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ORIGINAL ARTICLE

Neodymium:YAG laser treatment of lower leg telangiectasia: a new minimally invasive approach

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Abstract The aim of this study was to validate the safety and effectiveness of a new therapeutic procedure for the treatment of lower leg telangiectasia without clinical vein insufficiency. A group of 20 healthy women aged between 24 and 47 years (mean±sem 37.05±1.47) with lower leg telangiectasia without clinical vein insufficiency, previously investigated by echo colour Doppler sonography, were recruited and were treated with neodymium:YAG laser (mean±sem 2.5±0.11 sessions). Good or excellent results were obtained in 16 patients and the improvements were statistically significant ($p<0.01$). Out of the 20 patients, 16 were satisfied with the procedure. We strongly support laser treatment of lower leg telangiectasia since it allows injection of chemicals to be avoided, and changes the stromal micro-architecture rearranging the fibroblast network into a more resistant pattern reducing the likelihood of relapse.

All the authors contributed equally to this work.

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Keywords Telangiectasia · neodymium:YAG laser · Vein insufficiency

Introduction

Lower leg vein insufficiency is almost always preceded by or is concomitant with capillary dilatation and telangiectasia spots that result in an unpleasant appearance of the skin and sometimes discomfort, itching and bruising sensations and posttraumatic ecchymoses [1]. In healthy veins, one-way valves direct the flow of blood upward and inward. The failure of venous valves, that can be due to trauma, hereditary weakness of the vessel wall or hormonal influences, creates a high-pressure leak between the deep and superficial systems that make up the venous system. The high pressure within the superficial system causes local dilation and the normal veins become tortuous as a result of continuous high pressure and become nonfunctional [2]. The gold standard method for treating this unpleasant microvascular disease was sclerotherapy for many years until laser and intense pulsed light were introduced into vascular practice as a noninvasive effective cosmetic therapy [3].

The use of microsclerotherapy and insulated needles for the treatment of telangiectasia has been extensively reviewed [4, 5]. Nowadays the pulsed dye laser is widely used for several vascular lesions of the skin, including telangiectasia. One of the first studies using this approach for the treatment of leg telangiectasia was reported in 1997 [6]. Treatment with a 595-nm long-pulse flashlamp-pumped tunable dye laser at a dose of 18 J/cm^2 and Vigilon (a transparent hydrogel dressing applied for epidermal cooling) resulted in a clearance rate of 45.2% by 6 weeks and 64.7% by 5 months in vessels up to 1.067 mm in diameter. A later study showed that the pulsed dye laser is safe and effective

for the treatment of leg telangiectasia especially for vessels of diameter up to 0.52 mm, and also indicated that a wavelength of 595 nm is more effective than a wavelength of 600 nm, and that higher fluences (18 and 20 J/cm^2) are more effective achieving clearance in 59.2% of the 257 test areas in vessels up to 1 mm in diameter [7].

In laser phototherapy, light radiation penetrates the skin barrier to destroy the capillary vessels through energy uptake by the circulating haemoglobin. Indeed, the red pigment of haemoglobin is a selective target of the diode and neodymium:YAG (Nd:YAG) laser wavelength, but cooling of the skin surface is mandatory in order to avoid burning and a pigmentation reaction of the treated area [1, 8]. The use of laser energy as a therapeutic option in vascular lesion treatment is a conservative and effective approach [9, 10]. Several studies have been conducted to compare sclerotherapy and laser treatment of leg veins. In one study, the use of a long-pulsed Nd:YAG laser with cooling contact was compared to sclerotherapy with sodium tetradecyl sulphate in 20 patients (vessels ranging from 0.25 to 3.0 mm in diameter) at two comparable sites. A second treatment was performed if necessary at 8 weeks. By 3 months after the second treatment, the mean clearance scores were 2.5 (out of a possible 4.0) for laser-treated sites and 2.3 for sclerotherapy-treated sites. Among the subjects, 35% preferred the laser therapy and 45% preferred sclerotherapy [11]. Another study also found no significant difference between sclerotherapy and Nd:YAG laser treatment [12]. Moreover, epidermal light treatment requires a single or a certain number of sessions (especially with intense pulsed light) with some risk of tattooing and epidermal damage [13, 14, 15].

Fibre optic laser generation has opened a new perspective in the direct treatment of telangiectasia by allowing targeting of the dermal vascular structures directly. Here we propose an experimental approach using the Nd:YAG laser with very thin fibres of 200 μm diameter introduced through a 21 gauge needle lumen. In this approach the fibre, according to the patient's vein size, is inserted into the vessel (endovenous) or across the outer surface of the vessel and moved back and forth along the major axis, irreversibly creating heat damage from inside (intraluminal) or outside (percutaneous or meso-laser therapy). This percutaneous approach is very effective. It requires a connecting device between the plastic optical fibre and the inserted needle. When the introduced optical fibre is moved back and forth it intercepts the longitudinal shaft of the dilated vessels and directly targets the haemoglobin in sludged erythrocytes inside the lumen, as illustrated in Fig. 1.

The percutaneous approach is beneficial in that there is direct contact between fibre and the vessel and there is no indirect heating of the dermis or vessel which can cause the formation of pigmented spots and irregular destruction of telangiectasia. In this study we used the Nd:YAG laser

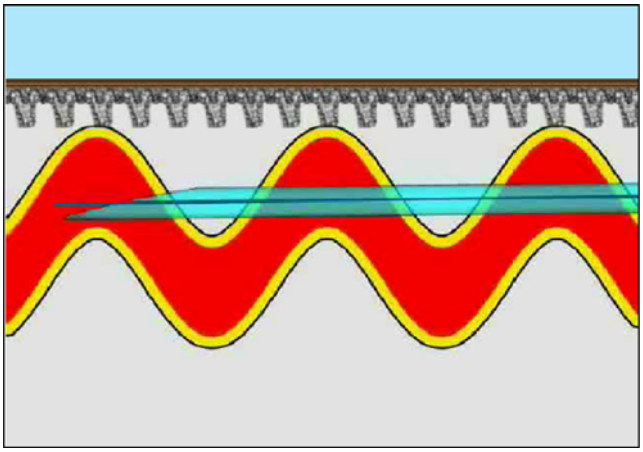

Fig. 1 Endoluminal laser treatment with a 200-μm optical fibre

because its use is growing among surgeons worldwide since it is cheaper than other lasers and it is quite effective due to the direct contact between optical fibre and the vascular structures. This original approach was developed by one of the authors and validated by the experience of the coauthors of this paper. The aim of this study was to validate the safety and effectiveness of this new therapeutic procedure in the treatment of lower leg telangiectasia without clinical vein insufficiency.

Materials and methods

Patients

Enrolled in the study were 20 healthy women (Fitzpatrick phototypes I–IV, five for each phototype; age range 24–47 years, mean±sem 37.05±1.47 years) affected by lower leg telangiectasia without clinical vein insufficiency previously investigated by echo-colour Doppler sonography. The patients had a mean total number of sites affected by telangiectasia of 35±8 (vessel diameters in the range 0.3–5.0 mm) and they were treated with a maximum of three Nd:YAG laser sessions (mean±sem 2.5±0.11). The patients were examined 4 weeks after each session to evaluate the outcome and to determine if they required another treatment. The last follow-up examination was at 6 months after the end of treatment when new photographs obtained, and the examination results were assessed and compared to those following the previous treatment. This study was performed in accordance with the Helsinki declaration and local internal review board (IRB) rules (a formal waiver was granted), and all patients signed an informed consent.

Procedure

The whole procedure required approximately 30 min per patient. A Nd:YAG laser with a wavelength of 1,064 nm

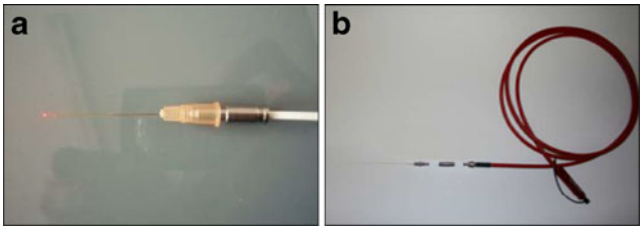

Fig. 2 **a** Needle used for passing through the skin. **b** High-power single-use 200-μm optical fibre tail

(EVLASER, Elettronica Valseriana, Casnigo, Italy) with a 200-μm optical fibre was used. With the patient lying in a supine position, an elastic loop was placed on the upper third of the thigh to enhance erythrocyte sludging into the capillaries, enlarging their lumen size to better target the endothelium with the laser light. The skin was cooled with ethylene chloride-soaked sponges and the cooling effect was prolonged by administration of a synthetic ice pack. In this way a skin temperature of about 21°C was achieved in all patients, and the temperature was monitored and kept constant during the whole procedure. If hyperalgesia reduced patient compliance, 0.1 ml of lidocaine was administered intradermally with a 34-gauge mesotherapy needle into the skin access area. When the skin temperature was significantly reduced, a 5-mm long 21-G needle (Fig. 2a) was introduced into the capillary lumen. The needle was connected via a stainless steel connector to a 200-μm optical fibre (Fig. 2b), which was advanced through the lumen 3–5 mm beyond the tip. The radiating fibre emitted a diode laser beam at a wavelength of 808 nm with a maximum power of 30 W. The final energy output across the fibre was 80 J/mm^2. The capillary lumen was irradiated for 3 s with pulsed infrared light and the optical fibre was moved back and forth to completely destroy erythrocytes and endothelial cells. From a single access, it was possible to treat an area of 7×7 cm.

We compared a technique involving direct irradiation via a needle penetrating the vessel with a technique involving passing the 200-μm optical fibre directly through the epidermal layers via a tiny hole in the skin to directly delivery the laser energy. In the latter case, the laser energy was delivered to the dermis to vaporize the capillary vessels from the outside until they were completely shrunk and destroyed. The treated vessels had disappeared at the end of the session. After completing the irradiation procedure, the needle or the fibre was withdrawn from the skin and bleeding from the spot was quickly stopped by light compression applied for a few seconds. An elastic bandage was wrapped around the treated legs and the patients were discharged immediately from the operative table, and were able to move freely without pain killers or alternative treatment.

Assessment of results

Patients were examined and photographed before and after treatment and the results were evaluated by two experienced dermatologists. Based on the examination and photographs, the dermatologists categorized the degree of resolution of lower leg telangiectasia into the following three groups: group 1, 0–50% improvement (no improvement, poor); group 2, 51–75% improvement (moderate improvement, good); group 3, 76–100% improvement (significant improvement, excellent). The patients rated their satisfaction and compliance as *1* not satisfied, *2* quite satisfied, *3* very satisfied.

Statistical analysis

Statistical analyses were performed using Minitab® (v15.1; UK). The data relating to the percentage improvement as assessed by the two dermatologists were checked for normality and then analysed using a paired *t*-test. A value of $p < 0.01$ was considered significant.

Results

Ten patients required only two treatment sessions since a good or excellent response was achieved, as assessed by visual and photographic examination. The remaining ten patients underwent a third session. A good or excellent response was achieved in six out of the ten patients. Overall, a good or excellent result was obtained in 16 patients (2 in

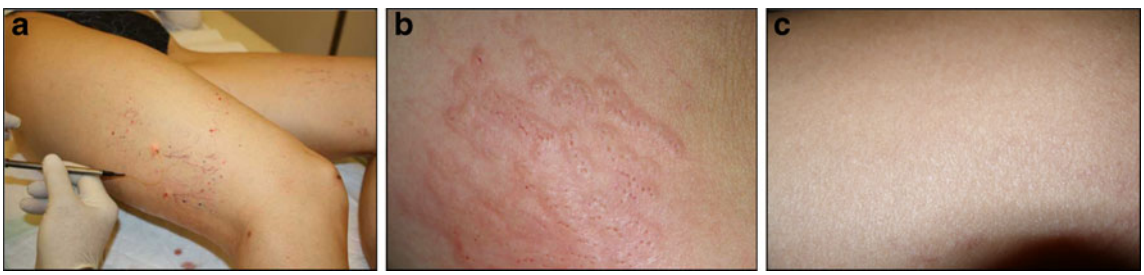

Fig. 3 Treatment of leg telangiectasia with the Nd:YAG laser: **a** before treatment, **b** immediately after treatment, **c** 6 months after treatment

group 2, and 13 in group 3), and the improvement was statistically significant ($p<0.01$). Of the 20 patients, 16 were very satisfied with the procedure, one was quite satisfied and 3 were not satisfied. Recanalization was observed in only two patients, as assessed directly using a magnifying glass, and new telangiectasia sprouts appeared in one patient. All the treated patients reported mild discomfort during the procedure, but they did not require any further specific analgesic treatment. There was no relationship between Fitzpatrick skin type and the degree of discomfort experienced. After administration of the cooling system at 5°C, slight pain was reported by the majority of patients, but it did not require any treatment except skin cooling with ethylene chloride plus the ice pack. The transdermal laser destruction of the capillaries prevented blood reflux-induced haemosiderin tags and the resultant persistent skin pigmentation that occurs especially after sclerotherapy. Some dyschromia (hypo-/hyperpigmentation) was observed in only two patients 4 weeks after the last treatment session, but it resolved within 4 months. Superficial textural changes were seen in five patients 4 weeks after the last treatment. At the last follow-up at 6 months, it was only detectable by very close examination and was not regarded as cosmetically relevant by the patients. Clinical photographs of telangiectasia in a typical patient before and after treatment are shown in Fig. 3.

Discussion and conclusion

This clinical study of fibre optic laser treatment of telangiectasia was an attempt to determine the feasibility and effectiveness of direct capillary destruction through delivery of a very narrow beam. In the past, larger spot sizes have been used to irradiate vascular skin lesions before the adoption of the optical fibre in vascular medicine and surgery, but the results were quite disappointing because a large surface was heated leading to some damage, pigmentations and burning in spite of the integration of the laser with a cooling system and freezing the spot window in contact with the skin. The irradiation of skin vascular lesions with a 200-μm optical fibre provides the great advantage of targeting the vascular network only, rather than inducing hyperthermia of the skin area on which the laser transducer is placed. It is possible to irradiate the telangiectasia through the epidermis, applying single light spots perpendicularly along the longitudinal axis of the vessel. This procedure results in the development of small crusts or tags in the following days which will drop off without any visible scarring. The technique involving the use of a needle to introduce the fibre directly into the dermis is a very practical and effective approach that requires only a single hole in the skin to destroy the vascular network, without producing any visible damage to the skin. In fact the skin is heated underneath and can be adequately cooled from above during the procedure, preserving the reticular stromal network and preventing pigmentation, erythema or burning.

The second approach involving direct laser fibre insertion confirms that it is possible to further simplify the procedure, avoiding the needle injury and creating a 200-μm tunnel, with direct advancement of the light emitting source. With this technique it is much easier to introduce the fibre along the vascular network definitely coagulating haemoglobin and destroying erythrocytes and endothelial cells.

In conclusion, our experience confirms that the skin damage is minimal or nonexistent and the direct insertion of the laser fibre through the skin without a needle guide allows better free up and down movements of the fibre along the treated subdermal surface and also in terms of cosmetic outcome. The previous strategy to irradiate over the cooled skin is undoubtedly less effective than intradermal fibre insertion, and can cause thermal damage to the epidermis and dyschromia. The heating beam in our procedure directly reached the target pigment in the vessels, and the heat spread widely through the dermis within the thermal relaxation time of the tissue, avoiding any major damage to elastic and collagen fibres.

We strongly support laser treatment of lower leg telangiectasia since it allows injection of chemicals to be avoided, and changes the stromal microarchitecture rearranging the fibroblast network into a more resistant pattern reducing the likelihood of relapse. Finally, intra- and perivascular laser treatment approaches make the laser procedure more effective than sclerotherapy that can cause tissue damage and pigmentation if extravascular spread occurs. In our experience this procedure is practical and has high patient compliance.

Conflicts of interest None.

Statement of authorship The authors hereby certify that all work contained in this article is original. The authors claim full responsibility for the contents of the article.

Informed consent Written informed consent was obtained from the patients for publication of the data included in this article. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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