Vielseitige Einsatzmöglichkeiten des Nd-YAG Lasers in der Behandlung vaskulärer Veränderungen im Gesicht

Versatility of the Nd-YAG laser in the treatment of facial vascular alterations

Alberto Goldman, MD[1], Flávia Rossato, MD[1], Uwe Wollina, MD[2]

Schlüsselwörter
Nd-YAG Laser, Gefäßveränderungen, Teleangiektasien, Retikulargefäße

Key Words
Nd-YAG laser, cutaneous vascular lesion, telangiectasia, reticular veins

Zusammenfassung
Die Behandlung von Gefäßveränderungen im Gesicht stellen eine große Herausforderung an den gegenwärtigen Einsatz und die Entwicklung der Lasertherapie. In den letzten Jahren sind verschiedene Lasersysteme in der Behandlung von oberflächlichen Gefäßveränderungen zum Einsatz gekommen. Bei den Gefäßveränderungen treten Teleangiektasien und kleine Äderchen besonders hervor, bedingt durch ihre Inzidenz, Häufigkeit und Beeinträchtigung des ästhetischen Erscheinungsbildes. Ein langgepulster 1064 nm Nd-YAG Laser (neodymium:yttrium-aluminium-garnet) hat sich als effizient in der Behandlung solcher Gefäßveränderungen erwiesen. Die vorliegende Studie untermauert die klinische Wirksamkeit und Sicherheit des Nd-YAG Lasersystems in der Behandlung von Gefäßveränderungen im Gesicht.

Summary
Treatment of vascular alterations on the face represented a real challenge before the current use and concept of laser therapy. In the past years, several types of laser have been used in the treatment of these very frequent cutaneous vascular lesions. Among such lesions, telangiectasias and small veins of the face have stood out due to their incidence, frequency and aesthetical repercussion. A long-pulsed Nd-YAG laser at 1064 nm (neodymium:yttrium-aluminium-garnet) has been proven efficient in the treatment of such conditions. This study shows the clinical effects and safety of applications with the Nd-YAG laser system when treating some vascular alterations on the face.

Introduction

Based on the principles of selective Photothermolysis, a variety of lasers and light systems have been incorporated into the treatment of vascular lesions such as the Argon laser, Cooper vapor and Cooper bromide laser, Krypton laser, Pulsed Dye laser (PDL), KTP, double-frequency Nd-YAG (532 nm) and 1064 nm as well as Intense Pulsed Light, among others [1–15]. Through the appropriate combination of wavelength, pulse duration and energy, the laser is absorbed by the specific target and reaches the chromophores, mainly the oxihemoglobin. The protection of the surrounding tissues such as the epidermis and dermis as well as the basic principles of the laser and its interaction with the tissues is an important aspect which must be observed. Among these principles, the thermal relaxation time, pulse duration, energy, spot size, wavelength and the specific absorption of energy by the target represent the most relevant points. In order to achieve a safe and effective response, other important characteristics of the laser-tissue interaction such as diffusion, reflection and absorption must be observed prior to the treatment of vascular alterations. Side effects and complications, mainly represented by scarring, purpura, pigmentary alterations or burning can be prevented through the correct selection of the laser system as well as the adequate treatment parameters.

1 *Clinica Goldman of Plastic Surgery, Porto Alegre, RS, Brazil*
2 *Department of Dermatology and Allergology, Hospital Dresden-Friedrichstadt, Academic Teaching Hospital of the Technical University of Dresden, Dresden, Germany*

Among the equipment options, the long pulsed 1064nm Nd-YAG laser has demonstrated to be an effective and safe method [17]. The main indications for the use of this laser are in the treatment of telangiectasias, leg vein vessels and reticular veins of the lower eyelids among other vascular alterations. The characteristics and physical properties of the long-pulsed 1064 nm Nd-YAG laser enable its efficient use in the treatment of small facial vessels in varying sizes, depth and color mainly due to its weaker melanin absorption and deep penetration. Furthermore, the Nd-YAG laser has a high absorption coefficient of methemoglobin and deoxyhemoglobin, which are the main components of some vascular conditions.

This study aims to show the versatility of the Nd-YAG laser in the treatment of frequent facial vascular lesions such as reticular veins, telangiectasias, venous lakes, angiokeratomas and hemangiomas, among others. These cutaneous vascular lesions can be congenital or acquired and represent a frequent cosmetic concern for both females and males of various skin types and ages [17].

Method

An accurate diagnosis is fundamental for the treatment. The main aspects to be assessed are the type and classification of the vascular lesion as well as its characteristics such as depth, color, size, content, and current appearance, while also taking into account the anatomical region where it is located. The patient's skin-type and clinical assessment are also crucial, as is knowledge of prior treat-

ments. An informed consent and standardized pre-treatment photos are part of the treatment. Exclusion criteria are: tanned patients, those with active herpes or infections located in the region to be treated, pregnant women and patients using photosensitive drugs or even those who are unable to appreciate the limitations, characteristics and risks of the treatment.

The most frequent parameters when using the long pulsed 1064 nm Nd-YAG laser are: fluence ranging from 80 to 145 J/cm^2 (reaching up to 200 J/cm^2 according to the lesion to be treated), usually with a 2.5 mm spot size. The pulse length ranged from 3 ms to 15 ms (Synchro® and Smartepil®, Deka, Florence, Italy). However, parameters are not fixed ones, and may vary according to each device, to each given case and each new session.

The procedure is generally well-tolerated and discomfort is minimal, rendering anesthesia unnecessary in most cases. A spray cooling system can be used in selected cases not only to reduce discomfort during the laser application but also to protect the skin. When need be, topical anesthesia using EMLA or a similar anesthetic may be used. It is important to avoid significant cooling of the skin due to vasoconstriction and the consequent fading or decrease of the target (hemoglobin). In order to avoid mechanical vasoconstriction, the handpiece should not be pressed against the skin. We aim at treating the patient in dorsal position, which enhances venous return in the face and allows for better exposure of the target to the laser. Adequate eye protection for the patient and team follows the standard safety norms for laser therapy. Immediately after the treatment, it is at times possible to notice the full clearance of the vessel or even of its thrombosis. Even if such findings are not instantly verifiable, the partial or full clearance is very likely to be observed within a few days, therefore, making the immediate lightening of the vascular lesion unnecessary. The main post treatment recommendations are the use of sun block and, in some cases, a few days of local cortisone cream. Due to the characteristics of the vessels and of individual responses, further sessions may be deemed necessary after 3 or 4 weeks.

Results and Case Reports

As long as the treatment is well-indicated and used within proper parameters, most patients' vascular alterations, mainly represented by telangiectasias and reticular vessels, improve significantly after one or more sessions using the Nd-YAG laser at 1064 nm. (Fig. 1–9). Complications, though very rare, may come in the form of an alteration of the pigmentation or scarring, pain, purpura, erythema or edema.

Discussion

Before the current advent of laser therapy, the treatment of vascular lesions mainly in the face posed a real challenge. Therapeutic options such as embolization, surgical excision, or the use of cauterizations of radiofrequency usually led to poor results and scarring [18–20].

Knowledge of the interaction between light energy and the tissues as well as the adequate diagnosis and anatomical identification of the vascular lesion and the target to be reached represent the most important aspects of the treatment. The effect of light energy on the

Fig. 1a: A 4-year-old child with telangiectasia.
Fig. 1b: Outcome after one session.

Fig. 2a: Angiokeratoma on the nose.
Fig. 2b: Outcome after one session.

Fig. 3a: A nose with several telangiectasias.
Fig. 3b: Appearance after treatment.

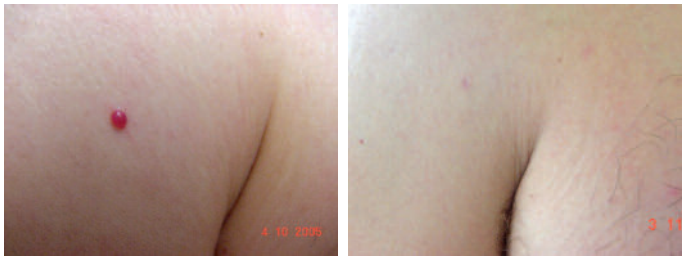

Fig. 4a: Nevus Ruby on the back.
Fig. 4b: Result after a single session of a long-pulse Nd-YAG laser at 1064 nm.

Fig. 5a: A 42 year-old patient with hemangioma in the malar region.
Fig. 5b: Appearance after 2 sessions of Nd-YAG laser.


Fig. 6a: Hemangioma on the face.
Fig. 6b: Result after the third session.

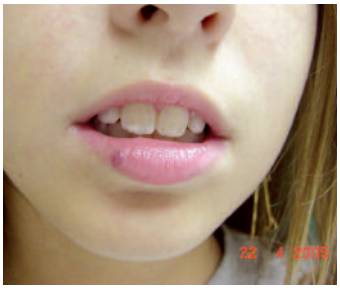


Fig. 7a: An 8 year-old patient with venous lake on the lip.
Fig. 7b: Appearance after one session of Nd-YAG laser.


Fig. 8a: A 57-year-old patient with several facial telangiectasias.
Fig. 8b: A month after a single session.

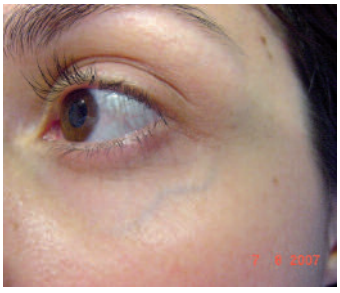


Fig. 9a: Reticular vein in lower eyelid.
Fig. 9b: Outcome after one session.

tissue will only occur if there is adequate absorption of the light. When treating vascular lesions, our prominent chromophore is hemoglobin or, more precisely, oxihemoglobin. The theory of selective photothermolysis, which advocates the use of ideal parameters for the selective destruction of the vessels without harming adjacent tissue, is the main concept to be understood in the treatment of vascular alterations in the face.

Given that oxihemoglobin is the main cromophore, it is vital to know its absorption curve. This chromophore has three optical absorption peaks (418, 542 and 577 nm). Although the absorption peak is at 585–600 nm, it is difficult to obtain a deeper light penetration by using such wavelengths, especially in cases involving deeper or larger-caliber vessels as those found in the reticular vessels located in the lower eyelid. Thus, the use of laser sources at higher wavelengths such as the 1064 nm herein proposed for the treatment of vascular lesions on the face, besides offering increased skin protection, aims at enhancing action on deeper vessels.

The density of laser energy applied on tissue is related to the peak temperature it will reach and is directly connected with the tissue damage and therapeutic effect. Photocoagulation of a vessel is deemed effective if there is a heating of its wall leading to a thermal denature, thrombosis and an eventual replacement for fibrous tissue. Should there fail to be efficient heating, there will only be a partial contraction of the vessel, which is insufficient for its complete clearance; hence the importance of adequate heating of the vascular endothelium and adjacent stroma through the use of adequate energy and other parameters.

The phenomena of diffusion and absorption of the tissue in these treatments, including not only the vessels but also the epidermis and dermis, should always be taken into account when attempting to achieve the intended effect while at the same time preserving the surrounding tissue. By selecting high wavelengths – as in the long-pulsed 1064 nm Nd-YAG laser – one can provide treatment of targets that are relatively deep in the skin, therefore reaching the target chromophore with proper epidermal safety. Furthermore, when it comes to the protection of adjacent tissue, the possibility of emitting high levels of energy in a short period of time is yet another edge pertaining to this kind of laser system. Pulse duration, along with the adequate choice of spot, wavelength, and fluence, is another relevant parameter, as are the thermal relaxation time and its relation with the damage or protection of adjacent structures. For the treatment of vessels, one should obtain selective absorption by the chromophore with enough generation and absorption of heat consequently coagulating the vascular walls. The ideal outcome of the treatment is the complete and irreversible stenosis of the blood vessel without its rupture or bleeding and without undesired effects such as burns or skin pigmentation alterations.

Despite the highly satisfactory results obtained using the 1064 nm Nd-YAG laser in the treatment of telangiectasias and other vascular lesions on the face, there are further types of laser such as the Dye Laser, Diode laser, KTP or even the Intense Pulsed Light and its several cut filters, which should always be taken into account when treating different kinds of vascular lesions such as hemangiomas.

Conclusion

The 1064 nm Nd-YAG laser has proven to be effective, noninvasive and easy to use in the treatment of telangiectasias, reticular veins of the face and other vascular alterations, including those on darker skins. Its physical characteristics enable the treatment of large regions in little time, with minimal discomfort and low risk of complications. Due to its wavelength, it reaches deep blood vessels with minimal absorption of energy by the epidermis, thereby representing yet another safe option in the treatment of vascular lesions.

References

1 West TC; ALSTER TS (1998) Comparison of the long-pulse dye (590-595 nm) and KTP (532 nm) lasers in the treatment of facial and leg telangiectasias. Dermatol Surg 24: 221-6.

2 Sadick NS (2007) Vasculight and other 1064 nm wavelength lasers for treatment of lower extremity veins. Scope Phleb Lymph 7: 170-5.

3 Sadick NS (2003) Laser treatment with a 1064-nm laser for lower extremity class I-III veins employing variable spots and pulse width parameters. Dermatol Surg 29: 916-9.

4 Sarradet DM, Hussain M, Goldberg DJ (2003) Millisecond 1064-nm neodymium: YAG laser treatment of facial telangectases. Dermatol Surg 29: 56-8.

5 Major A, Brazzini B, Campolmi P, et al (2001) Nd:YAG 1064 nm laser in the treatment of facial and leg telangectaias. J Eur Acad Dermatol Venereol 15: 559-65.

6 Bevin AA, Parlette EC, Domankevitz Y, Ross EV (2006) Variable- Pulse Nd-YAG Laser in the treatment of facial telangectasias. Dermatol Surg 32: 7-12.

7 Angermeier MC (1999) Treatment of facial vascular lesion with intense pulsed light. J Cutan Laser Ther 1: 95-100.

8 Weiss RA, Weiss MA (1999) Early clinical results with a multiple synchronized pulse: 1064 nm laser for leg telangectsias and reticular veins. Dermatol Surg 25: 399-402.

9 Sadick NS, Prieto VG, Shea CR, et al (2001) Clinical and pathophysiologic correlates of 1064-nm Nd:YAG laser treatment of reticular veins and venulectasias. Arch Dermatol 137: 613-617.

10 Sadick NS, Weiss RA (1999) The utilization of a new Nd-YAG pulsed laser (1.064 microns wavelength) for the treatment of varicose veins. Laser Surg Med suppl 1: 1-21.

11 Cisneros JL, Rio RD (2002) Láser Nd:YAG de 1064 nm de alta energía (Vasculight). Láser Fuentes de Luz Pulsada Intensa en dermatología y Dermocosmética, J. L. Cisneros Vela y F. Camacho Martínez, ed. Amolca 145-149.

12 Anderson RR, Parrish JA (1983) Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. Science 220:524.

13 Lopez JL (2002) Tratamiento de lesiones vasculares benignas mediante una fuente de luz pulsada intense no coherente. Láser Fuentes de Luz Pulsada Intensa en dermatología y Dermocosmética, J. L. Cisneros Vela y F. Camacho Martínez, ed. Amolca 137-143.

14 Anwar MU, Sharpe DT (2008) Efficacy of the Nd YAG Laser in the treatment of superficial cutaneous vascular lesions. Eur J Plast Surg 30: 219-222.

15 Anderson RR, Parish JA (1981) Microvasculature can be selectively damaged using dye laser: a basic theory and experimental evidence in the human skin. Laser Surg Med 1: 263-276.

16 Major A, Brazzini B, Campolmi B (2001) Nd:YAG 1064 nm laser in the treatment of facial and leg telangiectasias. JEADV 15: 559-565.

17 Lai SW, Goldman MP (2007) Treatment of facial reticular veins with dynamically cooled, variable spot-sized 1064 nm Nd:YAG laser. Journal of Cosmetic Dermatology, 1: 6-8.

18 Dzingel R (2004) Radiochirurgie in der Dermatologie. Kosmet Med 25: 66-71.

19 Sato Y, Frey EE, Wicklund B, Kisker T, Smith WL (1986) Embolization therapy in the management of infantile hemangioma with Kasabach merritt syndrome. Ped Radiol 17: 503-504.

18 Enjolras O, Mulliken JB (1996) Vascular cutaneous anomalies in children: malformations and hemangiomas. Ped Surg Int 11: 290-295.

Address of the corresponding author

Dr. Alberto Goldman
Av. Augusto Meyer 163 conj. 1203
Porto Alegre RS
Brazil 90550-110
alberto@goldman.com

Senior Member of the Brazilian Society of Plastic Surgery
Member of the International Society of Aesthetic Plastic Surgery
Member of the Brazilian Society of Laser in Medicine and Surgery