Treatment of Spider Leg Veins with the KTP (532 nm) Laser—A Prospective Study

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Background and Objectives: Spider leg veins are telangiectasias located intracutaneously. This condition poses a cosmetic problem.

Study Design/Patients and Methods: The purpose of this study was to determine what influence the KTP (532 nm) laser has on spider leg veins dependent on the vascular diameter and to what extent the skin has been affected. Seventy female patients were treated in three laser sessions. Analysis was done 30 weeks after the last laser treatment session.

Results: Fifty-six patients completed the study. In group 1 (vascular diameter $\leq$ 0.6 mm), spider leg veins were no longer visible in 33%; in 40%, a decrease in vascular diameter could be observed; in 27%, no change in size occurred. In group 2 (vascular diameter 0.7–1.0 mm), laser-treated spider leg veins were visible in all patients. Hyperpigmentation occurred in 13 patients.

Conclusions: The KTP (532 nm) laser is an effective for treating spider leg veins having a vascular diameter under 0.7 mm. Lasers Surg. Med. 31:194–201, 2002.

Key words: vascular diameter; hyperpigmentation; long-pulsed frequency-doubled Neodymium:YAG (Nd:YAG) laser; telangiectasias

INTRODUCTION

According to a large-scale study by Engel et al. [1], spider leg veins occur in 29–41% of the female and 6–15% of the male US population. Spider leg veins (synonym: telangiectasia arborescens) are small caliber venous angiectasis [2] with a diameter between 0.1 and 1.0 mm [3]. Usually the legs are afflicted, however, spider veins can also be found in the coastal region [2,4]. Spider leg veins mainly pose a cosmetic problem for women, without being of hemodynamical relevance [2].

Sclerotherapy and laser treatment using lasers of different wavelengths are established treatment methods. In literature, sclerotherapy is noted as the method of choice [5–8]. In case of vascular diameters less than 0.8 mm, sclerotherapy is difficult and shows greater side effects, such as hyperpigmentation, cutaneous gangrene, thrombosis, and allergic reactions [9–11] when using sclerotherapy on vascular diameters greater than 0.8 mm. Compared with sclerotherapy, laser therapy offers a non-invasive method of treatment, although its use is limited in vessels of greater diameter.

Since the development of the first laser (Rubinlaser, wavelength: 694 nm) in 1960, vascular lesions were treated with this method [12]. In literature, different laser systems such as the Argon [4,13,14], KTP (532 nm) [15,16], Neodymium:YAG [4], CO_2 [17], and the pulsed dye [4] are listed for treating spider leg veins of the lower extremity.

Chromophorous hemoglobin is the goal when treating vascular lesions. Hemoglobins absorption maximum lies at 418, 542, and 577 nm. Therefore, lasers with wavelengths between 488 and 600 nm are used for treatment of vascular lesions. The development of the argon laser with wavelengths between 488 and 577 nm allowed the successful treatment of vascular lesions. Its greatest disadvantage lies in the damaging of the surrounding tissue, including the epidermis is clinically-manifested as depigmentation, epidermic atrophia, and scarring [14,18,19]. The pulsed dye laser (wavelengths of 577 or 585 nm) developed in the 80's showed better vascular selectivity. The disadvantage of this laser results from the brief pulse duration of 300 to 500 microseconds, which leads to vascular rupture, thus to the cosmetically-irritating case of purpura [18,20]. Studies have shown that vascular rupture can be avoided by using longer pulse duration at a range from 1 to 10 microseconds [21]. The frequency-doubled Nd:YAG (KTP) laser allows variable pulse duration from 2 to 10 microseconds, and is, therefore, superior to the dye laser.

Laser light from a pulsed laser is absorbed at defined pigmented structures dependent on its wavelength. In areas of greater absorption, massive thermic damage occurs, whereby, the neighboring tissues is barely effected. The impulse time lies under the thermic relaxation time of the desired tissue so that this is not able to emit the absorbed energy to the surrounding tissue. At a wavelength

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of 532 nm, the light emitted by the KTP (532 nm) laser is mainly absorbed by hemoglobin, resulting in vascular selectivity, which protects the surrounding tissue. Thermic energy leads to the agglutination of erythrocytes in the vessel, i.e., coagulation. Rupture of the vessel wall is prevented by emitting high energy at a long pulse duration [12].

Goal of this study was to investigate what influence the KTP (532 nm) laser has on spider leg veins in regard to the vascular diameter and to what extent visible skin changes occur.

PATIENTS AND METHODS

Patients

Seventy female patients with spider leg veins of the lower extremity, mean age 39 (15–57 years) were included in this study. Criteria for inclusion were female Caucasians aged between 19 and 50 years with spider leg veins and skin types I–IV (see Table 1). The distribution of skin types of our patients are shown in Figure 1.

Criteria for exclusion were treated or untreated truncal varicose conditions, earlier treatment of spider leg veins with sclerotherapy or laser, chronic dermatosis, proven allergic reactions to local anesthetics, epilepsy, patients with skin types V or VI, tattoos in the are to be treated, predisposition to keloids or hypertrophic scarring, pregnancy (determined anamnestically) or taking of anticoagulants. Color-coded duplex sonography of the vena saphena magna and Vena femoralis of the extremity to be lasered was performed to rule out a truncal varicose disease [23,24].

Criteria for termination during the study period were pregnancy, allergic reaction to the surface anesthetic Emla® 5%-Cream, infection of the lasered region, and scarring.

Methods

Seventy female patients were randomized for three laser sessions over a period of 6 weeks. Randomization was done by a person not involved in this study, who sent the patients to the single laser sessions on hand of a randomization list. A 5 cm × 5 cm region of spider leg veins at the middle third of the lateral right or left thigh was selected for lasering. This region was marked with a water-soluble marker. For purposes of orientation during the following

TABLE 1. Classification of Skin Types I–IV According to Jung [22]

Skin type	Clinical picture after being exposed to sunlight for 30 minutes
I	Always erythema, no tanning
II	Always erythema, sometimes slight tanning
III	Sometimes erythema, always tanning
IV	No erythema, always tanning
V	Dark-skinned races
VI	Blacks

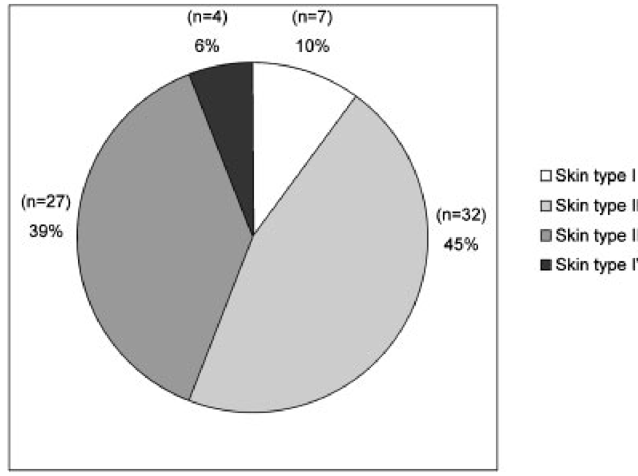

Fig. 1. Distribution of patients according to skin types I–IV (n = 70) in percent.

laser sessions, corner points of the marked region and other striking points on the skin (naevus, scars) were transferred to a transparent foil. Slides of the marked region were made for photographic determination of vascular diameters after the laser procedure. The distance between the objective and the surface of the skin was defined as 40 cm. In conclusion to photographic documentation, a superficial pain relieving anesthetic (Emla 5%-Cream; 1 g contains 25 mg Lidocain and 25 mg Prilocain) was administered after laser treatment and an occlusive bandage was applied for 45 minutes. Immediately thereafter, laser therapy of spider leg veins in the marked region was performed.

The laser used in our study was a KTP (532 nm) laser (Aura Star Pulse, Laserscope). A Yttrium/Aluminum Granite (YAG) containing small amounts of Neodymium (Nd) was used to generate the laser beam. Its wavelength is 1,064 nm and lies in the invisible infrared range. A second crystal consisting of a titanylphosphate from potassium carbonate (KTP) doubles the following frequency of the Nd:YAG laser to a wavelength of 532 nm. Thus, the emitted laser beam has a wavelength of 532 nm, and lies in the green spectrum of visible light.

Using the hand piece (1 mm-Dermastat, spot diameter: 1 mm), punctual, non-overlapping coagulation was performed using 15–16 J/cm^2 with a pulse duration of 10 microseconds and repetition rate of 3 pps (pulses per second), along the course of the vessel [25]. As soon as the vessel was no longer visible and no refilling of the blood column after smoothing occurred, laser application was terminated. The same vessel was treated a maximum of three times.

After laser application, cooling of the treated area was done with a cold-hot-pack (Flexoversal®, Firma Hospipharm) for at least 15 minutes. Twenty-four hours later, the patient applied a heparinoid cream (Lasonil® by Bayer, Ingredients: Heparinoid Bayer) twice a day (mornings and evenings) for 2 weeks. The patients were instructed to avoid UVA and UVB light at the laser-treated areas during the entire study period.

The vascular diameter at the laser-treated regions were determined on a slide, which was projected on a screen. A ruler was used for reference and photographed at the same distance to the camera as the marked area of the thigh.

After 6 and 12 weeks, the remaining spider leg veins were treated with the same laser technique. Clinical assessment regarding pigmentation, scarring, lesions, as well as photographic documentation was done prior to and 18 weeks after laser therapy.

Statistical Analysis

Statistical analysis was done using the data (see Table 2) from those patients who completed the study ($n = 56$). The correlation of comparative values were calculated and analyzed regarding significancy.

The patients treated (three laser sessions and control documentation) were divided into two groups. Division was based on the mean diameter of spider leg veins. Group 1 ($n = 30$) included patients with spider leg veins with a diameter of ≤ 0.6 mm and group 2 ($n = 26$) with a diameter between 0.7–1.0 mm.

Significant differences among both groups were investigated using the Mann–Whitney Test. Differences in vascular diameter within the same group were examined using the Wilcoxon Test. Changes in pigmentation (hypo- and hyperpigmentation) at the lasered-region during control documentation were investigated with the χ^2 test according to Pearson.

Results were considered to be significant when the possibility of error was less than 0.05 ($P < 0.05$). When the possibility of error was between 0.05 and 0.10 ($0.05 > P < 0.1$)it was defined as a trend. The results were represented as mean values ± mean deviation (range).

RESULTS

A total of 14 of the 70 patients who took part in this study were eliminated. Reasons for elimination were illness not related to laser therapy in two, lack of time in 10 cases, and two patients moved away. The results from the patients who completed the study are shown in Table 2. The results from 56 patients after three laser sessions, every 6 weeks, over a period of 30 weeks are shown below. In group 1 (patients with vascular diameter ≤ 0.6 mm), spider leg veins disappeared in 33% ($n = 10$) at the laser-treated (Fig. 5), in 40% ($n = 12$) reduction of the initial diameter could be observed (Fig. 6), and in 27% ($n = 8$), no change took place. In group 2 (patients with vascular diameter between 0.7–1.0 mm), the disappearance of spider leg veins could not be achieved in any patient, in 12% ($n = 3$), superficial vessels decreased in size, and in 88% ($n = 23$), no reduction was observed. Minor erythema and edema occurred in all patients at the treated region. In some cases, crusting of the lasered-region occurred, which disappeared after a maximum of 6 days. At follow-up, no scarring or necrosis of the treated area was evident. Figure 2 shows the changes in vascular diameter during the study period (from the initial examination until follow-up after 30 weeks).

In group 1, the mean values of vascular diameter prior to the first laser session was 0.4 mm (standard deviation: ± 0.11), after six weeks it was 0.4 mm (standard deviation: ± 0.15), after further 6 weeks, it was 0.2 mm (standard deviation: ± 0.20), and after 30 weeks, it was 0.2 mm (standard deviation: ± 0.19). Using the Wilcoxon-Test, changes in vessel diameter were investigated. The reduction in diameter compared to the initial situation and that 30 weeks later was significant ($P < 0.001$). The results did not show significant changes in both groups, 6 weeks after the first laser session ($P > 0.1$). Reduction between the second and the third laser session (12 weeks after initial laser session) was significant ($P < 0.01$), however, not significant ($P = 0.07$) between the third session and after 30 weeks. The mean vascular diameter in group 2 prior to laser therapy was 0.9 mm (standard deviation: ± 0.27), 6 weeks later, it was 0.9 mm (standard deviation: ± 0.30), further 6 weeks later, it was 0.9 mm (standard deviation: ± 0.37), and 30 weeks after initial treatment, it was 0.9 mm (standard deviation: ± 0.38). The Wilcoxon-Test showed that no significant changes in vascular diameter took place at any time during the study period ($P > 0.1$). Figure 3 shows the changes in vascular diameter in groups 1 and 2 before and after 30 weeks of treatment.

In group 2, no change in the diameter of spider leg veins took place 30 weeks after initial treatment (three laser therapy sessions) with the exception of patients 39, 42, and 44. Thirty weeks after initial laser treatment, 13 patients showed hyperpigmentation of the lasered region, 4 of 27 patients had skin type II, 8 of 21 patients had skin type III, and 1 of 2 patients had skin type IV. Six patients with skin type I did not show any changes in pigmentation (see Fig. 4). No hypopigmentation or scarring was found in any of our patients 30 weeks after initial laser treatment.

DISCUSSION

In our study, spider leg veins were no longer visible after laser treatment in 33% ($n = 30$) of the patients in group 1. In our study, this group showed the best results, even though the KTP (532) laser method for treatment of spider leg veins cannot be considered ideal with a success rate of 33%. Sclerotherapy of spider leg veins with similar diameters is at least as important as laser therapy [26]. In 40%, a reduction in diameter compared to the initial situation was achieved and in 27%, no change occurred. In group 2 ($n = 26$), spider leg veins were visible in all patients treated with laser; in 12%, a reduction in diameter was achieved; the other 88% showed no change. The minor improvement of treated spider leg veins in group 2 underline Bethge and Stadler's statement [12] that the frequency-doubled Nd:YAG laser does not provide sufficient treatment of larger vessels. We observed that spider leg veins of ≥ 0.7 mm didn't show any obvious changes after 30 weeks. We cannot explain why patients 39, 42, and 44 deviate from the median. Adrian [27] treated 50 patients with spider leg veins of the lower

TABLE 2. Data of Patients: Skin Type, Diameter of Vessels (mm), Hyperpigmentation

Number of patients	Skin type 1–IV	Diameter of vessels before 1st laser treatment	Diameter of vessels before 2nd laser treatment	Diameter of vessels before 3rd laser treatment	Diameter of vessels 18 weeks after 3rd laser treatment	Hyperpigmentation before 2nd laser treatment	Hyperpigmentation before 3rd laser treatment	Hyperpigmentation 18 weeks after 3rd laser treatment
1	II	1	1	1	1	0	0	0
2	I	0.8	0.8	0.8	0.8	0	0	0
3	II	0.5	0.5	0	0	0	0	1
4	II	0.5	0.5	0.2	0.2	0	0	0
5	I	0.3	0.3	0.3	0.1	0	0	0
6	III	0.5	0.5	0.5	0.5	0	0	1
7	III	1	0.5	1	1	0	0	1
8	III	0.2	0.2	0.2	0.2	0	0	0
11	II	0.8	0.8	0.6	0.6	0	0	0
12	III	0.8	0.8	0.8	0.8	0	0	1
13	II	0.5	0.5	0	0	0	0	0
14	II	1	1	1	1	0	0	0
15	II	1	1	1	1	0	0	1
16	II	0.5	0.5	0.5	0.5	0	0	0
18	II	0.3	0.3	0	0	0	0	0
19	III	1	1	1	0.5	0	0	0
20	III	0.5	0.5	0.5	0.5	0	0	0
21	II	1	1	1	1	0	0	1
22	II	0.3	0	0	0	0	0	0
23	III	1	1	1	1	0	0	0
24	III	0.4	0.4	0.4	0.4	0	0	0
25	III	0.3	0.3	0.3	0	0	0	0
26	III	1	1	1	1	0	0	0
27	III	0.3	0.3	0	0	0	0	1
28	II	0.4	0.4	0.4	0	0	0	0
29	II	0.4	0.4	0.2	0.2	0	0	0
30	II	0.7	0.7	0.7	0.7	0	1	0
31	III	0.5	0.5	0.5	0.5	0	1	0
32	I	1	1	1	1	0	0	0
34	III	0.4	0.4	0	0	0	0	0
35	IV	0.8	0.8	0.8	0.8	1	1	1
35	IV	1	1	1	1	0	0	0
38	II	0.4	0.4	0.4	0.4	0	0	0
39	III	0.6	0.6	0.2	0.2	0	0	0
40	I	0.4	0.4	0.2	0.2	0	0	0
42	I	1	1	1	1	0	0	0
43	III	0.8	0.8	0.8	0.8	0	1	1
44	III	1	1	1	1	0	0	0
45	II	0.6	0.2	0.2	0.2	0	0	0
46	II	0.4	0.4	0.2	0.2	0	0	0
48	II	0.6	0.6	0.6	0.2	0	0	0
49	II	0.4	0.4	0.2	0.2	0	0	0
50	III	0.6	0.6	0.6	0.6	0	1	1
51	I	1	1	1	1	0	0	0
53	II	0.8	0.8	0.8	0.8	0	0	0
54	II	1	1	1	1	0	0	1
55	II	0.6	0.4	0.4	0.4	0	0	0
56	III	0.4	0.4	0.2	0.2	0	0	0
58	II	0.4	0	0	0	0	0	0
59	II	0.8	0.8	0.8	0.8	0	0	0
60	II	0.4	0.4	0	0	0	0	0
65	II	0.8	0.8	0.8	0.8	0	0	0

TABLE 2. (*Continued*)

Number of patients	Skin type 1–IV	Diameter of vessels before: 1st laser treatment	2nd laser treatment	3rd laser treatment	Diameter of vessels 18 weeks after 3rd laser treatment	Hyperpigmentation before: 2nd laser treatment	3rd laser treatment	Hyperpigmentation 18 weeks after 3rd laser treatment
66	III	0.6	0.2	0.2	0.2	0	0	1
67	II	1	1	1	1	0	0	0
69	III	0.8	0.8	0.8	0.8	0	0	0
70	I	0.8	0.8	0.4	0.4	0	0	0

extremity using the VersaPulse frequency-doubled-Nd:YAG laser with variable pulse distance (Coherent Medical Corporation) fluence between 9.5 and 16.0 J/cm^2, spot sizes between 3 and 4 mm and cooling of the skin surface. The results of 62 laser treatments showed a $> 50\%$ improvement in 73% of the patients after the first laser session and 83% after the second laser treatment. A total of 18% showed a 75–100% improvement after one laser session and 63% showed improvement after two laser sessions.

The results of this study confirm our hypothesis that repeated laser sessions are necessary to achieve improvement of spider leg veins. Significant reduction in vascular diameter ($P < 0.01$) was observed in our study between the second and third laser session (12 weeks after initial laser session). Massey and Katz [16] treated 46 women with the VersaPulse (HELP-G)-frequency-doubled Nd:YAG laser. In group 1 (vascular diameter: < 1 mm), 80% and in group 2 (vascular diameter 1–2 mm), 67% of the patients reported a $> 50\%$ improvement in spider leg veins after two laser treatment sessions. Evidence that frequency-doubled Nd:YAG laser therapy is an effective method for treating small spider leg veins at the lower extremity was also observed in our patients, which, however, is not comparable with our study because of different treatment parameters. Bernstein et al. [28] treated 15 patients with spider leg veins having a vascular diameter less than 0.75 mm with a 10 microseconds pulsed 532-nm laser. The results showed that using a 3-mm hand piece and fluence of 16 J/cm^2 with simultaneous cooling of the treated area, more than 75% of the spider leg veins treated led to an improvement or reduction in size, after two treatment sessions. West and Alster [7] compared the long-pulsed dye laser (wavelength: 595 nm) with the KTP (532 nm) in treating spider leg veins. In 11 patients, significant improvement using the dye laser compared with the KTP (532 nm) laser was achieved.

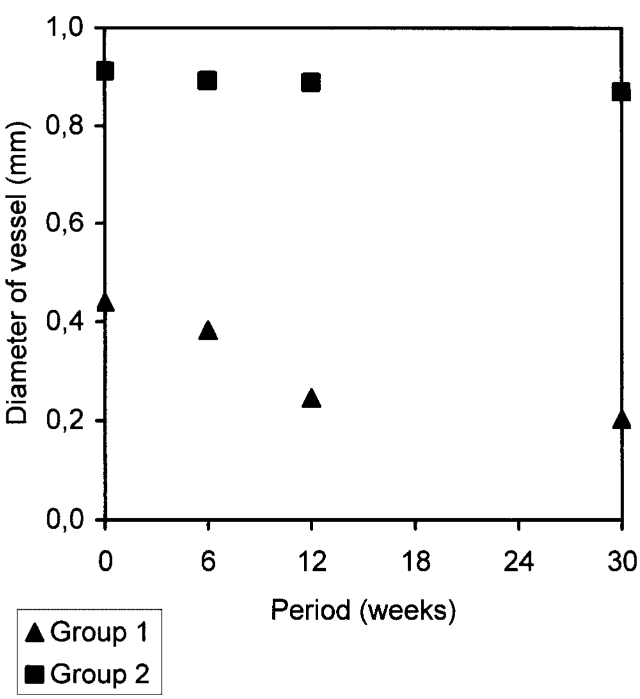

Fig. 2. Mean values in vascular diameter dependent on time.

Hyperpigmentation, which occurred during treatment was the most common side effect of laser therapy. After a total of three laser sessions, hyperpigmentation of the laser-treated area occurred in 13 of 56 patients, 30 weeks later. Hyperpigmentation, occurring in sclerotherapy and dye laser treatment, as well as KTP (532 nm) laser therapy

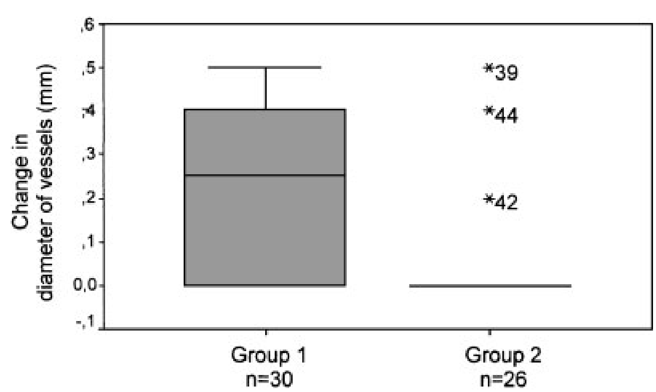

Fig. 3. Alteration in vascular diameter before and after 30 weeks, the first laser session. Alteration in vascular diameter in group 1 from 0.0 to 0.5 mm, no change in vascular diameter in group 2 with the exception of patients 39, 42, and 44.

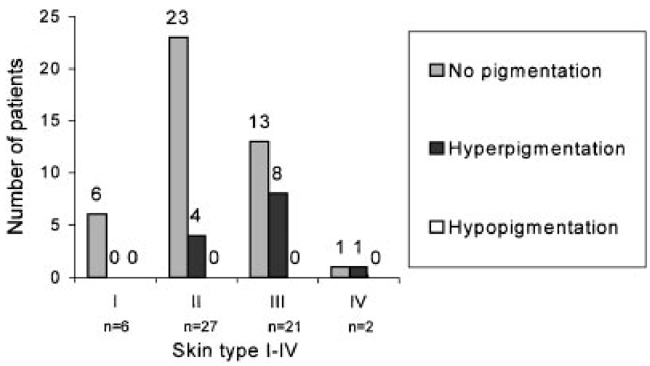

Fig. 4. Changes in pigmentation depending of skin type.

is probably caused by the extravasation of erythrocytes through the damaged vessel resulting in hemosiderin deposits and perivascular inflammation, leading to post inflammatory changes in pigmentation [26]. According to Bethge and Stadler, post inflammatory hyperpigmentation is reversible after 4–5 months [12].

In literature, hyper- and hypopigmentation is reported in 15%–20%, whereby hypopigmentation was still visible 6 months later [7,16]. In our study, no hypopigmentation was observed at the end of the study period.

No correlation to the skin types I–IV regarding hyperpigmentation was evident in our study, however, trend analysis ($P = 0.98$) showed more frequent hyperpigmentation in darker skin types. We only treated patients of skin types I–IV, since patients with skin type V and VI have a higher risk of intensive hyperpigmentation [29].

As expected [12,16], all patients developed minor erythema and edema of the area after laser treatment, which disappeared after a maximum of 24 hours. In some cases, crusting occurred, which normalized within 6 days. This side effect was caused by the effect of heat on the skin.

Simultaneous cooling during laser therapy in order to avoid epidermic heating, and thus damage of non-vascular tissue is advantageous [30,31]. In our study, laser therapy was performed without cooling, since we did not have the necessary equipment. We cooled the laser-treated area with a cooling compress (Flexoversal) for at least 15 minutes to prevent eventual thermically-caused damage.

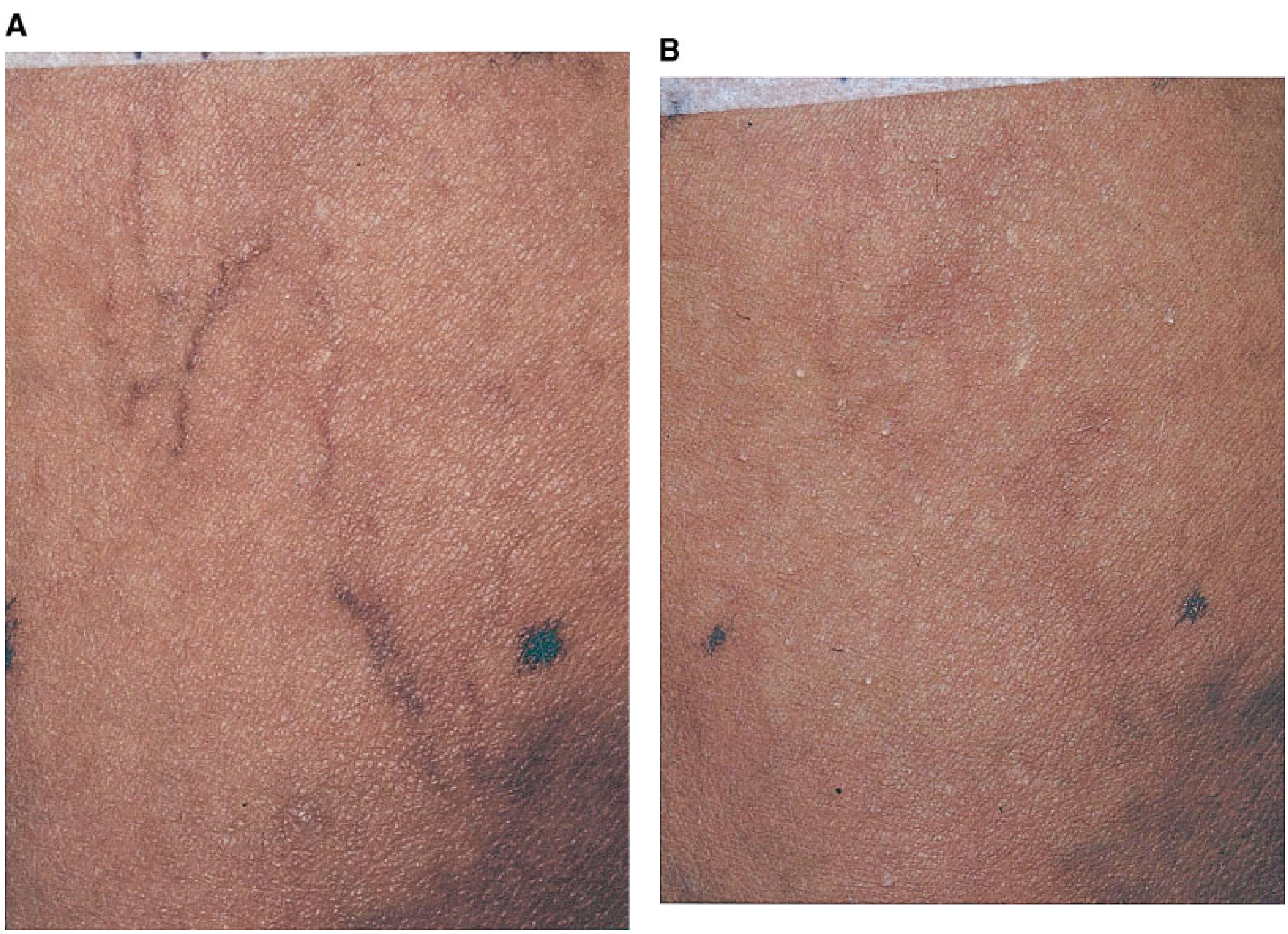

Fig. 5. Spider leg veins from patient no. 07 before treatment (**A**) and 30 weeks after the first laser session (**B**).

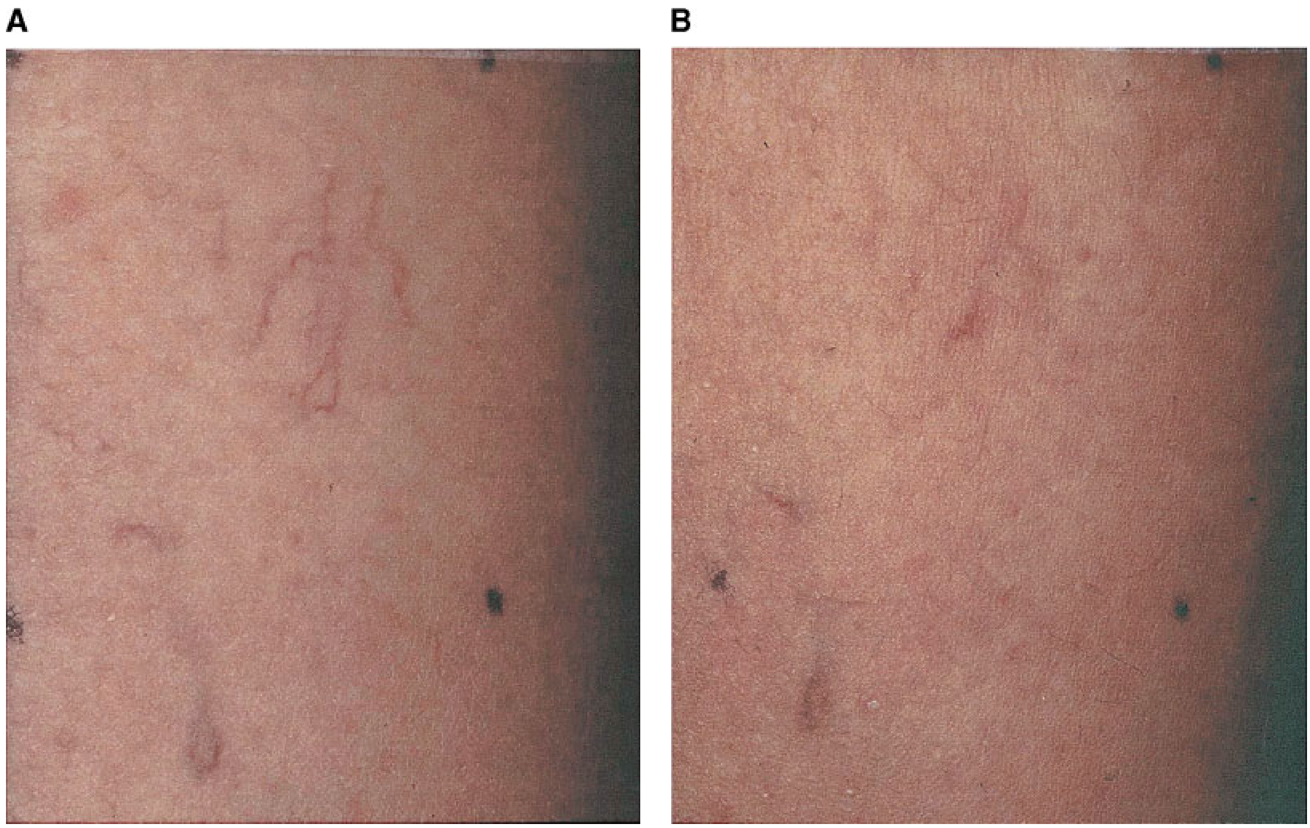

Fig. 6. Spider leg veins from patient no. 21 before treatment (**A**) and 30 weeks after the first laser session (**B**).

To relieve pain, a superficial anesthetic (Emla 5%-Cream) was applied 45 minutes prior to laser treatment. Grotewohl [25] reported about the influence of Emla 5%-Cream on vessels in the form of vasoconstriction. This was not noted in other studies. We observed palor of the skin after removing Emla 5%-Cream. However, the visible vascular pattern did not change before or after applying Emla 5%-Cream.

Information regarding the determination of the vascular diameters of spider leg veins is not given in literature. Direct measurement at the surface of the skin is difficult due to the small size of the vessels. By projecting slides of these vessels on a screen, we were able to achieve enlargement making exact determination of size possible.

CONCLUSIONS

The KTP (532 nm) laser is a non-invasive technique for treating spider leg veins at the lower extremity with vascular diameters of less than 0.7 mm and offers an alternative method to sclerotherapy. When applying fluence of the lower effective range (15–16 J/cm^2) changes in pigmentation occur in 23%.

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