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Long-pulsed Nd:YAG 1064 nm in the treatment of leg veins: Check up of results at 6 months in 100 patients

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Abstract

This study assessed at 6 months, subjectively and objectively, the efficacy of a long-pulsed Nd:YAG laser system in clearing leg veins.

A hundred female patients (25–60 y.o., skin types II–IV) with leg vein varicosities were treated with single pulse shots by a long-pulsed 1064 nm Nd:YAG laser, with 3, 5, 7 and 10 mm spot size diameters with related energies at 130, 120, 110 and 100 J/cm^2, and pulse lengths of 20, 30, 40 and 50 ms, respectively.

One or two treatments were given at 2-month intervals, with post-treatment assessments at 6 months. Patients subjectively assessed the treatment and their results were used to identify a satisfaction index (SI). Objective assessment was based on clinical photography and computer-generated data from a vein clearance detection program.

The overall patient satisfaction rate was 57% and objective assessments based on the clinical photography and computer assessment were 64% and 71%, respectively.

The Nd:YAG 1064 nm long-pulsed laser offered efficient treatment of leg veins irrespective of skin phototypes and results were better on blue and thick vessels. Side effects were minimal and transient.

Keywords: Leg veins; Long-pulsed Nd:YAG; Vascular lasers

Introduction

Leg veins can represent an aesthetic problem for many women, without the existence, necessarily, of a phenomenon of hemodynamic relevance [1]. Today we face a growing demand for the treatment of the small veins of the legs with lasers since they are considered as being an important technological advance which is capable of providing less invasive treatment [2].

Sclerotherapy, when suitably chosen for the treatment of small leg veins and practiced with a refined technique offers excellent results [3,4]. Laser is an alternative to such treatment, particularly when there is a resistance to sclerotherapy and in those cases in which the vein caliber is smaller and does not allow the insertion of the needle for the sclerosant injection or on superficial veins. Laser's coagulation effect inside the vessel rarely leads to extravasation, and, as a side effect, matting is less frequent. Laser is also greatly effective at treating superficial blue-colored veins and there is no need to inject foreign substances into the body.

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The thermal effect generated at the point of absorption in the treatment of leg veins by the laser is brought about by the absorption of near-infrared light between 800 and 1100 nm by oxyhemoglobin. The 1064 nm laser beam compared to other wavelengths has greater skin penetration and allows adaptations to cooling devices so as to adequately control the damage done to the epidermis. On the other hand, absorption by melanin located in the epidermis is relatively low and does not interfere with the penetration of a substantial amount of energy to coagulate the vessels located in the dermis.

The long-pulsed 1064 nm Nd:YAG laser has offered better results in leg veins up to 4 mm in diameter, in conjunction with epidermal cooling [5,6]. Further developments of long-pulsed Nd:YAG technology have allowed the delivery of a macropulse that could vary depending on the size and depth of leg veins [7].

The current study assesses subjectively and objectively, at 6 months after the final treatment, the efficacy of the 1064 nm long-pulsed Nd:YAG developed by the Company *Cutera Altus*, namely the *Vantage*.

Materials and methods

This retrospective study was based on the screening of 250 medical files at the Instituto Médico Vilafortuny, Cambrils (Spain) of women treated with the Nd:YAG laser for leg veins for a cosmetic reason. A hundred files, corresponding to female patients were randomly selected for this study. The check up of all related files containing information was approved by the Ethics Committee of the ANTONI DE GIMBERNAT FOUNDATION. The clinical characteristics of patients, vessel diameters and colors are listed in Tables 1A and B. Phototypes of all women treated were of Fitzpatrick's skin types II–IV, whose ages ranged from 25 to 60 (mean age 44). No patient treated was pregnant and none had a history of scarring or had previously undergone laser and/or sclerotherapy treatment. All patients had signed a document of informed consent for both their treatment and for the clinical photography. In addition, all of them had been informed as to the nature of the study and instructed concerning the characteristics of the questionnaires they had completed at the time of the treatment. Prior to the treatment, all patients had been examined by ecography to confirm that the saphenous vein and its collaterals were competent, without reticular or perforating vessels. All patients had undergone a maximum of two treatments at 2-month intervals and results evaluated at 6 months after the last treatment. The second treatment 2 months after the first, was only carried out if the patient had not been satisfied with the results obtained with the first treatment and if the physician considered that the results could be improved upon if the treatment session was repeated. To this end, all patients were instructed prior to treatment as to the characteristics of the questionnaire and how improvement should be estimated, discussing the details with them of treatment, expectations and limitations [8]. They had been made to understand that improvement would require time (based upon relevant literature [9] and our own experience). Consequently, patients were instructed only to return for the second treatment if they considered that the results had not been satisfactory in accordance with the instructions received.

The laser used was a long-pulsed Nd:YAG at 1064 nm wavelength "*Altus Vantage*" (Cutera, Burlingame,

Table 1A. Clinical characteristics of treated vessel in relation to patients' age and skin phototype

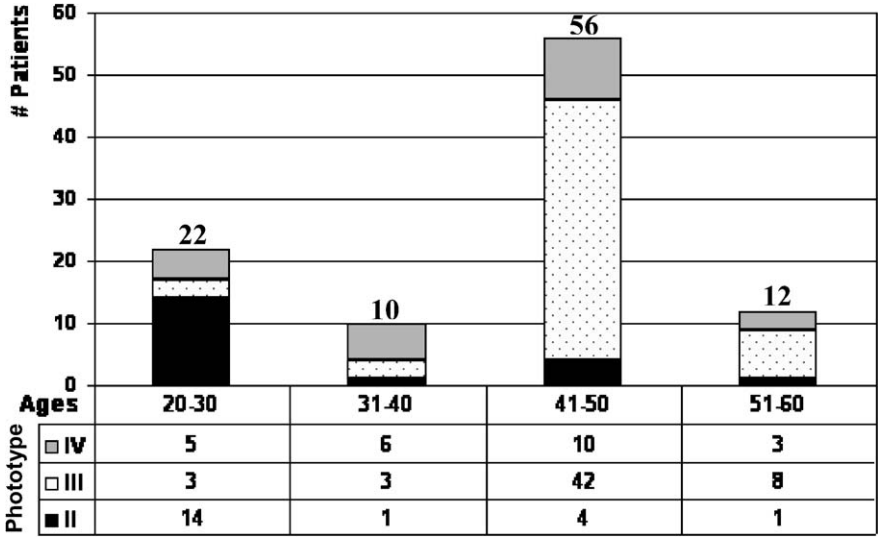
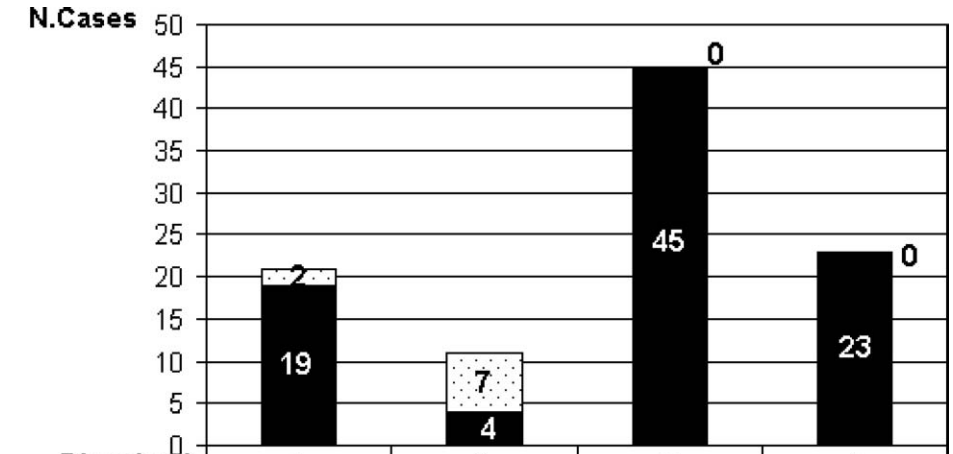
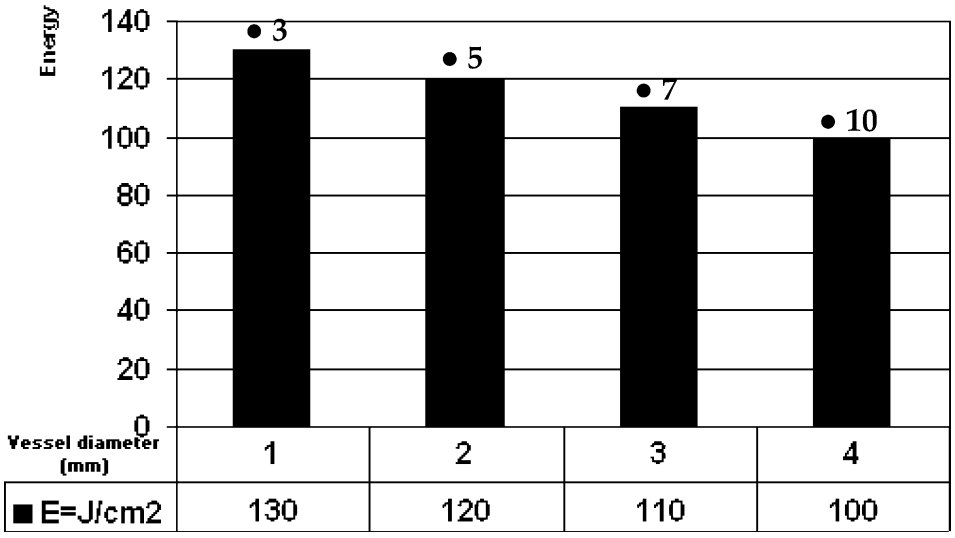


Table 1B. Number of treated vessels in relation to their color and diameter



Diam (mm)	1	2	3	4
Blue Vessels	2	7	0	0
Red Vessels	19	4	45	23
Total (100)	**21**	**11**	**45**	**23**

Table 2. Laser beam diameter in relation to vessel diameter and energy used in the treatment of leg veins



Vessel diameter (mm)	1	2	3	4
E=J/cm2	130	120	110	100

● Indicates beam diameter.
All treatments were done with single pulse.
The length of pulse, according to beam diameter, was ● 3 mm = 20 ms; ● 5 mm = 30 ms; ● 7 mm = 40 ms; ● 10 mm = 50 ms.

California) which incorporates a contact cooling system. The cooling surface is activated by a cold-water circuit.

After selecting the treatment vein, the front surface of the hand piece was applied with slight pressure in order to get good contact with the skin, and produce cooling. After approximately 5 s of cooling, the laser was shot. Then, the hand piece was moved, without overlapping the area of the previous shot and the same maneuver was carried out until the whole length of the vein was covered. Immediately after each laser shot, the treated area was covered with the surface of the hand piece, for approximately 5 s in order to cool the skin. Then, finger pressure was applied to ascertain whether coagulation existed. If the treated vein kept its characteristics and silhouette, it was considered demonstrative that the blood inside the vessel had coagulated. If, on the other hand, the vein disappeared when finger pressure was applied, filling up again when pressure ceased, treatment

was considered not to have been sufficient. Then, having finished treatment on the whole vein, cooling was done as previously described, but this time cooling contact was for a 10 s period, and the same treatment sequence as previously outlined was repeated with the same laser settings.

The parameters used to treat the veins varied depending on their diameter. If the two treatments were done, the second was carried out at 2 months. The settings were the same for all patients who presented the same vein diameter and for both treatments. No differentiation was made due to vein color or its apparent depth. To select the treatment program, only the vein diameter was taken into account: pulse length of 20 ms and 130 J/cm^2 was used for the 1 mm veins; 30 ms and 120 J/cm^2 for the 2 mm veins; 40 ms and 110 J/cm^2 for the 3 mm veins; and 50 ms and 100 J/cm^2 for the 4 mm veins (Table 2).

No topical anesthesia was administered to any patient and neither were compression bandages applied after treatment. Patients were recommended the use of a topical ointment of Prednicarbato (*Peitel*™, Lab. Novag S.A, Barcelona, Spain), 3 times per day for 5 days, and to avoid exposure to sunlight over the next 2 weeks after treatment.

Assessment of results

Six months after treatment, evaluation was done subjectively and objectively. For the subjective assessment, questionnaires were given to all patients so that they could score on a visual scale their degree of satisfaction in the light of the results. On this visual scale, they were asked to score as: Worse (worse than before treatment); Poor (clearance up to <25%); Fair (clearance <50–25%); Good (clearance <75–50%) and Very Good (clearance 100–75%). Assessment was done by all patients, whether they had received one or two treatments. In order to ascertain patient satisfaction, the results were correlated 'Very Good' with 'Very Satisfied', 'Good' with 'Satisfied', 'Fair' with 'Somewhat Satisfied'; 'Poor' with 'Not Satisfied' and 'Worse' with 'Worse'. The scores for 'Very Satisfied' and 'Satisfied' were taken together to give the overall satisfaction index (SI).

For objective assessment, photographs were taken before treatment and 6 months after the last treatment. Photographs were taken of the treated area using a digital camera set up for macrophotography (Sony MAVICA MVC-FD91, Tokyo, Japan).

Prior to taking the photographs, self-adhesive labels were placed in the area of treatment, as near as possible to the treated vessels, in an all but identical position each time, using the previous photograph as a guide, in order for the use of the computer program as described below. Digital photography for each patient was stored on an individual diskette and kept in her personal file. All photography was performed by the same person under as identical conditions as possible.

A physician who was not directly involved in the study, specializing in laser vascular treatments, assessed the change undergone according to the aspect of the treated veins by examining the photographs. Assessment was carried out following the same qualifications as for the subjective evaluation, linking the satisfaction scores to the percentage of vein clearance as in the questionnaires presented to the patients, e.g., treatment efficacy was scored on a five-point scale based on the clearance rate expressed as a percentage, with zero percent as the original condition: 'Very good', clearing of the veins from 100% to 75%, 'Good' clearing from 50% to 74%; 'Fair', clearing from 25% to 49%; 'Poor', clearing from 0% to 24%; and 'Worse' if the condition of the vessel was worse at the final assessment than at the pretreatment stage. The overall clearance index (CI) was obtained from the sum of Very Good and Good scores.

The same photographs were subjected to computer analysis consisting of the mapping of the treated area which was quantified in pixels by the computer, so as to compare the changes to the aspect of the vein after treatment against the scores of the questionnaires in the subjective assessment, and those of the objective assessment by the physician.

The computer program for the evaluation of results

The recorded digital images corresponded to a whole treated area from which image samples could be extracted. Samples were automatically normalized by removing noise, standardizing brightness and scaling using the fiducial labels, and adjusting contrast and luminosity parameters. All these procedures were performed by the computer program. This software was developed together

Table 3. Results at 6 months

Scores	Patients	Physician	Computer
Very good	18	23	28
Good	39	41	43
Fair	26	26	29
Poor	16	10	0
Worse	1	0	0
Overall results (%)	(SI) 57	(CI) 64	(CI) 71

Correlation of subjective patient evaluation with physician and computer program analysis. The overall satisfaction index (SI) as expressed by the patients is compared to the overall clearance index (CI) as estimated by the physician and the computer analysis programmes. The "Very Good", and "Good" scores were taken together to calculate the overall results in percentages: SI and CI.

with the Department of Computer Architecture, the University of Málaga (Spain)[10].

A Canny operator was next used as an optimal edge detector, working in a multistage process and which resulted in an image made up of one-pixel-thick connected segments that closely followed the faint margins of the feathering of the veins. In this way, the pre- and post-treatment areas of the affected zone in each image were computed as a percentage. This could thus be used as a sensitive and objective comparative measurement not only for diagnostic reports on the pretreatment condition of veins, but also for demonstrating objectively, in percentages, the improvement and efficacy of the prescribed treatment. The digital data of each set of before and after images were analyzed as described above, and a percentage clearance grade was assigned by the computer to each patient. This followed the same scoring system as the clinician's assessment scale. The CI was calculated from the top two scores. The results obtained were plotted onto a graph to show the relationship between the treated vein diameter and color and the percentual mean change detected in the image of the vein (''silhouette'') correlated to the computer program analysis.

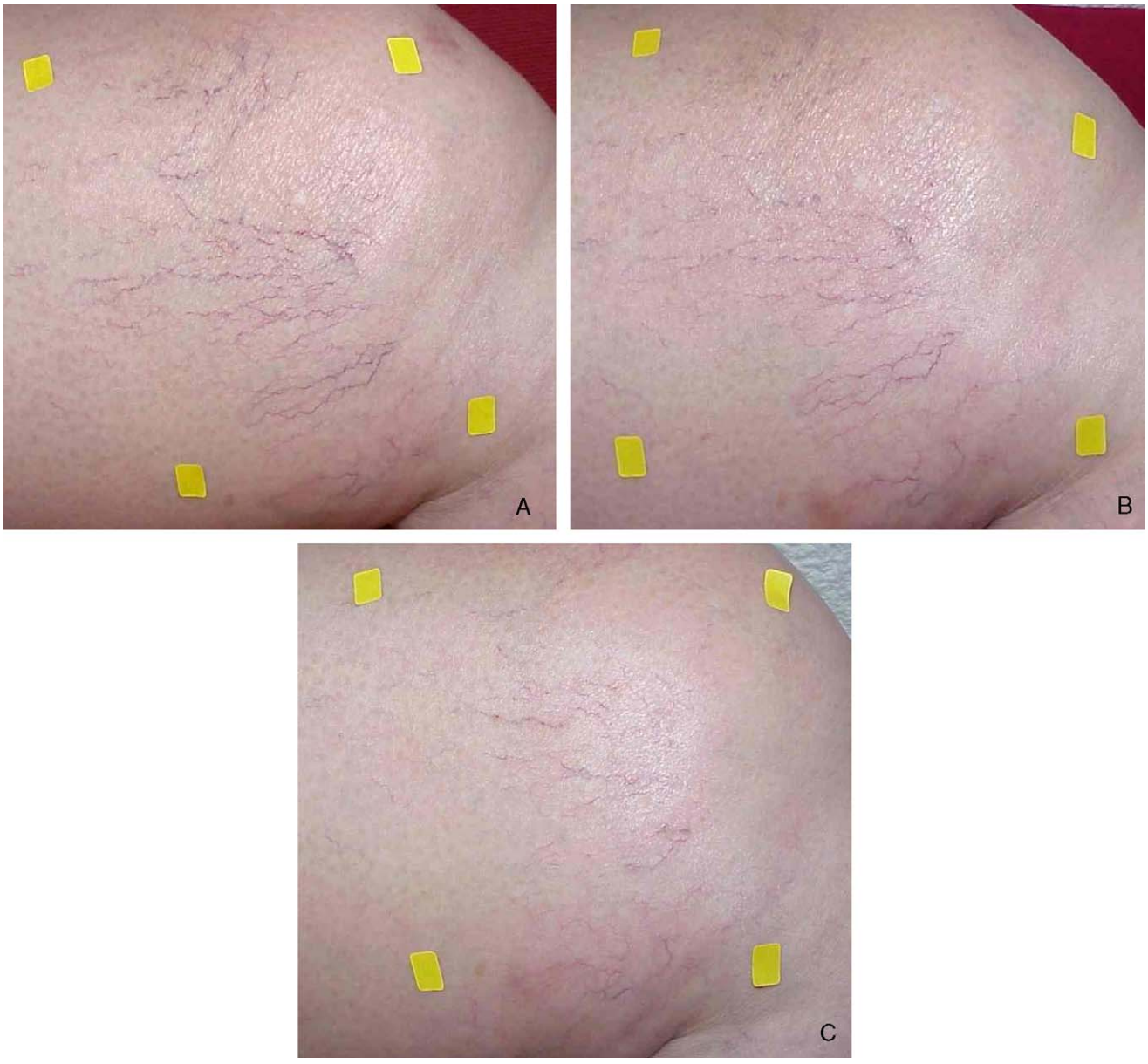


Fig. 1. Before (A), at 2 months (B), and 6 months after the second treatment (C). The results at 2 months after one treatment as scored by patient were ''Fair''. At 6 months after the second treatment (C), the treated area shows better, with less vessels. The results scored by the patient were ''Good'' though the impression is that small vessels do not react as well as the large ones.

Histology

From the selected files treated, 10 patients were chosen at random from the 100 cases studied and on whom histologies had been performed. These histologies it was assumed, represented a cross sample of the cases treated. Samples were taken with a sufficiently broad diameter punch, before and immediately after treatment. The sample taken after treatment was done about a centimeter away from the biopsy taken prior to treatment, once the vein had been treated along its whole length.

All specimens were routinely processed and stained with the Masson Trichromic technique.

Results

Two months after treatment, 55 patients returned for consultation. The remaining 45 were telephoned and they stated that they were satisfied with the results and that they preferred to wait until the 6-month check up. Of these 55 patients, 38 qualified their results as being "Fair", 16 "Poor", and 1 "Worse". This patient had suffered small burns, that had already been detected, which she said had formed blisters a few hours after treatment and she had treated with the aforementioned Prednicarbato ointment. At 2 months after the first treatment, the now repaired lesion presented pigmentary changes, and so it was decided to wait and not perform any further laser treatment on her. This patient was especially recommended to avoid sunlight. All those 55 patients were photographed and 54 patients underwent the second treatment. At 6 months after the last treatment, in all cases, all patients were controlled and the questionnaires were gathered which qualified their subjective impression, which, in turn, would be useful to determine the SI obtained (Table 3): 18 patients deemed their results as being Very Good, 39 Good, 26 Fair, 16 Poor and 1 Worse. This was the patient who suffered burning and had developed hypopigmentation in the area of blisters. The total SI scored was 57%, at 6 months after all treatments (Fig. 1A–C).

All patients reported discomfort during treatment, but there was no relationship between skin phototype and the discomfort experienced. The side effect of matting was detected in eight patients, but bore no relationship to the skin type. Hyperpigmentation was not observed. The one patient that had developed blisters presented secondary hypopigmentation. Skin color change was still present at the 6-month control.

The objective assessment carried out by the physician and the computer program analysis to assess the changes to the details of the vein, correlated with subjective evaluation done by the patients themselves are shown in Table 3.

At 6 months, the number of patients in the "Very Good", "Good", "Fair", "Poor" and, "Worse" groups as assessed by the physician from the clinical photography were 23, 41, 26, 10 and 0, respectively. At the control on those 54 patients at 6 months after the second treatment, it could be seen that they scored their results as "Very Good" and "Good" in greater number than when they were examined after just the first treatment.

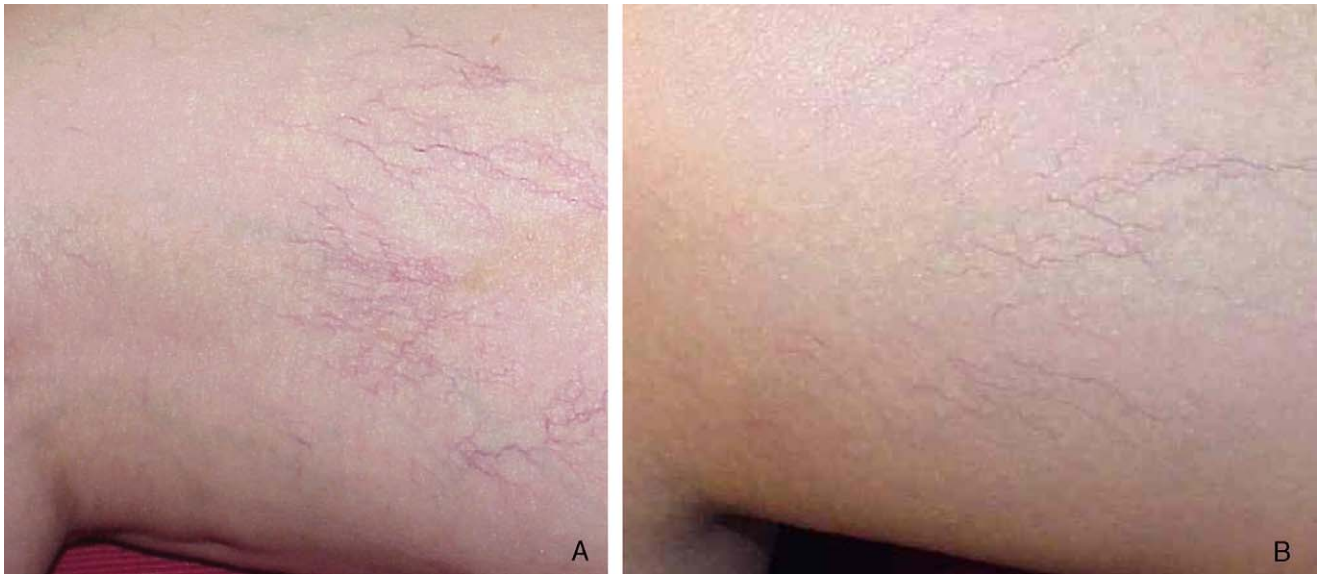


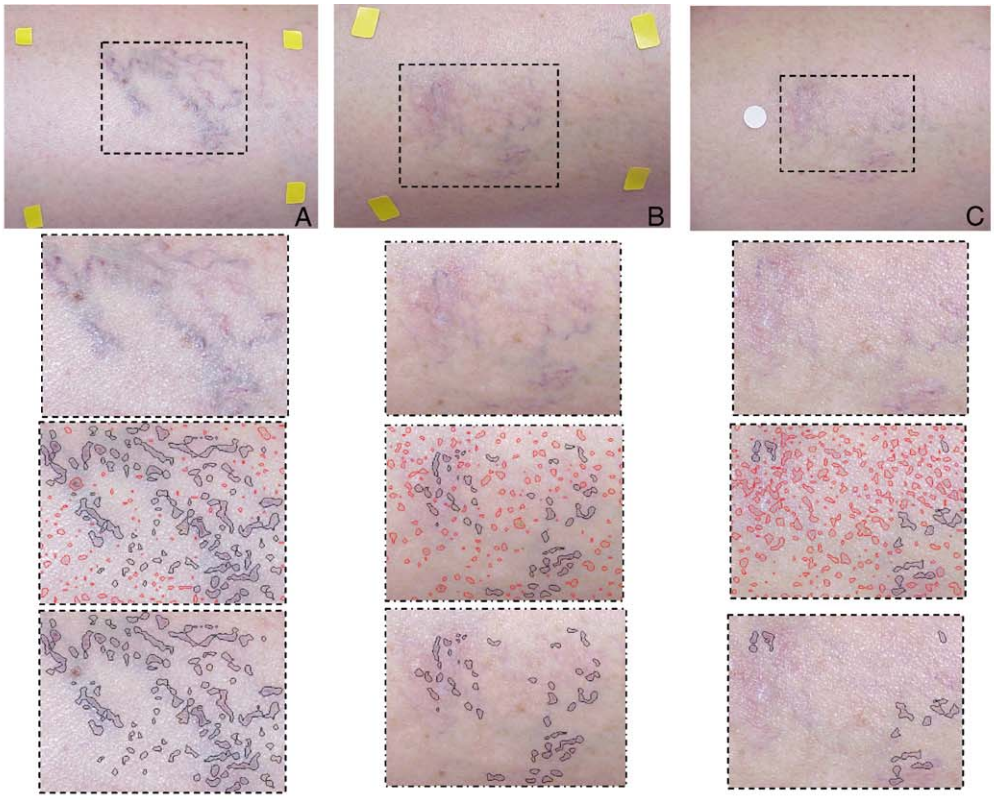
Fig. 2. (A) Before treatment: blue veins of 3 mm diameter are observed. (B) Six months after, veins appearance is less after only one treatment.

In total, the subjective SI value for all 100 patients, taking the "Very Good" and "Good" results, was 57 (57%) although 45 patients had received only one treatment, as they were already satisfied (Fig. 2A,B). The clinician and the computer analysis placed the objective assessments higher, at 64% and 71%, respectively (Table 3). This had been noticed in previous studies due to patients' expectations of results being higher than the realistic possibilities offered by treatment [8].

The computer-generated data showed that vessels changed in size, definition (silhouette), and number from before treatment to the 6-month assessment. Clearance of up to 76–100% was demonstrated by the image analysis program in some vessels (Fig. 3).

No significant correlation could be observed between skin phototype and treatment results at the 6-month assessment. Erythema was reported by all patients as present for 4–7 days after treatment, but edema was present for about 5 days after treatment, following the image of the vein, resembling its form but elevated on the skin surface. It was noticed immediately after treatment that the large and blue vessels tended to respond better to treatment (Fig. 4A–C and 5A,B). The shape of the coagulated vessel tended to remain present for longer, compared with smaller vessels. No palpable thromboses could be noted, and these areas of coagulation eventually disappeared. There was a positive correlation between size, color and response to treatment, the thicker and blue vessels being the ones to respond better (Table 4).

In general terms, in the histologies taken prior to treatment, the epidermis was observed to be slightly hyperkeratosic and of normal characteristics. In the



	B Before	1st treatment	2nd treatment
Total area	124230	124230	124230
Signal area	18948	6450	3644
SIGNAL	0,15252	0,05191	0,02933
Improvement %		65,9	80

Fig. 3. Computer analysis of before, 2 months, and 6 months after the second treatment. *Notice*: Patient scored "Fair" when she returned 2 months after the first treatment and in the control 6 months after the second treatment improvement is much better. Patient's score at this time was "Very Good". The physician also scored this case as "Very Good" as did the computer analysis. The process of calculation done by the computer program following details expressed in the text, gives a result of 80% clearance.

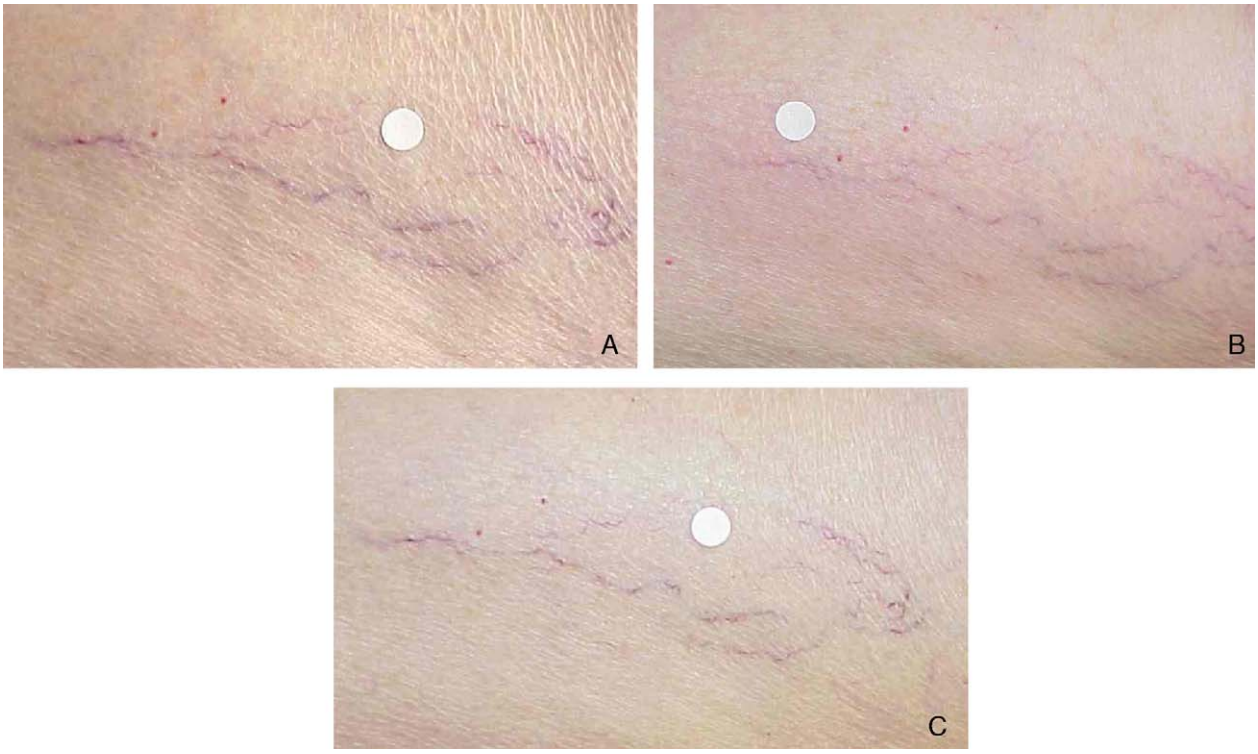


Fig. 4. Before treatment (A): red veins of 2 mm diameter are observed. (B) Immediately after treatment, little reactive vessel coagulation is observed. Erythema is noticed. This patient was retreated 2 months after. (C) ''Poor'' results at 6 months after the second treatment. Fiducial levels are placed to permit the computer program image analysis.

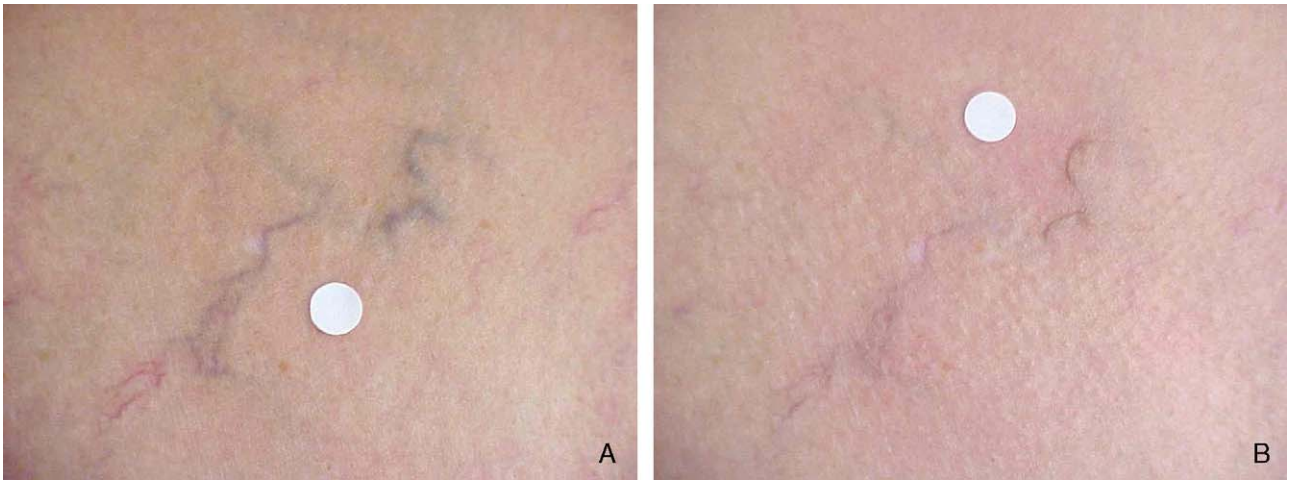


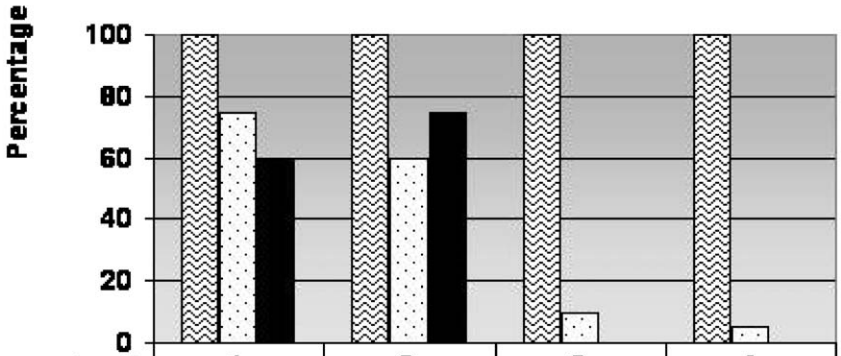
Fig. 5. Before (A) and immediately after treatment (B). Notice that the blue vessel reacts very positively to treatment. This patient only required one treatment and scored her final result at 6 months as ''Very Good''.

dermis, dilated veins were observed with a thickening of the wall and open *lumen*. Immediately after treatment, the vessels were collapsed and with coagulation phenomena inside the *lumen* and the intima appeared damaged (Fig. 6A–C). The coagulation phenomenon was also detected on the tissue surrounding the vein with changes in the aspect of the fibers, due to thermal diffusion during the laser pulse.

Discussion

The 6-month control, both subjectively and objectively shows the efficacy of the long-pulsed 1064 Nd:YAG laser for the treatment of leg veins up to 4 mm in diameter. The objective and the subjective scores were different but this can be explained by the shortfall between patient expectations and the final

Table 4. Correlation between vein size, color and response to long-pulsed Nd:YAG 1064 laser at 6 months



Vein diameter (mm)	1	2	3	4
Reference baseline	100	100	100	100
Blue vessels After	75	60	10	5
Red vessels After	60	75	0	0

The vertical axis represents the average percentage changes undergone in the vein image (silhouette). 100% is the baseline before treatment in accordance to vessel diameter (horizontal axis) i.e. total vessel appearance (silhouette). The columns show that best clearance was obtained by blue and thick vessels diameter.

result. This tells us about the need to have a solid patient education program, including clear and extensive explanations of the treatment process and goals.

Weiss [5] and Sadick [6] with the same technology have respectively reported similar results to ours, with significant achievements when treating leg veins, obtaining success in vessel number and sizes.

When using the Nd:YAG for clearing leg veins in single long-pulse mode, higher fluences have been previously reported to be necessary to achieve good results. Suthamjariya [11] has used up to 350 J/cm^2, and Coles [12] uses similar fluences. The pain associated with the single pulse mode and high fluences of their studies, however, makes treatment unpleasant, and according to our experience, sometimes even unbearable for the patient. It is possible that the fact that larger spot sizes were used with relatively lower fluences, led to much better and deeper distribution of energy, reducing negative laser thermal effects in the epidermis and thus permitting patients to handle pain better.

Reduced scattering is an important function in determining how deep light penetrates in the skin. Low scattering corresponds to deep penetration. The fact that scattering decreases at the 1064 nm wavelength permits "bulky energy" to penetrate deep, helped by a long-pulse duration. This means that the thermal effects can reach the target better. Moreover, a large spot size helps to cover a greater target area to coagulate and close large diameter vessels.

Only one patient suffered blisters which may have been due to the delivery of high fluence, possibly because of incorrect measurement of vessel diameter and the use of a small beam size. So, the unwanted wave of secondary heat may have diffused to the epidermis, and the epidermal cooling was insufficient to prevent this damage.

The long-pulsed Nd:YAG laser shows better results in the treatment of large vessels, even better than those results obtained with the 810 nm diode laser and the 755 nm alexandrite laser, as reported by Eremia [13]. Moreover, 810 and 755 nm lasers are less effective than the 1064 nm Nd:YAG when treating patients with a high skin phototype due to the lower absorption in melanin at 1064 nm [14]. Even when hyperpigmentation does develop following long-pulsed Nd:YAG treatment of leg veins, it clears up well with time [15].

Although treatment using a macropulse produced discomfort in all patients, pain was bearable and tolerated with prolonged cooling of the skin. The delivered energy was greater for the smaller diameter vessels and 100 J/cm^2 was used for 4 mm vessels with a 10 mm diameter beam but in a 50 ms single pulse. This radiant flux of these pulses did not harm the epidermis, via collateral thermal damage, since it was well controlled thanks to the cooling of 5–10 s, depending if one or two passes were needed in order to coagulate the vein. At the same time, avoidance of overlapping prevents the harmful effects of heat build-up. In addition, the interval before the second laser pass, if necessary, allows the "extra" incident energy to dissipate progressively but non-aggressively with the help of the post-laser pulse cooling. So, the collateral thermal damage in the dermis will not affect the epidermis [16]. Extra cooling help prevents primary photothermal damage due to the absorption characteristics of the 1064 nm wavelength, which targets protein of biological pigments such

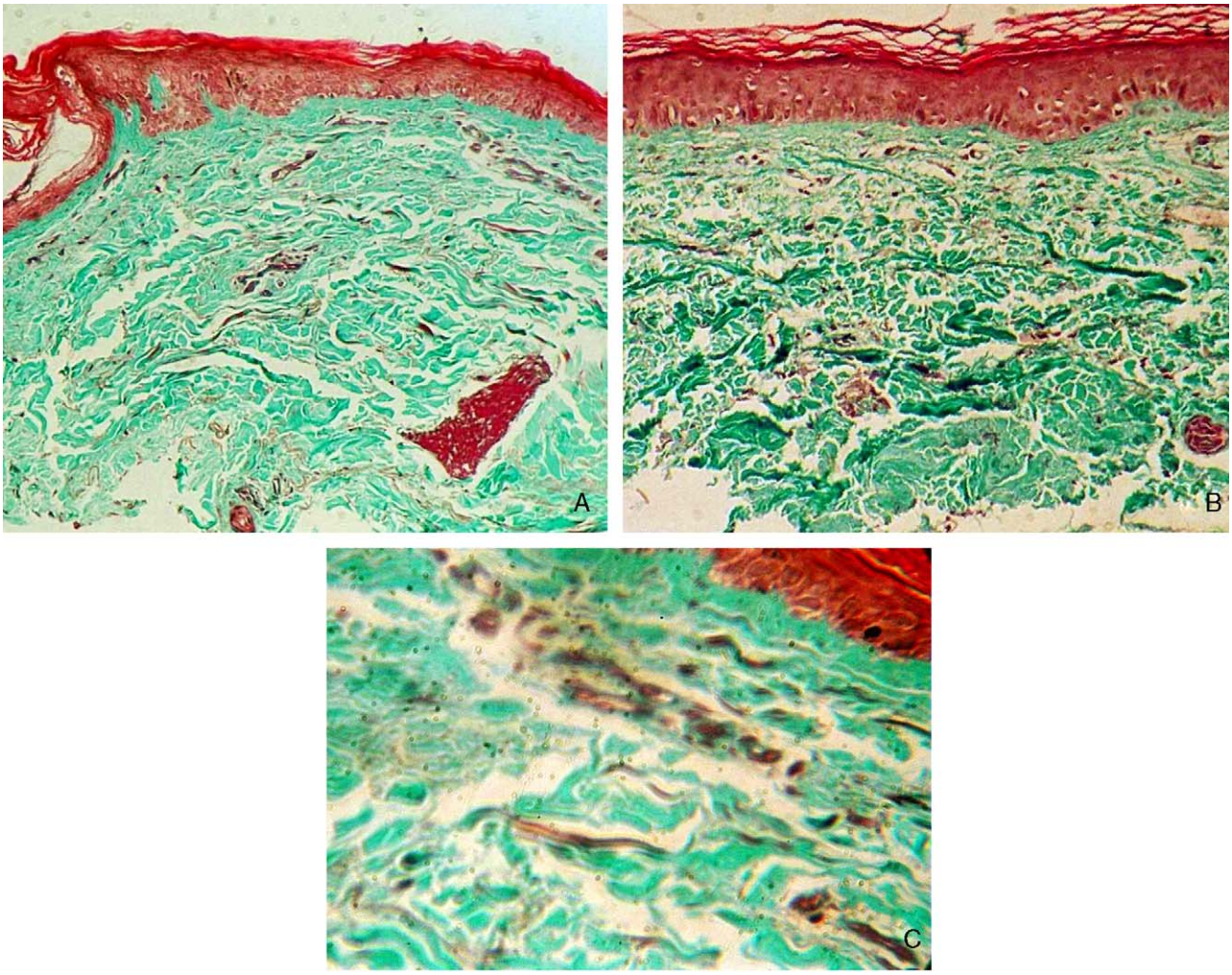


Fig. 6. Masson Trichromic Staining. (A) Skin × 125, before treatment. Notice dilated vessels in the dermis. The epidermis is normal. (B) Skin × 125, immediately after treatment shows vessels wall collapse and lesion of the intima, which can be seen in (C) (magnified × 400), and also perivascular fibers appear coagulated. In post-treatment images epidermis is preserved.

as epidermal melanin. Penetration of the 1064 nm wavelength will permit absorption by vessels located deep in the dermis. Also, thick vessels, and especially blue ones, will react better because of a higher density of their pigment content. Absorption will be more favorable at the level of vessels than at the melanin of the epidermis, even in those darker phototype patients treated here.

In order to improve on the results observed, the information in the report by Mordon on synchronized laser pulses [17] could be used as an ideal front of attack for leg vein treatment, combining the 1064 nm wavelength of the Nd:YAG laser in synchronized pulses of relatively short length carrying less energy. These settings should be delivered to tissue using a large beam size, in the order of 10 mm in diameter, for vessels of up to 6 mm, with delayed time between pulses enough to allow tissue to cool down but still maintaining the changes in hemoglobin, produced by the first pulse, that will facilitate effective coagulation with the following pulse. The cooling process for epidermis protection has to be prolonged before and immediately after treatment. A sequence of pulses in a synchronized manner, with a time interval between them, will allow build-up and accumulation of heat, sustaining the coagulation process. At the same time, the incidence of unwanted thermal damage by heat diffusion will be lowered.

The energy delivered by the laser used in these treatments in a large diameter beam (up to 10 mm), is effective as is demonstrated by the good response of coagulation in vessels. Perhaps these characteristics could prove even more beneficial if delivered in a sequence of pulses. Mordon [17] considers that the process of methemoglobin formation, initiated with the first laser pulse, changes the optical condition of blood absorption, making the thermal action of the following pulses more effective. With good epidermal cooling, a pulse sequence offers the possibility to achieve increased treatment efficacy.

Long-term assessment allows confirmation of the complete disappearance of treated vessels [18]. Surely, the computer-generated image extraction program presents the improvement much more clearly than the patients' subjective evaluation and the clinical photography. The program calculates the area of venous lesions before and 6 months after treatment with a pixel-based goniometric program which permits being well presented to patients to possibly help to bring the SI scores more in line with the physician's appreciation of results.

Hyperpigmentation at high fluences with the Nd:YAG can be a side effect as reported by Omura [19]. This drawback has not been seen even in phototype IV patients. This must be due to relatively lower energy, delivered in a large spot size, though a prolonged pulse length in comparison to that of Omura, but only for blue vessels. Small red vessels usually required more than one treatment. Kauvar [20] has noticed that high clearance rates can be obtained in vessels over 1.5 mm in diameter and that they respond often in only one treatment when using the 1064 nm Nd:YAG laser. Our observations coincide with this.

Conclusions

The long-pulsed 1064 nm Nd:YAG laser as applied in the presented cases offered a Very Good solution in the treatment of leg veins up to 4 mm in diameter. The objective assessments of the clinical results were Very Good, accompanied by a high SI from the group of 100 patients. Result obtained by a single treatment could enhance with a second one. Final results were achieved with very minimal complications.

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Zusammenfassung

Der Langpuls-Nd:YAG-Laser (1064 nm) zur Behandlung von Besenreiser-Varizen: Ergebnisse nach 6 Monaten bei 100 Patienten

In dieser Studie wird die Wirksamkeit eines Langpuls-Nd:YAG-Lasers zur Entfernung von Besenreiser-Varizen 6 Monate nach Behandlung mittels objektiver und subjektiver Methoden untersucht.

100 Patientinnen (25–60 Jahre, Hauttypen II-IV) mit Besenreiser-Varizen wurden mit einem Langpuls Nd:YAG-Laser mit 3, 5, 7 und 10 mm Fokusdurchmesser, Pulslängen von 20, 30, 40 und 50 ms und den entsprechenden Energiedichten von 130, 120, 110 und 100 J/cm^2 (mit jeweils Einzelpulsen pro Fläche) behandelt. Es wurden ein oder zwei Behandlungen innerhalb von zwei Monaten durchgeführt, die Nachbeobachtungszeit betrug 6 Monate. Die Patienten beurteilten die Ergebnisse selbst, aus diesen Beurteilungen wurde ein „satisfaction index" (SI) gebildet. Die objektiven Ergebnisse wurden anhand von Fotos und mit einem speziellen Bildverabeitungsprogramm, mit dem die entfernten Besenreiser detektiert wurden, ermittelt.

Die mittlere Zufriedenheitsrate lag bei 57%, die objektive Beurteilung anhand Fotos und des Computerprogamms ergab 64% bzw. 71% Behandlungserfolg.

Der Langpuls-Nd:YAG-Laser (1064 nm) ermöglicht eine effektive Behandlung von Besenreiser-Varizen unabhängig vom Hauttyp, die Ergebnisse waren besser bei dickeren und blau erscheinenden Gefäßen. Unerwünschte Nebenwirkungen waren minimal und vorübergehend.

Schlüsselwörter: Besenreiser, Langpuls-Nd:YAG-Laser, Gefäßlaser

References

[1] Weiss RA, Feied CF, Weiss MA. Vein diagnosis and treatment: a comprehensive approach. New York: McGraw-Hill; 2001.

[2] Dover JS, Sadick NS, Goldman MP. The role of lasers and light sources in the treatment of leg veins. Dermatol Surg 1999;24:328–36.

[3] Cabrera Garrido JR, Cabrera Garcia-Olmedo JR, Garcia-Olmedo Dominguez MA. Elargissement des limites de la schlérothérapie: noveaux produits. Sclérosants Phlébologie 1997;50:181–8.

[4] Mingo-Garcia J. Esclerosis venosa con espuma: foam medical system. Rev Esp Med Cir Cosmét 1999;7:29–31.

[5] Weiss RA, Weiss MA. Early clinical results with a multiple synchronized pulse 1064 nm laser for leg telangiectasias and reticular veins. Dermatol Surg 1999; 25:399–402.

[6] Sadick NS. Long-term results with a multiple synchronized-pulse 1064 nm Nd:YAG laser for the treatment of leg venulectasias and reticular veins. Dermatol Surg 2001;27:365–9.

[7] Trelles MA, Allones I, Martín-Vázquez MJ, Trelles O, Vélez M, Mordon S. Long pulsed Nd:YAG laser for treatment of leg veins in 40 patients with assessments at 6 and 12 Months. Lasers Surg Med 2004;35:68–76.

[8] Trelles MA, Pardo L, Ayliffe P, Trelles K, Vélez M, García-Solana L. Patients' answers to a postoperative

questionnaire related to laser resurfacing. Facial Plast Surg 2001;17:187–92.
[9] Sadick NS. Vasculight and other 1064 nm wavelength lasers for treatment of lower extremity veins. Scope Phleb Lymphol 2000;29:175–8.
[10] Trelles MA, Martín-Vázquez MJ, Trelles O. Objective follow-up by computational evaluation of tissue changes alter light treatment. Lasers Med Sci 2003; 18(Suppl. 1).
[11] Suthamjariya K, Farinelli WA, Anderson RR. Treatment of telangiectasias and reticular veins with a long-pulsed Nd:YAG laser. Lasers Surg Med 2002;14(Suppl.):41.
[12] Coles CM, Werner RS, Zelickson BD. Comparative pilot study evaluating the treatment of leg veins with a long pulse Nd:YAG laser and sclerotherapy. Lasers Surg Med 2002;30(2):154–9.
[13] Eremia S, Li C, Umar SH. A side-by-side comparative study of 1064 nm Nd:YAG, 810 nm diode, and 755 nm alexandrite lasers for treatment of 0.3–3 nm leg veins. Dermatol Surg 2002;28(3):224–30.
[14] Trelles MA, Allones I, Trelles O. An 810 nm diode laser in the treatment of small (<1.0 mm) leg veins: a preliminary assessment. Laser Med Sci 2004;19(1):21–6.
[15] Sadick NS, Weiss RA, Goldman MP. Advances in laser surgery for leg veins: bimodal wavelength approach to lower extremity vessels, new cooling techniques, and longer pulse durations. Dermatol Surg 2002;28:16–20.
[16] Bowes LE, Goldman MP. Treatment of leg telangiectasias with a 1064 nm long pulse Nd:YAG laser using dynamic versus contact cooling. Lasers Surg Med 2002; 14(Suppl.):40.
[17] Mordon S, Brisot D, Fournier N. Using a "Non Uniform Pulse Sequence" can improve selective coagulation with a Nd:YAG laser (1.06 μm) thanks to met-hemoglobin absorption: a clinical study on blue leg veins. Lasers Surg Med 2003;32:160–70.
[18] Rogachefsky AS, Silapunt S, Goldberg DJ. Nd:YAG laser (1064 nm) irradiation for lower extremity telangiectasias and small reticular veins. Efficacy as measured by vessel color and size. Dermatol Surg 2002;28(3):220–3.
[19] Omura NE, Dover JS, Arndt KA, Kauvar AN. Treatment of reticular leg veins with a 1064 nm long pulse Nd:YAG laser. Jam Acad Dermatol 2003;48(1):76–81.
[20] Kauvar AN. Optimizing treatment of small (0.1–1.0 mm) and large (1.0–2.0 mm) leg telangiectasia with long pulsed Nd:YAG laser. Lasers Surg Med 2001;13(Suppl.):24.