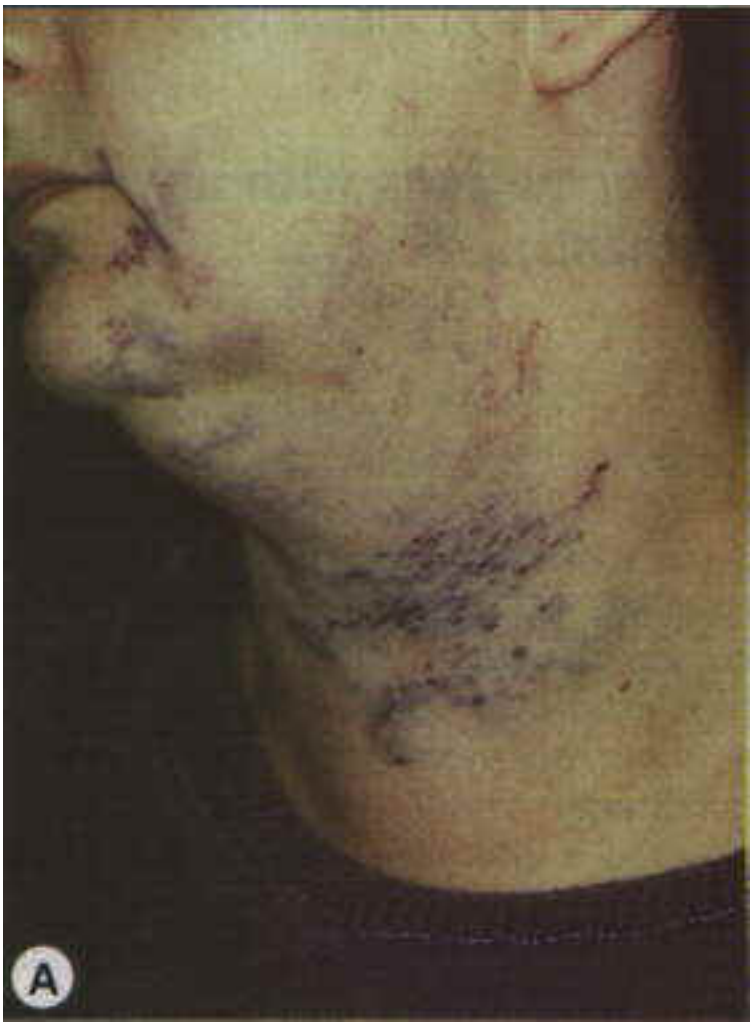
The treatment of extensive and deep-seated venous malformations is often difficult and frustrating. Hitherto applied methods have included surgical excision, mechanical compression, sclerosing, and in some rare cases, which require clear-cut indications, radiotherapy [1]. Dye laser and cryotherapy, which show excellent results in capillary hemangiomas, prove to be ineffective, owing to their superficial penetration depth, depending on the wavelength, and to their short pulse duration. An alternative to the above mentioned treatment options is the interstial Nd:YAG-Laser [2], which requires a high operative expertise and general anaesthesia. The PhotoDerm® VL device is an innovative, high intensity, polychromatic pulsed light source, a "flashlamp", which allows the treatment of benign vascular malformations of different depths and extent. This new device utilizes light beams, which may be varied in terms of wavelength, pulse duration, and fluence, enabling the physician to treat the full range of benign vascular lesions noninvasively and in an outpatient setting.

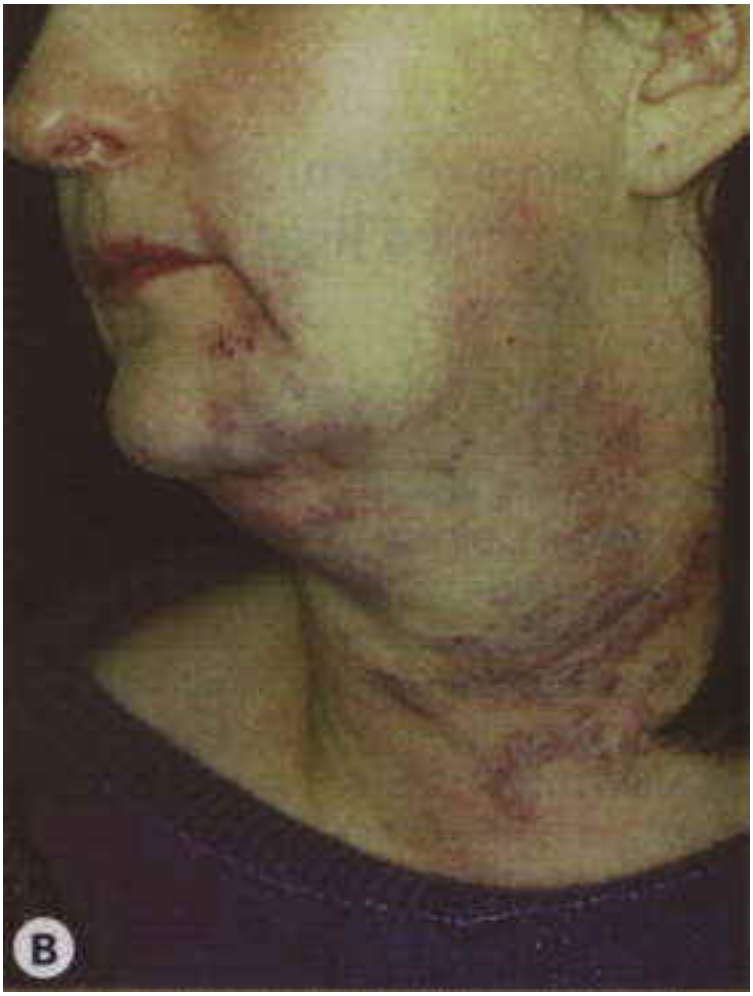
The following report demonstrates the successful treatment and outcome of two patients, who suffered from extensive venous malformations of the head and neck and the genital area, respectively. The vascular deformities of both patients could be treated very effectively with the PhotoDerm® VL. All other therapeutic options, e.g. surgical intervention or radiotherapy, were not applicable. or as for ND:YAG laser treatment, were rejected by the patients.

Patients and methods

Female patient

The 41-year-old female patient suffered from an extensive, congenital, livid, vascular malformation of the left facial, head and neck region (Fig. 1A). During her lifetime, the patient had developed a neurotic posture (torticollis) to conceal the disfiguring lesion. Before treatment, colour-flow Doppler sonography of the vascular system was carried out (Ultrasound system HDI, Advanced Technology Laboratories, Inc.; transducer CL 10.5-linear array - with high definitition of small parts and peripheral vessels. Treatment with the PhotoDerm® VL device (ESC Medical Systems Ltd., Needham, MA, USA) was started in December 1994. The 590 nm cutoff filter was used in general, resulting in a spectrum of longer lightwaves which target the deep-seated vascular cavities. The more superficial vessels were treated using the 570 nm cut-off filter. Double and triple impulses were applied, the energy fluence ranged between 45 and 77 J/cm² . The "long pulse" (see below), which targets vessels at a depth of up to 2 cm, was applied six times.

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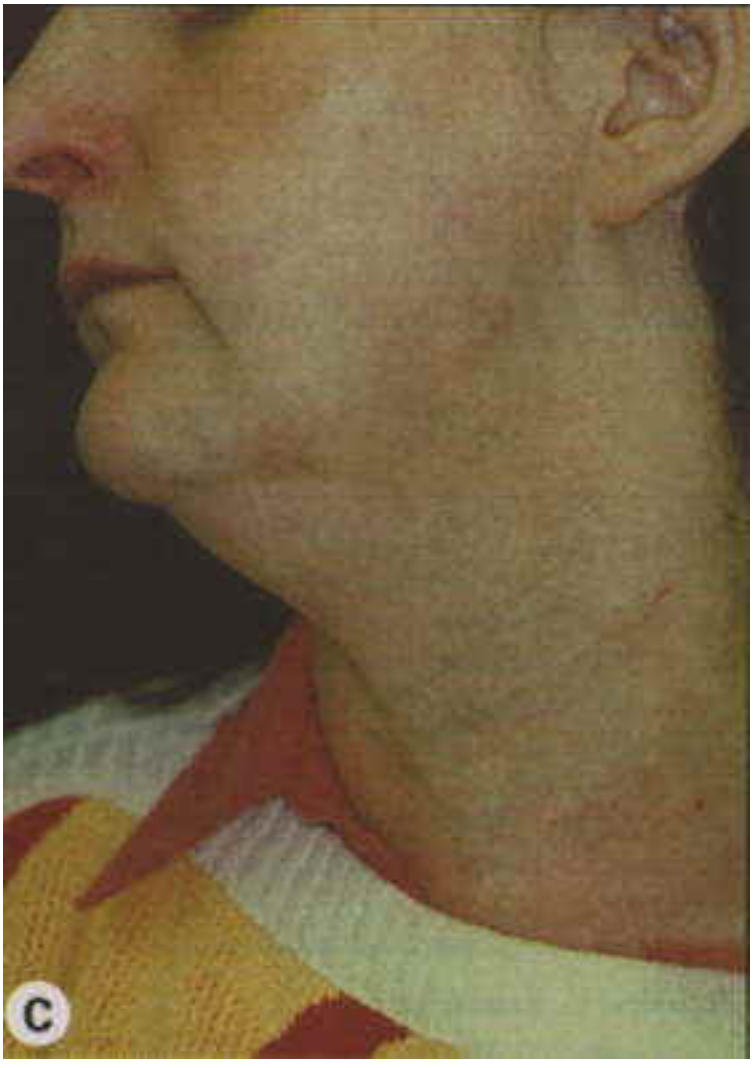
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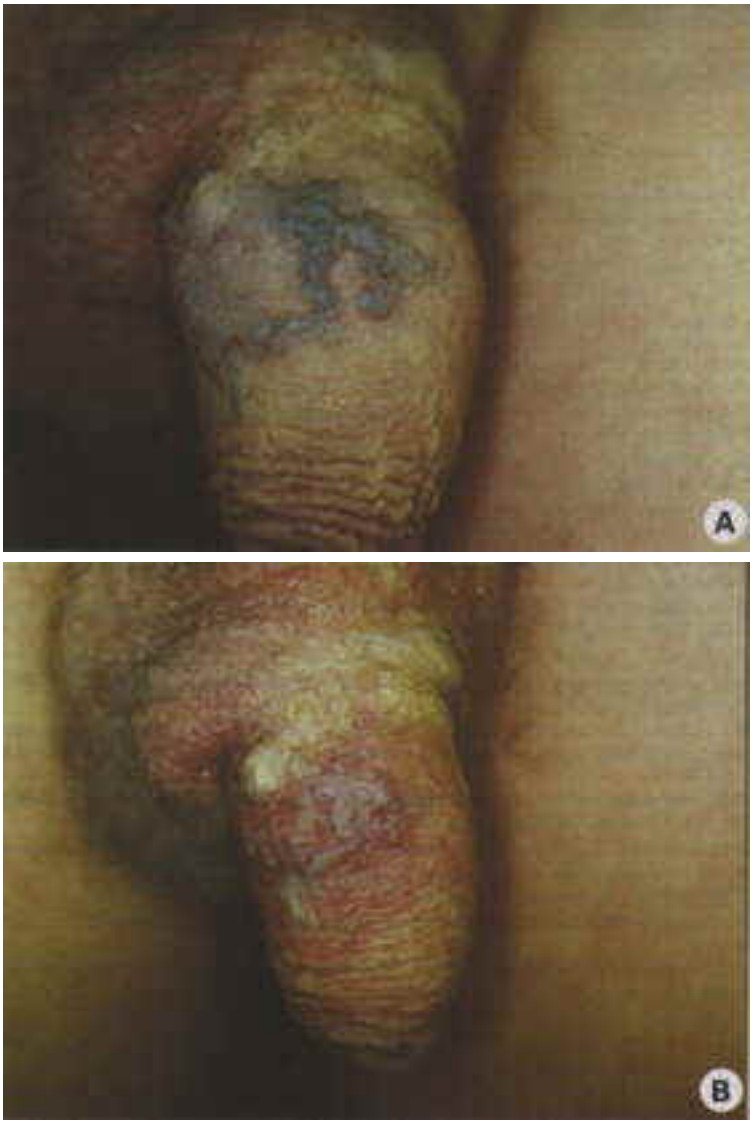
Figure 1. (A) Extensive and disfiguring venous malformation of the left head and neck area before treatment (December 1994). (B) Clinical picture of the patient after the first treatment with PhotoDerm® VL. (C) Clinical image of the patient after ten treatment sessions with the PhotoDerm® VL (December 1995).

Male patient

This 43-year-old suffered from a congenital vascular malformation of the penis and scrotum (Fig. 2A). He had undergone two unsatisfactory operations in 1959 and 1982, respectively. Treatment with the PhotoDerm® VL was administered in four sessions between December 1994 and November 1995. We used the 590 nm cut-off filter, triple impulse mode, and energy fluences of between 40 and 50 J/cm².



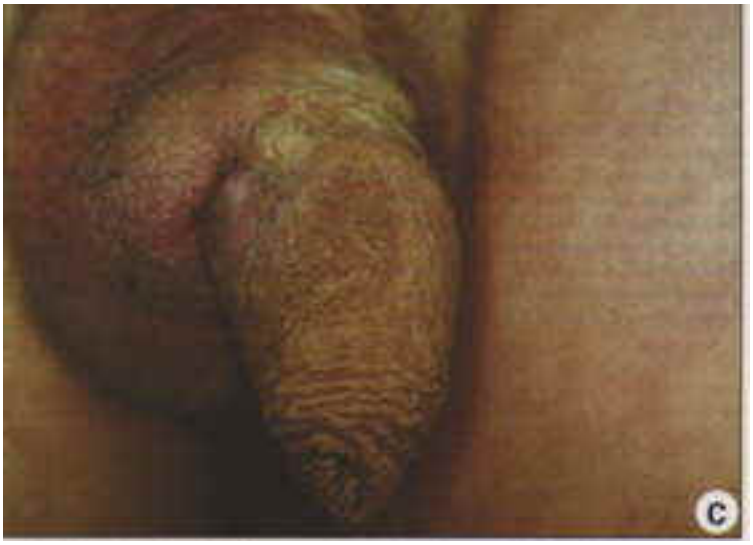


Figure 2. (A) Clinical picture of a vascular malformation of the penis and scrotum before treatment (patient 2). (B) Appearance of the lesion after two treatment sessions. (C) After four treatment sessions, the vascular lesion can no longer be observed.

Results

Female patient

B-mode sonography showed subcutaneous, hypoechoic, and compressible cavities. Colour-flow Doppler sonography (colour power angio mode) demonstrated a very low flow within the lesions. The deepest vascular formation could be detected at about 1.2 cm depth (Fig. 3A). Arteriovenous shunts or vascular connections to the large neck vessels could not be demonstrated. As an accessory finding, a nodular hyperthyreosis was found, which will be treated surgically within the next few months.

Immediately after the first treatment session, a considerable number of the pathologic vessels appeared obliterated (Fig. 1B). During the following ten sessions, which were held at 3-5 weeks intervals, the lesion gradually faded and diminished. Sonographically, no vascular flow could be detected within the treated area already after four sessions, whereas the untreated, neighbouring regions showed unchanged vascular structures and flow characteristics. After the tenth session, only partly cavernous structures were found within the former lesion. Even under mild compression, no perfusion could be demonstrated by Doppler-sonography, showing an effective obliteration of the formerly supplying vessels (Fig. 3B). Figure 1C shows the dramatically improved clinical picture in December 1995. The patient now feels no need for cosmetic camouflage.

Male patient

The lesions of this patient responded immediately to the first treatment trial. Figure 2B was taken immediately after the second session. The lesion appeared considerably faded and partially obliterated. After the last treatment session, the venous malformation had completely gone (Fig. 2C).

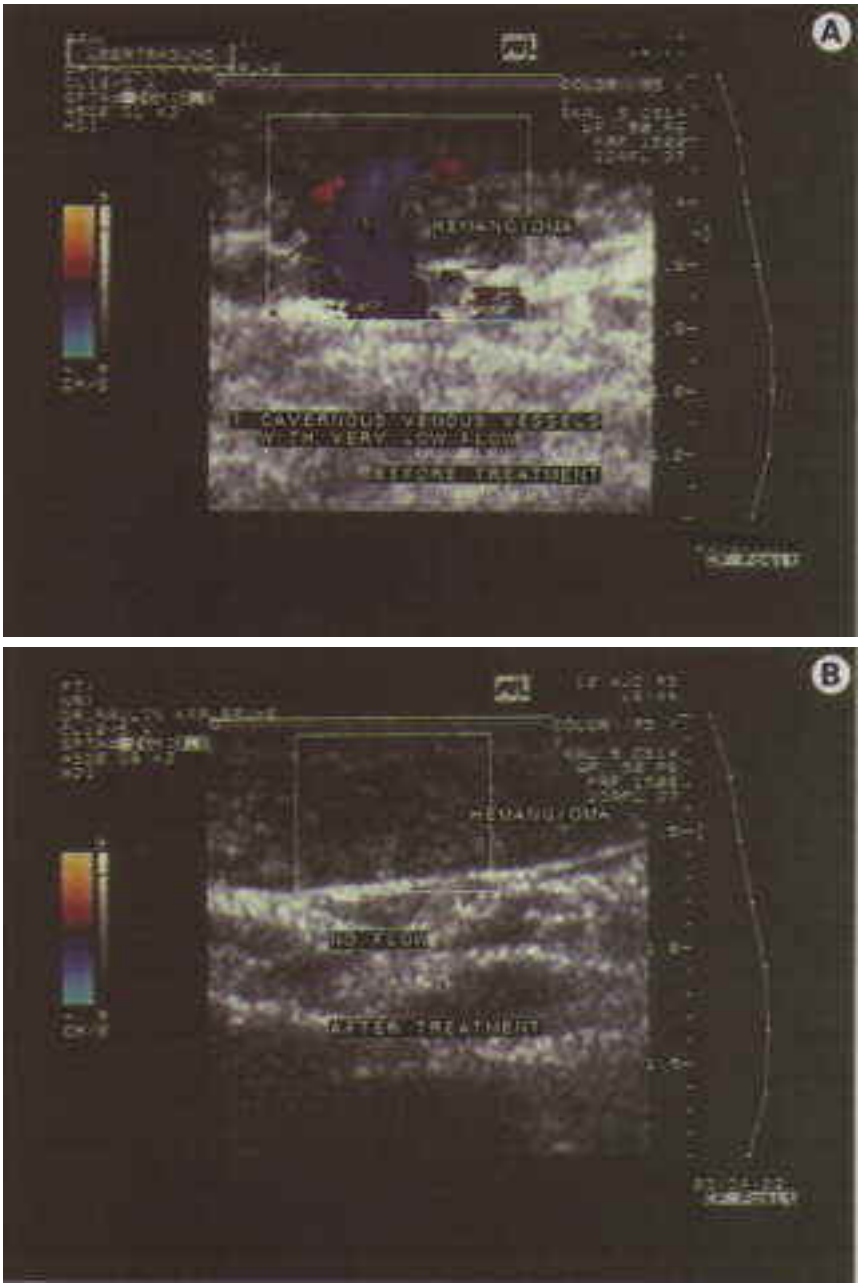


Figure 3. (A) Doppler sonography of the lesion before treatment, (patient 1) showing cavernous vessels with a very low flow profile. (B) Doppler sonography of the vascular structure after the treatment. No flow could be detected.

Discussion

Pulsed laser systems have proven extremely effective and safe in the treatment of vascular malformations. The flashlamp-pumped pulsed dye laser (585 or 577 nm wavelength) was developed especially for the treatment of infant nevi flammei and superseded the argon laser for this indication [8-12]. Besides other superficial vascular lesions such as capillary hemangiomas, spider nevi and telangiectasis may be treated effectively and with a low risk of scarring, using the pulsed dye laser equipment [8, 9, 11-16]. Deep-seated vessels and cavernous malformations can not be targeted successfully by the dye laser beam, because of its shallow penetration depth (0.5 to 1.2 mm, depending on the wavelength). A powerful complement or alternative in the treatment of benign vascular disorders is the PhotoDerm® VL, a "flashlamp" using non-coherent light in a wavelength spectrum of 515 to 1,200 nm. The impulse length ranges between 0.5 and 25 ms, the energy fluence lies between 3 and 90 J/cm². Single, double, and triple impulses may be used in one impulse

sequences. Depending on the characteristics of the lesion and the skin type of the patient, different filters can be used (515, 550, 570, and 590 nm), which cut out the corresponding wavelength subspectra. One impulse treats a rectangular area of 2.8 cm^2. In most cases, no local anaesthesia needs to be used; however, topical anaesthetics may be applied (e.g. prilocaine/lidocaine-cream, Emla®). Immediately after the treatment, ice-cold refrigerant packs are applied, to treat the sunburn-like discomfort and to prevent substantial inflammatory swelling. Erythema occurs commonly after treatment and lasts for 24-48 h. In our experience, crusting is rare and is treated with topical antibiotic cream (e.g. Aureomycin® Salbe). Patients should be strongly advised to avoid sun exposure during the whole treatment period.

The concept of the PhotoDerm® VL is selective photothermolysis [19]. It is, in principle, the same concept that is used in the dye laser. The target chromophore is oxyhemoglobin. The device takes advantage of the dependence of the scattering and absorption coefficient of oxy- and deoxy-hemoglobin on wavelength and on the strong dependence of vessel cooling time (thermal relaxation time; between 2 and 12 ms) and on the size (diameter) of the vessel. Thus, small and shallow vessels typical of port-wine stains are treated most effectively by using short pulses (2-3 ms) and short wavelength. In the case of larger and deeper vessels it is important to use longer wavelengths (i.e. 800-1,200 nm) and a longer pulse in the range of 20 to 100 ms to achieve high efficiency and selectivity ("long pulse" mode; see above). Larger vessels also require a higher fluence, since a larger volume of blood needs to be heated. The vessels are injured by selective photothermolysis, which leads to their destruction, removal, and replacement by granulation tissue [20, 21]. The impulse length of the light beam ranges well below the thermal relaxation time of dermal cells, thus avoiding involvement and damage of the surrounding tissue. Additionally, the PhotoDerm® VL allows the light beam to be applied as multiple pulses with a controlled gap between the pulses. This ensures adequate cooling of the epidermis and dermis between the flashes (double and triple pulses, see above). Therefore, side effects, e.g. scarring, are rare and dermatrophy is almost never seen. Post-therapeutic pigmental changes may rarely develop and are almost always transient. Hypopigmentation might evolve when deeply tanned or coloured patients are treated (skin types IV and V). Hyperpigmentation is a typical complication of an overly-large energy fluence.

A decisive advantage of the PhotoDerm® VL is the relatively large treatment area of 2.8 cm^2, which is covered by a single pulse. This technical feature allows the treatment of large affected areas within an acceptable time span. Therefore, it is possible to treat extended nevi flammei or a large erythrosis interfollicularis colli completely in one single session. The stitch-like, immediate pain, which converts to a sunburn-like discomfort is endured by most of the patients without any anaesthetic or analgesics. Instantaneously after the treatment, the area should be cooled to prohibit swelling and to relieve the discomfort.

Another advantage of the PhotoDerm® VL is the low cosmetic impairment by purpural spots, which appear regularly after dye laser treatment and which last for up to 2 weeks. After treatment with the PhotoDerm® VL, there is only a slight erythema, which disappears generally after 48 h [3]. We have also made the observation that therapy-resistant port-wine stains may be treated successfully with the PhotoDerm® VL [6].

In both cases presented, there were no other therapeutic options (e.g. sclerosing, pulsed dye laser or

surgical excision), because of the localisation and extent of the vascular lesions. ND:YAG laser treatment, which would have required an operation under general anesthesia [2] was refused. Therefore, the PhotoDerm® VL could be considered as an innovative therapeutic concept. The handling of the PhotoDerm® VL, however, is demanding, because of the many different combinations of technical parameters (i.e. wavelength, energy fluence, impulse duration, impulse frequency, and number of impulses). We consider that a cautious approach to the individual situation, which takes account of the skin type and the tanning grade is an essential prerequisite for treatment. To minimize the potential of hazardous side effects, a thorough pretherapeutic, diagnostic process, which should define the nature of the lesion as well as the vessel depth and diameter is considered a condition sine qua non. On this basis, treatment with the PhotoDerm® VL is as safe and as free of complications as the pulsed dye laser. Other indications for PhotoDerm® VL treatment, apart from those presented, are nevi flammei, therapy-resistant port-wine stains, essential teleangiectases, erythrosis interfollicularis colli, reddish keloids, leg veins and hypertrichosis [3-7].

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(For references please contact the authors)

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